Demonstrating the Benefits of "Tangible Symbol Systems", an Innovative Use of "Low-Tech" Materials for Students with Severe and Multiple Disabilities

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FINAL REPORT

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Abstract

Most often, when we think of the use of technology to resolve communication problems, we think of the use of rather sophisticated "high tech" systems for individuals whose impairments are essentially physical ones. In most cases, these systems presuppose the comprehension of an abstract symbol system (e.g. printed words or graphic symbols) or, at the minimum, two-dimensional symbols (i.e. pictures). Teachers and therapists are anxious to embrace the latest in technology and want to be able to solve communication problems through the use of such equipment. Unfortunately, for students who have severe or multiple disabilities, "high tech" systems often don't solve the problem. When the student doesn't learn how to use the system, students, teachers and families all become frustrated and the equipment falls into disuse. In other cases, the teacher realizes that the student does not have the cognitive skills necessary to use typical assistive communication devices and, lacking the knowledge of a suitable alternative, the student is not offered a means of communicating effectively. For many of these students who have multiple disabilities, the problem lies in the fact that they are not able to understand the use of symbols. Comprehension of a symbolic communication system is necessary before most communication devices designed to circumvent physical disabilities will be helpful. Unfortunately, learning to use a symbol system does not come automatically to many individuals, particularly those who have severe intellectual disability or sensory impairments.

Some years ago we conducted initial studies on the use of a "low tech" and conceptually concrete symbol system that we called "Tangible Symbol Systems". Tangible symbols are three- and two-dimensional objects that are used as symbols. For many individuals this system circumvents the intellectual limitations that prevent the comprehension of abstract symbols. For others, it accommodates the vision impairments that preclude the perception of two-dimensional symbols such as pictures. We first used tangible symbols in a small demonstration project for children with deaf-blindness. We later used the system with another small group of individuals with a broader range of severe and multiple disabilities. These limited studies had shown that students who could only communicate through gestures and who had failed to acquire abstract symbol systems such as speech or manual sign language could learn to

communicate using tangible symbols. In certain cases, the acquisition of tangible symbol systems served to bridge the gap between gestural communication and more sophisticated communication systems using pictorial or even printed word symbols.

The purpose of this project was to conduct a comprehensive evaluation of the benefits of using tangible symbol systems beyond what had been possible to date. The evaluation had three major goals: the first was to evaluate the efficacy of tangible symbols as a communication system for students with severe and multiple disabilities; the second was to evaluate the potential for tangible symbols to serve as a stepping stone to "higher tech" or more conventional communication systems; the third was to evaluate the efficacy of training materials designed to show teachers and speech-language pathologists how to implement tangible symbol systems.

I. Background and Rationale for the Project

A. Significance

Many students with severe or multiple disabilities fail to bridge the gap between presymbolic communication and the use of the formal language systems that are most often associated with functional communication and literacy (Rowland, & Schweigert, 1989). The whole field of augmentative and alternative communication (AAC) has arisen from the need to provide ways to communicate through means other than spoken symbols, and a number of viable alternatives have been developed for different populations (Baumgart, Johnson & Helmstetter, 1990; Mirenda, Iacono & Williams, 1990; Rowland & Stremel-Campbell, 1987). Some individuals are prevented from learning to use speech or manual sign language because of physical impairments. For these individuals, it is natural to turn to technology in the hopes of providing them with a reliable means of communication. Sophisticated technology, however, is only helpful if individuals have the necessary skills to operate it (Beukelman, Yorkston & Dowden, 1985). Most of the "high tech" communication devices presuppose the comprehension of an abstract symbol system, such as printed words, or at least the comprehension of pictures, which are used to identify the vocabulary that the user may access through the device. Unfortunately, there are many individuals who are not able to comprehend such symbolic systems, either because of intellectual or sensory impairments; and learning to understand a symbol system does not come automatically to many of these individuals. Children without disabilities go through a period of communicating very effectively using gestures and vocalizations before they learn to speak. It is now widely assumed that a generic ability to communicate, realized initially through presymbolic communication, is

the basis for later language acquisition. Our research with individuals who have multi-sensory impairments and other severe disabilities has revealed, however, that the acquisition of a gestural repertoire is not necessarily a sufficient basis for the acquisition of symbolic communication. Many individuals with severe or multisensory disabilities who acquire some gestural communication are not able to make the leap to communication using abstract symbols such as speech or manual sign language. Often, these individuals have received years of sign language training, resulting in the acquisition of only a few manual signs that are used interchangeably. These individuals seem to stumble over the concept of a one-to-one correspondence between an arbitrary motion (a manual sign) or an arbitrary sound (a spoken word), and its referent.

Although gestural communication is extremely effective and certainly is better than no recognizable communication, it limits the communicator to "the here and now". Gestures may only be used to make reference to physically and temporally present topics--for instance, referents that may be pointed to or touched. Symbolic communication, on the other hand, allows reference to physically or temporally distant entities, through symbols that bear a one-to-one correspondence to a specific referent. Symbols, in other words, are not context-bound. The problem that many individuals with multiple disabilities have in bridging the gap between gestures and symbols may be due to impairments in memory capacity, representational ability, or vision. We have developed a "low-tech" communication system that is designed to bridge the gap between presymbolic communication and abstract symbolic communication and that allows for literacy skills to develop for many children who previously would have been considered pre-literate. Our system uses what we call "Tangible Symbols."

What are Tangible Symbols?

Tangible symbols are three-dimensional symbols (objects) or two-dimensional symbols (pictures). They are a type of aided system (Lloyd & Karlan, 1984; Romski, Sevcik & Joyner, 1984). In contrast to the commercially available nonspeech symbol systems such as Blissymbolics (McNaughton & Kates, 1980), Rebus (Woodcock, Clark & Davies, 1969) and NonSLIP (Carrier & Peak, 1975), tangible symbols make relatively low demands on the user's cognitive abilities, memory and visual acuity. Tangible symbols are permanent, requiring only recognition out of an array of symbols rather than recall memory. They are manipulable, so that they may be held by the user, given to a receiver, or placed next to the referent (Blachman [1991] suggests the importance of concrete manipulatives in symbol training). Their use requires only a simple motor response, such as pointing or touching or picking up and extending, making low demands on the user's motor skills. Three-dimensional symbols are tactually discriminable and thus are especially appropriate for use by individuals without sight. Finally, tangible symbols bear an obvious perceptual relationship to their referents--that is they are iconic--making low demands on the user's representational skills.

The use of objects as symbols is not entirely new and seems to have been an outgrowth of Van Dijk's work (1966/67) with deaf-blind children, which in turn is based on the theories of Werner & Kaplan (1963). Stillman & Battle (1984), have described the use of object symbols within the context of "anticipation shelves" or "concrete calendar systems", where the objects are used initially as receptive cues within a time management system which may also serve as a context for communicative exchange. We have tried to extend the use of tangible symbols beyond these contexts to serve as

a means of expressive communication.

Types of Tangible Symbols

We have used tangible symbols that reflect several levels of representation, depending upon the cognitive and sensory abilities of the individual. An overview of these levels of representation is presented in Table 1, with examples of each. It is essential that tangible symbols are designed individually to accommodate the sensory abilities and life experiences of each user. What is meaningful to one individual may not be meaningful to another. For instance, a piece of a straw is not a meaningful symbol for "drink" for an individual who does not have experience drinking through straws. It is essential to understand that iconicity is in the eyes (or hands) of the beholder. What may seem like an obvious relationship between a symbol and referent may not be at all obvious for a particular individual, particularly if s/he has no sight.

Table 1. Types of Tangible Symbols and Some Examples

Level of Representation	Referent	Symbol
Identical Objects	Raisins	A few raisins glued to a piece of cardboard
	Bolt	A bolt is shrink-wrapped onto cardboard backing
Partial or Associated Object	Shoe	Shoelace
	Bicycle	Handle grip
	Car/Out	Car key
	Eating	Spoon
One or Two Shared Features	Pretzel	Thermoform (thin plastic impression) of pretzel (shares shape and size with referent)
	Multicolored Therapy Ball	Wooden bock with balloons of various colors stretched over it (shares texture and color with referent): for persons who are blind only one feature (texture) is shared
Artificial Association	Work Table	Ribbed rubber mat is attached to table: a small piece of the mat serves as the symbol
	Cafeteria	Wooden apple shape is attached to cafeteria door: a similar apple shape serves as the symbol

Who Needs Tangible Symbols?

There are three major indicators that would suggest that an individual might use tangible symbols for expressive communication:

a. The individual must have an intentional fine or gross motor behavior that enables the indication or selection of a symbol. This may take the form of picking up a symbol, pointing, eye pointing, or touching.

b. The individual must have some intentional communication--that is she must realize that she can control the behavior of another person through some means, generally preverbal gestures such as pointing, extending objects, tugging, or hand guiding. An individual who has no means of presymbolic communication is not ready for symbolic communication. If an individual will not extend an actual cup to request more drink from another person, one would not expect him to extend a symbol for a cup to make the same request.

c. The individual should not have the ability to use abstract symbols to communicate. An individual who can use a higher level of communication with reasonable efficiency should not be asked to use a lower level of communication. The exception to this rule is in the case where the environment does not support the individual's use of a higher level of communication. For instance, a student may be able to use some manual signs, but other individuals within the community may not know sign language. In this case, tangible symbols may make an effective “back up” system.

Using Tangible Symbols for Expressive and Receptive Communication

The instructional strategies used to teach individuals to use tangible symbols are no different from those used to teach the use of more conventional symbol systems. Training always takes place within functional routines or during the transition between routines. Specific strategies are discussed in detail by Rowland & Schweigert (1989, 1990). Below is a brief vignette illustrating the use of tangible symbols by an individual we worked with several years ago.

> Roger is totally blind and deaf. He returned to the community after 35 years in institutional settings, with no clearly intentional means of communication. He quickly and avidly learned to use three-dimensional symbols. Roger's tangible symbols are thermoform impressions of objects (thin plastic impressions about 1/4" in depth). He now has a book of shallow thermoform symbols that he uses at his work activity center. He has pages of symbols, which he leafs through quickly, "reading" or scanning them with his fingers. Thermoform sheets are normally used to reproduce Brailled text. Braille is a tactile representation of a completely abstract symbol system. For Roger, who has never heard the sounds that Brailled letters are associated with, Braille is meaningless. But the three-dimensional impressions of actual objects that are familiar to him have meaning. One symbol stands for each activity, and additional symbols stand for materials and tools used within each activity. He also has an abstract shape that means "finished". If no one is close by, he attracts attention by activating a buzzer that he carries clipped to his belt at all times.
>
> During break time, the floor supervisor extends the "finished" symbol to Roger to inform him that break is over. Roger demonstrates his comprehension of the "finished" symbol by standing up and unfolding his travel cane. The supervisor then opens Roger's book to the page containing a sequenced array of activity symbols, signs into his hands "what's next?", and directs his hands to the symbol array. Roger selects the symbol for the next activity and displays it to the supervisor. She confirms his response by signing "yes" into his hand, and Roger travels to the appropriate work station.
>
> At his work table, Roger begins work on an assembly task. Part way through the job, he runs out of one of the parts needed for the task. Roger activates his buzzer to request the attention of the floor supervisor. He then opens his book to the page containing thermoform symbols representing the various parts of that task. With the floor supervisor now present, Roger locates the symbol for the needed part and hands it to her to request more. The floor supervisor confirms this request signing "yes" into Roger's hands, replenishes his supply of parts, and reinforces him for a good job of problem solving.

B. Previous Research by the Authors

Prior to this project we had conducted promising research on the use of tangible symbol systems in two groups of children. Nine students with deaf-blindness, ranging in age from 5 to 16 years, participated in a two-year project designed to develop the concept of tangible symbol systems (OSERS Grant # G008530113). The major measure of communication skill acquisition was the number of tangible symbols that the participants acquired over the course of the project. Most students entered the project with no symbolic communication at all. The number of symbols acquired by project participants ranged from 16 to 98, with a mean of 43. For all students who received direct training from project staff, skill acquisition data were collected on a daily basis. The most telling figures that we compiled from these data were the mean number of sessions that the student required to reach criterion on the acquisition of new symbols. We analyzed the mean number of training sessions required by each participant to acquire the first three symbols trained versus the last three symbols trained. For most participants, the mean rate of acquisition dropped dramatically from the beginning to the end of project participation, suggesting that a generic facility for learning new symbols had been acquired. Two students were able to acquire new symbols in a single session by the end of the project.

We had also completed a second project (OSERS Grant # H086U90040) prior to this one that allowed us to investigate the use of tangible symbol systems with students who experienced a broader range of disabilities (students labeled "severely disabled" or "multiply disabled"). These were a group of ten students ranging in age from 4-19 years who were part of a larger group of students participating in a teacher training project. In

this project, teachers, as opposed to project staff, implemented the tangible symbols instruction. Throughout this project, communication behavior was measured using an observational data system entitled the Rate/Ratio System (Rowland, 1990). This system tracks the rate of presymbolic and symbolic communication by students. Students were observed at least monthly in a target activity during which the teacher specifically worked to improve communication skills and also in a generalization activity. The observations were scored on a modified frequency basis, scoring communicative behavior for each 30-second interval. Reliability was computed on an ongoing basis on 20% of the sessions. The measure reported in Table 2 is the mean proportion of 30-second intervals during which the student was observed to use tangible symbols for the first half (Pre) and the last half (Post) of the observation sessions. The mean probability of symbolic communication increased from .16 to .35 in the target activity over the course of project involvement, which ranged from 3 months to 7 months.

Table 2. Mean Probability of Symbolic Behavior During First Half (Pre) and Last Half (Post) of Sessions for "Tangible Symbol Systems…" Users

			P (Symbolic Behavior)			
			Target Program		Non-Target (Generalization) Program	
Year	Classroom	Participant #	Pre	Post	Pre	Post
1	1	1	.05	.11	.02	.06
2	6	14	.31	.31	.81	.84
	6	16	.44	.62	.15	.48
	7	17	.24	.51	.38	.43
	7	18	.26	.40	.74	.82
3	9	25	.00	.14	(No Generalization data collected in Year 3)	
	9	26	.11	.20		
	12	32	.32	.44		
	12	33	.21	.40		
	12	34	.08	.37		
		Mean	.16	.35	.42	.53

C. The Need for Comprehensive Research on Tangible Symbol Systems

The research noted above, although limited in scope, was extremely encouraging. All of the participants in the two projects learned to use tangible symbols to one degree or another. We have managed to keep in touch with most of the participants in the original two-year tangible symbols project. A number of those students have progressed to using more conventional symbol systems, including pictures, and even printed words. Time and again, our experience shows us that it is impossible to predict how far down the road toward conventional communication and literacy skills an individual with severe or multiple disabilities may progress. It seems clear that once a symbolic system is acquired, other symbolic systems may come more easily.

This project was developed to fulfill the need for definitive research on the use of tangible symbols. Specifically, we felt that three issues needed to be addressed.

1. The efficacy of tangible symbol systems should be demonstrated on a larger group of subjects.
2. The long-term impact of learning to use tangible symbol systems should be explored in a longitudinal study. We needed further information about the utility of tangible symbols as a stepping-stone to the use of more conventional or sophisticated communication systems.

These issues speak to the general question of to what extent tangible symbol systems can contribute to the emergence and development of communication skills in children who are not likely to learn to use more conventional symbol systems.

The third issue concerned the availability of training materials for teachers and

other professionals who might want to teach their students to use tangible symbols.

3. There was a need to develop video recordings of students using tangible symbols to supplement the printed materials that were developed as training materials through the original project. Videotapes in a case-study format that show students communicating at different stages of acquisition would be powerful training tools. In addition, we needed to evaluate whether the existing printed training materials needed to be expanded or revised.

D. Research Design

The three major studies of the project are briefly described below.

Study I was designed to document the efficacy of tangible symbol systems as a means of symbolic communication for students who had no means of communicating except for gestures. 20 students from Group I were to receive direct intervention in Year 1, while a matched group of 20 students in Group II were to be monitored that year. In Year 2, the Group II students were to receive intervention.

Study II was a longitudinal study designed to explore the long-term potential for tangible symbols as a possible stepping stone to the use of more conventional communication systems, including "high-tech" assistive devices. Teachers of the Group I students received consultation addressing their students' communication development in Years 2 and 3 of the project. The progress of communication skill development in these students was documented in the years following. This was essentially a descriptive study.

Study III was designed to evaluate the effectiveness of new training materials

developed through this project. A third group of students and their teachers (Group III) were involved in this study. Training materials included a new videotape that includes a series of case studies of students who have learned to use tangible symbol systems. This tape shows the students at different stages of acquisition, illustrates the instructional techniques used at each stage, and shows the youngsters using tangible symbols across functional contexts.

II. Summary of Accomplishments

A. Participants and Sites

Participants were recruited from the Portland, OR Public Schools; Evergreen School District #114 in Vancouver, WA; the Clackamas County, OR, Educational Service District; and the Washington County, OR, Educational Service District. Most of the students, however, were in the Portland Public Schools, where the bulk of the population resides in this area. The project was explained to interested programs and teachers and speech-language pathologists recommended children for the project. One of the goals of the project was to "push the envelope" with regard to the range of children who might benefit from using tangible symbols. That is, we wanted to more clearly define which children were not ready to use symbols yet (because their overall level of functioning was so low), as well as to determine whether children who were functioning at higher levels than we had encountered before might benefit from using tangible symbols. The children who were referred to the project had little, if any, conventional communication skills. Most of them were not able to understand speech, printed language or manual sign language: for the most part, receptive communication skills were limited to the comprehension of gestures, facial expressions, tactile signals and perhaps tone of voice. Expressively, some of these individuals could communicate very effectively through gestures and a few used some manual signs or speech approximations, while others had no clearly interpretable communicative behaviors at all. The children as a group experienced combinations of the following disabilities: severe mental retardation; vision impairment; hearing impairment; autism; physical disabilities; and chronic illness. Many of these children had rare syndromes or genetic

abnormalities about which little is known by either the medical or educational profession. These are students who typically learn very slowly: only prolonged intervention is likely to result in measurable and meaningful progress.

Ultimately, 52 children were referred to the project. We accepted all of them and they were an extremely varied group. In the end, because of families moving or the physical instability of the child, a total of 47 children actually received direct intervention through the project. Demographics on these children appear in Table 3. Although ages ranged from 3 to 18 years, the mean age was 6 years, since many of the children (36) were 5 or under. Thirty-two of the students (62%) were males. By far the most prevalent etiology for this group of children was “unknown” (n = 31). This is in part related to the extreme youth of many of the children--we would expect more precise diagnoses as they mature. Another group of 10 children were involved indirectly in the project when their teachers and/or speech-language pathologists field-tested training materials in Year 3. Their demographics are not included here.

Table 3. Demographics for Participants

Participant	Age in Years at Start of Intervention	Gender	Major Handicapping Conditions*	Etiology
1	5	M	OI, SD, VI, HI, MR	Unknown
2	3	M	DD, VI, OI	Intrauterine stroke/microcephaly
3	8	F	SD, OI, VI, MR	Unknown
4	8	M	A, MR, VI, OI, SD	Unknown genetic
5	8	M	VI, (Blind), OI, MR	Cytomegalovirus
6	6	M	VI (Blind), OI, DD	Unknown
7	4	M	VI, OI, DD	Acute neonatal hypoglycemic
8	5	F	OI, CI, DD	Chromosomal abnormality
9	11	F	OI, VI, MR	Unknown
10	4	F	DD, VI	Di-George syndrome
11	5	M	DD, OI, VI	Unknown genetic
12	4	F	SD, CI, DD, OI	Hydrocephalus, microtic anemia
13	12	F	MR, VI	Cytomegalovirus

Participant	Age in Years at Start of Intervention	Gender	Major Handicapping Conditions*	Etiology
14	3	M	DD, OI, SD	Unknown genetic
15	4	F	VI, DD	Prematurity
16	4	M	OI, DD, VI	Unknown
17	3	M	SD, OI, DD	Undiagnosed congenital syndrome
18	5	F	OI, VI, DD	Unknown
19	3	F	VI (Blind), DD	Structural neural abnormality
20	3	F	SD, OI, DD	Metabolic disorder
21	9	M	HI, VI, DD, MF	Congenital abnormalities
22	3	M	OI, CI, DD	Chromosomal abnormality
23	4	M	SD, OI, VI, DD	Traumatic brain injury
24	3	M	DD	Down syndrome
25	9	F	MR, A, VI, HI	Congenital static encephalopathy
26	5	M	DD, OI, VI	Traumatic Brain Injury
27	4	F	A, DD	Unknown
28	4	F	A, DD	Unknown
29	17	M	OI, HI, DD	Unknown

Participant	Age in Years at Start of Intervention	Gender	Major Handicapping Conditions*	Etiology
30	4	M	A, DD	Unknown
31	3	M	A, DD	Williams syndrome
32	10	M	MR, OI, VI, A	Unknown
33	3	M	DD	Unknown
34	18	F	VI (Blind), HI, MR	Unknown
35	3	M	OI, DD	Unknown
36	3	F	DD	Unknown
37	3	M	DD	Unknown
38	14	F	VI, HI, MR	Unknown
39	4	M	A, DD	Unknown
40	5	M	VI, A, DD	Unknown
41	3	F	OI, DD	Unknown
42	3	F	D.D., O.I.	Unknown
43	9	M	A., V.I., S.D., M.R.	microcephaly
44	11	M	H.I., M.R.	Genetic Static Neurologic Abnormality
45	3	M	O.I., D.D., V.I.	unknown

Participant	Age in Years at Start of Intervention	Gender	Major Handicapping Conditions*	Etiology
46	3	M	A., D.D.	unknown
47	4	F	D.D, S.D., O.I.	unknown
48	3	F	S.D., O.I., D.D.	unknown
49	11	M	O.I., V.I.	Hypoxia
50	4	M	D.D, O.I., S.D., V.I., H.I.	unknown
51	4	F	S.D., D.D, V.I., O.I.	hydrocephalus
52	3	M	S.D., V.I., O.I.	unknown

*Key to handicapping conditions

A = Autism
HI = Hearing impairment
VI = Vision impairment
SD = Seizure disorder
OI = Orthopedic impairment
DD = Developmental delay
MR = Mental retardation
CI = Chronic illness

There were 13 teachers and classrooms whose students participated in the project (again, excluding the classrooms involved in field testing training materials). Nine of the teachers had Master's degrees. Their special education teaching experience ranged from 2 years to 23. Demographics for these teachers appear in Table 4.

Table 4. 1993-1996 Teacher Demographics

I.D. #	Gender	General Teaching Experience (Years)	Special Education Teaching Experience (Years)	Area of Master's Degree	Other Areas of Certification
1	F	0	2	--	Bachelors Degree Special Ed. (severe)
2	F	0	6	Special Education	Handicapped learners cert. Bach..-Speech Pathology
3	F	4	8	Special Education--severe	Bachelors—Elem. Ed.
4	F	0	8	Special Education--severe	Bachelors—Elem. Ed.
5	F	0	8	Curriculum & Instruction	Bachelors degree—Special Ed.
6	F	0	6	Hearing Impaired	Handicapped learners cert.
7	F	3	11	Elementary Ed.	Handicapped Learners cert.
8	F	0	12	Hearing Impaired	Elem. Education, handicapped learner/LD
9	F	0	12	Special Education	Elem. Education, handicapped learner
10	F	0	23	Handicapped learner	Elementary and special education
11	F	0	2	--	Psychology/handicapped learners
12	F	0	2	--	Bachelors degree Special Ed./ECSE
13	F	0	5	--	Bachelors degree Special Ed.

B. Status of Project Activities

In this section, all objectives and activities from the original proposal are listed, with comments regarding the final status of each activity.

Objective 1 DEMONSTRATE EFFICACY OF TANGIBLE SYMBOL SYSTEMS (Study I)

Activity 1.1 Assign students to groups. After initial observations, classrooms of students were assigned to the two major groups of subjects. It was not possible to assign students in the same classroom to different groups, since the natural language approach implemented is likely to influence an entire classroom of students.

Activity 1.2 Assess students. Students' communication skills were assessed using the Communication Matrix (Rowland, 1984, 1996). The A.C.E. (Rowland & Schweigert, 1993) was used to assess a representative activity for each student prior to intervention. A baseline observation was made using the Rate /Ratio Observational Data System (Rowland, 1990).

Activity 1.3 Provide instruction to students in Group I. Project staff met with teachers to review assessment data and discuss intervention plans. In Year 1, project staff provided direct instruction to Group I students during one activity per school day. Teachers were expected to provide additional training throughout the week in a variety of contexts. In Year 1, this grant was transferred from Oregon Research Institute to Washington State University. This transfer resulted in delays in first year activities. Direct intervention did not begin until March of Year 1 for the Group I students. To make up for this delay, we were able to work with some of these students in their homes in the summer between Years 1 and 2. We continued to provide direct intervention for 5 Group I students in Year 2, to make up for the brief duration of intervention provided in Year 1.

Activity 1.4 Provide training to teachers in Group I. In Year 1, teachers of Group I students and their educational assistants received training from project staff in the form of consultation regarding project participants and the demonstration of instructional strategies by project staff who provided direct intervention to students.

Activity 1.5 Monitor students in Group II. In Year 1, the progress of students in Group II (who were not receiving intervention) was monitored using the Communication Matrix on an annual basis. Rate/Ratio observations were made twice prior to the initiation of direct intervention--once in the spring of Year 1 and once again in the Fall of Year 2.

Activity 1.6 Provide instruction to students in Group II. In Year 2, the Group II students received direct instruction from project staff, as described in Activity 1.3. Five students from Group II were no longer available, however, in Year 2.

Activity 1.7 Provide training to teachers in Group II. In Year 2 teacher/speech language pathologist teams serving the 17 children comprising Group II participated in meetings with project staff. Each team averaged 4 meetings throughout the year. Each of these children was also receiving direct intervention from project staff at this time. Their progress within those programs was discussed. Generalization strategies for recently acquired communication skills were developed, as were plans for expanding the opportunities for students to use emerging symbolic communication skills across their entire day.

Activity 1.8 Compare performance of students under non-intervention and intervention conditions. Results of the comparison between of Group I and Group II students appear in the Results section of this document (Section IV).

Objective 2 INVESTIGATE LONG-TERM IMPACT ON LITERACY SKILLS (Study II)

Activity 2.1 Provide ongoing consultation and support to teachers in Group I. Of the original 15 students in Group I, 5 continued to receive direct intervention during Year 2 of the project due to the late start of intervention in Year 1. Of the remaining 10,

3 were lost to transitions or family moves, and 7 were monitored in Year 2 with their teachers receiving consultation from project staff.

Activity 2.2 Monitor students in Group I. Of the 12 Group I students who were available in Year 2 (5 continuing in direct intervention and 7 receiving consultation), 11 were monitored through collection of Rate/Ratio data by project staff. Communication Matrix data was collected on 10 students and Classroom Symbol Use data was gathered on these same 10.

Activity 2.3 Document progress of students across three years. A description of the development of participants= communication skills across the duration of the project appear in the Results section (Section IV).

Objective 3 EVALUATE EFFICACY OF TRAINING MATERIALS (Study III)

Activity 3.1 Monitor students and teachers in Group III. We had initially planned to monitor Group III students (whose teachers would receive training in Year 3) for a year in advance--during Year 2. However, at the end of Year 2, the Portland Public School program serving students which made up a large percentage of our target population, disbanded. All students were transitioned to their home districts, making many of them inaccessible to the project. The early intervention program serving children 0-5 years of age is a very fluid program, which also made selection of students one year in advance impossible. As a result, we felt that all eligible participants in the early intervention program should receive direct intervention when they were identified rather than hoping they would still be attending the same program in the following year. Therefore, this activity was not accomplished.

Activity 3.2 Provide training to teachers in Group III At the beginning of Year 3, seven teachers and speech language pathologists from the Clackamas County, OR

Educational Service District and one from Washington County, OR Educational Service District agreed to participate in the tangible symbols training. An additional group of ten teachers and Speech Language pathologists from the Portland Early Intervention Program signed on for this training in December. Support and release time arrangements were achieved through negotiations with each program's administration. Each participant served students with severe and multiple disabilities. The students ranged in age from 3-21 years. Two 1/2- day meetings with each group were conducted. Assignments were given, and the Tangible Symbol manual and the new video tape were viewed. Each participant chose a target student with whom to implement tangible symbol systems.

Activity 3.3 Monitor students and teachers in Group III after training of teachers. Three additional 1/2 day meetings were then scheduled with each group. The focus of these sessions was their individual implementation of Tangible Symbol Systems with the selected child in their classroom, in a targeted activity. Monthly videotapings of these activities were made by project staff. These videotapes served as the basis of discussion in our subsequent meetings. Each participant would narrate their tape and analyze its content. Changes in intervention were decided upon for each participant typically through group discussion. Additionally, project staff were available for telephone follow up initiated by the participants. In several instances, on-site consultations were provided. Rate/Ratio data was gathered from the video samples and the ACE was administered also to the videotapes. In the spring of Year 3, each participant was asked to complete the Communication Matrix as well as the A.C.E.

Activity 3.4 Compare performance of teachers and students before and after training. The progress of teachers who received training and of their students is

discussed in the Results section (Section IV).

Objective 4. PRODUCT DEVELOPMENT AND DISSEMINATION

Activity 4.1 Make videotaped records of student performance. Students were videotaped once a month during direct intervention phases.

Activity 4.2 Develop videotaped case studies. Videotapes were edited together at the end of the second project year to produce live-action case studies illustrating the development of five students. These video case studies were invaluable training aids for Study III. They were included in the final videotape produced by the project.

Activity 4.3 Revise training materials. Printed materials developed on the original tangible symbols project were not revised. All teachers and speech-language pathologists involved in the project were asked whether they thought that the original manual should be revised, and none of them perceived the need to do so.

Activity 4.4 Seek publication of revised materials. The revised videotape was submitted for publication to Communication Skill Builders (a division of the Psychological Corporation), the company that had published the original Tangible Symbols manual and video. They accepted the new video and it is listed in their current catalogue. Commercial publication is the most effective way to disseminate training materials such as these.

Activity 4.5 Present project results at national conference. Presentations by project staff related to this project are listed below.

Rowland, C. Beyond the milieu approach: Communication strategies for individuals with multiple disabilities. Fourth Annual State-of-the-Art Conference on Augmentative and Alternative Communication and Crossroads Conference on Communicative Disorders, October, 1993.

Rowland, C. Intervention strategies for the early stages of communication: Issues and solutions for young children who have multiple disabilities. Conference on Intervention Strategies in Early Communication, Mackay Center, Montreal, Quebec, April, 1994.

Rowland, C., Stremel, K., Schweigert, P., Stillman, R., Mar, H. And Linam, A. Children with multiple disabilities: Impacting home, school and adult settings. 1994 ASHA Annual Convention, New Orleans, November, 1994.

Schweigert, P. & Rowland, C. Tangible Symbol Systems: An Alternative Communication System for Children Who Have Multiple Disabilities. Council for Exceptional Children Annual Convention, Indianapolis, April, 1995.

Rowland, C. Tangible Symbols Revisited: Case Studies and Results of Further Research. 4th Annual Conference on Research and Applications Related to Developmental Disabilities: St. Amant Centre, Winnipeg, Canada, October, 1995.

Rowland, C. & Schweigert, P. Communication Intervention for Young Children with Severe and Multiple Disabilities. Shoreline ESD, Seattle, WA, July, 1996.

Rowland, C. & Schweigert, P. Communication Intervention for Young Children with Severe and Multiple Disabilities. University of California at Santa Barbara, CA, August, 1996.

Rowland, C. & Schweigert, P. Tangible Symbols Revisited: Case Studies and Results of Further Research. International Society for Augmentative & Alternative Communication Conference, Vancouver, B.C., August, 1996.

IV. Results

A. THE MAJOR DATA SYSTEMS

Despite the recent spate of development in alternative communication techniques, there still are no standardized assessment instruments that adequately measure the communication skills of alternative communication users. The measurement instruments that were used in this project are ones that were designed by the authors to fulfill this purpose. They have all been used extensively in previous projects and have been subjected to reliability studies. Below we describe the major data systems used in this project along with procedures implemented to assess inter-observer reliability.

1. Communication Matrix (Rowland, 1990, 1996).

This instrument covers seven levels of communication development, ranging from pre-intentional communication to the use of two and three-symbol combinations. It accommodates any means of communication, from gross body movements to tangible symbols to speech, and also documents the range of communicative intents expressed by the subject. It was administered on a pre-post intervention basis and at least annually by either teachers, speech-language pathologists or project staff.

2. A.C.E. Inventory (Rowland & Schweigert, 1992).

This is an inventory designed to evaluate the degree to which a specific activity encourages communication for a particular student. It is a check-list of techniques and characteristics of the physical and social environment that may be in place that would increase the socio-communicative value of an activity. It was used to document any gains in communication and social integration in activities in which students were using tangible symbols. The ultimate goal of communication and literacy skills is, after all, to

function effectively in the social world. Thus, intervention techniques were expected to promote social relationships and social integration. The ACE Inventory was administered after making observations of live programs or videotapes of programs. Reliability was computed on at least 20% of the sessions for each participant. Inter-observer agreement was computed as number of agreements/number agreements + disagreements. The mean inter-observer agreement obtained on the ACE across all three project years was 97%.

3. Rate/Ratio Data System (Rowland, 1984).

This observational system tracks the rate and type of presymbolic and symbolic communication by students; communicative functions or intents expressed by students; rate of initiated communication by students; and the rate of cues for communication from teachers or peers. Observations are made on a modified frequency basis, scoring the presence of each category of behavior during each 30-second interval. Project staff were already skilled at using this observational system. Reliability checks were conducted on at least 20% of the sessions for each participant, spaced evenly throughout the school year. The Rate/Ratio data were collapsed into two data points for each student year, representing mean performance for the first half of the year versus the last half of the year. Experience has shown that observational data of any sort taken on students with severe disabilities in typical classroom situations is extremely uneven. Three figures were computed to assess inter-observer reliability for these data: the Mean Occurrence Reliability (the mean agreement on the occurrence --as opposed to the non-occurrence--of a behavior category)--a score above .80 is preferred), the Chance Agreement (the probability that agreements will occur by chance)--a low score is preferred) and the Mean Kappa Coefficient (an agreement statistic that takes into

account the rate of occurrence and non-occurrence of the behavior category)--a score greater than .60 is preferred. Reliability was computed on each behavior category. The figures reported below in Table 5 are taken across all behavior categories and all students and sessions for each of the three years of the project.

Table 5. Inter-Observer Reliability Figures for Rate/Ratio Data System

Year of Project	Mean Occurrence	Chance Agreement	Mean Kappa Coefficient
93/94 (Year 1)	.89	.21	.88
94/95 (Year 2)	.90	.16	.90
95/96 (Year 3)	.90	.22	.90
Mean	.90	.20	.89

4. Direct Intervention Data

When students received direct intervention, they generally received one-on-one instruction from project staff for one program out of every day that they attended school. Programs were structured around the children's favorite activities, since these are more motivating contexts for learning and for communication in particular. Staff who conducted the programs used highly prescribed and individualized approaches, but they were provided in a naturalistic and spontaneous manner. Programs were designed to encourage the child to communicate using whatever means was most appropriate for the child. Staff took data on the child's response to each opportunity provided for communication. An independent behavior was always the ultimate objective and only independent behavior by the child was scored as successful. Programs were changed as often as was necessary to respond to the child's performance. If the child were failing, then the program would be changed to make it easier for the child to succeed. If

the child were succeeding, then the instructor would ”up the ante” to promote further learning. All program changes were tracked on the Intervention Record form.

Project staff took data on the child’s target behavior each time they conducted the program (each session) and within each session they took data on each trial or opportunity to use the target behavior that was provided. Given that during a typical school day approximately 12 hours of direct intervention were delivered to approximately 18 children on an individual basis, it was not possible to conduct reliability checks on a full 20% of the data. The following reliability checks on the direct intervention data were thus conducted. Due to the late start of intervention in our first project year (a result of prolonged child identification and staff hiring processes) no reliabilities were gathered for that year. However, of the fourteen children who received direct instruction in Year 1, five continued with the project into Year 2 and reliabilities were computed on their interventions during that year. Inter-observer agreement was computed as number of agreements/number agreements + disagreements with each trial as the unit of assessment. First, a reliability probe was conducted by the Project Coordinator during live observations of the programs on 40% of all direct intervention programs conducted during a period of five consecutive days at the beginning of Year 2. Reliability ranged from 71%-100% with a mean of 92%. Thereafter, the two instructional assistants coded videotapes of each other conducting programs and assessed their reliability. Reliability was assessed in this way on one direct intervention session per participant per month. This amounted to approximately 10% of the sessions for the entire school year (the total number of sessions for an intervention year per child, ranged in total from 25 to 96 or from 4 to 12 per month). Across Years 2 and 3 the mean inter-observer agreement on direct intervention programs was 89.5%.

Agreement was high due to the precise nature of the instruction conducted primarily using discrete trial training. The inter-observer agreement figures convinced us that any additional reliability was unwarranted and, in any case, it would have been unmanageable.

B. Three Groups of Participants and How They Differed

To present the data on our participants, we will need to spend some time explaining a system that we developed to better describe them after our first year of effort with the initial group of students. We had intentionally accepted a widely varied group of children to participate in the project, with the avowed intent of better describing the sorts of children for whom tangible symbols was and wasn't useful. Therefore, we included some children who were much higher functioning and some much lower functioning than those whom we had taught to use tangible symbols in past projects. By the end of our first year it became clear to us that the children were too heterogeneous to lump them all together as we attempted to describe our interventions and the student's performance. Goals and expectations for such widely varied students cannot be uniform. For instance, for one child, the overriding goal was to assist him to develop a reliable means of gaining attention and to encourage a desire to do so. For another child, we focused on combined symbol use to increase her length of utterance, as well as increasing the number of communicative functions she could fulfill using symbolic communication.

We reviewed all of our initial data--both subjective impressions of the children as we first encountered them and objective assessments of their success or failure with tangible symbols--to find a way to characterize these children in terms of our expectations and their successes and failures. Ultimately we developed ratings of their

"Readiness" for tangible symbol systems and of their "Performance" or their acquisition of tangible symbols.

1. Readiness: How They Looked Prior to Intervention

Our first attempt to describe these children was based on assessment results from the initial Communication Matrix observation, interviews with teachers, and unstructured interactions with the children (usually 4-5 sessions). We referred to these sessions as rapport building time, during which time project staff would attempt to engage the children in social interaction. Within this playful context, children displayed their preferences for various types of toys and social interactions, and we could observe first hand the means by which they could express themselves. Based on these data and experiences with the child, we scored their "Readiness" for symbolic communication on a Likert-type scale of 0-5 (0=low, 5=high) on the following seven subjective variables:

Presymbolic Behavior-- presence of pre-intentional or intentional nonconventional communicative behaviors .

Presymbolic Communication --presence of conventional gestural communication or other conventional forms of early communication including speech approximations

Use of abstract symbol systems--all children who were considered for project participation evidenced significant delays in abstract symbolic communication, but a few showed some minimal speech or sign approximations.

[Note: all of above were based on the Communication Matrix data]

Social Readiness--desire to interact with others as indicated by attending to others, initiation and reinstatement behaviors.

Non-social Readiness--desire or interest in the physical environment as indicated by attention and reaction to objects, toys etc. and variety of means of acting on these items.

Overall consistency in behavior--influenced by medical fragility, seizure disorders, alertness, distractibility, orthopedic needs.

Readability of response--influenced by orthopedic involvement.

Scores on these variables were tallied, with a maximum possible score of 35. The "Readiness" ratings for the Year 1 participants ranged from 8-29, with a mean of 18.6. The children were then grouped according to the logical breaks in the distribution of Readiness ratings (Group I=0-11; Group II=12-23; Group III=24-35). Table 6 below shows the actual mean and range for students in each group for Year 1.

Table 6. "Readiness" Ratings for Three Groups of Students in Year One

Readiness Ratings	**Group I**	**Group II**	**Group III**
Mean	8.5	16	26.8
Range	8-9	12-22	24-29
n	2	8	5

2. Performance: How They Looked After Intervention

Acknowledging the degree of subjectivity in the above ranking process, a second more objective system was devised based on the participant's actual performance during the first year of intervention. The following seven variables related to actual child performance were assigned rankings based on data taken during direct intervention. The variables and rating system were as follows:

Number of Symbols Acquired (during direct intervention by project staff): 0=0-1; 1=2-3; 2=4-10; 3=11-15; 4=16-24; 5=25 or more.

Length of Utterance (the number of symbols that the child was able to string together into one utterance): 0 = no symbols; 1 = one-symbol utterance; 2 = two-symbol utterance; 3 = three-symbol utterance.

Number of Symbolic Intents (number of communicative intents or functions that the child was able to fulfill using symbols): 4 is the maximum score indicating all of the following intents--Requesting, Labeling, Yes/No, Receptive Uses

Array Size (number of symbols in the array out of which child selected symbols to communicate). The greater the array size, the greater are the demands on the child's discrimination abilities: the larger the array size, the more efficient the system is because it is more accessible): 0=no symbols; 1=1; 2=2; 3=3; 4=4-6; 5=7+

Distractor Type (In any symbol display, 1 symbol is relevant or correct at the time, while the others are distractors. The demands on the child are greatest when all symbols displayed are of equal preference or relevance to the child, since the need to visually and/or tactually attend to the symbols is the greatest): 0=no symbols acquired; 1=no distractors (symbols used in 1-symbol arrays

only); 2="nothing" distractor (e.g. a blank card with no referent); 3= symbol for non-preferred item; 4 = symbol for equally preferred item

Acquisition Rate-Pre (The number of instructional sessions the child needed to acquire the first set of symbols): 0=10+; 1=8-9; 2=6-7; 3=4-5; 4=3; 5=2

Acquisition Rate-Post (The number of instructional sessions the child needed to acquire the last set of symbols):0=10+; 1=8-9; 2=6-7; 3=4-5; 4=3; 5=2

This second set of scores were tallied, with a maximum possible "Performance" rating of 31. Scores on the Year 1 students ranged from 0-29, with a mean of 15.4. The participants were then grouped according to the logical breaks in the distribution of Performance scores (Group I=0-10; Group II=11-20; Group III=21-31). The results appear in Table 7 below. All but one of the students maintained the same Group placement in the Performance rating as they did in the Readiness rating. Thus, the predictive validity of the initial subjective impressions of readiness for symbolic communication was 93%.

Table 7. "Performance" Ratings for Three Groups of Students in Year One

	Group I	**Group II**	**Group III**
Mean	0	13.3	25
Range	0	10-20	21-29
n	2	8	5

3. Intervention Strategies Used

At the end of Year 1 we also analyzed the intervention strategies employed with each child by project staff. All changes in the direct intervention programs were recorded throughout the course of intervention on the Intervention Record form. This form tracks change options in five major areas: Assessment (additional assessments conducted); Symbolic (symbolic issues such as size of symbol array, type of symbols; comprehension checks); Presymbolic (the function of presymbolic communicative behaviors) and Procedure (general instructional issues such as instructional prompts, correction procedures) and Environmental (changes in communication partner, setting, etc.). For each Year 1 participant, we analyzed the number of instructional changes made in each of the categories and subcategories on the Intervention Record forms. Then we compared the types of instructional changes made for the three groups. The instruction provided to the students in the three groups was strikingly different, as would be expected. Table 8 below shows the percent of intervention changes related to Symbolic issues, Presymbolic issues, and all other issues for the three groups of participants in Year 1.

Table 8. **Percent of Changes in Each of Three Categories for Direct Intervention Programs for Students in Three Groups in Year One**

Area of Change	Type of Program Change (from Intervention Records)	Group I	Group II	Group III
Symbolic Issues	Vocabulary	0	3	10
	Array Size	6	16	20
	Distractor Type	9	8	5
	Symbol Type	9	6	9
	Protocol (order of presenting symbols, objects)	3	8	8
	Length of Utterance	0	0	1
	Generalization	0	2	3
	Portability of Symbols	0	1	2
	Symbolic Function or Intent	0	0	4
Presymbolic Issues	Presymbolic Function or Intent	6	2	2
Environmental, Assessment or Procedural Changes not related specifically to symbol use	Other (general instructional issues)	67	55	35

The data show very clearly that Group I received a great deal of instruction related to presymbolic and general procedural issues, but not to symbolic issues, while Groups II and III received progressively less instructional changes related to procedural issues and more related to symbolic issues.

We continued to use the Readiness and Performance rating systems and to track changes in intervention programs over the following 2 years. The table below shows how the two rating systems held up in subsequent project years. The data in Table 9 show the pre-intervention Readiness score and the post-intervention Performance score for children who participated in Years 2 and 3 of the project.

Table 9. **Readiness and Performance Ratings for Three Groups of Students in Years Two and Three**

Rating System	Measure	Group I (n=9)	Group II (n=15)	Group III (n=13)
Readiness (Pre-Intervention) Rating	Mean	7.6	18.9	27.3
	Range	1-12	14-23	24-34
Performance (Post-Intervention) Rating	Mean	6.2	16.6	24.3
	Range	0-15	12-20	20-29

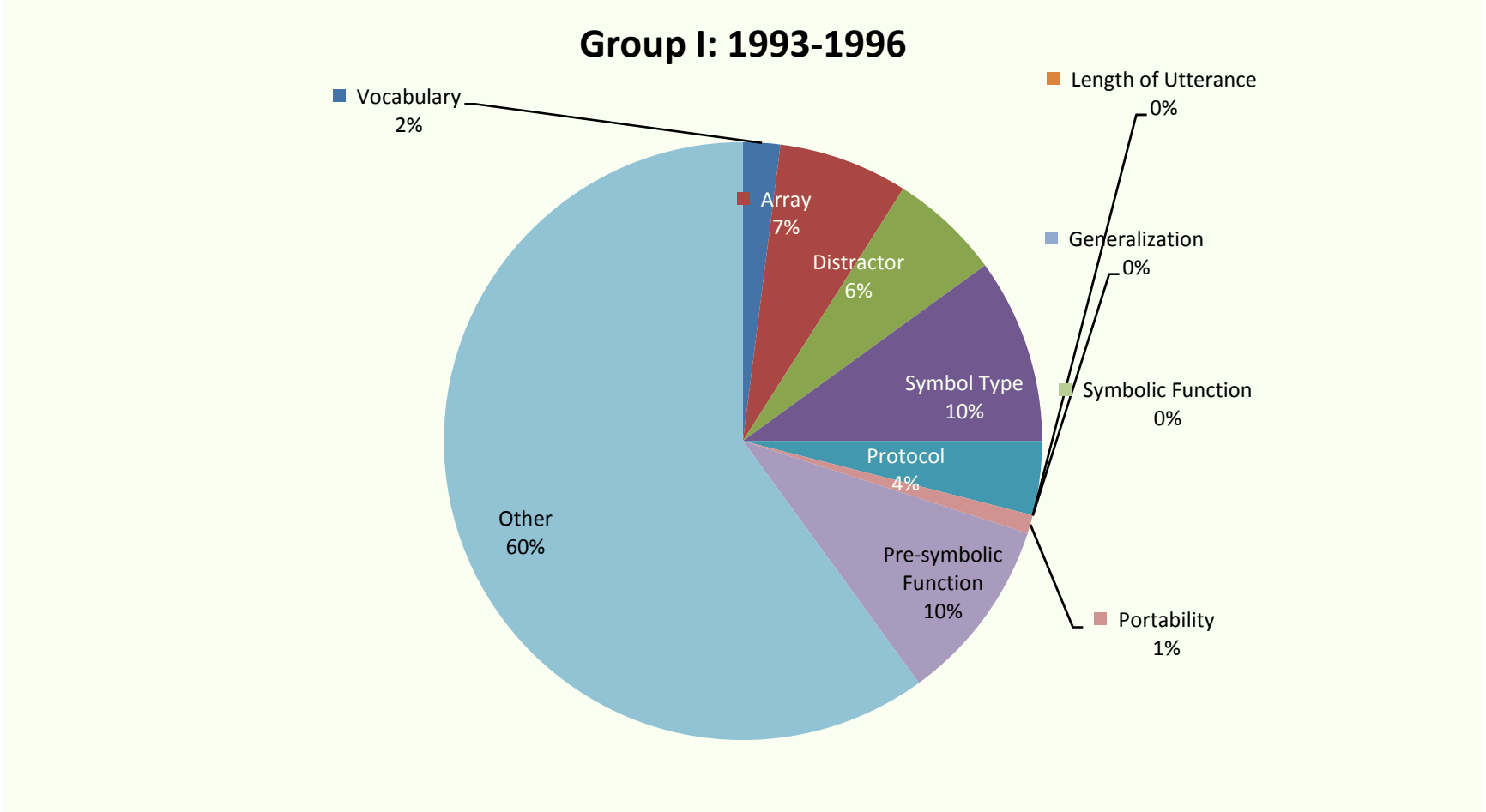
Across all three years of the project 47 out of 52 students (90.4%) were ranked in the same group on the Performance rating as on the Readiness rating. Five students did not appear in the same group post-intervention as pre-intervention. For three of these children, the Performance grouping was lower than the Readiness grouping because of poor performance during intervention. This poor performance was affected by poor health (frequent absences), or low availability for intervention due to scheduling problems. Of the two students who ranked in a higher Performance group than

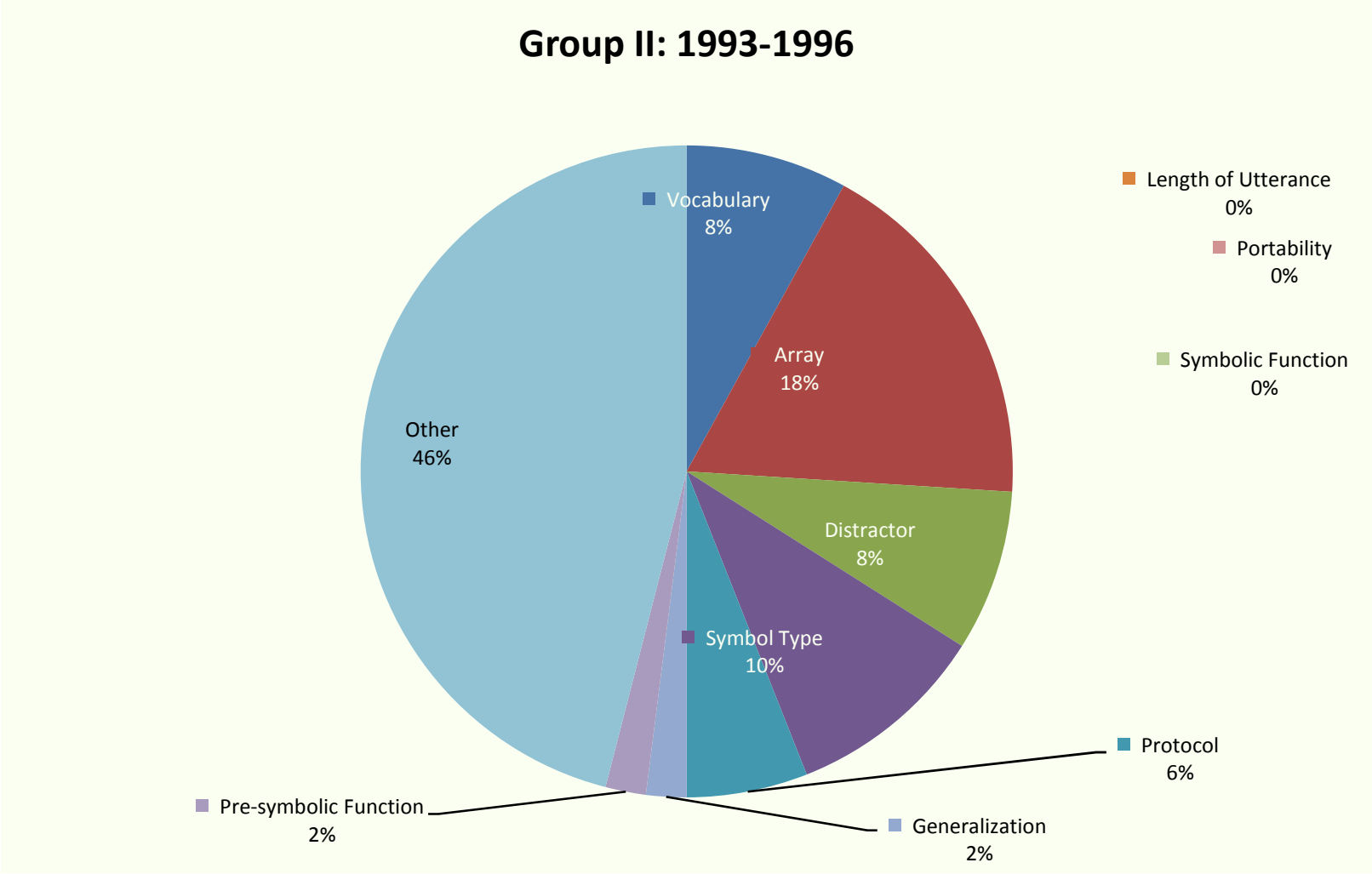
expected based on their Readiness rating, both had spent 6-9 months of intervention focused on strengthening their presymbolic communication skills (their Readiness ratings placed them in Group I). When finally introduced to tangible symbols, they both very quickly acquired an initial vocabulary and their success in this realm pushed their Performance rating up to a Group II level.

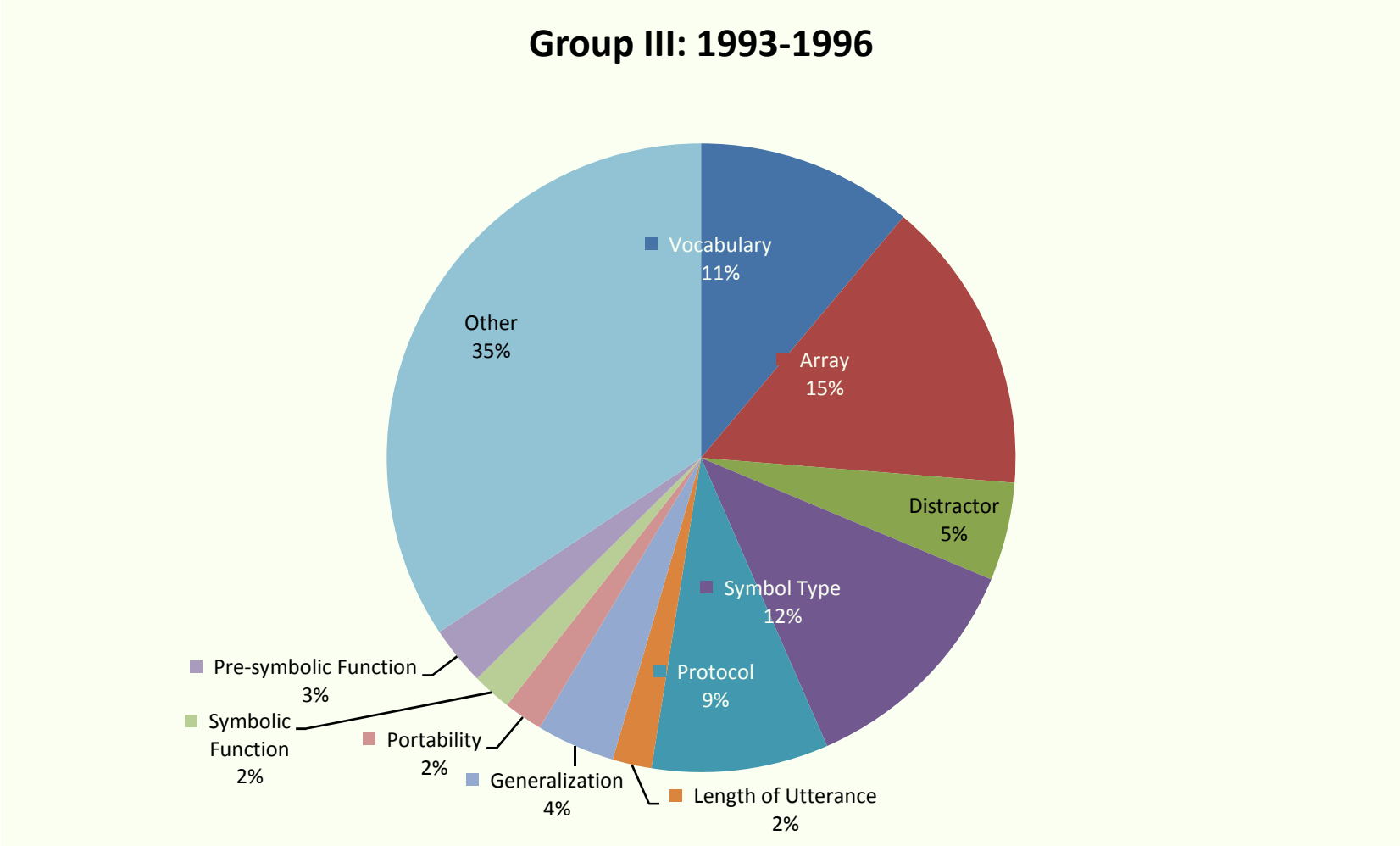
By the end of the project we also had a more complete picture of the differences in instruction required by the three groups. The three pie charts on the following pages show how the groups differed in terms of the intervention changes made in programs run by project staff across all three project years. For students in Group I, the percent of intervention changes that dealt with symbolic communication variables averaged only 30%: 10% involved presymbolic functions; and the remaining 60% of interventions involved nonsymbolic matters such as procedural methods, instructional prompts and assists, or further assessments. This contrasts significantly with Groups II and III. In Group II intervention changes involving symbolic communication averaged 52%, with presymbolic functions at 2% and all other nonsymbolic issues averaging 46%. Group III intervention changes involving symbolic communication averaged 63%, with presymbolic issues averaging 3% and all other nonsymbolic issues averaging 34%.

Most obvious in all of these analyses is the significance of readiness for symbolic communication acquisition. Clearly the less adept the child is presymbolically as revealed in the subjective rankings, the less “ready” they are for symbolic communication and the slower their progress toward symbolic communication. Readiness also involves the child’s interest in others, interest in the physical environment, and the consistency and readability of the child’s responses. All these

factors together served as predictive indicators of the child's acquisition of symbolic communication. Moreover, these indicators become the focus of much of our intervention efforts with the child. For the child who showed little in terms of readiness for symbolic communication, extensive efforts (and in some cases, all efforts) were directed toward helping the child become a competent communicator using presymbolic means prior to any attempt to introduce symbolic communication.


Group I: 1993-1996
Vocabulary 2%
Array 7%
Distractor 6%
Symbol Type 10%
Protocol 4%
Pre-symbolic Function 10%
Other 60%
Length of Utterance 0%
Generalization 0%
Symbolic Function 0%
Portability 1%


Group II: 1993-1996
Vocabulary
8%
Array
18%
Distractor
8%
Symbol Type
10%
Protocol
6%
Generalization
2%
Pre-symbolic Function
2%
Other
46%
Length of Utterance
0%
Portability
0%
Symbolic Function
0%


Group III: 1993-1996
Vocabulary 11%
Array 15%
Distractor 5%
Symbol Type 12%
Protocol 9%
Length of Utterance 2%
Generalization 4%
Portability 2%
Symbolic Function 2%
Pre-symbolic Function 3%
Other 35%

C. Question 1: How Did Direct Intervention Affect the Participants' Communication Skills?

Direct interventions conducted by project staff were videotaped monthly. The Rate/Ratio code was administered to these tapes. The Communication Matrix was administered pre- and post-intervention, and the Intervention Records maintained throughout intervention showed specific aspects of symbolic communication achieved by each participant. The tables below present the major data collected on participating students for the first half versus the last half of direct intervention. N=s vary in cases where we were unable to collect a complete set of data or where specific variables were not applicable to all students (e.g. if a student is only using picture symbols, then the use of object symbols is irrelevant).

1. Rate/Ratio Data

The Rate/Ratio data were grouped into pre- and post-sessions, by simply dividing the data set into two, computing means for the first half of intervention (pre) versus the last half of intervention (post). Table 10 shows the pre and post means group by group, plus the gain score showing the change from pre to post scores.

The proportion of intervals during which communicative behavior by the student was observed--P (Communicative Behavior)--was highest (pre and post) for Group III and lowest for Group I. For most children with severe communication delays, the rate of communication is low and increases in the rate are desirable. It should be noted, however, that for children already communicating at a satisfactory rate, this rate of communication would not be a targeted variable. All groups, however, gained on this measure from pre to post, with an average gain of .09.

The proportion of intervals during which cues for communication were

observed--P(Cues for Communication)-- is a less straightforward variable. Students who are communicating at a satisfactory rate, particularly those who are initiating some communication, may not need a higher rate of cues for communication to learn to communicate better--they may simply need cues for more sophisticated types of communicative behavior. Students receiving very low rates of cues and producing low rates of communication and no initiations generally benefit from increased rates of cues. For students who currently receive very high rates of cues, but do not initiate communication, it is generally a mark of success when the rate of cues can be reduced while the rate of communicative behavior either maintains or increases--or initiations increase. In any event, the skill of project staff is such that they normally produce high rates of cues for communication as is reflected in both pre and post scores on this variable for all three Groups.

The proportion of intervals in which students were observed to initiate communication showed stark differences between the three groups both pre and post, with Group III showing the highest rate of initiations and Group I the lowest. All three groups improved on this measure over time, with gain scores averaging .05.

Rates of Object Symbols and Picture use--P (Object Symbol) and P (Picture Symbol) are averaged only across the students who were actually using the type of symbol, thus reducing n=s for these figures (the reduced n=s are provided in appropriate cells Table 10). For those 12 students who were learning to use object symbols (of whom there was only one in Group III), all three Groups showed gains in the rate of use averaging .06. For those 26 students who were learning to use picture symbols (of which there were only 2 in Group I), all three groups showed gains in the rate of use, averaging .08.

Table 10. Rate/Ratio Data from Direct Intervention

	Pre (first half of intervention sessions)			Post (second half of intervention sessions)			Gain Score		
Variable	Group I (n = 9)	Group II (n = 17)	Group III (n = 15)	Group I (n = 9)	Group II (n = 17)	Group III (n = 15)	Group I (n = 9)	Group II (n = 17)	Group III (n = 15)
P(Communicative Behavior)	.17	.39	.52	.27	.45	.64	+.10	+.06	+.12
P(Cue for Communication)	.58	.58	.51	.52	.65	.71	-.06	+.07	+.20
P(Initiated Communication)	.01	.09	.22	.07	.15	.25	+.06	+.06	+.03
P(Object Symbol)	.01 (n=5)	.04 (n=6)	.00 (n=1)	.08 (n=5)	.06 (n=6)	.08 (n=1)	+.07 (n=5)	+.02 (n=6)	+.08 (n=1)
P(Picture Symbol)	.00 (n=2)	.09 (n=10)	.15 (n=14)	.04 (n=2)	.19 (n=10)	.26 (n=14)	+.04 (n=2)	+.10 (n=10)	+.11 (n=14)

2. Communication Matrix Data

The Communication Matrix was administered by project staff and teachers, usually in collaboration. It shows overall (across all contexts) what specific communicative behaviors and intents are used by the child to communicate, across a sequence of seven levels of communicative development. Of the eleven students in Group I, three gained two Matrix levels, five gained one level, and three stayed the same. Of the 19 students in Group II, one gained three Matrix levels, nine gained two levels, six gained one level and three stayed the same. Of the 17 students in Group III, six gained three Matrix levels, three gained two levels, six gained 1 level and two stayed the same.

An analysis of the number of different intents that participants used symbolic means to express pre and post-project intervention was conducted based on the Matrix data in 15 cases where project staff had completed both the pre and the post Matrix. For Group I (n=2), the mean number of symbolic intents rose from 0 to 2.5. For Group II (n=7) the mean number of symbolic intents rose from .7 to 7.2. For Group III (n=6) the mean number of symbolic intents rose from 2.5 to 7.3.

3. Symbolic Skill Acquisition from Performance Data Collected from Direct Intervention

The trial-by-trial data taken by staff who conducted direct intervention programs were analyzed at least weekly and often daily to determine what changes needed to be made to the programs in response to the child's successes or difficulties. These data were summarized to obtain five major measures: the number of symbols acquired by each participant; the rate of symbol acquisition; the final array size used by the child (the number of symbols presented together out of which the child had to select symbols); and the mean length of symbolic utterances (the number of symbols that the child could string together into

one utterance). Acquisition criteria were strict. For a symbol to be considered acquired, the participant had to demonstrate 80% or greater accuracy for two days (sessions) in a row (thus the fastest acquisition rate possible was 2 sessions), and the symbol had to be used within an array of at least 3 symbols (an exception to the 3-symbol array stipulation was made for the few students whose orthopedic impairments so limited their scanning ability that they could only scan two items widely separated in one array). These figures were compiled only for children who were first-time symbol users--that is those who for the first time learned to use symbols as a result of our direct intervention efforts (a few children already knew how to use some symbols prior to joining the project). Table 11, below, shows total increases in number of symbols acquired, final array size, and mean length of utterance at the end of direct intervention.

Table 11. Vocabulary, Array Size and Length of Utterance at End of Direct Intervention For Students in Three Groups

Group	# Symbols Acquired (Mean and Range)	Array Size at End of Direct Intervention	Mean Length of Utterance at End of Direct Intervention
I (n=11)	1.3 (0-4)	1.5	1
II (n=15)	9.6 (1-21)	2.8	1
III (n=15)	18.5 (3-75)	5.1	2

Array size was counted up to 6 symbols. Many students (12) ended up using a book that contained many more than six symbols in the total array. Because it is movement

through the smaller array sizes that is most difficult, six was the largest number credited for an array size. The data in Table 11 show clear differences between the three groups in terms of vocabulary size and array size, with Group III outperforming Group II and Group II outperforming Group I. Mean length of utterance was one for Groups I and II and 2 for Group III. Combining symbols into utterances is a skill that is only appropriate for Group III students who have larger vocabularies. Table 12, below, shows the dramatic decrease in acquisition rate in Groups II and III.

Table 12. Acquisition Rate for First and Last Set of Symbols Acquired during Direct Intervention for First-time Symbol Users for Three Groups

Mean Number of Sessions Required to Acquire Each Symbol		
Group	First set of symbols acquired	Last set of symbols acquired
I (n = 11)	(The seven of this group who acquired symbols only acquired one set)	
II (n = 15)	7.67 (n = 10)	2.77 (n = 10)
III (n = 15)	4.35 (n = 12)	2.00 (n = 12)*

*This represents a ceiling effect, since a minimum of two consecutive sessions was required to claim acquisition.

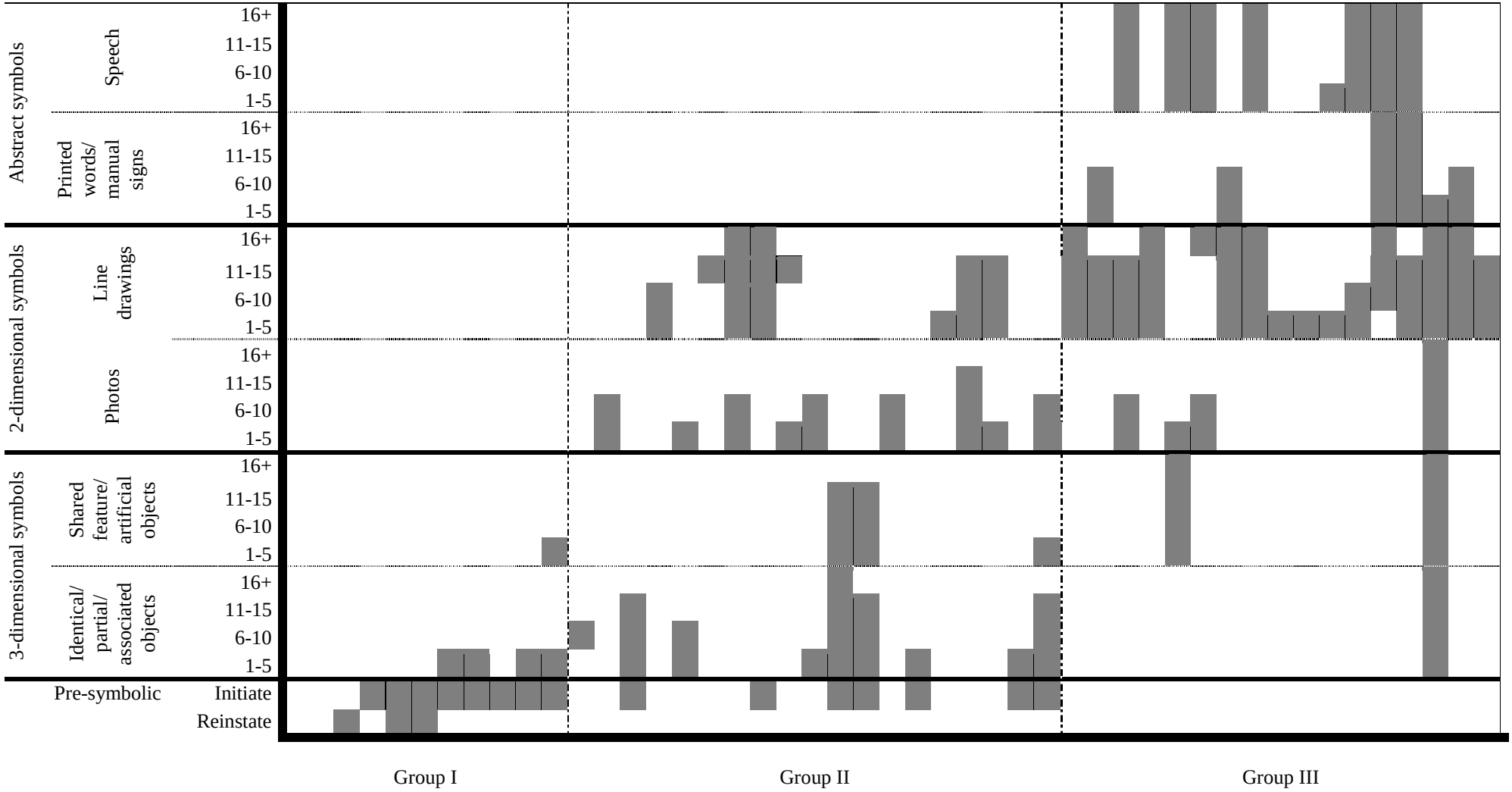
Besides the clear differences between groups in the total number of symbols acquired and the array size, the pre-post rate of acquisition is extremely revealing. Both Groups II and III seemed to demonstrate a “learning to learn” effect, with their acquisition rate for new symbols decreasing dramatically from the beginning to the end of intervention. Many students became “one trial learners” (although our strict acquisition criteria prevented the acquisition rate from falling

below two sessions). Thus what may have been initially a laborious process as the student first learned what to do with symbols became a much more efficient process over the course of the project.

4. Level of Representation Achieved During Direct Intervention

The Matrix data gave a fairly global perspective on communication development over the course of the project. Figure 1 shows the levels of representation (the specific type of symbol) acquired by each participant over the course of the project for the three Groups as well as the vocabulary size at each level (each participant is represented by one bar on the x-axis). In Group I, 2 children gained no communicative skills, 5 gained presymbolic means of communication (1 learned to reinstate, and 4 learned to initiate communication--by attracting attention) and 4 learned to use between 1 and 5 identical/partial or associated objects as symbols. In Group II, 4 learned to use identical/partial or associated objects as symbols; 2 learned to use more abstract objects as symbols; 7 learned to use photographs as symbols; and 5 learned to use line drawings as symbols. In Group III, 3 learned to use line drawings as symbols; 6 learned to use printed words or manual signs as symbols; and 8 learned to use speech.

Figure 1. Levels of representation and vocabulary size acquired during direct intervention



D. Question 2: How Did Direct Intervention Performance Compare to Performance in Other Classroom Programs?

For fourteen students who received direct intervention during Year 1 we collected data on teacher-supervised programs run concurrently with our direct intervention. Teachers selected a program that they thought would best reflect the child's communication skills. These programs were videotaped twice in the spring of Year 1 for seven teacher/student pairs and once during that time for another seven teacher/student pairs. Data were averaged across two sessions where two videos were available. These means were compared to means across the direct intervention sessions conducted concurrently by project staff. A comparison of these two sets of data appears in Table 13, below.

Table 13. Rate Ratio and ACE Data on Direct Intervention and Teacher Programs Run Concurrently

Variable	Teacher Programs	Direct Intervention Programs
Rate/Ratio Code		
P(Communicative Behavior)	.23	.42
P(Cue for Communication)	.38	.60
P(Initiated Communication)	.05	.12
P(Object Symbol)	.05 (n=6)	.03 (n=6)
P(Picture Symbol)	.22 (n=10)	.19 (n=10)
P(Speech)	.12 (n=3)	.23 (n=3)
ACE Score	41%	58%

Clearly, intervention programs conducted by project staff were associated

with higher rates of communicative behavior by students, higher rates of cues for communication and a greater percentage of initiated communication by the student. The rate of object and picture symbols use, however, was slightly lower in direct intervention programs, while the rate of speech for the three students who used some speech was much higher in programs run by project staff. Among other things, these data show that the ACE is sensitive to changes in the social and physical environment that are associated with higher rates of communication by the students as evidenced by higher Rate/Ratio and ACE scores for direct intervention programs. More importantly, the data suggest that it is quite possible for regular classroom staff to implement similar communication-related interventions that, without scoring as high as the extremely skilled project staff in overall measures of communication value, still allow children to use their symbol systems.

E. Question 3: To What Degree Were Gains Achieved During Direct Intervention Maintained During Subsequent Years?

In the second and third years of the project, we offered consultation to teachers who had students for whom we had provided direct intervention in the past. Consultation was provided around the needs of 30 participants. For eleven of these children, the consultation spanned two teachers, as the children moved to a new classroom each year. The average consultation lasted 2 hours and was conducted on site, although telephone contacts also occurred in many instances. The average number of contacts per teacher was 4.6, while the average number of contacts per student was 6.3. In the final year of the project we attempted to track the degree to which teachers implemented suggestions made in these consultations. This study

involved 12 teachers. The staff person who had provided consultation noted the major suggestions made and provided these suggestions to the observers. When observers took follow up data, they also noted whether each major suggestion appeared to have been implemented. Two observations were made for each teacher. The implementation rate for the first observation was 47% (n=11) and for the second observation was 43% (n=10).

1. Follow Up Observations Conducted

The following discussion involves observations made of teacher-supervised programs conducted after participants received direct intervention. There are two major difficulties with these data. First, children often moved to new classrooms each year, so that the teacher observed at follow-up was different from the one who was present during direct intervention. Second, although most observations were based on live observations of an hour in length, two were based on videotaped programs that were coded later. Finally, the length of time that elapsed between the end of intervention and the final observation varied from 2 months to 24 months, depending upon the year in which the participant received direct intervention. The mean amount of elapsed time between the end of intervention and the last follow up observation was 6.6 months. There were 24 students for whom we gathered follow-up data on teacher-supervised programs. Table 14, below, shows the Rate/Ratio and ACE data collected for students in the three Groups. For each symbolic mode (the proportion reported is taken only on the number of students actually using each mode, rather than the whole group of students), the figures in parenthesis indicate the number of students using that mode at follow-up as compared to the number who were using that mode at the end of direct

intervention.

Table 14. Data on Teacher-Supervised Programs at Final Follow-Up Observation

Variable	Group I (n = 7)	Group II (n = 10)	Group III (n = 7)
Rate/Ratio Data P (Communicative Behavior	.26	.25	.41
P (Cue for Communication)	.47	.41	.38
P (Object Symbol)	.26 (2/5)	.08 (3/5)	(0/1)
P (Picture Symbol)	.06 (1/0)	.25 (3/6)	.08 (3/6)
P (Speech)	---	.29 (1/1)	.16 (4/4)
P (Printed Word)	---	.43 (1/0)	.95 (1/0)
P (Manual Sign)	---		.10 (1/1)
ACE Score	44%	35%	54%

Although many teachers were maintaining the conditions necessary to allow their students to communicate symbolically, a few of them were not. In Group I, only 3 out of five who had learned to use symbols earlier were still doing so. In Group II, two students who had severe orthopaedic impairments and who had learned to indicate picture symbols using eye-pointing were no longer using any symbols. In Group III, one student who had used three-dimensional symbols for 5 1/2 years no longer used any symbols.

2. Level of Representation Reported at Last Contact

We were able to collect final reports of maintenance on most students through the completion of surveys that were sent out to teachers at the end of the project. Of these surveys, 16 were returned with complete data. These surveys provided us with

information about the entire vocabulary of symbols currently being used by the child--in contrast with the Rate/Ratio observational data reported in the previous section, which only characterized an hour's worth of behavior. Of the 16 students, twelve at least maintained the same level of representation. Of those 12, eight gained a higher level of representation and/or increase in vocabulary size. Four students stayed the same on these parameters, while the remaining four lost ground.

F. Question 4: How Did the Performance of Students Who Received Direct Intervention Compare to That of Students Who Didn't Receive Intervention?

During the first year of the project we were able to monitor a group of potential participants who did not receive intervention that year. Our intent was to provide intervention to these students in the second year so that they would constitute a waiting list type of control group. Ten students of this group remained available to the project in the second year. Below we describe data taken on the ten students who were monitored prior to any project intervention and who received direct intervention the following year. These data were collected from one-hour live observations of the students in their regular classroom activities made prior to intervention, once during the spring of Year 1 and once during the fall of Year 2. Teachers were asked to select an hour out of the child's day that was likely to capture the most communicative behavior by the child. Mean scores for the second observation were uniformly higher--so these are reported in the table below. In Table 15, below, these pre-intervention data are compared to data taken during direct intervention averaged across the entire intervention phase.

Table 15. Comparison of Ratio/Ratio Data Taken Prior to Intervention and During Intervention

Rate/Ratio Variable	First Observation	
	Prior to Intervention	During Intervention
P(Communicative Behavior)	.04	.20
P(Cue for Communication)	.11	.44
P(Initiated Communication)	.01	.03
P(Object Symbol)	.00 (n=0)	.05 (n=4)
P(Picture Symbol)	.04 (n=3)	.08 (n=4)
P(Mechanical Device)	.03 (n=2)	.05 (n=3)

The overall rate of communication by students--P(Communicative Behavior)--was dramatically higher (mean = .20) during intervention than during the wait list phase (mean = .04), as was the rate of cues for communication--P(Cues for Communication --.44, as compared to .10. The rate of use of object symbols, picture symbols and mechanical communication devices was also higher for direct intervention. More significant than the rate of use is the number of students who were learning to use various symbolic communication systems. During the wait-list phase only 5 students were using any sort of augmentative communication system and none were using object symbols. During intervention, all ten students were using either object or picture symbols and/or a mechanical device to communicate. The stark contrast of the data prior to and during intervention suggests that the students' performance was the result of the direct intervention.

G. Question 5: How Effective Were the Training Materials Developed Through the Project?

By the end of Year 2, we had developed the prototype version of a completely new 80-minute videotape explaining the use of tangible symbols. We had also decided that the existing print manual would continue to serve effectively to complement the videotape, and we did not revise it. In Year 3, teachers and speech-language pathologists in our tri-county area were offered the opportunity to participate in a "Tangible Symbols Internship". Sixteen teachers and speech-language pathologists took advantage of this offer. The project paid for release time for teachers to attend. This internship revolved around a series of training sessions using the prototype of the videotape developed through this project and the existing Tangible Symbols manual.

The materials were presented in one 2 day session. A pre-post test was administered to the interns to test their acquisition of the material. The mean pre-test score was 41% and the mean post score was 72%. The interns were also asked for subjective feedback on the videotape (which was in a prototype format at that point) and they were asked to consider whether the existing Tangible Symbols manual should be revised to accompany the new videotape. None of them thought that a revision of the manual was necessary.

After this initial training, interns selected a target student with whom they would implement tangible symbols instruction. Project staff videotaped these students and the interns working with them and coded the videotapes using the Rate/Ratio Code and the ACE Inventory. Three tapes were made on each target student, with the exception of two students on whom only two tapes were made. The tapes spanned 3-4 months in most cases. Three 2 day sessions with the interns were held during these four months and were devoted to viewing the videotapes as a group and brainstorming ways to improve the skills of the students. Data from the first and last of these videotapes are presented below to show gains made by the target students (Rate/Ratio Data) and the design of the activities (ACE Inventory). It is significant that <u>all</u> of the interns' programs increased in terms of ACE scores.

Table 16. Rate/Ratio and ACE Data for Intern Programs

Variable	First Videotape	Last Videotape	Gain Score
Rate/Ratio P(Communicative Behavior)	.27	.51	+.24
P(Cue for Communication)	.50	.64	+.14
P(Object Symbol)	.21 (n=3)	.45 (n=3)	+.24 (n=3)
P(Picture Symbol)	.11 (n=5)	.46 (n=5)	+.35 (n=5)
P(Sign)	.00 (n=1)	.04 (n=1)	+.04 (n=1)
ACE Score	32%	44%	+12%

V. DISCUSSION AND CONCLUSIONS

This section summarizes major findings of the project. Broadly speaking, these findings include the overall success of tangible symbol systems as an effective means of communication; insight into when individuals are or are not ready to learn to use symbols; the lack of follow-through in certain cases in subsequent environments; and the development of a new videotape that shows how to use tangible symbols.

A. Readiness

A great deal of discussion has been given to the role of readiness as described earlier in this report. Data from numerous sources have provided a detailed account of how critical a consideration this is as the practitioner ponders the appropriateness of symbol communication instruction for young children with severe disabilities. Eleven participants were placed in Group I, indicating that they were not yet ready to use a symbol system, based on "Readiness" ratings of 11 or less. Rather than declining to serve these children whose assessments revealed a lack of readiness for symbolic communication, we provided the direct instruction needed to prepare them to use symbols. As discussed earlier our focus turned to helping these students increase presymbolic readiness. This primarily involved assisting these students to develop a reliable and intentional means to engage other people and to express their needs and wants through unconventional gestural behaviors, eye gaze or affective responses. For some, this entailed the shaping and defining of readable and reliable responses. For others it also included developing their understanding of the need and value of communicating to others in their world. For a few it entailed undoing a developing sense of helplessness, and replacing it with the feeling that the world about them was

responsive to their signals. During the course of intervention, (3 months to 10 months each) 5 of these 11 children moved on into an initial tangible symbol system. Given our experience in previous projects that allowed more prolonged intervention, it is likely that others in this Group I may eventually acquire symbols also. This project has allowed us to describe more clearly the characteristics of the student who needs to work on presymbolic communication rather than symbolic communication. The Communication Matrix and the Readiness Ratings make this assessment relatively simple.

B. Wide Applicability of Tangible Symbols

This project involved a total of 52 children with widely varying diagnoses and handicapping conditions and of these only four of these students failed to acquire symbolic skills.

Besides allowing us to better describe the individual who is *not* ready for symbolic communication, this project also showed us that tangible symbols are useful for individuals demonstrating a much wider range of disabilities than had previously been assumed. In the past, we had used tangible symbols with students who had severe and multiple disabilities and students with deaf/blindness. In this project, we took on students who had milder disabilities (many undiagnosed), including many children who appeared to have no physical or sensory impairments but who experienced general developmental delay, and some who had autism or other pervasive developmental disorders. Across all three groups, only 16% had diagnosed hearing impairments, while 53% had diagnosed vision impairments. Developmental delay or mental retardation was present in 96% of the students. Significantly, 16% experienced autism. In Group III, the group that experienced the greatest success, far

fewer experienced vision impairment (35% as compared to 75% and 63% for Groups I and II). Although the mean number of handicapping conditions per child was 3, five children experienced only developmental delay. Two children had experienced traumatic brain injury, while the remaining children had been born with disabilities.

When we couple the fact that many of these children had relatively mild disabilities with the fact that many progressed to using more conventional forms of communication after learning to use tangible symbols, we can conclude that tangible symbols may well form a bridge between gestural communication and conventional symbolic communication.

C. Level of Interference with Speech Acquisition

Of the 47 students who received direct intervention from this project, 9 students demonstrated some minimal speech or speech approximations, consisting primarily of single word utterances. Assessments at the start of their involvement with the project revealed that while some speech approximations were presently a part of their communication repertoire, speech was not their primary mode: rather, unconventional and conventional gestures comprised the majority of their expressive communication.

For 4 of these 9 children, Rate/Ratio data was collected on teacher-run programs at the beginning of the project. A mean of only 9% of the intervals observed at that time contained any speech. A mean of only 2% contained any other expressive symbol use. Comparable data from the first half of our direct intervention sessions showed a mean of 26% of all intervals contained speech with 10.8% showing other symbol use. In other words, while learning to use tangible symbols, their rate of speech increased. This compares dramatically to data from the last half of intervention, when a

mean of 53% of all intervals included speech and 23% included other tangible symbol use. Of these 9 students, follow-up observations reveal that for 6 of them, *speech has now become their primary mode of communication*. For the remaining 3, while speech continues to develop, the use of tangible symbols augments and likely supports this development. This data clearly demonstrates the fact that the introduction of tangible symbols in no way impeded their development of speech. In fact, their overall level of communication rose as did their speech.

Anecdotally, we can report that in one case where project follow up was requested for a former participant, project staff went in and assisted the child to demonstrate the use of his tangible symbol system in a brief 20-minute session. Two speech/language pathologists familiar with the child observed this interaction and commented that they had not heard as much speech from this child in 3 months as he was now revealing in this brief session. Tangible symbols presently augment his developing spoken communication.

For another child with a diagnosis of autism, a brief follow up by project staff in the fall allowed us to examine whether there remained a need for tangible symbol use as she was now communicating through speech. Her picture communication book had been faded out and she was readily producing 3-4 word spoken utterances to request various activities, needs and wants throughout her day (initially it was noted that she would point on the table surface as she spoke her requests as she had done when she was pointing to pictures to communicate). An instructional program was designed to help her learn to request “help” when she needed it. Despite multiple sessions of verbal prompting and modeling, the child did not independently begin to make the spoken

request “I want help”. Instead she would resort to hand guiding her partner or became frustrated. We suggested that a picture symbol for “help” be introduced. A hierarchy of prompts was instigated and within three sessions this child was independently requesting “I want help” appropriately using picture and speech. The picture symbol was subsequently dropped and the child continued to verbally request help independently 84% of the time on average. This brief data probe suggested that although no longer her main mode of expression, tangible symbols may continue to assist this child in the near future to develop additional speech skills and functions. A sequential display of pictures continues to be used for time management purposes with this child.

D. Lack of Follow Through in Some Environments

The one discouraging finding of the project was that some participants, as they transitioned into other classrooms following direct intervention, were not allowed to continue communicating through tangible symbols or through any symbolic communication system. Although this was not a widespread problem, it was deeply disappointing for project staff when it happened, and clearly it was the child who suffered most of all from having an effective means of communicating removed. The unfortunate aspect of any “aided”communication system, including tangible symbols, is that the availability of the system is often not under the user’s control.

Many reasons may account for why in some instances the tremendous gains by some children seemed to be lost when the child transitioned to a new educational setting. From the project’s end of things it may be that we failed to find the best way to pass on the information about the communication abilities and needs of the children.

Despite written reports to families and schools, telephone follow up, on site monitoring and on-site training and demonstrations, there were a few cases where the child's skills were disregarded. From the receiving environment's stand point, it may be due at least in part to a lack of skill on the part of the receiving practitioner, and in at least one case a lack of preparedness and skill by the receiving inclusive environment. Finally, from the child's standpoint it may have to do with a lack of persistence in attracting or demanding the attention of another person with whom to communicate. Unfortunately, in some classroom settings, it appears that the usual means of gaining attention from adults are not adequate.

E. Prospects for Future Implementation

A tremendous effort was expended by project staff in developing a new videotape showing how to teach individuals to use tangible symbol systems. This is an 80-minute videotape. It includes testimony by parents, teachers and other professionals, detailed instructional strategies, and five case studies of a variety of students who learned to use tangible symbols. The tape consists entirely of "real-life" (that is, unstaged) footage of participants in their classrooms and homes, drawn from our archives of videotapes made regularly to document student progress over the years of this project and earlier projects. Although the footage is not professionally made, it was professionally edited and enhanced by titles, captions, narration and music. The end result is a comprehensive product that communicates a large amount of information in an attractive package. The existing Tangible Symbols manual complements the videotape. Both manual and videotape are available now at a modest price through a commercial publisher--Communication Skill Builders, a division of the Psychological

Corporation.

It is our hope that the availability of these products will make it increasingly likely that teachers, parents and speech-language pathologists will consider developing tangible symbol systems for individuals who would benefit from them. We were encouraged in this regard by our experience with the "Tangible Symbols Interns" in Year 3 who were trained using the new videotape and who were extremely successful in implementing the strategies illustrated on the videotape. We are currently in the midst of an early childhood outreach project through which we are bringing Tangible Symbols training to early childhood professionals throughout the country.

F. Summary

As important as providing a symbol system that is appropriate to the child's sensory and cognitive abilities is the provision of *systematic* instruction in how to use it. Systematic instruction requires a firm grasp of the child's current abilities, continuous collection of data that shows whether the child is succeeding or failing to *understand* the use of symbols, and constant changes in instructional programs to promote steady progress. Finally, the symbol system has to be made available to the child in every context, 24 hours a day so that the child can communicate at will. The instructional materials developed through this project stress a systematic and comprehensive approach to teaching children to use tangible symbols. We hope that these materials will be widely adapted to the extent that they are appropriate for children with severe communication disorders.

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