

An Investigation of the Communicative Use of Trained Symbols Following Multimodality Training

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Several studies have addressed the ability of people with aphasia to use trained nonverbal means of communication spontaneously to circumvent their verbal deficits. For example, Calculator and Luchko (1983) attempted to train subjects to use communication boards. Other researchers, such as Coelho and Duffy (1985, 1987), Coelho (1991), and Bellaire, Georges, and Thompson (1988), trained aphasic subjects to acquire manual gestures. The results of these studies have been tempered because subjects often acquired the target signs or symbols but did not use them for functional communication.

More recently, Garrett, Beukelman, and Low-Morrow (1989) used a multimodal approach in developing an augmentative communication system for a subject with a Broca's type aphasia. These authors suggested that a multimodal approach can potentially increase the efficiency of the communication efforts because it increases the opportunity for the subject to access residual capabilities.

Given aphasic subjects' reduced ability to retrieve symbols, the idea of multimodal training for them is worthy of study. If aphasic individuals fail to communicate in one modality, they could switch to a different modality. Therefore, if subjects were trained to acquire symbols in multiple modalities, overall communicative performance might be more successful.

The purpose of this study was to examine aphasic subjects' communicative use of trained symbols following multimodality training. The following specific questions were addressed:

1. Do aphasic subjects use trained symbols on structured communication tasks?
2. Do aphasic subjects improve their performance with cueing?
3. Which modalities do aphasic subjects use?
4. Do aphasic subjects spontaneously switch between modalities to communicate when an initial attempt fails?

METHOD

Subjects

Fifteen nonfluent aphasic subjects participated in this study. Subjects were right-handed, were native speakers of English, had normal estimated premorbid intelligence, and passed screening tests for vision and hearing. A summary of subject characteristics is listed in Table 1. Only subjects living at home with active communicative partners were selected; these subjects were believed to be most likely to succeed on functional communication tasks because they had the opportunity for meaningful, daily communicative interactions. Because the focus of this study was on symbol usage, subjects who were likely to be trainable were selected. Therefore, only aphasic patients with a *Porch Index of Communicative Ability* (PICA) (Porch, p. 81) overall percentile of 25 or greater were selected. This cutoff point was suggested by Coelho and Duffy (1985), who found subjects below this point were unable to acquire manual signs.

Symbol Acquisition

Twenty target symbols were trained in three different tasks representing three distinct modalities: communication board, gesture, and verbal. For

Table 1. Descriptive Information and Test Data for 15 Aphasic Subjects

<i>Values</i>	<i>AGE</i>	<i>ED</i>	<i>IQ</i>	<i>MPO</i>	<i>PCOA</i>	<i>CADL</i>
Mean	61.9	13.8	111.1	39.7	40.4	84
SD	9.6	2.9	9.9	51.1	10.7	16.4
Range	43-76	9-20	102-141	4-156	25-63	57-115

Note: ED = years of education; IQ = estimated premorbid intelligence quotient (Wilson, Rosenbaum, Rourke, Whitman, & Grisell, 1978); MPO = months post onset; PICA = *Porch Index of Communicative Ability* overall percentile; CADL = *Communicative Abilities of Daily Living* total score (number possible = 136).

the purpose of this study, a symbol is defined as a picture, sign, or word that represents a given concept. Seven symbols that commonly function as nouns, seven as verbs, four as adjectives, and two as adverbs were trained. All symbols were drawn from the *Communicative Abilities of Daily Living* (CADL) (Holland, 1980) and were judged to be representative of everyday communicative activities. See Appendix A for specific symbols trained.

A multiple baseline across behaviors design was used to train the 20 target symbols in three different communicative modalities. Initial baseline measures were taken over a 3-day period. The mean baseline was 80% on the communication board task (range, 45–100). All subjects had a stable baseline (< 5% variance between measures) on the board. The mean baseline performance for the gesture task was 34% (range, 0–60). Thirteen of the subjects had a stable gesture baseline. Mean baseline performance for the verbal task was 28% (range, 0–65). Eleven of the subjects had a stable verbal baseline. Training was then initiated.

Communication Board. Training began with an introduction to the symbols on the communication board. The 8 1/2-by-11-in. board was divided into a 4-by-6-in. grid that contained black-and-white line drawings representing the 20 target concepts. The word for each concept was printed above the appropriate picture. The examiner stated the concept and pointed to the corresponding picture on the communication board. All 20 symbols were introduced in this manner. During training trials, the symbol was stated and used in a sentence (e.g., "pencil—I write with a pencil"), and the subject was then required to point to the appropriate picture. If the subject was unsure of the correct response, a gestural cue was provided. If an error was made, the examiner showed the subject the accurate response and provided repetitions of the verbal and gestural stimuli. One to four training trials were run during each session. Testing trials were conducted at the conclusion of each training session. Again, the subject was asked to point to a picture when given an auditory stimulus. Responses were scored as accurate or inaccurate. To progress to the next training task, subjects must have attained 80% accuracy on three consecutive testing sessions.

Gesture. Training began with an introduction to the task. The examiner showed the subject a picture (as on the communication board) and demonstrated the corresponding gesture. Training proceeded to an imitative level. The subject was shown the picture stimulus and asked to imitate the gesture demonstrated by the examiner. A verbal explanation accompanied the gesture for the more abstract target concepts (e.g., "You're in a hurry so you go *fast*"). After successfully imitating all gestures, the sub-

ject began the formal training trial, in which the subject was expected to provide the correct gesture in response to the picture presentation only. Errors were corrected by giving the subject a verbal explanation (to ensure knowledge of the concept to be expressed) and demonstrating the correct gesture. When necessary, the examiner manipulated the subject's hand to form the correct gesture. The testing trial was conducted in the same manner as the training trials. The subject was expected to provide the correct gesture in response to a picture (without verbal input). Responses were scored as accurate or inaccurate. Training moved to the final task when the subject attained 80% accuracy on three consecutive testing sessions.

Verbal. Target responses were introduced by having the examiner show a picture to the subject and stating the appropriate word. Training for verbal responses began at an imitative level. Subjects were shown the same stimulus picture and asked to imitate the word. Phonemic, semantic, and visual placement cues were provided to facilitate verbal production. The subject was given three tries for each target, with feedback, before proceeding to the next item. Once a subject produced the word imitatively or in response to the cueing, formal training trials were conducted. The training trials consisted of eliciting the word in response to the picture only. Training ended when subjects reached 80% accuracy or after 20 training trials.

Baseline and Maintenance Probes. During training of the communication board task, baseline measures continued to be taken on the gesture and verbal tasks during each testing session. Once criterion was met for the communication board task, baseline measures continued to be taken on the verbal task, and maintenance of the communication board performance was probed every session. During training of the final task, performance maintenance was probed on the communication board and gestural tasks every testing session.

Overall Criterion. To participate in the current study, subjects had to maintain 80% accuracy in at least two of the three modalities trained. The mean accuracy was 91% on the communication board task (range, 80–100%), 90% on the gestural task (range, 80–100%), and 49% on the verbal-naming task (range, 0–80%). All subjects met the 80% criterion on the communication board and gestural tasks; only four subjects met criterion on the verbal task. All subjects acquired every symbol in at least one of the two nonverbal alternative modalities (communication board or gesture), and 9 of the 15 subjects had every symbol in both nonverbal modalities. Therefore, if subjects failed with their verbal attempts, they all had the potential means to communicate nonverbally with 100% accuracy on each functional communication task.

Functional Communication Tasks

Following training, subjects' use of the trained symbols was tested. Two functional communication tasks were designed to assess whether subjects spontaneously used trained symbols accurately to communicate specific information. These two tasks provided multiple opportunities to use the trained symbols. In addition, the two tasks represented different genres of communication, thus allowing examination of the similarities and differences in performance on different communicative activities. All tasks were recorded on audiotape and videotape for later analysis.

Structured Conversation. The first functional communication task simulated a conversation about common daily activities (e.g., driving and shopping). The communication board was placed on the table to the subject's left side, and the subjects were told to use it whenever they needed to. The examiner followed a highly structured script designed to elicit the trained symbols. All stimuli in the script were one to two sentences in length. One repetition was allowed at the subject's request. If the target symbol was not elicited following the stimulus, a standard cue was provided. Each cue consisted of a single sentence intended to elicit the target symbol (e.g., for the symbol "car," the cue was, "How do you get around town?").

Six variables were defined to describe subjects' performance on the structured conversation task. Three variables addressed successful symbol usage (the total number of correctly used target symbols emitted *spontaneously*, following a *cue*, and in each *modality*), and three variables addressed subjects' spontaneous attempts to switch to an alternative modality when the initial attempt failed (the ratio of the number of *successful*, *unsuccessful*, and *total* attempts to switch modalities to the number of opportunities to switch).

Referential Communication Task. The second task was a referential communication task consisting of 15 picture descriptions. Each picture contained two to three of the target symbols. Some symbols were used in more than one picture, so the total number of symbols targeted in the 15 pictures was 33. To demonstrate that the target concepts were accurately and clearly represented in the pictures and could be easily elicited, six non-brain-damaged adults were shown the pictures and asked to describe them. These subjects responded with all the target symbols in a given picture on the first attempt 87% of the time. All the remaining target symbols were identified on the second attempt. Message receivers were able to identify the target picture with 98% accuracy.

The communication board was placed on the aphasic subject's left side, and the subject was told to use it whenever necessary. The aphasic subject

(sender) was then shown a target picture and required to communicate the contents of the picture to a receiver using whatever means the subject chose. The receiver—someone with whom the subject was very familiar—then attempted to select the target picture from four pictures. The receiver was allowed to make one request for additional information from the sender, if needed. If the receiver was unable to make a correct picture selection, the examiner then cued the subject by pointing to the target symbol in the picture and requesting, "Tell us about this."

The same six variables defined for the conversation task were used on the referential communication task. Again, three variables pertained to the number of target symbols correctly used by the aphasic subjects (spontaneously, following a cue, and in each modality), and three variables addressed aphasic subjects switching behavior (successful, unsuccessful, and total).

Intraexaminer Reliability

Intraexaminer reliability was determined for all variables by rescoring the videotaped performance of the first 10 subjects. Point-to-point agreement ranged from 80–90%.

RESULTS

Structured Conversation

The percentage of correctly used target symbols elicited spontaneously and with cueing are listed in Table 2. Spontaneous use averaged 49% for the group (9.8 symbols). When subjects were cued, usage increased by an average of 34% (6.4 symbols). Paired *t*-tests demonstrated a significant difference between the total number used spontaneously and following a cue ($t = -8.51$, $df = 14$, $p < .001$).

The percentage of target symbols used correctly in each modality (communication board, gestural, verbal) can also be found in Table 2. A repeated measure multivariate analysis of variance (MANOVA) demonstrated significance $F(2,28) = 13.05$, $p < .001$. Post hoc *t*-tests demonstrated that subjects spontaneously used the verbal mode significantly more than the gestural mode (34% versus 10%) ($t = 3.34$, $df = 14$, $p < .01$) or the communication board (34% versus 5%) ($t = 4.20$, $df = 14$, $p < .01$). There was no significant difference between use of gesture and the communication board ($t = -1.4$, $df = 14$, $p = .18$). The same pattern of usage was found following a cue. Again, a MANOVA revealed significance $F(2,28) = 12.96$,

Table 2. Percent of Symbols ($N = 20$) Correctly Used on a Structured Conversation Task

Values	Spontaneous				Cued				Spontaneous + Cued
	CB	Gest.	Verb.	Total	CB	Gest.	Verb.	Total	
Mean	5	10	34	49*	4	7	23	34	83*
SD	8.2	9.2	22.6	16.5	6.1	10.3	12.4	12.2	13.3
Range	0-30	0-25	0-65	20-70	0-20	0-40	0-45	0-55	45-100

Note: Spontaneous = symbols used spontaneously; Cued = symbols used with a cue; CB = communication board; Gest. = gesture; Verb. = verbal.

*Difference between the means is significant ($p < .001$).

$p < .001$. Post hoc t tests showed that subjects correctly used the verbal mode significantly more than the gestural mode (23% versus 7%) ($t = 3.31$, $df = 14$, $p < .01$) or the communication board (23% versus 4%) ($t = 4.85$, $df = 14$, $p < .01$). Again, there was no significant difference between use of gesture and the communication Board ($t = -1.05$, $df = 14$, $p = .31$). Subjects' first responses generally were verbal. Thus, the pattern of symbol usage was opposite that of symbol acquisition during the training task; that is, subjects used least frequently the modalities with which they were most successful during training (communication board and gesture). Subjects were least successful with the verbal modality during training (only four subjects reached the 80% criterion), yet this was the most frequently used modality.

Next, the ratio of the number of times each subject spontaneously attempted to switch between modalities to the number of opportunities present to switch was calculated (see Table 3). The results demonstrated that when subjects' first attempts to communicate failed, they attempted to switch to an alternative only 41% of the time that an opportunity was present ($N = 280$). Because most initial communicative attempts were verbal, the switch was almost always made from the verbal to a nonverbal modality. Of the total number of attempts made to switch ($N = 115$), 67% were successful ($N = 77$) and 33% were unsuccessful ($N = 38$). Although training apparently had provided subjects the means to use alternative modalities when their initial communicative attempt failed, they did not switch to these modalities as frequently as was expected.

Referential Communication Task

The percentage of target symbols correctly used spontaneously and with cueing (33 possible) can be found in Table 4. Subjects spontaneously used

Table 3. Number of Spontaneous Modality Switches on a Structured Conversation Task

<i>Values</i>	<i>Opportunities to Switch</i>		<i>Switches (N = 115)</i>	
	<i>Available</i>	<i>Taken</i>	<i>Successful</i>	<i>Unsuccessful</i>
Total	280	115	77	38
Mean	18.7	7.7	5.1	2.5
SD	8.3	5.9	4.1	2.2
Range	8-35	0-19	0-13	0-7

53% (175) of the symbols. Usage increased by 23% following a cue. Paired *t*-tests demonstrated a significant difference between the number of symbols used spontaneously and following a cue ($t = -8.6$, $df = 14$, $p < .001$).

In terms of the mode of response, a pattern similar to the structured conversation task was demonstrated. For spontaneous symbol usage, a MANOVA demonstrated significance $F(2,28) = 9.15$, $p < .001$. As can be seen in Table 4, subjects correctly used the verbal mode most frequently both spontaneously and following a cue (34% and 12%), followed by the gestural mode (16% and 8%), and finally the communication board (3% and 3%). Post hoc *t*-tests showed that the differences in spontaneous symbol usage were significant between verbal and communication board ($t = 4.16$, $df = 14$, $p < .01$). There was no significant difference between verbal and gesture ($t = 2.05$, $df = 14$, $p = .05$) or gesture and communication board ($t = 2.7$, $df = 14$, $p = .02$). For usage following a cue, a MANOVA revealed significance $F(2,28) = 4.4$, $p < .02$. Post hoc *t*-tests showed significant differences between verbal and communication board ($t = 2.86$, $df = 14$, $p < .01$). There was no significant difference between verbal and gesture ($t = -1.06$, $df = 14$, $p = .30$) or gesture and communication board ($t = 2.45$, $df = 14$, $p = .03$). As was found with the structured conversation task, the communication board and gesture were used less frequently than the verbal mode despite a high degree of accuracy with these modalities on the training task.

An analysis of subjects' switching behavior can be found in Table 5. Of the total number of opportunities present ($N = 494$), subjects attempted to switch modalities only 37% of the times an opportunity was present. Of the total number of times a subject switched ($N = 183$), 80% ($N = 147$) of the attempts were successful and 20% ($N = 36$) were unsuccessful. This pattern is similar to that found with the structured conversation task. That is, subjects did not typically initiate switching between modalities, but when they did, they were usually successful.

Table 4. Percent of Symbols (N = 33) Correctly Used on a Referential Communication Task

<i>Values</i>	<i>Spontaneous</i>				<i>Cued</i>				<i>Spontaneous + Cued</i>
	<i>CB</i>	<i>Gest.</i>	<i>Verb.</i>	<i>Total</i>	<i>CB</i>	<i>Gest.</i>	<i>Verb.</i>	<i>Total</i>	
Mean	3	16	34	53*	3	8	12	23	76*
SD	5.6	14.7	25.4	19.3	4.5	6.9	9.9	10	17.1
Range	0-15	0-45	0-73	21-82	0-12	0-27	0-30	6-42	36-97

Note: Spontaneous = percentage of symbols used spontaneously; Cued = percentage of symbols used with a cue; CB = communication board; Gest. = gesture; Verb. = verbal.
*Difference between the means is significant ($p < .001$).

Table 5. Number of Spontaneous Modality Switches on a Referential Communication Task

<i>Values</i>	<i>Opportunities to Switch</i>		<i>Switches (N = 183)</i>	
	<i>Available</i>	<i>Taken</i>	<i>Successful</i>	<i>Unsuccessful</i>
Total	494	183	147	36
Mean	32.9	12.2	9.8	2.4
SD	15.1	8.2	6.5	2.3
Range	11-57	0-25	0-18	0-8

DISCUSSION

This study demonstrated that multimodality training was successful in that all subjects were able to maintain a minimum of 80% of the symbols in at least two of the three modalities. However, though the subjects did correctly use the symbols in structured communication tasks, they did not use as many as the groups' high performance on the training tasks might have suggested. As a group, subjects spontaneously used only approximately 50% of the symbols on both communication tasks. It should be noted that correct symbol usage increased to 85% following a cue. This suggests that subjects did have the symbols available but that they could not always access them until the additional structure of the cued condition was provided.

The results also showed that the verbal modality was the most frequently used modality both spontaneously and following a cue, even

though this was the modality with which subjects had the least success during training. In fact, the number of verbal symbols used correctly correlated significantly with the number of verbal symbols acquired (conversation, $r = .87$; referential communication, $r = .92$). It is likely that the verbal modality was used most frequently because it is the most natural or automatic means of communicating. Communication by gesture or a communication board is less automatic, and thus these modalities were used infrequently.

It is reasonable to hypothesize that ability to switch between modalities could affect successful use of trained symbols. If subjects attempted to switch to alternative modes, even if they were not successful, this would be evidence that they at least recognized their failure and the need to change approaches or try another alternative. Their lack of success may be because they could not access or produce the appropriate symbol. However, if subjects did not even attempt to switch, this would be evidence that some other factor was involved that interfered with the subjects' ability to recognize their failure or plan an alternative approach.

Aphasic subjects as a group switched modalities only 39% of the time. When they did switch, however, they were usually successful (73% of the time). Thus, even though they appeared to have adequate alternatives available to facilitate their communication, the communication attempt often failed because subjects did not switch to these means when their verbal attempts failed. There are several possible reasons why subjects did not spontaneously switch modalities. Perhaps it was because they were not trained to do so. The intent of this study was to examine what subjects did on their own, so it did not attempt to train the concept of switching between modalities. Future research could address whether specific training of switching behavior might enhance communicative use of trained symbols.

It may also be that specific subject variables may influence performance, including premorbid communicative style, personality variables, or psychological motivation to perform the task. However, these variables are difficult to control in group studies and would be more appropriately addressed in individual case studies.

Finally, switching behavior may be related to certain aspects of cognition for which aphasic subjects may experience deficits. Kraat (1990) has suggested that deficits in cognition could influence and limit subjects' use of alternative communication strategies. In describing aphasic subjects' performances, she noted that "it was as if the aphasic subjects did not think to turn to these alternative forms, could not shift strategies to use them, or somehow could not integrate them into real communicative contexts (p. 324)." More research is needed to identify the cognitive variables that may influence aphasic subjects' ability to use alternative communicative strategies.

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APPENDIX A

<i>Nouns</i>	<i>Verbs</i>	<i>Adjectives</i>	<i>Adverbs</i>
car	move	flat	fast
tire	push	mad	slow
gas	break	blind	
shoelace	hit	cold	
boy	smoke		
fan	stop		
pencil	hurt		