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NONVOCAL LANGUAGE ACQUISITION IN ADOLESCENTS WITH SEVERE PHYSICAL DISABILITIES: BLISSYMBOL VERSUS *ICONIC STIMULUS FORMATS*

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This study compared training in two language systems for three severely handicapped, nonvocal adolescents: the Bliss symbol system and an iconic picture system. Following baseline, training and review trials were implemented using an alternating treatments design. Daily probes were conducted to assess maintenance, stimulus generalization, and response generalization, and data were collected on spontaneous usage of either language system throughout the school day. Results showed that students required approximately four times as many trials to acquire Bliss symbols as iconic pictures, and that students maintained a higher percentage of iconic pictures. Stimulus generalization occurred in both language systems, while the number of correct responses during responses generalization probes was much greater for the iconic system. Finally, students almost always showed more iconic responses than Bliss responses in daily spontaneous usage. These results suggest that an iconic system might be more readily acquired, maintained, and generalized to daily situations. Implications of these findings for the newly verbal person were discussed.

DESCRIPTORS: cerebral palsy, generalization, language, nonvocal communication, retardation

In spite of recent legislation (e.g., PL 94-103, 1975; PL 94-142, 1975) requiring that educational programming be made available to all persons, regardless of their degree of mental and/or physical handicap, the training needs of persons with severe neuromuscular disorders and associated retardation have often been overlooked. This is especially true in the area of communication, where severe physical disability and retardation frequently combine to render typical methods of instruction ineffective in developing an expressive language repertoire. However, although motor dysfunction may differentially impede the development of vocal speech or complex manual skills (e.g., sign language), it may have relatively little deleterious effect on receptive abilities (Harris-Vanderheiden, Brown, MacKenzie, Reinen, & Schiebel, 1975; McDonald & Schultz, 1973). Thus, it has become increasingly apparent that severely handicapped persons might benefit greatly from language instruction in which the expressive component can accommodate extremely limited and often idiosyncratic motor topographies (Balfour, 1972; Elder & Bergman, 1978, Feallock, 1958, Hagen, Porter, & Brink, 1973; Reid & Hurlbut, 1977).

The most frequently used language systems developed for the severely handicapped involve various types of communication boards (Bullock, Dalrymple, & Danca, 1975; Feallock, 1958; Hagen et al., 1973; McDonald & Schultz, 1973). A major advantage of these devices is the relatively simple response required of the

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"speaker" (e.g., pointing or button pushing). However, in spite of this attractive feature of communication boards and the fact that a number of languages have been developed in conjunction with their use (Bliss, 1965; Clark, Davies, & Woodcock, 1974; Fristoe & Lloyd, 1978; McNaughton, 1976), very little experimental research has been conducted to identify variables that promote the acquisition of functional language by the severely handicapped (Elder & Bergman, 1978; Hill, Campagna, Long, Munch, & Naecher, 1968; Reid & Hurlbut, 1977).

At least two sets of variables must be considered in teaching communication board usage. First, an appropriate response that can be discriminated must be identified, as well as shaped to the point where it occurs reliably. Reid and Hurlbut (1977), for example, examined the use of instructions, praise, and manual guidance in developing pointing with either the hand or head, first to arbitrarily selected "target" areas of a communication board, and later to photographs depicting leisure areas around the institution. Second, since the motor topography used with a communication board will often remain constant for a given individual, the range of communication that can be differentiated by the "listener" will be limited to those language symbols (e.g., words, pictures) that can be correctly identified by the "speaker." Thus, both response and stimulus variables are of particular importance during the course of communication board training, and although Reid and Hurlbut (1977) provided an extensive analysis of the former, the present study attempted to address the latter.

In a survey of professionals working in the area of nonspeech communication, Fristoe and Lloyd (1978) found that the majority of programs currently in use are based on two stimulus formats. The first is a system known as Blissymbolics (Archer, 1977; Bliss, 1965), in which concepts are represented by combinations of geometric shapes. Blissymbolics originally was designed as a universal language that would supplement existing languages (e.g., as informational signs), later adopted for use with stroke victims who lost their speaking ability and, most recently, used with the developmentally disabled (Song, 1979). In some cases, symbols visually resemble the objects they represent. However, based on the assumption that the user will acquire a logical communication system, symbols more often represent abstract concepts rather than concrete objects. The symbol for "school," for example, consists of a combination of the symbols "house-gives-knowledge." The second system uses simple, iconic line drawings that generally show a high degree of similarity to the objects they represent. Figure 1 shows several examples of commonly used Bliss and iconic stimuli that were used in the present study. A more extensive listing of Bliss symbols can be found in McNaughton, Barlow, and Beesley (1974), while the Rebus program (Clark et al., 1974) provides an excellent source for selecting iconic stimuli.

Fristoe and Lloyd (1978) noted that in making decisions regarding curriculum selection, careful attention should be paid not only to individual abilities, but also to strengths and weaknesses characteristic of the particular language system. For example, more rapid acquisition of communication skills might be expected with a pictorial language than with Blissymbolics, due to the iconic nature of the pictorial stimuli. Two recent studies on sign language have yielded somewhat mixed findings regarding the effects of iconicity on acquisition. Griffith and Robinson (1980) found that subjects acquired iconic sign-word pairs more rapidly than non-iconic pairs, while Kohl (1981) found that the degree of iconicity had no apparent effect on rate of sign acquisition. Conflicting predictions also have been made regarding the effects of iconicity on generalization. On the one hand, it has been argued that Bliss symbols might facilitate better transfer than pictorial stimuli since, in the Bliss system, "conceptualization of a thought or idea is not tied to a specific picture" (Harris-Vander-

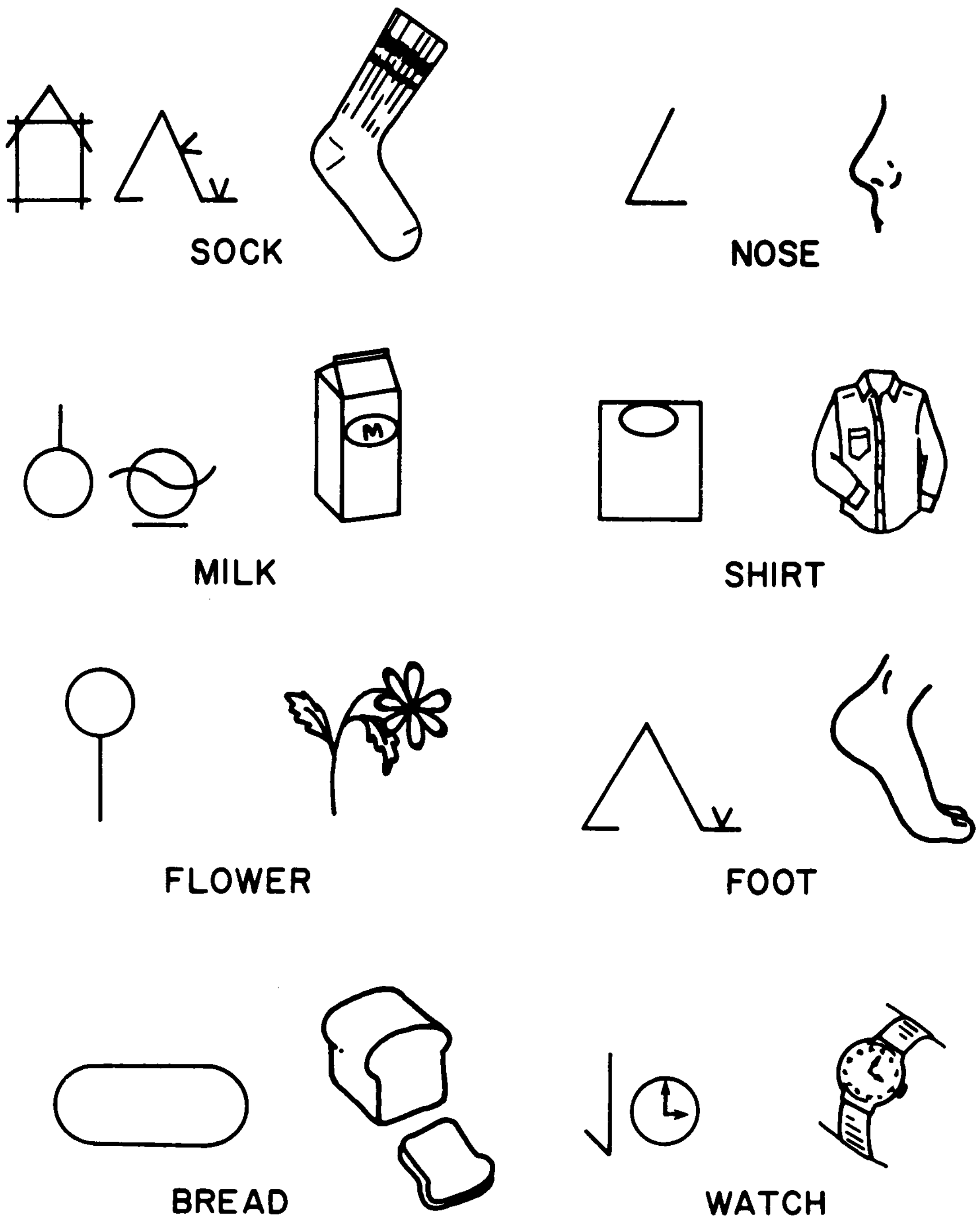


Fig. 1. Examples of experimental stimuli used to depict several common objects and body parts. Bliss symbols appear to the left of each word; iconic stimuli appear to the right.

heiden et al., 1975). On the other hand, results of a study comparing pictorial representations versus real objects in teaching object naming have suggested that formal similarity enhances generalization (Welch & Pear, 1980). Unfortunately, these studies provide not only conflicting, but also indirect evidence regarding differential outcome with Bliss versus iconic stimulus formats, since none of the research to date has incorporated an experimental comparison of the two procedures.

The purpose of the present study was to conduct several comparative analyses within a nonvocal language training program. Three cerebral palsied adolescents received concurrent instruction in the use of both Blissymbolics and a pictorial language, and their acquisition rates were compared. Probe data were also taken in order to assess maintenance, stimulus and response generalization, and spontaneous usage within the two systems.

METHOD

Participants and Setting

Three multiply handicapped students attending a school program for the severely mentally impaired participated in the study. Randy was a 14-yr-old, nonambulatory male, diagnosed as having cerebral palsy resulting in severe spastic quadriplegia. Results of the Denver Developmental Screening Test showed a level of 14 mo for personal social skills, 7.5 mo for fine motor skills, 10 mo for expressive language, and 2.5 mo for receptive language. Tom was an 18-yr-old male, diagnosed as having cerebral palsy with moderate athetoid quadriplegia. He achieved mobility both by crawling and by pushing an upright walker. Results of the Denver Developmental Screening Test showed a level of 16.5 mo for personal social skills, 7.5 mo for fine motor skills, and 13.5 mo for receptive language. George was a 16-yr-old, nonambulatory male, diagnosed as having cerebral palsy with severe chorioathetoid quadriplegia. Formal test data were not available for George; however, his general level of functioning was similar to that of Randy.

Classroom staff reported that all students exhibited receptive language abilities beyond those suggested by formal assessments. Expressive language, however, was limited to yes/no responses, idiosyncratic gestures, two Bliss symbols for Randy, three Bliss symbols for Tom, and one Bliss symbol for George. All students had been receiving training in the use of Blissymbolics for approximately one year. The study was conducted in the students' special education classroom.

Apparatus

The students' communication boards were similar to traditional models (Feallock, 1958; McDonald & Schultz, 1973). Randy's board was constructed of a sheet of 1.27 cm thick plywood covered by .635 cm thick plexiglass. Both pieces were 65 by 35 cm and rested on a tray attached to his chair. Movable 4 by 4 cm pictures and symbols were placed underneath the plexiglass approximately .75 cm apart. Tom's board was made of two pieces of 46 by 53 by .635 cm plexiglass placed back-to-back. Movable 7.5 by 7.5 cm pictures and symbols fit, also back-to-back, between the pieces of plexiglass approximately 1.5 cm apart. George's board was made of a single piece of 100.5 by 90.75 by 1.27 cm plywood. Movable 10 by 10 cm pictures and symbols were arranged on the board approximately 1.5 cm apart. George's lack of manual coordination necessitated the use of a pointing device. Through a parabola worn on his head and plugged into an AC wall outlet, George was able to focus a beam of light to various locations on the board by tilting his head.

Pretesting and Stimulus Selection

Prior to conducting baseline sessions, two conditions were implemented. The first condition assessed students' ability to follow instructions similar to those used throughout the experiment. Each student was presented with 10 simple commands and allowed 15 sec to respond (e.g., "Lift your head," "Open your mouth," "Lift your arm,"). All students responded correctly to each of the 10 commands.

In the second prebaseline condition, students were asked questions about each of 60 objects and body parts in order to assess their ability to identify or "tact" (Skinner, 1957) stimuli that would be used as the basis for training. When presenting stimuli, questions requiring a yes/no response were asked (e.g., "Is this a cup?"). Randy responded by vocalizing "uh-huh" or "uh-uh," Tom answered by pointing to the word "yes" on the upper left section of his tray or to the word "no" on the upper right section. George responded by moving his eyelids up and down ("yes") or directing his eyes to the right and left ("no"). Students were given 10 sec to respond after the presentation of the stimulus. Reinforcement was provided for correct responses as well as appropriate attending behavior, and consisted of social praise (e.g., "You're really working hard today"; "You're holding your head up. I like to see your face"; "That's right. This is a plate. Nice job"), tokens (Randy and George only), and edibles. Incorrect answers were ignored.

Randy and Tom tacted 59/60 objects correctly, and George tacted all 60 correctly. From this list of known objects and body parts, 20 items were initially chosen for baseline presentation. Item selection was based on apparent functional relevance in the sense that each student came into contact with all items at least once daily. Twenty Bliss symbols and 20 corresponding iconic pictures (colored line drawings) representing the experimental stimulus items were randomly placed on each student's communication board. Each symbol and picture had its printed word beneath it. The placement order of the symbols and pictures was changed before each session throughout the study to control for the possibility that a student might "learn" a symbol or picture by attending to its location on the board rather making visual discriminations among objects, symbols, and pictures (Elder & Bergman, 1978).

Trials and Response Definitions

Each trial throughout the study (i.e., baseline, pretraining, training, review, probe) began when the student's head was in an upright position while making eye contact with the experimenter. The experimenter then presented an item (i.e., held up an object or pointed to a body part) and asked, "What is this?." The student was given 30 sec (45 sec for George) to make a response using his communication board. Correct responses were defined as follows. Randy (Tom) was to place the thumb (forefinger) of either hand within or on the boundaries of the appropriate symbol or picture for at least 1 sec. In addition, Randy was required to vocalize "uh" concurrent with a correct response. George was to focus the beam of light from his head pointer within or on the boundaries of the correct symbol or picture for at least 1 sec. During each trial throughout the study, only the first response that occurred within the time limit was considered for the purposes of scoring, reinforcement, and/or correction.

Experimental Conditions

Baseline. Each student's ability to tact each of the 20 items with the use of his communication board was assessed. Each item was presented five times. To increase the likelihood that incorrect responses reflected deficiencies in acquisition as opposed to maintenance, reinforcement was provided throughout baseline in a manner identical to that described previously (see Pretesting). If, for any item, a student responded correctly twice in the same language system, that item and its corresponding Bliss symbol and iconic picture were eliminated from the study and were replaced by a new item, symbol and picture chosen from the original prebaseline list. Thus, the resulting list for each student consisted of 20 items correctly tacted a maximum of one out of five times during baseline.

The list was then randomly divided into two groups of 10 items each, one group designated as the list to be trained and the other group used to assess response generalization. The list of items to be trained was then further divided into two groups of five items each. Because a number of the items were the same for all students, a counterbalancing procedure was used for the

Table 1

Training items and language systems used for each student.

Word	Randy	Tom	George
Sock	Iconic	Bliss	*
Foot	Iconic	Bliss	Iconic
Shoe	Iconic	Bliss	*
Hair	Iconic	Bliss	Iconic
Table	Iconic	Bliss	Bliss
Tray	Bliss	Iconic	Iconic
Door	Bliss	Iconic	*
Plate	Bliss	Iconic	Bliss
Straw	Bliss	Iconic	*
Pants	Bliss	*	Iconic
Token	*	Iconic	*
Underwear	*	*	Bliss
Hand	*	*	Bliss
Coat	*	*	Bliss
Pocket	*	*	Iconic

*Item not trained.

training items to control for the possibility that items taught in one language system were more conducive to acquisition than items trained in the other language system. Table 1 presents the 10 training items used for each student, and the language system in which each item was trained, while Table 2 presents the 10 items used for assessing response generalization. All 20 symbols and all 20 pictures remained on the board throughout the study.

Pretraining. Almost all Bliss symbols are designed so that they may be combined and/or altered to form new "words" and, in fact, most commonly used Bliss symbols consist of two or more combined stimuli. In addition, symbols for certain classes of items (e.g., persons, some articles of clothing) contain one stimulus that remains redundant and another that varies. For example, "pants" is comprised of the symbols "clothing," "protection" and "legs," while "shoes" consists of "protection" and "feet." These features of Bliss symbols form a logical system that can be expanded to encompass a multitude of linguistic concepts. With respect to training, however, these same features raise the question of whether or not initial instruction should use distinctly separate rather than combined stimuli. In the absence of any data suggesting that either approach might have facilitative or inhibitory effects on later learning, the following pretraining condition was implemented. (Since Bliss stimuli used in the present study included both separate and combined stimuli, effects due to pretraining could be assessed by examining the acquisition data for selected words.)

Before initiating instruction on the list of items to be trained, students were brought to criterion (10 consecutive correct responses) on separate Bliss symbols that were components of combined symbols to be used in the study. Students learned the component parts for all combined symbols appearing on their boards, regardless of whether any given item was to be trained in either the Bliss or iconic format, or untrained. Again, correct responses and attending behavior were reinforced.

Training. Sessions were conducted each school day morning and consisted of acquisition and review trials. Acquisition trials were presented for one Bliss symbol and one iconic picture per day. All trials pertaining to one language system were presented before trials pertaining to the other system, the order of presentation being determined daily by the flip of a coin. During each session, acquisition trials for a symbol or picture were conducted until (a) the student reached a criterion of 10 consecutive correct responses (up to eight consecutive responses could be carried over from the previous day's session), or (b) 10 trials were presented without reaching criterion. If criterion was not met, the symbol

Table 2

Response Generalization Items Used for Each Student

Randy	Tom	George
Bread	Ball	Apple
Cup	Belt	Bread
Hand	Bib	Cup
Token	Bread	Flower
Mat	Floor	Mat
Shirt	Mat	Milk
Spoon	Nose	Pillow
Tape	Spoon	Toothpaste
Toothbrush	Tape	Watch
Toothpaste	Underwear	Wedge

or picture was placed at the top of the list of items to be trained. If criterion was met, review trials were begun.

The purposes of review trials were to maintain previously learned symbols and pictures, and to ensure that the student was making a specific response to a specific item being shown. Review trials consisted of nine trials presented in a random order. On three of these trials the experimenter presented the item for which the student had just met criterion. If the student scored 3/3 correct, that item was placed on the list of learned items. If not, the item went back to the top of the list of items to be trained. On the other six trials, the experimenter presented three trials on each of two items from the list of learned items. The student had to score at least 2/3 correct in order for an item to remain on the list of learned items. Otherwise, the item went to the top of the list of items to be trained. Learned items were rotated such that each picture or symbol was reviewed every few sessions, with first-learned items receiving about the same number of review trials during the study as later-learned items. If three sessions were conducted without the student meeting criterion during acquisition, review trials were conducted on three items from the list of learned items.

A correction procedure for wrong answers was used during acquisition trials only. Following the incorrect response, the experimenter held up the training item and said, "What is this?" then pointed to the correct symbol or picture on the board while naming the item. If the student did not provide a correct response at this point, the experimenter again held up the training item and said, "What is this?," pointed to the correct symbol or picture while naming the item and then said, "Point to the picture/symbol for ——." If the student still did not provide the correct response, the second step was repeated and the experimenter physically guided the student's response.

Reinforcement as described previously was delivered for correct responses and attending behavior on both acquisition and review trials. Correct responses during the correction procedure were reinforced with social praise only.

Probes

In addition to collecting data on correct responses during morning acquisition and review trials, a series of afternoon probes was administered in order to assess maintenance, stimulus generalization, and response generalization. Reinforcement contingent upon attending behaviors only was given throughout the afternoon probe sessions. The quantity of reinforcers given during probes was roughly equal to the quantity given during training and review sessions in which correct responses were reinforced.

Maintenance. Each student was presented with one probe during the afternoon session on each symbol and picture from his list of learned items. This was to determine whether or not learned symbols and pictures were maintained while new symbols and pictures were being trained.

Stimulus generalization. Daily probes were conducted for each item from the student's list of learned items. When a symbol or picture was learned, three to seven other objects were chosen from its stimulus class, which differed from the training object along some dimension of size, color, and/or shape (e.g., for the item "sock," probe stimuli consisted of socks of different colors, sizes, and patterns from the specific sock used throughout training). During each stimulus generalization probe, one of these objects was presented to the student. The purpose of these probes was to determine whether or not the student's responding would generalize from the specific training item to other items of the same stimulus class.

Response generalization. One probe was conducted each day on the 10 untrained items listed in Table 2 that were reserved for assessing response generalization. The purpose of these probes was to determine whether the student could respond correctly to untrained stimulus-objects pairs as a function of training on other pairs and, if so, to determine which language system (symbol vs. picture) the student would select in making a response.

Spontaneous Usage

One of our instructional goals in conducting the present research was to produce a verbal repertoire that could be used outside the experimental situation. One step toward that goal was the selection of training stimuli that represented objects that the students encountered on a frequent basis. However, in order for spontaneous language to acquire functional properties, it would also seem critical to arrange the physical and social environment so as to occasion the response and to reinforce its occurrence (Halle, Marshall, & Spradlin, 1979; Hart & Risley, 1968, 1980; Simic & Bucher, 1980). This is especially true in the case of spontaneous "expressions of desire" or "mands," whose occurrence is occasioned by some antecedent event (e.g., a deprivational state, aversive condition, or the signaled availability of an event) and maintained by reinforcement that is both specific to the response and mediated through another person (Skinner, 1957). For example, one who is water deprived (thirsty) will usually limit the use of the response "water" to situations that have been previously associated with the delivery of water, or with individuals who provide it.

In light of these considerations, the following situation was designed both to assess and to promote the development of students' spontaneous verbal responses (board usage) outside of the experimental sessions. Students' communication boards remained with them throughout the school day, and all items depicted on the boards were present in the classroom and usually within immediate sight. At least one experimenter was always present in the classroom whose primary responsibility was to monitor students' board usage. The experimenter never provided an initial prompt for students to use their boards, but reacted in several ways when a spontaneous response occurred. First, in order to control for inappropriate learning that might result from reinforcing incorrect or random responding, the student was asked if he knew what the symbol/picture meant (i.e., he was asked to point to or focus the light on the object that the symbol/picture represented). Incorrect responses were then ignored, while correct responses were recorded as one or more instances of spontaneous usage, and then reinforced. Prior to the delivery of reinforcement, the experimenter determined if the response was a mand (expression of desire) or a tact (description). As illustrated in the following examples, the student was usually asked if he wanted something pertaining to the response.

1. Response: "Tape"; Question: "Do you want the tape player on?"
2. Response: "Cup"; Question: "Do you want your cup?" Response: "Yes" Question: "Do you want juice in your cup?"

Mands were reinforced with delivery of the item identified in the student's response. If it was determined that the student was not manding, his response was reinforced with social praise or pats on the back.

Reliability

Independent observations were conducted for over 50% of prebaseline trials, 50% of all acquisition, review and probe trials, and for 33%, 45%, and 55% of all instances of spontaneous usage for Randy, Tom, and George, respectively.

The following procedures were used to assess reliability during training and review trials. The experimenter (primary observer) administered reinforcement or began a correction procedure 2 sec after a response was made. During the 2-sec period the reliability observer also scored the trial on a small, prenumbered piece of paper and dropped the paper in a box on the floor. If at the end of 2 sec the paper was not in the box, an automatic disagreement was scored. If a response did not occur by the end of 30 sec, an automatic agreement on "incorrect response" was scored. The purpose of this procedure was to give the student feedback on the correctness of incorrectness of his responses as quickly as possible while maintaining independence between the primary and reliability observers. If the experimenter had waited until the end of the 30-sec time limit to give feedback, a potential lengthy delay between response and reinforcement or correction could have occurred. Without the 2-sec delay, however, scoring by the reliability observer may have been differentially affected by the experimenter's application of consequences (Harris & Ciminero, 1978). This control procedure was not used during afternoon probe sessions, since correct responses to the probes were not reinforced.

Reliability assessment for students' spontaneous usage was conducted in a different manner, since it was impossible to have two observers continually attending to the students over the extended time periods during which responding might occur. On days when a reliability observer was present in the classroom, the primary observer, upon seeing a students' response, would indicate to the student, "I see you talking. Could you wait a minute?" The primary observer would then call over the reliability observer and then say to the student, "OK, can you say that again?" This procedure, although somewhat intrusive, did not appear to have any differential effect, in that the students' level of responding during reliability sessions was comparable to that found at other times.

For training session and probe data, reliability was calculated by dividing the number of agreements by the agreements plus disagreements and multiplying by 100. An agreement was scored if both observers scored a correct response or if both scored an incorrect response on a given trial. Reliability for spontaneous usage was calculated with the same formula but, in this case, an agreement was scored only if both observers marked the same actual word and language system (e.g., both marked the Bliss symbol for "table" or agreed on the iconic picture for "hair"), and reason for responding (manding or tacting).

Agreement scores for session data averaged

Table 3

Reliability scores for students' correct and incorrect responses across experimental conditions.

	Correct Responses		*Incorrect Responses*	
Condition	*Mean*	*Range*	*Mean*	*Range*
Prebaseline				
Randy	100%	-	100%	-
Tom	100%	-	100%	-
George	100%	-	100%	-
Baseline				
Randy	100%	-	95%	75%-100%
Tom	98%	92%-100%	95%	81%-100%
George	96%	82%-100%	94%	75%-100%
Training				
Randy	98%	86%-100%	100%	-
Tom	99%	92%-100%	99%	82%-100%
George	99%	87%-100%	99%	80%-100%
Probe				
Randy	96%	83%-100%	97%	67%-100%
Tom	99%	87%-100%	98%	87%-100%
George	98%	93%-100%	98%	80%-100%

98%, 99%, and 98% for Randy, Tom, and George, respectively. Agreement for spontaneous usage was 100% for all students throughout the study. More specific reliability information for both correct and incorrect responses is presented in Table 3.

Experimental Design

Within-subject designs were used to compare the effects of Bliss versus iconic training on students' acquisition, maintenance, generalization, and spontaneous usage of communication board skills. In order to reduce the likelihood that sequence confounding might result from extended exposure to one independent variable prior to the other (as would be the case with a reversal design), all students received both types of training each day throughout the study in the manner described previously. Although several different names have been used to describe this type of design, for example, the multielement baseline design (Ulman & Sulzer-Azaroff, 1975) or the alternating treatments design (Barlow & Hayes, 1979), the essential feature of the design involves brief and repeated exposure to the different treatment conditions (in this case, the two types of training).

RESULTS

During baseline, Randy required the presentation of 22 items before the list of 20 items to be trained was obtained. He responded to the two eliminated items by using the iconic picture system. Tom required the presentation of 39 items in order to obtain his list of items to be trained. He responded to 18 of the 19 eliminated items in the iconic picture system; the remaining item was a Bliss response. George required the presentation of 41 items; all 21 eliminated items consisted of iconic responses.

Table 4 presents a summary of the training data, expressed as the number of trials to criterion for each symbol and picture. The first entry after each word represents the number of trials to initial criterion (10 consecutive correct responses). Additional entries represent subsequent sets of trials necessary for reacquisition following poor performance during review trials. The final and in some cases only entry after each word represents the total trials to final criterion (i.e., 3/3 or 2/3 correct responses on review trials). Whereas all iconic pictures were maintained after initial training, Randy and Tom were retrained on four of five Bliss symbols, and George was retrained on all five Bliss symbols. Table 4 also shows the mean number of trials to final criterion for all symbols and pictures, and it can be seen that each student required approximately four times more trials to learn Bliss symbols than iconic pictures. Finally, Bliss symbols comprised of single versus multiple (combined) components are noted in Table 4. An examination of students' acquisition of these symbols suggests that pretraining on component parts had no consistent effect on the learning of combined stimuli when compared to the results obtained for single stimuli.

Table 5 shows the results of the maintenance probes. These data reflect a different aspect of maintenance than the training data depicted in Table 4, since maintenance probes were conducted outside of the training context under conditions where correct responses were not reinforced. The total number of probes administered

Table 4
Trials to Acquisition, Reacquisition, and Final Acquisition For Each Symbol and Picture

	Randy		*Tom*		*George*	
Word	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*
Sock*		20	15+28=43			36
Foot*		21	30+73=103			
Shoe*		30	35+32+19=86			
Hair*		13	11			11
Table		32	41+34=75		39+19+14+26=98	
Tray*	70			30		20
Door	32+35=67			21		
Plate	85+10=95			11	21+10=31	
Straw*	111+25+31=167			11		
Pants*	42+13=55					11
Token				11		
Underwear*					20+27=47	
Hand					45+31+44+10=130	
Coat*					39+43=82	
Pocket*						11
Mean =	91	23	64	17	78	18

*Bliss symbols for these items were comprised of two or more combined stimuli.

Table 5
Proportion of maintenance probes correct out of number of probes given for each symbol and picture.

	Randy		*Tom*		*George*	
Word	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*
Sock		.84	.92			
Foot		.85	.72			.95
Shoe		.96	.71			
Hair		1.00	.84			.95
Table		.81	.92		.75	
Tray	.57			.96		.75
Door	.77			.96		
Plate	.75			1.00	.75	
Straw	.29			.76		
Pants	.50					.95
Token				1.00		
Underwear					.63	
Hand					.70	
Coat					.70	
Pocket						.75
Mean =	.58	.89	.82	.94	.71	.87

per item varied depending upon students' acquisition rates. Tom and George received 50 probes for each symbol and picture, while Randy received between 20 and 52 probes per symbol and picture. Results of these probes are expressed as the proportion correct out of the total number administered, and indicate that maintenance was superior for items trained in the iconic system. Randy, Tom, and George, respectively, provided correct responses on an average of 31%, 12%, and 16% more maintenance probes on iconic pictures than on Bliss symbols.

Table 6 shows the proportion of stimulus generalization probes correct out of the total presented. Randy's generalized responding from a specific training object to others of the same stimulus class consistently was higher for items trained with iconic pictures. Some variability was seen in the other students' performance; however, all three students averaged higher scores on iconic picture probes than on Bliss symbol probes.

Figure 2 shows the daily number of correct responses made in each language system on the 10 untrained items presented during response generalization probes. Randy and Tom showed increased correct usage of untrained iconic pictures as training progressed, while George's responses to untrained iconic pictures was rather high to begin with. George's performance is unusual, since he was unable to respond correctly to these stimuli during baseline, yet after acquiring his first iconic picture, he made eight correct responses to untrained picture-object pairs on the first probe. Randy, Tom, and George, averaged 4.2, 5.7, and 7.5 correct responses respectively, on the response generalization probes using the iconic stimuli, and .06, .65, and zero correct responses, respectively, using the Bliss symbols.

Daily spontaneous usage for the three students is shown in Figures 3, 4, and 5 as the mean number of symbols and pictures used per hour. The data are also presented in six categories, reflecting both the total number of responses per day and the number of different responses per day. Two categories, "Trained Bliss Symbols" and "Trained Iconic Pictures," represent symbols and pictures for which the student had reached criterion during acquisition trials and maintained during review trials. The next two categories, "Untrained Bliss Symbols" and

"Untrained Iconic Pictures," each include two groups of items: (a) those on the lists of items to be trained for which the student had not yet met criterion, and (b) those for which the student had met criterion in one language system and had spontaneously transferred to the other language system. The final two categories, "Response Generalization: Bliss" and "Response Generalization: Iconic," include spontaneous usage of untrained items from both language systems at times other than during the daily response generalization probes.

Randy made a total of 148 spontaneous Bliss symbol responses during the study (mean = 2.8 per day). All these responses were trained previously. His spontaneous responses in the iconic picture system totaled 615 (mean = 11.6 per day). A breakdown of this total revealed 162 (mean = 3.1 per day) responses in the "Trained Iconic Pictures" category; 421 (mean = 7.9 day) responses in the "Response Generalization: Iconic" category; and 32 (mean = .6 per day) responses in the "Untrained Iconic Pictures" category. All the untrained iconic responses represented transfers from previously trained Bliss symbols.

Tom used 14 Bliss symbols spontaneously (mean = .39 per day), all consisting of previously trained symbols. His spontaneous iconic picture responses totaled 165 (mean = 4.2 per day). An analysis of these responses revealed 85 (mean = 2.18 per day) in the "Trained Iconic Pictures" category; 77 (mean = 2.0 per day) responses in the "Response Generalization: Iconic" category; and 3 (mean = .08 per day) responses in the "Untrained Iconic Pictures" category. Two of the untrained iconic responses were transfers from trained Bliss symbols.

As with Randy and Tom, George's spontaneous Bliss usage consisted entirely of previously trained symbols (total = 13, mean = .43 per day), and his spontaneous picture usage was both much higher (total = 270, mean = 9.0 per day) and more complex. George made 117 (mean = .39 per day) responses in the "Trained Iconic Pictures" category; 109 (mean = 3.63 per day) responses in the "Response Generalization: Iconic" category; and 44 (mean = 1.47 per day) responses in the "Untrained Iconic Pictures" category. All of George's untrained iconic responses consisted of transfers from trained Bliss symbols.

Table 6

Proportion of stimulus generalization probes correct out of number of probes given for each symbol and picture.

	Randy		*Tom*		*George*	
Word	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*	*Bliss Symbol*	*Iconic Picture*
Sock		.84	.65			
Foot		.85	.88			.95
Shoe		.96	.38			
Hair		.96	.84			1.00
Table		.85	.73		.80	
Tray	.17			.84		.75
Door	.56			1.00		
Plate	.38			.67	.65	
Straw	.75			.25		
Pants	.62					.95
Token				1.00		
Underwear					.47	
Hand					.55	
Coat					.75	
Pocket						.75
Mean =	.50	.89	.71	.75	.64	.88

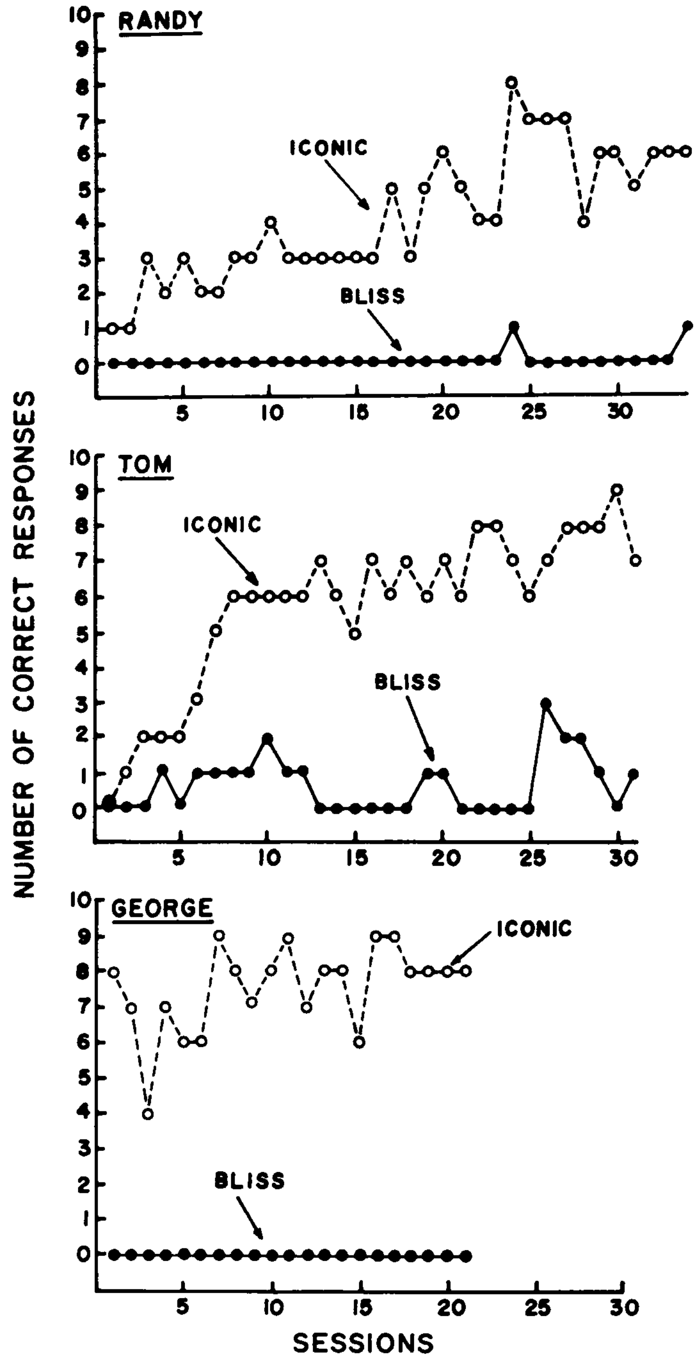


Fig. 2. Number of correct responses in both language systems on the 10 items presented during response generalization probes.

DISCUSSION

Results of this study showed that training stimuli consisting of iconic line drawings were superior to Bliss symbols in facilitating the development of nonvocal language skills. Performance differences were consistent for each student across all measures taken—acquisition,

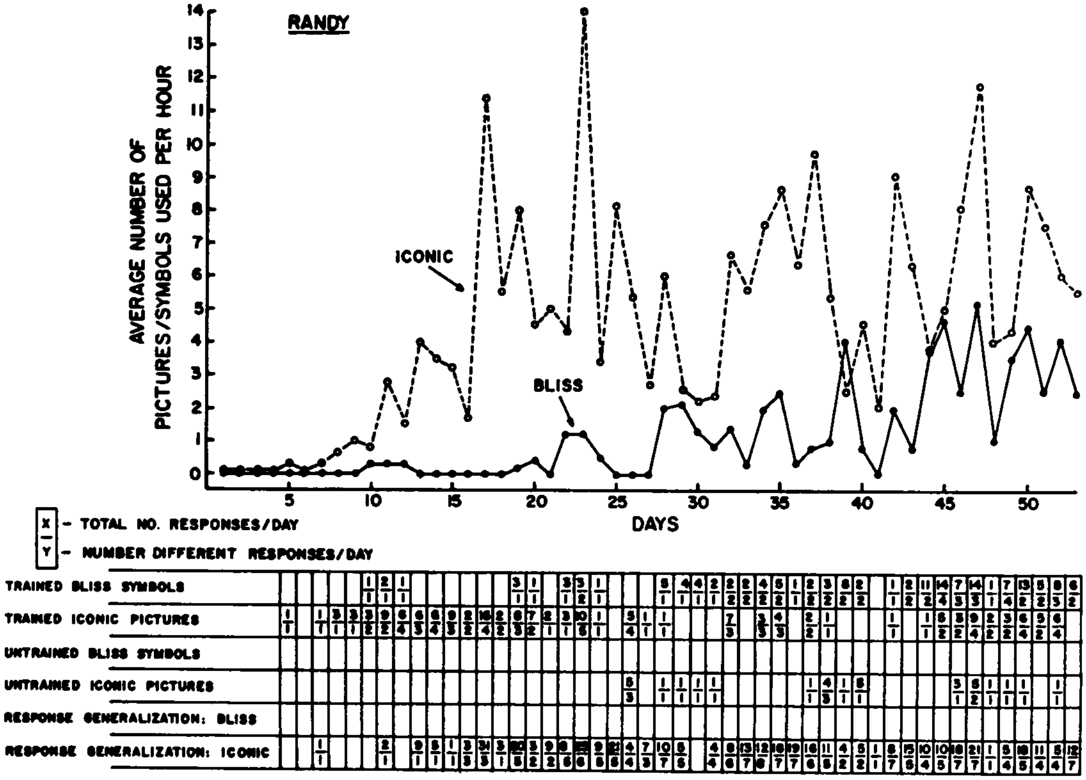
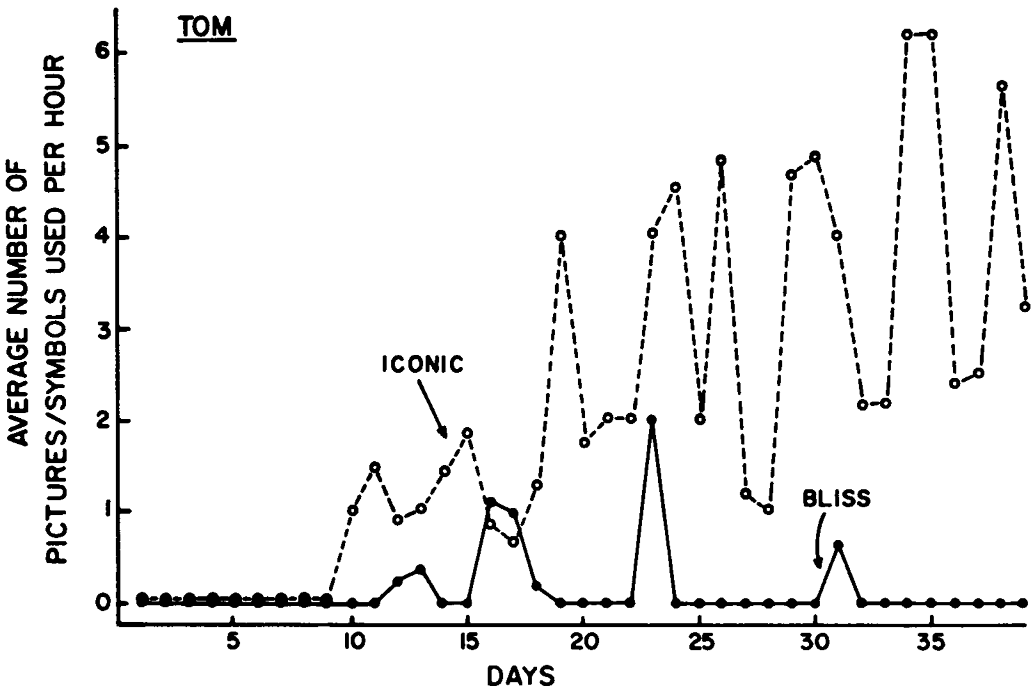


Fig. 3. Mean number of pictures and symbols used spontaneously per hour per day for Randy. Data are broken down further into six categories, each reflecting the total number of responses per day, as well as the number of different responses per day.

maintenance, generalization, and spontaneous usage. These differences strongly suggest that formal similarities (i.e., iconicity) between a representational stimulus and its corresponding object may affect multiple aspects of learning, and are consistent with results obtained by Welch and Pear (1980).

Training data revealed that students required approximately four times as many trials to acquire Bliss symbols as iconic pictures. Furthermore, whereas students retained all iconic pictures following initial acquisition, they required retraining in almost all Bliss symbols. The maintenance probe data are consistent with these findings and represent a more conservative estimate of students' responding in Bliss versus iconic formats. Maintenance probes were taken on a given symbol or picture only if the student had reached criterion on both acquisition and review trials. Maintenance probes were not taken if review trial data indicated that a symbol or picture had not been learned. Thus, instances of a total lack of maintenance are not reflected in the maintenance probe data, yet results clearly favored the iconic pictures.

Stimulus generalization (i.e., the ability to use previously trained symbols or pictures to tact novel objects of the same stimulus class as those used during training) was evident in both language systems, although students' scores were higher for the iconic pictures. These data are somewhat difficult to interpret due to the fact that poor performance on the Bliss stimulus generalization probes to some extent may have been a function of poor maintenance. That is, given that students maintained fewer Bliss symbols, it was not surprising to find that their stimulus generalization responses in Bliss were also lower. Still, the data are important in addressing one criticism of the use of iconic picture training



TRAINED BLISS SYMBOLS			1/1	2/2			5/1	2/1	1/1					1/1								2/2								
TRAINED ICONIC PICTURES	1/1	3/3	3/3	4/1	3/1	5/2	4/2	1/1	3/1	3/2	3/3	1/1	1/1	2/2	5/4	2/2	11/4	4/1	1/1	2/2	1/1	2/2			6/3	6/3	2/2		2/2	4/1
UNTRAINED BLISS SYMBOLS																														
UNTRAINED ICONIC PICTURES		1/1														2/2														
RESPONSE GENERALIZATION: BLISS																														
RESPONSE GENERALIZATION: ICONIC					2/1				2/2	1/1	2/2	1/1	3/2		4/2	2/1	4/3			5/2	4/3	3/2	2/1	4/1	8/5	10/3	8/3	3/1	5/1	4/2

Fig. 4. Mean number of pictures and symbols used spontaneously per hour per day for Tom. Data are broken down further into six categories, each reflecting the total number of responses per day, as well as the number of different responses per day.

(Harris-Vanderheiden et al., 1975), by demonstrating that such training does not inhibit stimulus generalization. For example, in comparing the data from Tables 5 and 6, it can be seen that students' performance on maintenance and stimulus generalization probes generally was comparable.

Results of the response generalization probes indicated that students responded correctly to untrained stimulus-object pairs to a much higher degree in the iconic system than in the Bliss system. It is doubtful that data from these probes were affected by differential maintenance of previously trained stimulus-object pairs, since students were unable to respond correctly to the probe stimuli during baseline, and since instruction was not provided on the probe items. Instead, students' performance on the probes most likely reflects the use of a generalized match-to-sample skill with novel stimulus-object pairs, and the data suggest that the iconic stimuli facilitated the use of that skill. Based on the results of the response generalization probes, it might be expected that if match-to-sample skills can be developed as a result of or concurrent with training in specific stimulus-object relations,

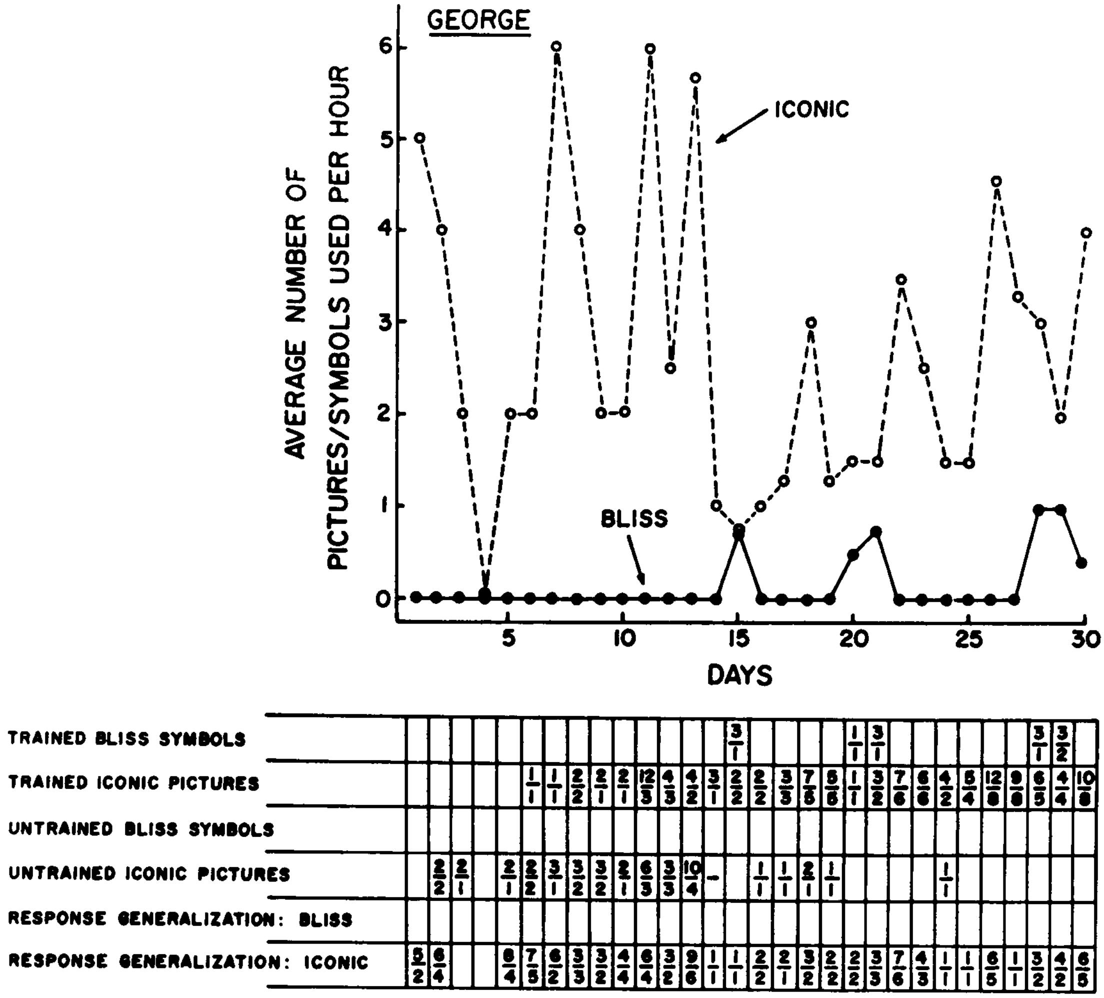


Fig. 5. Mean number of pictures and symbols used spontaneously per hour per day for George. Data are broken down further into six categories, each reflecting the total number of responses per day, as well as the number of different responses per day.

new relations can be acquired readily under conditions where the stimuli and objects share a number of common characteristics.

Data obtained on students' spontaneous usage were consistent with the results of the maintenance and generalization probes. These data indicated that although students made both types of responses (Bliss and iconic) during daily activities, the use of iconic pictures was more extensive in terms of both frequency and variety. The total number of spontaneous iconic responses ranged from a low of four times the number of Bliss responses (Randy) to a high of 21 times (George). In addition, all of the students' Bliss responses consisted of previously trained symbols, whereas their iconic responses contained a large number of response generalization items, as well as several "crossovers" (i.e., instances in which a student substituted an untrained iconic picture for a previously trained Bliss symbol). The data on crossovers are especially interesting and, although it is not clear why students made these substitutions, at least two possible explanations exist. First, crossover responding may merely indicate preference for the iconic format. A more likely explanation is that students' tendency to substitute untrained iconic pictures for previously trained Bliss symbols reflects both the lack of maintenance seen with the Bliss symbols, as well as the ease with which iconic training generalized to untrained items.

In light of the present findings, it appears that an iconic picture system has a number of advantages over a more abstract symbol system as an initial means of communication for severely handicapped and retarded individuals. We must emphasize, however, that the superiority of the iconic training format may not extend to situations requiring more complex verbal skills. Needless to say, iconic pictures cannot be drawn for all parts of speech (e.g., many adjectives and adverbs), and in the advanced stages of language instruction, it would seem important to teach relations that can be represented only by abstract visual stimuli. Such a goal does not preclude the use of iconic stimuli during initial language acquisition, however. In fact, the present data suggest that (compared to Bliss training) iconic training may have the overall effect of strengthening communication as an operant. Thus, following early successes with simple forms of language, more complex relations may be taught using a number of transfer of stimulus control procedures, for example, visual fading (Sidman & Stoddard, 1967), time delay manipulation (Striefel, Bryan, & Aikens, 1974; Touchette, 1968), and functional equivalence training (Sidman & Cresson, 1973; Sidman, Cresson, & Willson-Morris, 1974).

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