Intensive, comprehensive treatment using a variety of applied behavior analysis methods was provided to a toddler who was determined to be at high risk for autism at the age of about 1 year. Initially, treatment was delivered in a one-to-one adult-child format in the child's home and other settings, with gradual transitions to group instruction in early intervention and preschool classrooms. Intensive treatment continued for 3 years; by the 4th year, the child was spending most of her time in a regular preschool classroom, with minimal ongoing one-to-one instruction. Direct observational data and results of norm-referenced tests documented large increases in language, social, cognitive, and daily living skills over the course of treatment. After 4 years, the child demonstrated no behavioral or developmental abnormalities, performed above her chronological age level on norm-referenced tests of cognitive and language skills, and was functioning as a typical child in a regular public school kindergarten classroom.

Intensive Behavioral Treatment for a Toddler at High Risk for Autism

GINA GREEN
New England Center for Children and the University of Massachusetts

LYNN C. BRENNAN
Bedrosian Associates

DEBORAH FEIN
University of Connecticut

Early intensive intervention using the methods of applied behavior analysis (ABA) has been shown to produce substantial improvements in many young children with autism and pervasive developmental disorder not otherwise specified (PDD-NOS) (Anderson, Avery, DiPietro, Edwards, & Christian, 1987; Birnbrauer & Leach, 1993;

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Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991; Lovaas, 1987; Sheinkopf & Siegel, 1998; Weiss, 1999). Some children who had moderate-to-severe delays in cognitive, communication, social, and adaptive skills when treatment began were shown to have age-appropriate, normal-range skills in most or all domains after 2 to 3 years of early intensive ABA. Other children made more modest, but still clinically significant, improvements (e.g., Birnbrauer & Leach, 1993; Lovaas, 1987; Perry, Cohen, & DeCarlo, 1995; Weiss, 1999). Gains achieved by the "best outcome" children in the Lovaas (1987) study were maintained into early adolescence (McEachin, Smith, & Lovaas, 1993).

Treatment models varied somewhat across the published studies, but most of them had several features in common: (a) Treatment was comprehensive, addressing all skill domains, and individualized to each child's strengths and deficits; (b) many behavior analytic procedures were used to build functional repertoires and reduce interfering behavior (e.g., differential reinforcement, prompting, discrete-trial instruction, incidental teaching, activity-embedded trials, task analysis, and others) (see Anderson & Romanczyk, 1999; Green, 1996); (c) one or more individuals with advanced training in ABA and experience with young children with autism directed treatment; (d) normal developmental sequences guided selection of treatment goals and short-term objectives; (e) parents served as active cotherapists for their children; (f) treatment was delivered in one-to-one fashion initially, with gradual transitions to small-group and large-group formats when warranted; (g) treatment typically began in the home and was carried over into other environments (e.g., community settings), with gradual, systematic transitions to preschool, kindergarten, and elementary school classrooms when children developed the skills required to learn in those settings; (h) programming was intensive, including 20 to 30 hours of structured sessions per week plus informal instruction and practice throughout most of the children's other waking hours, year round; (i) in most cases, the duration of treatment was 2 or more years; and (j) most children started treatment in the preschool years, when they were 3 to 4 years of age.

The characteristics of autism can be measured reliably in children 18 months of age, and recent research has identified specific behaviors

that distinguish infants with autism from others at 12 months of age (for reviews, see Filipek et al., 1999; Stone, 1997). Mounting evidence that early experience plays a critical role in shaping language and social skills (e.g., Hart & Risley, 1995) and brain development (Fischer & Rose, 1994; Shore, 1997), together with evidence that effective early intervention can prevent mental retardation and other developmental problems (Guralnick, 1998; Ramey & Ramey, 1998), suggests that early intensive ABA might be efficacious for toddlers who are on the autism spectrum. To date, however, little has been published on that topic. One case study documented recovery from autism in two siblings who began receiving intensive ABA treatment when they were about 2 years old (Perry et al., 1995). In a recent article, McGee, Morrier, and Daly (1999) described the Walden Toddler Model, a program for toddlers with autism, 15 to 30 months of age. The Walden program reportedly provides children with 30 hours of intervention per week for 1 year, using mostly incidental teaching techniques in an integrated setting (although some other ABA techniques are also used). McGee et al. (1999) presented "preliminary" outcome data for 28 children who entered Walden at an average age of 2 years, 5 months, as follows: 36% of the children "emitted verbalizations at program entry, although much of the language of verbal children consisted of echolalic or perseverative speech" (p. 143). After a year of treatment, 82% were reported to be "verbalizing meaningful words." Twenty of the 28 children (71%) were said to show improvement in the amount of time they spent within 3 feet of other children. The authors also reported improvements on measures of children's verbal interactions with their parents, vocabulary size, social responsiveness to adults, levels of engagement in toy play, and independent self-care skills; however, no actual data from those measures were included in the article. It is difficult to compare the outcomes of the Walden program with the results of published studies of early intensive ABA because of the limited information about measurement methods and the limited data provided in the McGee et al. report. In addition, the outcomes appear to have been derived from a descriptive program evaluation rather than a controlled study, and the Walden model appears to differ considerably from the early intensive ABA treatment model described earlier.

Given the dearth of empirical evidence, evaluations of the efficacy of early intensive ABA for toddlers on the autism spectrum seem warranted. Of course, controlled studies afford the most rigorous tests of treatment effects, but some valuable information can be gleaned from nonexperimental or quasi-experimental evaluations. Even case studies can support valid inferences about treatment effects if they include such features as objective measurement; continuous assessment before, during, and after treatment; and immediate and large changes after treatment begins. Intensive studies of individual cases can be conducted in typical clinical situations where true experiments are not feasible for practical, methodological, or ethical reasons. Data aggregated across a number of such individual cases can constitute rather strong evidence about treatment effects. In sum, the systematic case study with objective assessments repeated over time can be a very useful tool for conducting initial clinical investigations of treatment efficacy (Kazdin, 1982, 1998).

We report such a case study here. The early intensive ABA treatment model described in several studies with preschoolers with autism was extended and modified for a toddler who was deemed at high risk for autism. Multiple objective assessments of the child's cognitive, communication, social, and adaptive skills were conducted before treatment began and at intervals of several months during 3 years of intensive treatment and near the end of a 4th year of less intensive treatment. Because of the paucity of published information on treatment for very young children on the autism spectrum, the overall program, procedures, representative data, and modifications in programming over the course of treatment are presented in detail.

METHOD

PARTICIPANT

Catherine was the daughter of two physicians. She had two older brothers. One, about 3 years older than Catherine, had been diagnosed with autism when he was approximately 3 years old. The other, about

4 years older than Catherine, was described as exhibiting some language delays but was otherwise typically developing.

Catherine was the product of a normal pregnancy and delivery. She was reported to reach most early developmental milestones (e.g., sitting, walking) at the typical ages, and her hearing had been determined to be within normal limits. Her parents reported that she babbled at 6 to 9 months of age but did not imitate speech sounds or words or utter any understandable words. When Catherine was 10.5 to 11 months old, her parents observed diminishing levels of eye contact, babbling, responsiveness to spoken language, and appropriate play. By the age of 12 months, Catherine made only two sounds, very infrequently and at low volume. She was reported to show unusual interest in long, narrow objects such as pencils and chopsticks, which she held in a vertical position in front of her face for long periods of time. She went to considerable effort to close any open door she saw, actively avoided eye contact with anyone who was within a few feet of her, did not respond to her name or simple instructions spoken by her parents and others, and displayed little or no facial expression or affect. She was described as showing selective attachment to her mother but little interest in other people. Joint attention behaviors (i.e., using eye gaze for social referencing, pointing, showing) were absent. Catherine occasionally imitated the actions of one of her brothers, but infrequently and unreliably. She did not reliably imitate actions on request.

Those observations and their experience with their second son led Catherine's parents to seek evaluations from three different professionals when Catherine was about 1 year old. A pediatric neurologist who specializes in autism determined that Catherine was "at high risk for PDD/autism." A speech-language pathologist's evaluation report stated that she was "at risk for autism spectrum" and exhibited "significant delay in linguistic-communicative development." A developmental neuropsychologist specializing in autism and related childhood disorders (the third author of this article) expressed "serious concerns [about] onset of autistic disorder." Results of standardized tests administered by the third author and the speech-language pathologist at the time of diagnosis are summarized in the first column of Table 1. They indicated that Catherine's daily living and motor skills

TABLE 1
Mental Age Equivalents (years, months) From Standardized Tests Administered to Catherine at Chronological Ages Shown Over the Course of Treatment

	Chronological Age (years, months)					
Skill Domain	*1 to 1, 2 (diagnosis)*	*1, 9*	*2, 1*	*2, 9*	*3, 0*	*4, 11*
Cognitive		1, 9 (Leiter)	2, 1 (Leiter)	3, 5 (Leiter)	3, 3 (McCarthy)	5, 6 to 7, 0 (WPPSI-R) VIQ = 109 PIQ = 127 FSIQ = 119
Language						
Receptive	3-6 months (RITLS)	1, 8 (PLS)		2, 5 (PPVT-R)		5, 4 (PLS)
Expressive	3-6 months (RITLS)	1, 7 (EOWPVT)		4, 0 (EOWPVT)		5, 6 (PLS)
Overall						5, 4 (PLS) 5, 10 (CELF)
Adaptive (VABS)						
Communication	1-3 months	1, 5	1, 10	2, 11		
Socialization	4-8 months	1, 2	1, 10	2, 5		
Daily living	1, 1	1, 4	1, 5	2, 5		
Motor	1 year	1, 6	2, 1	2, 5		

NOTE: Empty cells indicate that no standardized tests were administered. WPPSI-R = Wechsler Primary and Preschool Scale of Intelligence–Revised; VIQ = verbal IQ; PIQ = performance IQ; FSIQ = full-scale IQ; RITLS = Rosetti Infant-Toddler Language Scale; PLS = Preschool Language Scale; PPVT-R = Peabody Picture Vocabulary Test–Revised; EOWPVT = Expressive One-Word Picture Vocabulary Test; CELF = Clinical Evaluation of Language Functions; VABS = Vineland Adaptive Behavior Scales.

were age appropriate but that communication and social skills were substantially below age level.

TREATMENT

At the time Catherine was diagnosed, her parents had been implementing an intensive home-based ABA program for their son with autism for several months. Shortly after Catherine was diagnosed, the parents asked the local public early intervention program to fund a similar program for Catherine; the agency readily agreed. Intensive ABA programming began when Catherine was 1 year, 2 months of age, and continued until she was 4 years, 5 months old. Program design and procedures were derived from the research literature on intensive ABA for young children with autism (e.g., Anderson et al., 1987; Birnbrauer & Leach, 1993; Fenske et al., 1985; Lovaas, 1987; Perry et al., 1995; also see Maurice, 1993; Maurice, Green, & Luce, 1996), with modifications drawn from the literature on early child development, research on autism in very young children (see Stone, 1997), and our clinical experience.

Staffing. The second author had primary responsibility for the design and implementation of Catherine's program, in conjunction with Catherine's parents and home-based teacher (selecting treatment goals and objectives, developing instructional procedures, and training the personnel who implemented the program). She was an Ed.D. psychologist with training in behavior therapy and about 3 years' experience in directing intensive home-based behavioral programming for young children with autism at the time Catherine's treatment began. The psychologist supervised treatment directly for 2 to 4 hours every 2 weeks for the first 2 years of treatment, once a month throughout the 3rd year, and as needed thereafter. The first author, a Ph.D. behavior analyst, provided consultation on all aspects of the program and observed programming, reviewed data, and discussed potential program modifications with the treatment team for about 2 hours each month during the first 2 years of treatment, and as needed thereafter. Intervention was delivered principally by a teacher with a bachelor's degree and dual certification in elementary and special education, as

well as by Catherine's mother; both were trained by the second author to use behavioral methods. When Catherine's treatment began, both were concurrently implementing intensive home-based ABA programming with Catherine's older brother with autism under the supervision of a master's-level behavior analyst. In conjunction with that programming, during the 1st year of Catherine's treatment, the teacher and mother also participated in quarterly workshops provided by a Psy.D. behavior analyst with extensive experience in intensive ABA for children with autism. The supervising psychologist, Ph.D. behavior analyst, home-based teacher, and mother constituted Catherine's treatment team. A speech-language pathologist also consulted occasionally, and another adult who had worked in the home-based ABA program with Catherine's brother provided some direct services to Catherine during the 2nd year of treatment, for about 10 hours a week. The third author diagnosed Catherine, evaluated her progress about every 6 months during the first 2 years of treatment, and made recommendations regarding treatment objectives but did not participate directly in treatment.

Overview of treatment. Figure 1 represents an overview of the programming in which Catherine participated over the entire course of treatment. Formal, planned intervention was provided for 25 to 33 hours each week initially. Most of that intervention was delivered in a 1:1 adult:child ratio in one or two rooms in the home set aside for that purpose. Skills developed in those settings were practiced—and as Catherine progressed, some new skills were taught—in other settings, including other rooms in the home, the yard, and community settings like stores and playgrounds. Formal intervention sessions were arranged to accommodate Catherine's nap schedule and the family's routines. The total amount of formal intervention increased to 30 to 36 hours per week in the 2nd year, some delivered in the home and in community settings, some delivered in early intervention and preschool classrooms (described below). The principal home-based teacher worked one-to-one with Catherine for 20 to 25 hours per week during the first 2 years of treatment, as well as working with her in an early intervention classroom (Years 1 and 2) and regular preschool classrooms (Years 2-4). Catherine's mother typically provided

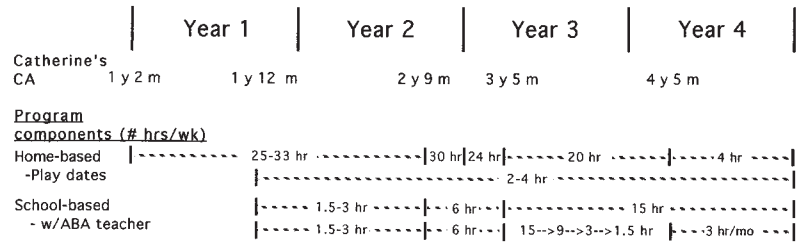

Figure 1. Overview of components of Catherine's treatment program.
NOTE: The figure shows the hours per week that each component was in effect and chronological ages (CA) at which major program changes occurred. ABA = applied behavior analysis.

instruction for 3 to 8 hours per week, varying with the amount of time she was working concurrently in her son's intensive home-based ABA program. Both parents and the family's au pair provided Catherine with additional instruction and practice opportunities in naturally occurring situations throughout most of her waking moments outside formal sessions for the duration of treatment.

About 9 months into treatment, Catherine began spending 1.5 to 3 hours per week (either one or two 90-minute sessions each week, alternating by the week) in a public early intervention classroom. She was accompanied by her home-based teacher, who shadowed Catherine to prompt and reinforce peer interactions, follow group instructions and classroom routines, and participate in activities like circle time and music. The classroom consisted of six toddlers with mild language or developmental delays; none had diagnoses of autism or other pervasive developmental disorders. Two early childhood teachers were in the classroom full-time; a speech-language pathologist and an occupational therapist joined them periodically. Catherine continued to receive intensive one-to-one ABA in the home for about 30 hours per week.

When Catherine was 2 years, 9 months old, she was enrolled in a private preschool for typically developing children two mornings per week. There she was again accompanied by her home-based teacher, who provided unobtrusive prompting and reinforcement when necessary and recorded data on Catherine's performance in that setting (i.e., following a "supported inclusion" model) (see Johnson, Meyer, &

Taylor, 1996). That classroom included 14 typically developing youngsters ages 3 to 4 years, one teacher, and one aide. Intensive home-based programming continued for about 30 hours per week. Five months later, when she was 3 years, 2 months old, Catherine began attending a different preschool, initially for two mornings per week (a total of 6 hours) for the summer, then five mornings per week (a total of 15 hours) starting that fall.

For a year, Catherine was in a preschool classroom comprising 12 to 14 typically developing 3- to 4-year-olds, one teacher, and one to two aides. Then, she spent 9 months in a pre-kindergarten classroom in the same preschool with 12 to 14 other children ages 4 to 5 years, one teacher, and one to two aides. Her home-based teacher also supported her in that setting, initially accompanying and unobtrusively instructing Catherine during all the hours she was in the preschool, then gradually decreasing her support from 15 hours per week to 9 hours per week (for 4 months), then 3 hours per week (for about 1.5 months), and then 1.5 hours per week (for about 1.5 months).

At that point, when Catherine was 4 years, 5 months old, intensive ABA programming was essentially completed, a little more than 3 years after it had started. Catherine spent the next 9 months in the aforementioned pre-kindergarten classroom, with her home-based teacher checking in once a month to monitor Catherine's progress. The teacher also provided about 4 hours per week of intensive one-to-one intervention to improve Catherine's vocal speech skills, principally syntax and volume. Catherine's family continued to provide many opportunities for Catherine to practice social, play, and communication skills in the context of naturally occurring activities, such as play dates, summer day-camp programs, and family outings. When she was 5 years, 5 months old, Catherine enrolled in a regular public school kindergarten with no diagnosis, no individualized education plan, and no ongoing specialized intervention of any kind.

Behavior change procedures. Several behavior analytic skill-building procedures were used throughout treatment, varying with the skills targeted, Catherine's performance level on each skill, and the setting in which instruction was delivered. They included discrete-trial, incidental teaching, play-based, and activity-embedded instruc-

tional procedures (see Anderson & Romanczyk, 1999; Green, 2001). Antecedents (i.e., spoken cues, prompts such as manual guidance or models), target skills, instructional materials, and reinforcers were tailored to Catherine's chronological age, her current performance (determined through standardized testing and direct observational measurement), and her preferences. Small bits of preferred edibles were used as reinforcers initially, because social consequences were ineffective. We quickly conditioned social and other secondary reinforcers (e.g., praise, hugs, stickers, coins) and used them extensively as long as our data indicated that they were effective. Primary reinforcers continued to prove necessary from time to time when new or particularly difficult skills were introduced.

In general, most-to-least prompt and prompt-fading techniques were employed to teach new skills. That is, Catherine was provided with as much assistance as she needed to perform new or unreliable responses correctly and to obtain reinforcement frequently. For example, because she had very limited skills when treatment began (including no reliable comprehension of spoken language), she was provided with gentle physical guidance as a prompt for the first several teaching trials on any new skill. When the aim of instruction was to establish stimulus control by spoken words, or by the actions modeled by an adult, those stimuli accompanied the prompt. Prompts were faded rapidly in most-to-least fashion, and reinforcement was shifted from prompted to unprompted responses to promote independent performances (Green, 2001; MacDuff, Krantz, & McClannahan, 2001).

Initially, we tried a combined child-initiated/adult-directed "naturalistic" approach (cf. Koegel, 1995). A therapy area in the home was arranged to include only 2 to 4 sets of age-appropriate materials that seemed to interest Catherine (e.g., pots and wooden spoons, various toddler toys); no other materials were present. Catherine moved freely around the area, with the teacher following her closely. If Catherine showed interest in any of the materials, the teacher immediately initiated a teaching trial. For example, if Catherine touched one of the pots or wooden spoons, the teacher positioned herself in front of Catherine, picked up another pot and spoon, and attempted to initiate a motor imitation teaching trial by saying "Do this" and hitting the bottom of the pot with the spoon. If Catherine responded by imitating the action, the

teacher delivered a small preferred edible and brief, enthusiastic praise immediately. If Catherine did not respond within about 5 seconds of the teacher's model, the teacher manually guided Catherine through the modeled action and then provided an edible and praise. Any spontaneous eye contact or appropriate vocalizations that occurred during these sessions were also reinforced immediately.

After about 2 weeks, it was apparent that the naturalistic approach was affording very few opportunities for Catherine to develop useful skills because she spent most of these sessions moving aimlessly around the area, engaging only very briefly, if at all, with any of the materials that were available and very rarely interacting with the teacher in any way. The treatment team, concerned about Catherine's lack of progress, decided to use a more adult-directed approach to teach foundational skills (looking on request, imitating, following directions, requesting, matching, naming objects, etc.). For much of that instruction, Catherine sat in a small Rifton-type chair. The teacher sat or knelt directly in front of her and initiated teaching trials by saying Catherine's name, prompting her to orient toward and look at the teacher (using gentle manual guidance and a preferred edible held in Catherine's line of vision and then swept to a position next to the teacher's eyes). The teacher then provided a brief antecedent (e.g., "Do this" and a simple action to be imitated), prompted the desired response (e.g., with gentle manual guidance), and delivered a reinforcer immediately following each correct response. Initially, 3 to 5 such trials were conducted consecutively. Then the teacher attempted to engage Catherine in a baby game like pat-a-cake or peek-a-boo, prompting and reinforcing behaviors such as eye contact and vocalizations in the context of those activities, or took her out of the chair for a few minutes of play (also embedding teaching trials in those activities) before returning to short blocks of discrete trials. The number of consecutive discrete trials was gradually increased (to a maximum of 10-15), but blocks of discrete trials continued to be alternated with other types of activities as just described.

Most communication skills were established with incidental teaching procedures. For instance, on an incidental teaching trial, Catherine's teacher or mother arranged for one of Catherine's preferred items to be within her sight but out of her reach. The adult

looked at Catherine expectantly and waited for her to initiate by reaching for or pointing to the item at first; later, she was required to vocalize any approximation of the name of the item, then the entire word, then multiple-word phrases like "Want juice, please." If Catherine did not initiate a response within about 5 seconds, the adult prompted one or prompted a more elaborate response. Catherine was given the item immediately after the response occurred (Fenske, Krantz, & McClannahan, 2001; Hart & Risley, 1968, 1982, 1995).

Once a skill was mastered (generally, unprompted correct performance on 9 of 10 discrete, incidental teaching, or activity-embedded trials for two consecutive sets of 10 trials) in formal intervention sessions, it was practiced and reinforced frequently in other settings. When data indicated that early foundational skills were firmly established in Catherine's repertoire, relatively more instruction was delivered using activity-embedded and incidental teaching procedures, although discrete-trial procedures continued to be used to introduce some new skills and for skills that Catherine did not readily acquire in the less-structured formats. Throughout treatment, interfering behavior (such as stereotypy) was gently blocked or interrupted, and a more appropriate alternative response was immediately prompted and reinforced. Competing alternative responses were also reinforced when they occurred spontaneously.

Curriculum. Target skills were selected from the research literature and from published curriculum guides on early intensive ABA for children with autism (e.g., Lovaas et al., 1981; Taylor & McDonough, 1996), child development texts, and standardized and direct observational assessments of Catherine's skills. Skills were built systematically from simple to more complex. At the beginning of treatment, we focused on "learning to learn" and early social and communication skills (such as eye contact, requesting, motor and vocal imitation, following directions, joint attention) as well as other skills that are typically exhibited by infants and toddlers in the first 14 months. Figure 2 illustrates the skills taught and the order in which they were introduced during the 1st year of treatment. Thereafter, we drew from the aforementioned curriculum guides for preschoolers with autism, the research literature on early social-communication skill development,

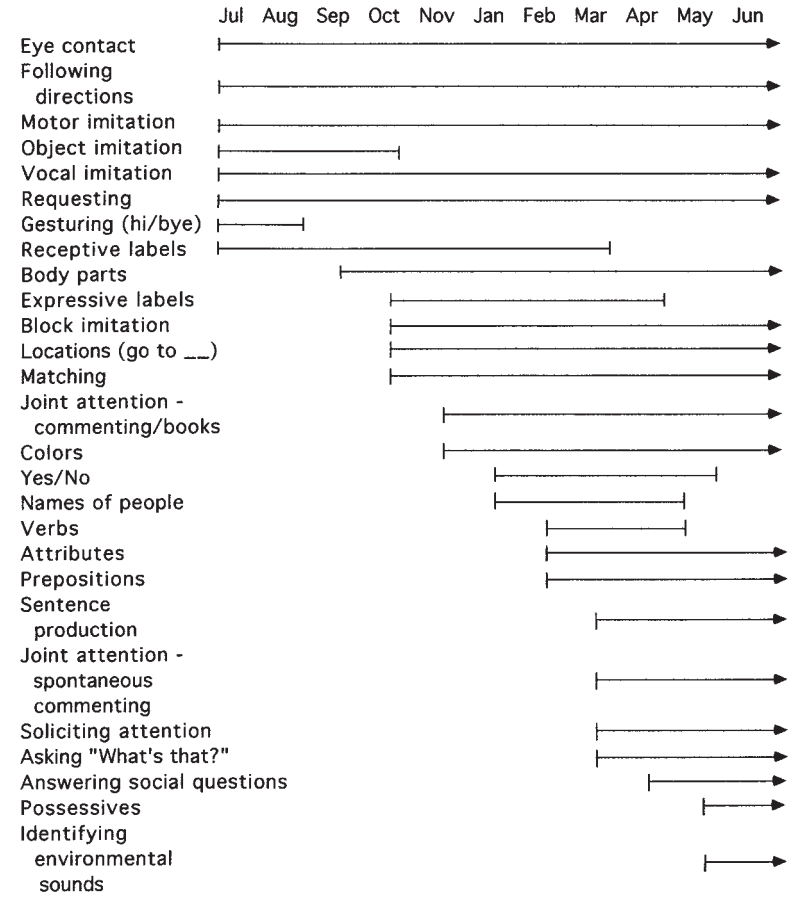

Figure 2. Skills introduced during the 1st year of treatment.
NOTE: Vertical lines indicate when skills were introduced and mastered in planned, structured teaching sessions; arrows indicate that direct instruction on the skill continued into the 2nd year of treatment. All skills mastered in structured sessions were practiced in other settings throughout treatment.

direct observation of the skills required for successful participation in the early intervention and preschool classrooms Catherine attended (cf. Johnson et al., 1996), and our clinical experience. We were particularly careful to address social interactions with both adults and children throughout treatment, for several reasons: (a) Children on the

autism spectrum often have severe deficits in that domain, (b) Catherine was in a family that included another child with autism and severe social skill deficits, and (c) research suggests that early development of those skills may be associated with better long-term outcomes for children on the autism spectrum (e.g., Klinger & Dawson, 1992; Mundy & Crowson, 1997; Mundy, Sigman, & Kasari, 1990).

We introduced peer social skills training about 6 months into treatment. First, Catherine's oldest brother (then 5 years of age) was trained to prompt and reinforce social responses by Catherine (e.g., looking at him, imitating his actions, taking turns with him, responding to his questions or play bids) in a variety of contexts, such as "playing teacher," toy play, and simple games. He continued to interact effectively and enthusiastically with Catherine throughout the course of treatment. Play dates with same-age peers were also arranged once or twice a week, during which Catherine's teacher or mother prompted and reinforced social interactions between the two youngsters. They continued throughout treatment. As mentioned earlier, about 9 months after treatment began, Catherine began attending a public, center-based early intervention program, later moving into regular preschool and pre-kindergarten classrooms. The primary focus of the home-based teacher's instruction in those settings was peer social interactions, although other skills (e.g., communication, preacademics) were also taught and practiced.

MEASURES AND DATA COLLECTION

Data on Catherine's performance of most target skills in home-based programming were recorded daily by either the teacher or Catherine's mother, with each serving as a secondary data collector for interobserver agreement purposes on each skill either weekly or biweekly. The home-based teacher recorded data on Catherine's performance in the early intervention and preschool settings, with the second author and Catherine's mother occasionally serving as secondary data collectors. These data were reviewed frequently so that instructional procedures could be adjusted if Catherine was not making adequate progress and to ascertain when skills were mastered so that they could be transferred to other settings and new skills could be

introduced. Other dependent measures were standardized tests of cognitive, communication, and adaptive skills completed by professionals who were not involved in treatment. The third author evaluated Catherine's skills in her office about every 6 months for the first 2 years of treatment. When Catherine reached 3 years of age and again when she was not quite 5 years old, local school district professionals (a psychologist and a speech-language pathologist) administered standardized tests and informal observational assessments. Standardized test results reported here (see Table 1) were taken from written reports prepared by the aforementioned professionals.

RESULTS

YEAR 1

As described previously, Catherine had reportedly exhibited a regression and loss of skills just before her 1st birthday. Standardized tests administered when she was diagnosed at 12 to 14 months of age confirmed that her language and social skills were severely delayed (see Table 1, column 1). Evaluators noted that she was nearly silent, made eye contact only fleetingly and from a distance, was difficult to engage in any activities for more than a few seconds (except watching a Barney video and gazing at long, thin objects held vertically in front of her face), showed little affect or interest in others, and demonstrated little attention to or comprehension of spoken language. Imitation occurred only sporadically. Motor and daily living skills were evaluated to be age appropriate.

Almost immediately after we changed the principal instructional approach from a naturalistic, child-initiated format to a more adult-directed format, Catherine began to acquire skills at a relatively rapid rate. Informal observations indicated that she appeared to enjoy the structured sessions and the high rates of reinforcement, as she came to them willingly, and spontaneous eye contact and smiling increased during those sessions. Her progress is illustrated in Figures 3 through 6, which show representative data on Catherine's acquisition of key learning-to-learn skills in the structured sessions. All four

figures depict the cumulative number of component skills mastered, that is, performed independently on at least 9 of 10 trials for two consecutive sets of 10 trials. Interobserver agreement on the data shown in these figures averaged 98% (range = 86%-100%).

As Figure 3 shows, no motor imitation skills were performed without prompting for the first 10 days those skills were taught. Two simple one-step actions were imitated independently by Day 12, then no new skills were mastered until Day 21. From that point on, however, Catherine began mastering new actions at an accelerating rate. After 60 days of instruction, she imitated 48 different one-step actions with no prompting; by then, she was demonstrating generalized imitation in that she imitated new actions the first time they were presented. Figures 4 and 5 show similarly rapid mastery of receptive labels for objects (matching dictated words to corresponding objects) and expressive labeling (oral naming) of those same objects. In contrast, Figure 6 indicates that many trials were required before Catherine began to follow spoken one-step directions (e.g., "Wave," "Clap hands," "Give kiss") without prompting. This was not surprising given her severe language comprehension deficits. After 65 days of direct instruction, she performed 20 different one-step directions independently.

Standardized test results (age equivalents) from a reevaluation conducted by the third author when Catherine was 1 year, 9 months of age (about 6 months into treatment) are shown in the second column of Table 1. Catherine's performance on the Leiter International Performance Scales suggested that her nonverbal cognitive skills were age appropriate; verbal cognitive skills were not assessed. No standardized tests of cognitive skills had been attempted when Catherine was diagnosed, so no pretreatment data were available for comparison. Results of standardized language tests and the Vineland Adaptive Behavior Scales (VABS), however, showed substantial gains over pretreatment age equivalents: more than a year on tests of receptive and expressive language and on the communication domain of the VABS, and about 8 months in the socialization domain of the VABS. Smaller gains were noted in daily living and motor skills, which were age appropriate before treatment began and were not emphasized during the first 6 months of treatment.

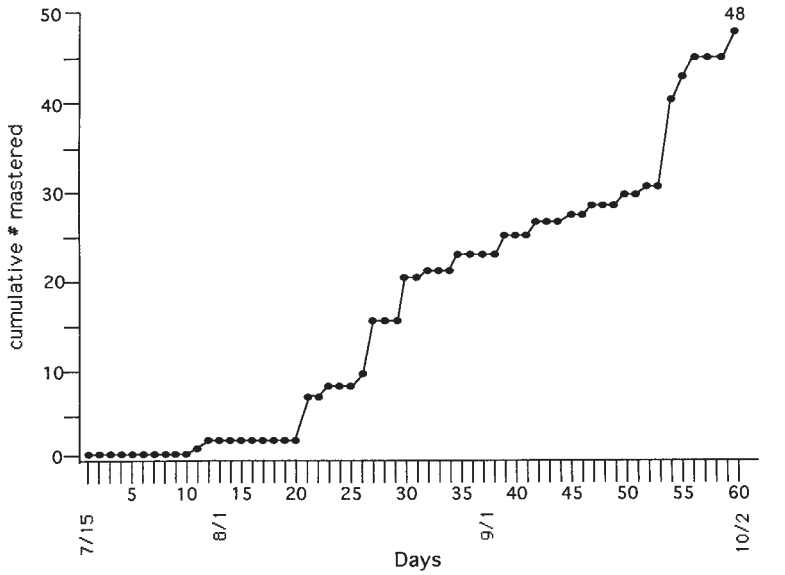

Figure 3. Cumulative motor imitation skills mastered during early months of treatment.

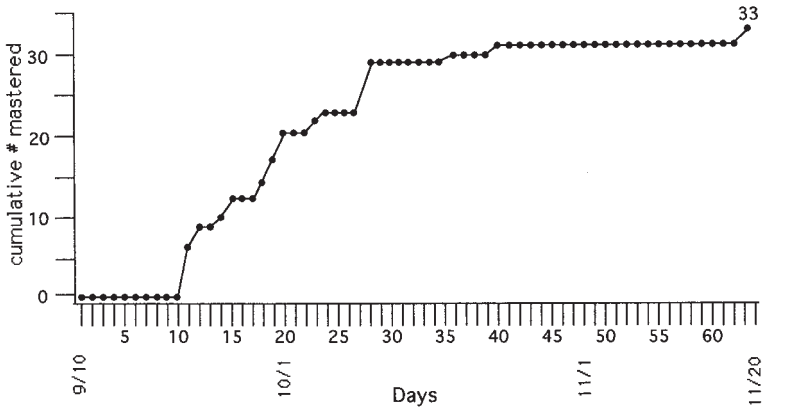

Figure 4. Cumulative receptive object labels mastered during early months of treatment.

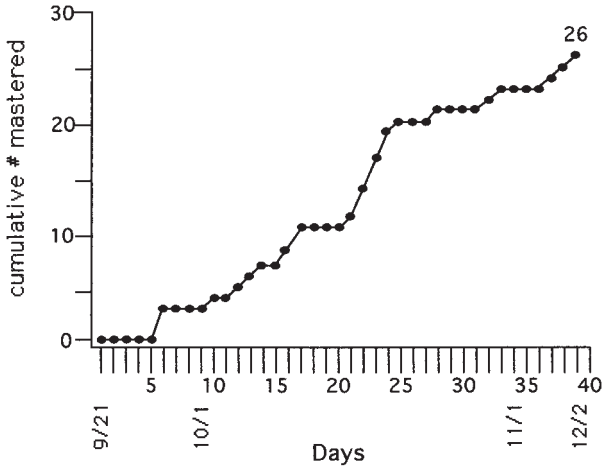

Figure 5. Cumulative expressive object labels mastered during early months of treatment.

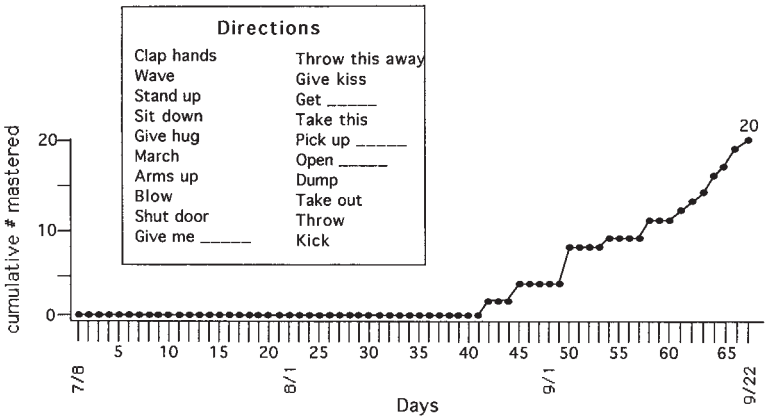

Figure 6. Cumulative one-step directions mastered during early months of treatment.

Other observations from the same evaluation report were that Catherine's eye contact, social awareness, reciprocal interactions, play skills, and general emotional tenor were substantially improved.

She demonstrated appropriate independent play, some parallel play with her oldest brother, and some emerging symbolic play skills. Spontaneous smiling at adults and pointing to request, with eye contact, were observed during the evaluation, although joint attention was still limited. Catherine was very cooperative with the examiners and seemed to enjoy doing the tasks they presented to her.

Shortly after the reevaluation, Catherine began attending a public early intervention classroom (described previously) for one or two 90-minute sessions per week with her home-based teacher. After a few weeks, informal observations and teacher reports indicated that she consistently imitated other children without prompting from an adult, followed class routines when the classroom teacher gave instructions to the entire group of children, learned new routines fairly quickly, remained in close proximity to other children, and exhibited appropriate independent and parallel play. In circle-time activities, she made eye contact with the classroom teacher consistently, engaged in most activities appropriately, and made some spontaneous comments. While engaged in independent play, however, Catherine attended almost exclusively to the materials, making very little spontaneous eye contact with nearby adults or other children. Play narration was almost completely absent. She rarely initiated interactions without prompting.

To address those remaining deficits in social interaction skills, the treatment team initiated several programming changes at this juncture. In the early intervention classroom, Catherine's home-based teacher prompted and reinforced periodic lifting of Catherine's gaze from her play materials to the teacher and to adjacent peers (a form of checking-in that we had observed other children engaging in during independent play). Requests to peers (e.g., for toys or snacks) were also prompted and reinforced. Spontaneous checking-in and requesting were reinforced whenever they occurred. In addition, the treatment team set up play dates with typical peers in the home, trained Catherine's 5-year-old typically developing brother to interact with her in the context of teaching programs and play activities, and increased the use of incidental teaching and other child-initiated procedures in home-based programming to promote spontaneous vocal

speech and social interactions. We also intensified efforts to promote generalization of skills from the home to the early intervention classroom and other environments.

YEAR 2

The programming just described continued throughout most of the 2nd year of treatment. Results of standardized assessments administered by the third author near the beginning of that year, when Catherine was 2 years, 1 month old, suggested that Catherine's nonverbal cognitive skills were developing at a normal rate and were age appropriate (see Table 1, column 3). Improvements over the assessment conducted 6 months earlier were recorded in all skill domains of the VABS except daily living skills, which had not been targeted in early programming.

Another evaluation conducted by the third author that same year, when Catherine was 2 years, 9 months old, documented substantial improvements in virtually all skill areas. Age equivalents from the standardized tests administered at that time are shown in Table 1, column 4. They show that after about 18 months of intensive ABA treatment, most of Catherine's skills were at or above age level. For example, her performance on the Leiter yielded an age equivalent of 3 years, 5 months, and she performed at the 4-year-old level on the Expressive One-Word Picture Vocabulary Test. Receptive language, socialization, daily living, and motor skills were assessed to be just slightly below her chronological age, and overall communication skills as measured by the VABS were slightly above age level. Other observations from that evaluation were that Catherine consistently made very good eye contact and exhibited spontaneous and age-appropriate speech (including commenting), joint attention, and play skills. The report also stated that Catherine looked "wonderful," and that "it would be very difficult to pick her out from a group of typical toddlers." Skills identified as needing further remediation included expressing emotions, articulating spoken words, some social communication skills, and some daily living skills.

YEAR 3

Based on the evaluation just described and direct observational data from the home-based program, Catherine's programming was modified in the 3rd year to emphasize daily living skills (such as toileting, dressing, and tooth brushing), fine motor activities (e.g., coloring, cutting, drawing), peer social skills (including interactive play), speech articulation, and advanced language skills such as verb agreement, prepositions, answering wh- questions, functions of objects, and answering social questions. As described earlier and illustrated in Figure 1, Catherine's participation in a regular preschool classroom was increased to 15 hours per week. Her home-based teacher initially accompanied and instructed her during all of that time but gradually faded the amount of support she provided in that setting over the course of the year.

Near the beginning of that year, when Catherine was nearly 3 years old, her skills were evaluated by a local school district psychologist as part of the process of determining if she was eligible for special services. Her overall performance on the McCarthy Scales of Children's Abilities yielded an age equivalent of 3 years, 3 months and a general cognitive index of 107 ($M = 100$, $SD = 16$). The psychologist's report indicated that Catherine displayed excellent attention to task, was cooperative and compliant with requests, and appeared to enjoy the tasks involved in the McCarthy. He described her as "a delight to test." His informal observations in the classroom suggested "considerable interest in peers" and consistently age-appropriate social behavior. Some low speech volume and articulation errors were noted. A school district speech-language pathologist also observed Catherine in her preschool classroom. The speech-language pathologist's report noted high levels of appropriate engagement in tasks and classroom routines, interactions with children and adults (including spontaneous initiations), smiling and laughing appropriately while playing, imaginative play, and following the teacher's directions. During the observation, Catherine spoke spontaneously "in sentences with age appropriate content, structure, and use" and "good intonation." Her speech was judged to be intelligible approximately 90% of the time, with rapid rate and low volume apparently accounting for the occasional unintelligible utterance. Although the results of these assessments did

not indicate that Catherine was eligible for special education services, the home-based treatment team viewed her social and communication skills as emerging and somewhat fragile. Our experience with other children with autism indicated that the transition to full-time regular class participation can be very challenging and that children often require substantial support in the regular classroom as well as intensive ongoing instruction in the home and other settings, much of which is typically provided by parents. Because Catherine's mother was working intensively with her son with autism in the home, and Catherine's father was working outside the home full-time, it was not feasible for the parents to provide the instruction in social and communication skills that was deemed necessary for Catherine. In consideration of those facts and Catherine's history, the school district agreed to fund continuation of the intensive treatment program.

No formal tests of social skills were conducted during Year 3, but Catherine's home-based teacher monitored Catherine's social skills in the preschool setting on a regular basis, particularly her spontaneous interactions with peers. Samples of the teacher's direct observational data recorded about 3 to 4 months into Year 3 are shown in Figure 7. The graph in the top panel represents rates of initiations (number per minute) to peers during group play periods of 5 to 10 minutes' duration by Catherine (filled bars) and three other typically developing girls of approximately her same age. Data were collected on one of those children and on Catherine during each data collection period. An initiation was recorded each time the child gave a verbal direction or request to one or more other children. These data show that Catherine initiated interactions at about as high a rate as the other same-age peer during 6 of the 14 observations, at a slightly higher rate during 2 sessions, and at a lower rate in the remaining 6 sessions. The lower panel of Figure 7 illustrates the proportion of responses to the total number of initiations from a peer in the same group play sessions for Catherine and two of her same-age peers, one per observation. A response was defined as complying with a verbal direction or request or acknowledging a comment from a peer within 5 seconds. During the first observation, the target peer received no initiations from others, and neither Catherine nor the target peer received any initiations in the session on October 27. For the remaining 12 observations,

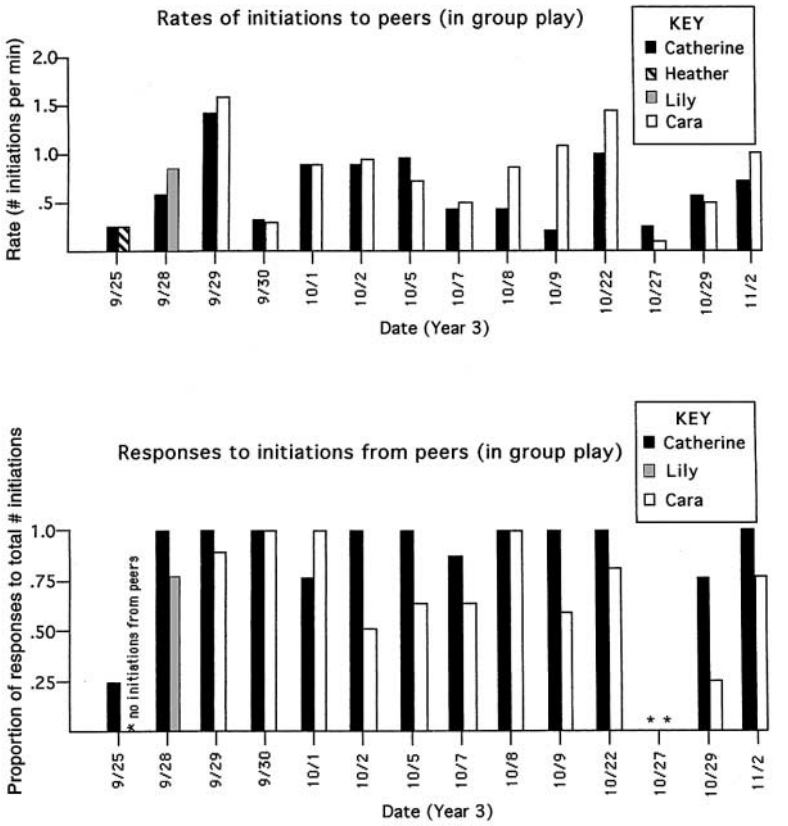

Figure 7. Initiations to peers (top panel) and responses to initiations from peers (bottom panel) by Catherine and same-age typical peers in group play situations in a preschool classroom, Year 3.

Catherine's level of responding to peer initiations was the same as that of the peer on 2 occasions, higher on 9 occasions, and lower during 1 observation. Unfortunately, no secondary data collector was available for these sessions, so the reliability of these data is unknown. We offer them as an estimate of Catherine's peer social skills in typical, age-appropriate play situations during Year 3 of treatment.

YEAR 4

About a year after the foregoing observations of Catherine's interactions with typical peers, we conducted another direct observational sampling of her peer social skills during play dates. Initiations and responses were defined as above. For these observations, Catherine and the target peer (one of four typically developing youngsters of approximately her same age, one boy and three girls) were the only children engaged in a play activity. All observation periods were 10 minutes in duration. Catherine's home-based teacher served as the primary data recorder, and her mother independently observed and recorded data during three of the five observations. Interobserver agreement averaged 98.75% (range = 95%-100%). Results are shown in Figure 8. The graph in the top panel again represents rates of initiations to the other child. Catherine initiated interactions at a higher rate than her peer in all five observations. It is also noteworthy that her rates were consistently higher than those that were recorded for her the year before (see Figure 7, top panel, filled bars); however, that difference might have been due to the differences in the contexts (group play vs. dyad). The graph in the lower panel of Figure 8 shows responding to peer initiations during the same observations, represented as the proportion of responses to total number of initiations. Catherine's level of responding was the same as or higher than that of the peer during all five observations.

Near the end of Year 4, when Catherine was 4 years, 11 months of age, her skills were reevaluated by the same psychologist who tested her at age 3. As shown in the rightmost column of Table 1, Catherine's performance on the Wechsler Primary and Preschool Scale of Intelligence–Revised produced age equivalents that were well above her chronological age, and a full-scale IQ of 119. Her performance IQ score (127) exceeded her verbal IQ score (109), but both were above the mean. Catherine's Draw-a-Person production (not shown in Table 1) was evaluated to be at the 5-year level, with many details and bright colors. The psychologist's report noted that Catherine exhibited excellent eye contact, persistence, and attention span throughout the 2-hour testing session. He described her as "cooperative and eager to please," although somewhat quiet; however, he noted that she had a cold and was noticeably fatigued near the end of the session when the

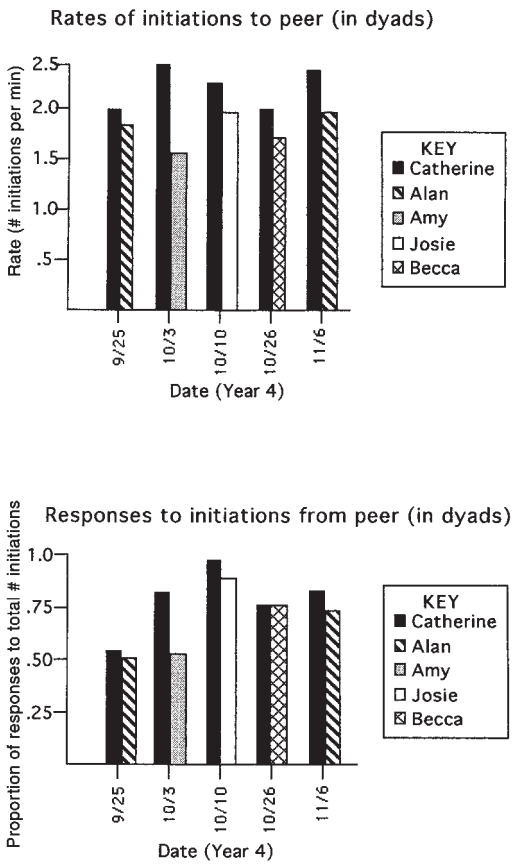

Figure 8. Initiations to peer (top panel) and responses to initiations from peer (bottom panel) by Catherine and same-age typical peers in dyads (play dates), Year 4.

verbal test items were being administered. No behavioral or developmental abnormalities were noted. The psychologist concluded that Catherine was "well equipped for the cognitive demands of kindergarten" and that her "alertness, vigilance, persistence, and eagerness to please and do well augur strongly for success within the school setting." He found that she was not in need of special services but suggested that her history might warrant some ongoing monitoring of her progress in the public school setting.

The following fall, Catherine enrolled in a regular kindergarten class with no specialized services, support, or ongoing intervention. Her teachers were not informed of her previous diagnosis and history. They described her as somewhat reticent to participate in large-group activities at the beginning of the school year, but that quickly resolved. At this writing, they have reported no concerns, as Catherine is functioning at age level academically, socially, and otherwise in school.

SUMMARY

It has been suggested that the goal of early intervention for children with, or at risk for, developmental disabilities should be to change their developmental trajectory to more closely approximate that of typically developing youngsters (Ramey & Ramey, 1998). That was accomplished in this case, as illustrated in Figure 9. The typical developmental trajectory—1 year's increase in developmental level for every year of chronological age—is represented in the graphs by the diagonal lines. Symbols in the graph in the upper panel represent Catherine's age-equivalent scores on norm-referenced tests of cognitive, receptive language, and expressive language skills conducted periodically over the entire course of treatment (also shown in Table 1). Symbols in the lower panel represent her age-equivalent scores in each domain of the VABS, which was administered during the first 2 years of treatment only (also shown in Table 1).

As noted previously, data in these graphs indicate that when she was diagnosed at about 1 year of age, Catherine's communication and social skills were well below her chronological age (age equivalents of 1-8 months, represented by the open and filled squares in the upper panel and the open and filled circles in the lower panel of Figure 9). Treatment initially focused on early learning-to-learn, social, and communication skills. Standardized testing documented accelerating development of receptive and expressive language skills over the course of treatment, to the point that Catherine was functioning above her chronological age level in those skill domains by the time she was about 5 years old (open and closed squares, respectively, in the upper panel of Figure 9). Similar patterns were evident in communication and socialization skills as measured by the VABS during the first 2

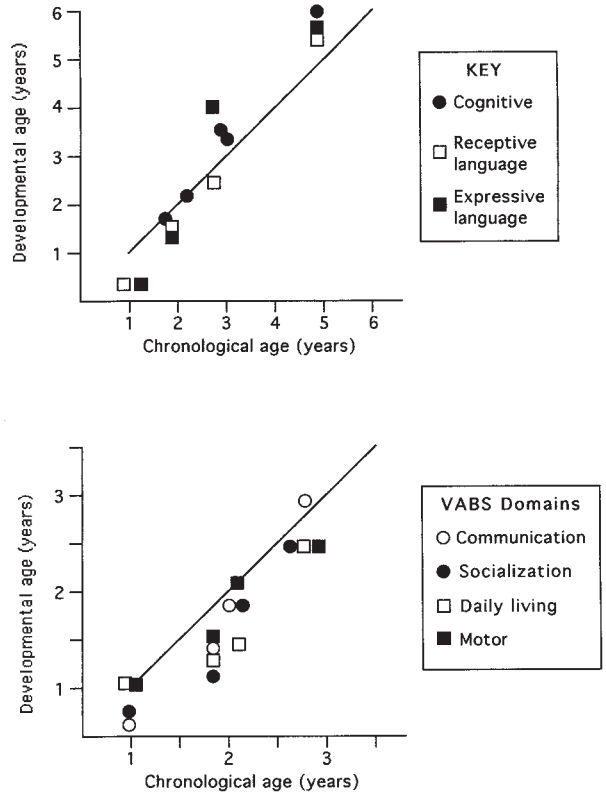

Figure 9. Catherine's developmental levels at diagnosis (age 1 year) and over the course of treatment, as measured by norm-referenced tests of cognitive and language skills (upper panel) and the Vineland Adaptive Behavior Scales (VABS) (lower panel). The typical developmental trajectory is represented by the diagonal lines.

years of treatment (open and closed circles, respectively, in the lower panel of Figure 9). Cognitive skills were not tested directly before treatment began. Scores on the Leiter administered just before and a few months after Catherine's second birthday indicated nonverbal cognitive performances that were age appropriate (closed circles, upper panel of Figure 9). When Catherine was 3 years old, both the Leiter and the McCarthy (administered by two different examiners) yielded age-equivalent scores that were above chronological age, as

did the Wechsler Primary and Preschool Scale of Intelligence–Revised administered by a third examiner when Catherine was just under 5 years of age (closed circles, upper panel of Figure 9).

It is noteworthy that daily living and motor skills, which were assessed to be age appropriate before treatment, were not targeted during the 1st year of treatment. When the VABS was readministered just before and again a few months after Catherine's second birthday, results indicated that development in those domains had not kept pace with chronological age increases. They were then addressed in treatment, and by the time Catherine was 2 years, 11 months old, daily living and motor skill age-equivalent scores were just a few months below her chronological age (open and closed squares, respectively, in the bottom panel of Figure 9).

DISCUSSION

Early intensive ABA programming, which has been developed and studied principally with preschoolers with autism and PDD-NOS, was extended and replicated successfully with a toddler at high risk for autism. Over the course of 3 years of intensive, comprehensive treatment, Catherine progressed from exhibiting substantial delays in multiple skill domains to functioning at or above age level in all domains. Those gains were documented by standardized, norm-referenced tests administered by several independent evaluators who were not involved in her treatment, as well as by direct observational data and informal observations conducted in natural settings, such as regular classrooms. By the end of a 4th year of less intensive ABA intervention combined with instruction in a regular preschool, Catherine did not meet diagnostic criteria for autism or any other disorder, did not have an individualized education plan, and did not require any special education services. Her kindergarten teachers, blind to Catherine's history, reported nothing that distinguished Catherine from her same-age, typically developing peers. This case study therefore adds to the empirical evidence that some children on the autism spectrum can recover with early intensive behavioral treatment (Lovaas, 1987; McEachin et al., 1993; Perry et al., 1995).

Although this was a case study, it included several features that support a valid inference that the treatment was responsible for the observed outcomes. First, effects were measured continuously before, during, and after treatment. Multiple measures were administered by multiple independent evaluators, several of whom were not involved in delivering treatment. Second, the pretreatment assessments of Catherine's skills, together with extensive research on early intervention for children with or at risk for disabilities (Guralnick, 1998; Ramey & Ramey, 1998), suggest that without treatment Catherine's developmental trajectory would have had a very shallow slope; that is, she probably would have made relatively small gains in most skill domains over the 4 years of this case study. Our data showed that Catherine's skills began to improve almost immediately after intensive ABA treatment began and that her developmental rate increased dramatically over 3 years of treatment (see Figure 9). Third, the efficacy of various ABA methods for increasing Catherine's skills substantially over zero or near-zero baseline levels was replicated across many different skills. In addition, large improvements in motor and daily living skills occurred only when those skills were trained directly. Taken together, then, the features and results of this case study support a reasonably strong inference that the documented effects were due to the treatment and not to other factors, such as repeated testing, statistical regression, maturation, or extraneous variables (Kazdin, 1982, 1998). Of course, because it is just one case, external validity is very limited, and replications using true experimental designs are needed.

There are ongoing debates about the desirability of, and methods for, diagnosing autism and related disorders in very young children (Filipek et al., 1999; Lord, 1997; Vig & Jedrysek, 1999). Because there is no biological marker (and hence no medical test) for autism, diagnosing this disorder remains a subjective exercise because evaluators must rely on observations of the child's behavior, parental reports, and developmental histories (Filipek et al., 1999). For those and other reasons, a question may arise as to whether Catherine had autism, or was at genuine risk for autism, when she entered treatment. In response, we would offer the following facts: (a) Catherine was evaluated independently by three different professionals, two of whom

were very experienced autism diagnosticians and researchers, and all three determined that Catherine was at serious risk for autism or was exhibiting signs of the onset of autistic disorder; (b) the clinical impressions of the first two authors, who have extensive experience with children with autism, confirmed those diagnoses; (c) Catherine's brother had been diagnosed with autism just a couple of years before Catherine was diagnosed; and (d) by all observations, at the time of diagnosis, Catherine exhibited the behavioral deficits that have been shown to distinguish autism from both typical development and mental retardation in 1-year-olds: reduced eye contact, orientation to name, pointing, and showing (Mars, Mauk, & Dowrick, 1998; Osterling & Dawson, 1994).

As described earlier, combinations of various ABA methods were used to build Catherine's repertoire of functional skills, to promote generalization of those skills, and to reduce behaviors that interfered with learning. Incidental teaching and other methods that have been part and parcel of genuine ABA since its inception in the 1960s (see Green, 2001) were used liberally; no set of procedures was used exclusively. That is, it would be grossly inaccurate to describe our treatment approach as discrete-trial training, which has become a popular mischaracterization of intensive behavioral intervention. It is important to note, however, that almost immediately after adult-directed discrete-trial instruction was initiated, Catherine's level of engagement with others, range of interests, affective expression, and skill development began to improve. Thereafter, discrete-trial procedures proved very effective and efficient for teaching Catherine a number of important skills, but again they were not the only procedures we used. Contrary to an assertion made by one set of authors (McGee et al., 1999) based on a preliminary report of this case, we do not "[advocate] for beginning intervention with infants confined to their high chairs" or using other unnecessarily "restrictive" procedures. In fact, Catherine was not confined to her high chair any more than typical toddlers her age. As reported earlier, she was only placed in a Rifton-type chair for very brief periods of time early in treatment, and those periods were interspersed frequently with periods of time out of the chair. At the same time, it is important to note that we did not rely exclusively on naturalistic, child-initiated instruc-

tional methods; indeed, the treatment team determined that such methods were not effective initially because Catherine did not spontaneously exhibit much interest in many items, activities, or people (cf. Anderson & Romanczyk, 1999). Perhaps rates of learning and outcomes like those documented here can be produced by intervention that relies more on naturalistic, incidental, child-initiated procedures and less on adult-directed instruction than ours did (cf. McGee et al., 1999), but at present that appears to be an open empirical question.

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At the time this work was completed, Gina Green was the director of research at the New England Center for Children and a research associate professor at the University of Massachusetts Medical School, Shriver Center. Her principal interests are in stimulus control, autism, and other developmental disabilities.

Lynn C. Brennan works as a behavioral consultant for Bedrosian Associates in Northboro, Massachusetts. She specializes in intensive behavioral treatment for young children with autism.

Deborah Fein is a professor of psychology at the University of Connecticut. Her main area of research interest is the neuropsychology of autism.