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DIFFERENTIAL RATES OF SKILL ACQUISITION AND OUTCOMES OF EARLY INTENSIVE BEHAVIORAL INTERVENTION FOR AUTISM

Mary Jane Weiss*
Rutgers, The State University of New Jersey, Piscataway, NJ, USA

Intensive behavioral intervention for very young children with autism has received increased attention in recent years. Researchers have documented unprecedented success in educating some young children with autism, although not every child makes dramatic developmental gains. It might be useful to identify early in treatment those children who will benefit most from the current methodology and who might require slight variations in instructional format or curricular focus. The present study suggests that initial learning rates are moderately correlated with treatment outcomes after two years. Among 20 children receiving early, intensive behavioral intervention, initial acquisition of skills was correlated with later learning rates, severity of autism symptomatology and adaptive behavior profiles two years into treatment. Implications are discussed, especially in light of the universal need for intensive intervention in this population.

Until very recently, the widely accepted view of the outcome for individuals with autism was pessimistic (Rapin, 1991). Historically, sthe majority of individuals with autism have required specialized treatments and lifelong supports (Gerhardt & Holmes, 1997; Rimland, 1994; Rutter & Schopler, 1987; Schroeder, LeBlanc, & Mayo, 1996). Applied behavior analysis, however, has been documented to substantially impact on the behaviors of children and adults with autism (Harris & Handleman, 1994; Lovaas, 1987; Matson, Benavidez, Compton, Paclawskyj, *et al.*, 1996).

The benefits of intensive applied behavior analytic programming for preschoolers with autism have been compelling (see, e.g., Anderson, Avery, DiPietro, Edward, & Christian, 1987; Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris, Handleman, Gordon, Kristoff, & Fuentes, 1991; Lovaas, 1987). Approximately 50% of children with autism participating in such programs have been shown to have significant increases in IQ and/or be placed in regular

* Correspondence to: Rutgers Autism Program, Center for Applied Psychology, 41 Gordon Road, Suite A, Piscataway, NJ, 08854-8067, USA.

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educational classrooms with little or no support. A number of researchers have documented that intensive behavioral intervention (i.e. 30–40 hours per week) begun before age 4 and lasting at least 2 years sometimes produces these dramatic effects, although studies vary in degrees of experimental control and treatment fidelity. Some studies reported that just under half of the children with autism achieved essentially normal functioning (Birnbrauer & Leach, 1993; Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Perry, Cohen, & DeCarlo, 1995). Children receiving less intensive behavioral intervention (i.e. 20 hours per week or less) did not achieve normal functioning, but many made substantial gains in IQ scores, adaptive functioning, and language (Anderson *et al.*, 1987; Harris *et al.*, 1991). The age of initial intervention appears to be critically important. There appears to be a much higher likelihood of eventual enrollment in regular education classes if intervention begins prior to age 5 than at a later age (Fenske *et al.*, 1985).

In the most comprehensive and best controlled of these studies, Lovaas (1987) compared 40 hours a week of intensive 1:1 behavior analytic treatment to a minimal treatment control group (less than 10 hours of 1:1 instruction), and to a second group of children receiving non-behavioral services elsewhere. Among the intensive treatment recipients, 47% (9 of 19) successfully completed first grade and scored in the average to above average range on standardized IQ tests and other measures (Lovaas, 1987). These results were maintained at follow-up when the average age of these children was 13 (McEachin *et al.*, 1993). Only 2% of the minimal treatment group achieved such gains. None of the children in the other control group achieved this outcome.

The findings from these studies offer significant support to the premise that intensive behavior analytic intervention is the treatment of choice for young children with autism (see, e.g., Green, 1996; Lovaas, 1987; McEachin *et al.*, 1993; Perry *et al.*, 1995). The term intensive has been defined as 1:1 instruction for 30 to 40 hours per week for at least 2 years (Green, 1996). The components of effective intervention are generally regarded to include discrete trial instruction as well as naturalistic learning opportunities (Anderson, Taras, & O'Malley Cannon, 1996). The delineation of the sequence of steps in teaching and in prompt fading methods are critically important. A firm foundation in applied behavior analysis is critical for the success of the intervention (e.g., Green, 1996; Romanczyk, 1996).

Initial skills targeted for acquisition typically focus on areas of severe deficits. For example, deficits in imitative skills are a hallmark characteristic of children with autism (see, e.g., Harris & Handleman, 1994). Therefore, targeting the development of imitative skills is an important initial focus (Taylor & McDonough, 1996). Imitation and matching, in particular, have been identified as two important kinds of discrimination learning that provide the basis for teaching many complex behaviors (Lovaas & Smith, 1989). Similarly, initial receptive language skills are also critically important because complex learning depends upon the comprehension of words. Early verbal imitation and expressive language skills are also commonly emphasized as the building blocks for communication (Harris & Handleman, 1994).

The benefits of intensive early intervention for young children with autism have been reasonably well documented. However, initial strong predictors (such as IQ or language) of outcome for children provided with this intervention (e.g., Lovaas, 1987) have not yet been identified. It seems reasonable to speculate that the rate at which a child learns in the early stages of intervention may be critically important, given that faster rates of acquisition will lead to more rapid narrowing of developmental lags. In fact, Lovaas and colleagues have speculated that early acquisition rates are related to outcome (McEachin *et al.*, 1993). Their Early Learning Measure is an assessment tool developed to monitor initial acquisition of basic skills. Lovaas has discussed the predictive utility of the Early Learning Measure (Lovaas, 1994). This test assesses mastery of basic skills in the areas of non-verbal imitation, receptive commands, verbal imitation, and expressive language. Formal data on the use of this measure are not yet available in the literature.

The present study represents an attempt to assess outcome in the context of an applied, and home-based model. The goal of the present study was to attempt to assess the predictive utility of early learning rate within this model. These rates were compared to global indices of progress (i.e. in autistic symptoms and in functional skills) and to long-term gains in specific curricular areas. The present study does not represent a controlled research study. It does, however, provide clinical data regarding progress in young children with autism receiving intensive behavioral treatment. The data presented were collected in home-based programs, where the ability to control variables was, by definition, limited.

METHOD

Participants

Participants were 19 boys and one girl with autism receiving intensive behavior analytic home-based intervention for 40 hours a week. They were selected from a group of 80 young children receiving services through the Center for Applied Psychology at Rutgers University. The 20 children selected had all received services from the same clinician or pair of clinicians for the duration of treatment and represented the entire caseload of the primary clinician. The Center for Applied Psychology is a non-profit service agency directed by university faculty. The boy: girl ratio in this sample was representative of the population of children served at the center. Of the 80 children, four were girls. The average age of children at the start of intervention was 41.5 months (range: 20–65 months). Thirteen of the 20 youngsters started intervention prior to age 4, and 19 of the 20 children began intervention before age 5. All parents of the children receiving services had contacted the Rutgers Autism Program (at the Center for Applied Psychology) and requested services. Children resided in several states, including New Jersey, Pennsylvania, Connecticut, New York, and Maryland.

All of the children had received the diagnosis of autism or PDD/NOS from independent qualified professionals (i.e. doctoral level psychologists, pediatric neurologists). In each instance, all children were seen by at least two professionals who indicated that the child met DSM IV criteria (American Psychiatric Association, 1994) for a pervasive developmental disorder (i.e. Autistic Disorder or PDD-NOS). Eighteen of the 20 children had independent diagnoses of autism, while the remaining two had diagnoses of PDD-NOS. None of these professionals were employees of Rutgers University or involved in the intervention in any way. In addition, an initial observational screening by the author confirmed that each child met the DSM IV criteria (American Psychiatric Association, 1994) for Autistic Disorder.

All of the children received services directly from the author, who saw the children regularly (i.e. every 4–6 weeks) throughout the program. Four of the 20 children were seen slightly less regularly by the author for the final four months of the study. However, they remained on the same (4–6 week) follow-up schedule. Interim follow-ups were conducted by a senior staff member from the Rutgers program. In all cases, therefore, the children were seen directly and regularly by the author over the 2 year period.

Procedures

Measures

All children were assessed with the Childhood Autism Rating Scale (CARS) (Schopler, Reichler, & Renner, 1988) and the Survey form of the Vineland Adaptive Behavior Scale (Sparrow, Balla, & Cicchetti, 1984) at the start of intervention and approximately 2 years into treatment. The CARS consists of 15 subscales based on specific behavior observation and has generally good inter-rater reliability and discriminant validity based on DSM-IIIR criteria

(Parks, 1983; Sevein, Matson, Coe, Fee, & Sevin, 1991). The Vineland Adaptive Behavior Scales are widely used to assess developmental and self-help competencies in four domains: communication, socialization, daily living skills, and motor skills. Additionally, an adaptive behavior composite score provides a summary of comprehensive adaptive functioning (Harris, Delmolino, & Glasberg, 1996). These were administered by the author. The Vineland and CARS for 12 of the children were re-administered independently by a master's level clinician at the Rutgers Autism Program. This clinician was not involved in the child's program and arranged for a separate interview within one week of the original interview.

Mastery of initial skills was also evaluated. Nine initial programs chosen for their importance in early learning were selected for analysis. (See Table 1.)

Mastery data were obtained by a review of archival program records for each child. Two measures of initial skill acquisition were used for each program: number of days to mastery of the first five items and number of days to mastery of the first 30 items. These two measures were obtained for all nine of these initial programs. In all cases, data were recorded by instructional staff in the home-based program. Many instructors took trial by trial data, while others computed ratios of correct responses over total opportunities. If ratio data was taken, it was replaced with trial by trial data when ratios approached 70% correct responses. Additionally, all instructional staff took trial by trial data on regular (i.e., every three days) probes of skills to determine the mastery of skills. At times, additional information on prompts given or on field size were included. Mastery was always determined through trial by trial data collection. Mastery always reflected 90% performance (9/10 trials) across two instructors in two consecutive sessions. In this way, the acquisition rate for all 30 items for each program and the initial acquisition rate for the first five items of each program were assessed. It was not possible to specify the number of trials per day, as this was not required of instructional staff.

In general, mastery was determined by instructors. Mastery dates were recorded for first and second mastery of each item. First mastery was the first instance of 90% or better performance, while second mastery was the second instance of performance at this level. Second mastery had to be with a different instructor and in a consecutive session. Full mastery could take place on one day if first and second mastery occurred on the same day. Trial by trial data collection was taken for mastery. On each follow-up visit, the author would collect data on the demonstration of mastered skills.

In addition to mastery of initial skills, mastery of complex curricular goals (i.e., current abilities) was also evaluated. The areas assessed are shown in Table 2. Assessment of these skills was done to obtain additional information

Table 1. Initial programs

1. NVI (non-Verbal Imitation)	SD: "Do this"	
Sample items:	stomp feet	bang table
	clap hands	raise arms
2. OM (Object Manipulation)	SD: "Do this"	
Sample items:	peg in pegboard	move car on table
	block in bucket	place ring on stacker
3. 3D–3D Matching (Identical Object Matching)	SD: "Put with same"	
Sample items:	plates	cups
	bowls	spoons
4. RC (Receptive Commands)	SD: "(Action)" (e.g. "clap hands")	
Sample items:	stomp feet	stand up
	clap hands	raise arms
5. RL (Receptive Labels)	SD: "Touch"	
Sample items:	car	hat
	book	shoe
6. VI (Verbal Imitation of sounds/words)	SD: "Say"	
Sample items:	ah	eee
	ooo	mmm
7. VI 2 words (Verbal Imitation of 2 words)	SD: "Say"	
Sample items:	bye bye	all done
	I want	I am
8. EL (Expressive Labels)	SD: "What is it?"	
Sample items:	car	hat
	book	shoe
9. SQ (Social Questions)	SD: "(Appropriate question)" (e.g. "How are you?")	
Sample items:	What is your name?	How are you?
	Where do you live?	How old are you?
		What's your brother's name?

about later curricular mastery. This information provides global indices regarding the possession of skills in critical curricular areas two years into treatment.

Skills in the complex curriculum category were coded (*post hoc*) by lead instructors and a Rutgers behavior specialist as present or absent, based on whether programs in each of these categories had been completed and maintained. For example, a child would be coded as possessing complex receptive language skills if he/she could follow randomized two and three step commands, identify a variety of abstract concepts receptively (eight colors, eight shapes, random mixed attributes), and identify 60 objects by their characteristics. Each of these skills would have involved the mastery (90% or better across two

Table 2. Complex curricular goals

1. Complex Receptive Language
   - Receptive color identification
   - Receptive shape identification
   - Mixed attributes
   - Random 2 and 3 step receptive commands
   - 60 functions of common objects
2. Generalized Imitation
   - Mastery of: 30 items gross motor; 15 items out of chair; 10 oral motor items; 10 fine motor items
   - Mastery of 2 part chaining (random presentation)
   - Novel imitation probes
3. Generalized Manding
   - Completion of 5 task completions with interrupted chain (requesting)
   - Probes with novel tasks
4. Conditional Comprehension
   - If/Then Program (20 items)
5. WH Discrimination
   - Who/what/where/why/when programs
   - Listen to a story with WH questions
6. Age-level Academics
   - Numbers (receptive ID, expressive ID, 1:1 correspondence of pictures/objects to numbers)
   - Letters (matching upper and lowercase, receptive ID, expressive ID)
   - Reading (sight words; comprehension and production)
   - Math (quantity creation, addition)
   - Coins (coin receptive identification, coin receptive ID of value)
7. Following Group Instruction
   - 15 minute mock Circle Time (novel content: songs, receptive commands, imitative games)
8. Appropriate Solitary Play (10 minutes)
9. Cooperative Play
   - Joint imaginary play (10 minutes)
   - Turn taking (10 minutes)
10. Sustained Pretend Play (10 minutes)
11. Sustained Reciprocal Conversation
    - 10 exchanges (information, animals, community helpers)
12. Comprehension of Social Cues
    - Non-verbal communication
    - Social rules
    - Role play
    - Perspective taking

instructors in two consecutive sessions) and maintenance at 3 months (90% or better across two instructors in two consecutive sessions) of at least 30 items (e.g., objects, commands) per skill area.

Training

The treatment took place in the homes of the children. The instructors were all trained in an initial 2 day workshop and received additional training every 4 to 6 weeks. Workshop training was conducted by the author, a doctoral level clinical psychologist with extensive experience using applied behavior analytic methods with children with autism. In some cases, workshops were co-led by a behavior specialist employed by Rutgers University with extensive experience. In these cases, both the author and the behavior specialist demonstrated instructional techniques. Initial topics covered in this training included definitions of terminology in applied behavior analysis, basics in the technique of discrete trial instruction, and prompting strategies. The majority of the workshop was spent modeling instructional techniques and observing the implementation of these techniques by participants. A simple checklist of instructional competence in discrete trial instruction was used to evaluate competency. The child was present for the workshop and was worked with directly for the majority of the time.

Follow-up training afforded opportunities to hone complex clinical techniques such as shaping and prompt fading. Follow-up training (every 4 to 6 weeks) was conducted by the author or the author and a behavior specialist. The workshop leader also organized development of the curriculum for each child. The prior experience and knowledge levels of instructors (i.e. individuals providing direct instruction) were variable. Many instructors were college students or graduates specializing in psychology or special education. All of the instructors were hired by the families to provide direct instruction. Typically, each instructor was paired with an experienced instructor for 18 hours of training before working individually.

Instruction and Skill Acquisition

The children generally received six hours of instruction per day, seven days a week. The six hours of daily instruction were divided into two 3 hour sessions. During the work sessions, instructional demands were interspersed with periods of free play. Children generally worked for 5 to 20 trials, and then played for 1 to 3 minutes. This pattern was repeated throughout the session.

The author did not collect data on the precise number of hours of instruction each child received per week. All families were advised to provide 40 hours of instruction per week. All parents logged hours and all parents reported that the children received about 40 hours per week throughout the 2 year period.

All skills were initially presented in isolation (without distractors and not mixed with previously mastered items), and were introduced with prompts. A most to least prompt hierarchy was used to maximize success and reduce errors. Prompts were then faded. After acquisition had been established, an instructional 'NO' was used for incorrect responses. When a prompted trial was done, a most to least strategy was used. Thus, the instructor ensured correct responding through the use of a more intrusive prompt. Two consecutive incorrect responses set the occasion for a prompted trial (after acquisition of a skill).

New items in programs were introduced after mastery in expanded trials (i.e. after mastery in discrimination with previously mastered items). As soon as an item met this criteria (90% in expanded trials with two instructors in two consecutive sessions), the next item on the list was introduced. These decisions were made by instructional staff who had item list progressions. An individualized curricular progression was provided for each child. General long-term progressions were outlined at follow-up visits to ensure continuous introduction of material. There were no known lags in progressions due to unavailability of the clinician or the curriculum. Hour long phone contacts were conducted at least weekly and video reviews generally occurred at least once between visits. These interim supports afforded additional opportunities for problem identification, trouble shooting, and curricular updates. In addition, teams met weekly to review programs and address concerns.

RESULTS

Autism Severity

Prior to intervention, all 20 children scored in the severely autistic range on the CARS ($M = 45.9$, range 37.5–58, $SD = 5.30$). Post-intervention scores on the CARS were consistent with differential outcomes (see Table 3). Nine participants scored clearly in the non-autistic range (i.e., below 30). Four additional children scored in this range but were noted to exhibit several mild manifestations of autism. Four youngsters scored in the mild–moderate range of autism (30–36), and three scored in the severe range (37–60). The mean post-intervention CARS score was 27.2 (range 16.5–42.5, $SD = 8.74$).

Adaptive Behavior Information

As shown in Table 3, the range of adaptive behavior composite standard scores on the Vineland Adaptive Behavior Scales (Sparrow *et al.*, 1984) prior to intervention was 38 to 63 ($M = 49.85$, $SD = 7.84$). This mean falls well below an

Table 3. CARS and Vineland scores

Child	*Pre-treatment CARS*	*Post-treatment CARS*	*CARS change*	*Pre-treatment Vineland*	*Post-treatment Vineland*	*Vineland change*
1	43.5	19	−24.5	48	101	+53
2	41	16.5	−24.5	52	113	+61
3	41	16.5	−24.5	50	113	+63
4	43	16.5	−26.5	50	110	+60
5	53.5	34.5	−19	39	41	+2
6	37.5	24	−13.5	47	94	+47
7	45.5	27.5	−18	39	91	+52
8	43.5	26	−17.5	46	110	+64
9	47.5	39.5	−8	48	50	+2
10	46.5	27	−19.5	45	54	+9
11	42	23	−19	55	78	+23
12	47	23.5	−23.5	61	95	+34
13	52	42.5	−9.5	63	64	+1
14	38.5	24	−14.5	63	109	+46
15	58	40.5	−17.5	38	42	+4
16	43	15.5	−27.5	49	113	+64
17	41	19	−22	60	125	+65
18	50	32	−18	43	59	+16
19	49	35.5	−13.5	57	60	+3
20	50.5	36	−14.5	44	50	+6

average score of 100. In fact, the whole range falls more than two standard deviations below an average score on this measure (Sparrow *et al*., 1984). Post-intervention scores were more variable ($M = 83.6$, range 41–125, $SD = 28.28$). Eight children's scores were over 100, and three scored in the 90s. The remaining nine children's scores break down as follows: one in the 70s, two in the 60s, four in the 50s, and two in the 40s.

Variability in Skill Acquisition

A great deal of variability in skill acquisition was evident (see Figure 1). The total number of days to mastery of 30 items was highly variable across children. The range for acquisition of 30 receptive commands (RC), for example, was 30 days to 548 days ($M = 110.37$, $SD = 126.49$). Variability in verbal imitation was even greater, ranging from 30 days to 659 ($M = 106.94$, $SD = 197.05$) days for 30 sounds/words.

Variability in acquisition rates was also evident in the learning rates for items 1–5. Ranges for non-verbal imitation (NVI) were 6–149 days ($M = 29.15$, $SD = 39.36$) for all of the first five items. Similar ranges were evident on

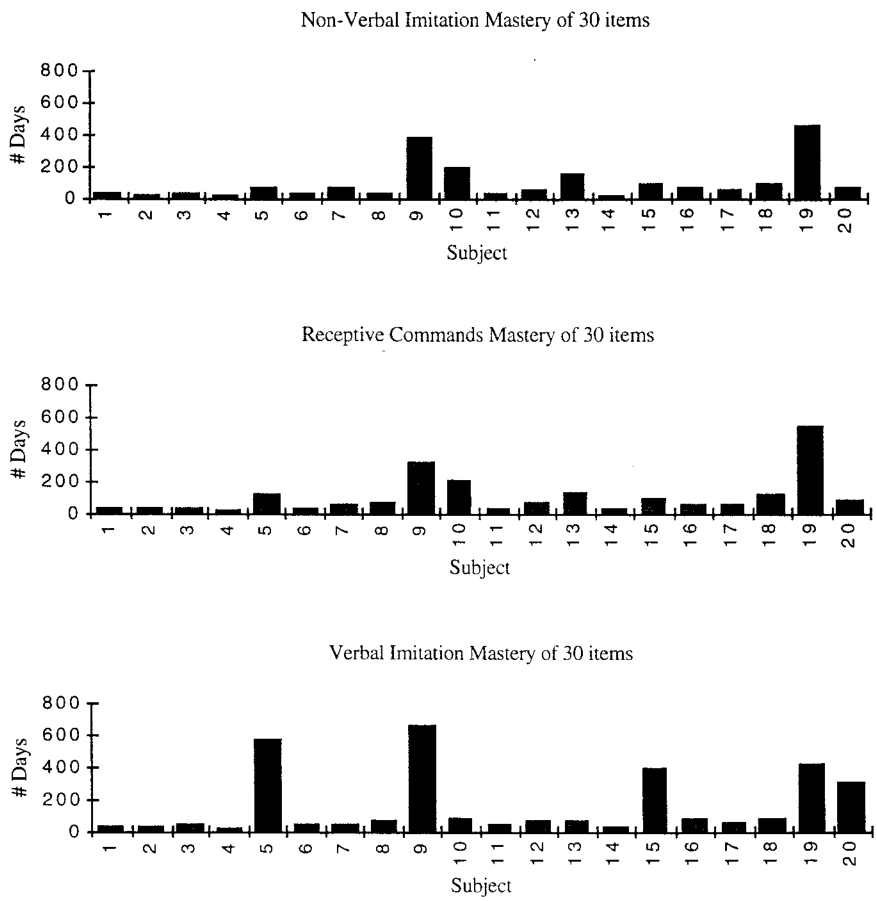

Figure 1. Variability in Acquisition

receptive commands (RC) (range 6–146 days, $M = 31.9$, $SD = 39.10$) for all of the first five items. Variability in verbal imitation was even greater for all of the first five items (range 5–256 days, $M = 51.7$, $SD = 90.64$).

The mean number of days to mastery of the first five items, as expected, also shows variability. The range of mean number of days for items 1–5 in non-verbal imitation (NVI) was 1–30 days ($M = 5.93$, $SD = 7.89$). The range of mean number of days for items 1–5 in receptive commands (RC) was 1–31 days ($M = 6.49$, $SD = 8.13$). Variability in verbal imitation was even greater; the range for mean number of days for mastery for the first five items was 1–51 days ($M = 12.44$, $SD = 18.07$). Average numbers of days to master each item for items 1–5 on three initial programs are listed in Table 4.

Table 4. Average numbers of days to mastery of each item for items 1–5

Subject	*Non-verbal Imitation*	*Receptive Commands*	*Verbal Imitation*
1	1.8	1.4	1.4
2	1.2	1.4	1.4
3	1.40	1.40	2.00
4	1.20	1.20	1.00
5	3.2	4	45
6	1.4	1.6	2.8
7	4.2	3.6	1.8
8	3.4	4.6	3
9	25.4	24	51.2
10	8.2	13.6	2.2
11	1.4	1.6	1.8
12	5	3.2	4
13	11.8	13.6	3
14	1.2	1.6	1.4
15	5	4.2	34.2
16	3.8	4.2	5
17	3	2.4	3.8
18	2.4	6.2	4.2
19	29.8	31.2	49.6
20	3.8	4.8	30
Average	5.93	6.49	12.44

Differential Rates

The acquisition rate of the first five items of a program was positively correlated with the overall rate of skill acquisition (i.e., acquisition rate for 30 items of the same program) ($r(18) = 0.96$, $p = 0.001$). This was true for the individual programs as well as for the overall trend (e.g., NVI $r = 0.987$, $p = 0.0001$; RC $r = 0.98$, $p = 0.0001$). Correlations are listed in Table 5.

The acquisition rate of the first five items on the learning tasks was correlated with changes in adaptive functioning and in the severity of autism symptomatology. The acquisition rate for the first five items was moderately correlated with Vineland Adaptive Behavior Scale scores two years into treatment ($r(19) = -0.60$, $p = 0.004$) and to the changes in Vineland scores ($r(19) = -0.66$, $p = 0.001$). The relationship between acquisition rates and Vineland scores is inverse; more days to mastery of the learning tasks was associated with lower Vineland scores. Similar predictive relationships were found for CARS scores 2 years into treatment ($r(19) = -0.66$, $p = 0.001$) and for changes in CARS scores from time 1 to time 2 ($r(19) = 0.59$, $p = 0.005$).

The overall mean number of days to learn skills was moderately correlated with scores on the subsequent (i.e., two years later) administration of the

Table 5. Correlations between skill acquisition rates, autism severity, and adaptive behavior

Acquisition information	*Post-treatment CARS*	*CARS change*	*Post-treatment Vineland*	*Vineland change*
Average No. sessions to master each item (based on 1st 5 items)	$r = 0.65997$ $p = 0.0015$	$r = 0.59237$ $p = 0.0059$	$r = -0.60279$ $p = 0.0049$	$r = -0.66490$ $p = 0.0014$
Average No. sessions to master each item (based on all items)	$r = 0.71001$ $p = 0.0005$	$r = 0.59774$ $p = 0.0054$	$r = -0.67361$ $p = 0.0011$	$r = -0.70066$ $p = 0.0006$

Vineland. The correlation between the overall mean and the second administration of the Vineland was statistically significant, but not strong ($r(19) = -0.67, p = 0.001$). The correlation between the overall mean number of days and the difference in the first and second administration of the Vineland was also significant ($r(19) = -0.70$, $p = 0.0006$). There was a non-significant trend for a negative correlation between the overall mean of days for skill acquisition and the initial Vineland ($r(19) = -0.10$, $p = 0.65$).

The relation between the overall mean number of days to learn skills and the scores on the CARS was more consistent than for the Vineland. The correlations were statistically significant for the initial CARS ($r(19) = 0.57$, $p = 0.01$), for the second administration of the CARS ($r(19) = 0.71, p = 0.0005$), and for the difference in the CARS scores for pre to post ($r(19) = 0.59$, $p = 0.005$).

Predictive Utility of Acquisition Measures

Multiple regression analyses were performed to assess the predictive power of early skill acquisition measures. Specifically, the scores on the second administrations of the CARS and Vineland were predicted from program acquisition rates. In addition, the changes in CARS and Vineland scores were predicted from the acquisition data.

The results of the regression indicate that scores on the second administration of the CARS were predicted by rate of progress on three initial programs: Verbal Imitation, Receptive Commands, and Object Manipulation. Together, the acquisition on the first five items of these programs accounted for over 70% of the variance on CARS scores two years into treatment ($R^2 = 0.731$). Verbal Imitation alone accounted for 46% of the variance ($R^2 = 0.469$).

Scores on the second administration of the Vineland were predicted by early acquisition data as well. Three programs were delineated in a step-wise regression model: Verbal Imitation, Non-verbal Imitation, and Receptive Commands. The rates of acquisition for the first five items of these programs accounted for over 70% of the variance ($R^2 = 0.714$).

Current Abilities Profiles

Assessment of complex play and social skills yielded interesting results. Children were classified as possessing or not possessing skills in each of the areas outlined in Table 2. (This was a *post hoc* coding technique and had no impact on the assessment of acquisition or mastery.) These skills were operationally defined as mastery of programs within areas, as listed. None of the 20 participants possessed any of these 12 skills when intervention began. Following intervention, nine of the 20 subjects possessed all of these skills. Three additional children demonstrated at least 10 of the 12 skills.

School Placement

Two years into treatment, the children were placed in a variety of educational settings. See Table 6 for the breakdown of placement information. Information on school placement was obtained by parents and verified by school personnel. Seven of the 20 participants were enrolled full-time in regular education without support. Three additional children were enrolled full-time in regular education with minimal support (i.e. had some related services or a part-time instructional assistant). None of these children received any individual instruction in their classroom settings and received minimal help from the instructional assistants. Thus, a total of ten participants were receiving regular education services, participating in group instruction, and reportedly acquiring skills within a typical classroom environment.

The remaining ten participant still required some individualized instruction. Five of these ten children were placed full-time in regular education, but received 1:1 discrete trial instruction from aides for part of the school day. All of these children also required full-time aides to successfully participate in group activities.

The remaining five participants were placed in special education. Two of these five students were receiving 1:1 discrete trial instruction for at least 30 hours per week. Three of these five received a combination of 1:1 discrete trial instruction and small group instruction.

Table 6. Classroom placement after 2 years of treatment

7	Full time regular education with no support
3	Full time regular education with minimal support
5	Regular education with full time aides and with discrete trial instruction for part of day
5	Full time special education (2 of 5 receiving 30 hours 1:1)

Discriminant Function Analysis

A discriminant function analysis was performed to assess whether initial acquisition rates predicted membership in group (i.e., included with no or with minimal support versus still receiving systematic instruction). The goal of this analysis was to determine whether initial acquisition rates could predict school placement outcome 2 years later. The two outcome groupings used for the purposes of this analysis were: 'included with no or minimal support' versus 'still receiving systematic ABA instruction' (regardless of setting placement). In this way, outcomes were dichotomized. Statistical predictions (based on initial acquisition rates) were then compared to actual clinical outcomes. This analysis indicated that three children were misclassified. Eighty-five percent of the subjects (i.e. 17 out of 20) were classified into posterior probability groups that matched their clinical outcomes. In all three cases of misclassification, the children were statistically classified as belonging to the superior (i.e. no longer receiving systematic instruction) outcome group, but actually belonged to the less superior outcome group (still receiving systematic instruction). One of three cases was included in regular education, but still required some 1:1 discrete trial instruction. The other two cases were in special education, receiving small group instruction (i.e., no 1:1 and no discrete trial instruction). Although they were not receiving 1:1 instruction, they were classified into group 2 because of the restrictiveness of the setting.

Reliability

Inter-rater reliability data were available for the CARS and Vinelands for 12 of the 20 subjects. The subjects for whom reliability data were available were widely variable in characteristics and outcome (range of initial Vineland scores, 38–60; range of second Vineland scores, 50–113). Four of the twelve subjects scored above 100 on the second administration of the Vineland.

Reliability data was available for four pieces of data: scores on the initial administration of the CARS; scores on the second administration of the CARS;

Table 7. Reliability (CARS and Vineland scores)

Child	*CARS 1*	*REL CARS 1*	*CARS 2*	*REL CARS 2*	*VIN 1*	*REL VIN 1*	*VIN 2*	*REL VIN 2*
1	43	43	15.50	16	49	49	113	112
2	37	46.50	23.50	23.50	61	61	95	95
3	42	42.50	23	23	55	55	78	79
4	52	52	42.5	42.5	63	63	64	65
5	41	41.5	19	19	60	60	125	125
6	58	59	40.5	40.5	38	38	42	42
7	47.5	48.5	39.5	39.5	48	48	50	51
8	45.5	46.5	27.5	28	39	40	91	92
9	43.5	43.5	26	26	46	46	110	110
10	46.5	46	27	28	45	45	54	54
11	37.5	37.5	24	23	47	47	94	96
12	43	43	16.5	17	50	50	110	111
Mean	44.71	45.79	27.04	27.17	50.08	50.17	85.50	86.00
Standard deviation	5.89	5.56	9.16	9.10	8.17	8.05	27.59	27.45

scores on the initial administration of the Vineland; and scores on the second administration of the Vineland. Fifty eight percent of the scores (28 out of 48) were exactly the same. Ninety-four percent of the scores (46 out of 48) were within one point of each other.

The Pearson product moment correlations were all above 0.90 ($r(\text{CARS1}) = 0.992$, $p = 0.0001$; $r(\text{CARS2}) = 0.998$, $p = 0.0001$; $r(\text{VIN1}) = 0.999$, $p = 0.0001$; $r(\text{VIN2}) = 0.999$, $p = 0.0001$). In addition, the means and standard deviations for the reliability data were closely matched (see Table 7).

DISCUSSION

The present study is limited in some critical ways. There was no control group or group receiving a different level of treatment. It therefore exists primarily as a clinical description of the effects of this model of intensive behavioral intervention. Nevertheless, it yields important information given the limited research available in this area, especially involving larger numbers of children. Clearly, there is a need for caution in interpretation.

There are some problems with the measures selected for outcome. Both the CARS and the Vineland are widely used and are seen as instruments with some clinical utility and face validity. However, while the CARS may be potentially quite useful for diagnostic screening, it has serious limitations. It is not an instrument which discriminates effectively between autism and other disorders, and it is not based on current criteria for diagnoses (Lord, 1997). Also, both the CARS and the Vineland rely on parental report.

Some important information regarding child and family characteristics was not collected. For example, the Rutgers Autism Program did not inquire about family SES or the family environment. It can be speculated that the children receiving services through Rutgers Autism Program generally came from families who were very involved with their children and parents who advocated for their children. This certainly influences the generalizability of findings within the population of children with autism.

Also IQ data were absent. None of the children were tested by Rutgers Autism Program staff. In addition, IQ data from independent evaluations was not required. This is a serious omission, as a standardized measure of IQ would strengthen the study. Additionally, IQ may be shown to have some prognostic value.

A significant limitation is that there may be many other factors confounded with learning rate. For example, children varied widely in their responsiveness to selected rewards. Variability in responsiveness to reinforcement may be a central confounding variable. Furthermore, it is impossible to capture the individualization of the approach for each child. This individualization of programming efforts, tailored to each child's learning style, reinforcer preferences, and other characteristics, may be of critical importance.

A related possible source of impact is variability in the skill levels of teams. While training was equivalent, some teams were more enthusiastic, more acutely aware of nuances of instruction, or more thorough in their communication. This is a natural variable in clinical endeavors. It may have had an impact which was not possible to control.

The results of the present study indicated that the initial learning rates of children with autism, as assessed by the Rutgers Autism Program, were somewhat related to later learning and status after two years. Children who initially learned quickly continued to demonstrate rapid acquisition rates. Initial learning rates were also positively correlated with the child's scores on the CARS and Vineland two years into treatment.

Every child who initially learned very quickly (e.g., mean of less than 2 days for acquisition of the first five items) continued to learn at very rapid rates. These children also showed the greatest changes in autism severity and in adaptive behavior. There were a few children who initially learned a little more slowly (e.g., more than 5 days for acquisition of the first five items) who had outcomes similar to those of the very rapid learners discussed above. All children who struggled substantially with initial skill acquisition, however, continued to struggle with skill acquisition. These children also exhibited higher degrees of autistic behavior and lower adaptive behavior skills two years into treatment.

In addition to documenting the correlations between measures of initial learning and certain outcome measures, the results of the present study support the impact of intensive behavioral intervention for young children with autism (see, e.g., Anderson *et al.*, 1987; Birnbrauer & Leach, 1993; Fenske *et al.*, 1985; Harris *et al.*, 1991; Lovaas, 1987; McEachin *et al.*, 1993; Maurice, 1993; Perry *et al.*, 1995). This study lends support to the potential benefit of intensive (40 hours a week, 1:1) instruction.

Given the limitations and results of the current study, assessment of initial learning rate should not be used to determine the intensity of services. All of the children, regardless of outcome, were in need of intensive intervention, and all children benefited from intervention. Their lives were positively impacted through intervention. The challenge to service providers is to identify children who may require additional services or alternative emphases in goals rather than to exclude some children from treatment. It may be that the children who progressed less substantially would have progressed further if changes in strategy or supplements had been made in the early stages of intervention.

Although there is no data to support specific programming adaptations, some of these children might have benefited from a more visual or functional curricular emphasis. The early introduction of the Picture Exchange Communication system (Bondy & Frost, 1989), for example, might have helped these children to develop functional receptive language and meaningful communication skills (Bondy, 1988). It might also have been helpful to provide these children with more functional programming, focusing on the development of daily living skills and self-help skills. Given their difficulty in receptive language and abstract concepts, an earlier shift in the focus of instruction might have been helpful.

In summary, the present study supports the use of early, intensive, behavioral intervention for children with autism. The results are consistent with those of previous researchers regarding the benefits of such intervention (e.g., Anderson *et al.*, 1987; Birnbrauer & Leach, 1993; Fenske *et al.*, 1987; Harris *et al.*, 1991; Lovaas, 1987; McEachin *et al.*, 1993; Perry *et al.*, 1995). This study suggests that early learning rates may predict outcomes, but much more research needs to be done. Learning rates were moderately correlated with autistic symptomatology, adaptive behavior, and cumulative skill mastery two years into treatment.

These data have implications for treatment. All children with autism require and benefit from intensive intervention, and should have access to these services, regardless of learning rate. Children whose learning rates are slower may be helped by earlier alterations in approaches and strategies. Such changes or additions to intervention may augment the degree to which these children benefit from treatment. The answers to these questions may be gleaned from future research.

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