A Training Matrix Approach for Gestural Acquisition by the Agrammatic Patient

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The use of formalized gestural training in aphasia rehabilitation has become popularized in the recent literature (Skelly et al., 1975; Davis and Wilcox, 1981). Gestures are introduced by the clinician with the presupposition that they will facilitate verbal output and serve as a self-cueing mechanism for the aphasic patient. In other situations however, gestures are introduced as a compensatory system for those aphasic patients in whom speech reacquisition is not likely. The use of gestures as a compensatory modality for expressive communication purposes has been introduced far too often after exhaustive speech rehabilitation attempts. Therefore, aphasic clients in a fairly chronic state of disorder have been expected to learn gestural representations after many failing attempts at speech.

Matrix training procedures (or miniature linguistic systems) have been used to train speech and gesture in other language disordered groups—namely language impaired children and the mentally retarded (Wetherby and Striefel, 1978). These procedures have facilitated the investigation of language generalization in these individuals, and it is reasonable to assume that a matrix training approach might have useful applications for studying gestural acquisition in chronic aphasic patients. This investigation was undertaken to determine whether matrix training procedures could facilitate the acquisition of verb + object gestural representations in chronic agrammatic aphasic patients.

Subjects. Four aphasic adult males with a history of single episode left hemisphere cerebrovascular accidents served as subjects in this experiment. Each subject had speech and language symptomatology characteristic of Broca's aphasia—comprehension skills which were more intact than verbal expression skills, agrammatism, and apraxia of speech. None of the subjects had received gestural communication training in speech and language therapy prior to the initiation of matrix training procedures. In addition, all of the subjects had some degree of right-sided hemiparesis.

Gestures and Signs. Four verbs and eight nouns were selected for training. Some of these items were signs commonly utilized in Amerind (Skelly et al., 1975) or American Sign Language (Fant, 1971). Others were gestural representations which were easily recognizable in context and which could be produced with one hand. The individual items selected for training were spill, drink, buy, pour, milk, coke, tea, coffee, juice, water, beer, and wine. Prior to implementation of matrix training procedures, these items first were trained in isolation in imitation of the clinician, and finally in response to a verbal production of the word by the clinician. Before matrix training was begun, individual subjects had to produce appropriate gestural representations in response to the clinician's verbal productions of individual words in 100% of their attempts over three consecutive speech and language therapy sessions. Since each of the aphasic subjects was able to achieve criterion on this prerequisite task, it was logical to assume that they could perform the experimental task without significant problems from limb apraxia or auditory comprehension disturbances.

Matrix Construction. A 4 x 8 matrix was constructed using the four verbs and eight nouns. This array of 32 verb + object combinations is pictured in Figure 1. For training purposes, this matrix was subdivided into two 4 x 4 matrices. Seven items were selected for training purposes, "spill" with the nouns "milk," "coke," "tea," and "coffee" and all of the verbs with the noun "milk." These exemplars (around two sides of the matrix) were selected based on prior successes reported in the child language literature (Wetherby and Striefel, 1978).

	MILK	COKE	TEA	COFFEE	JUICE	WATER	BEER	WINE
SPILL	SPILL MILK T	SPILL COKE T	SPILL TEA T	SPILL COFFEE T	SPILL JUICE E	SPILL WATER E	SPILL BEER E	SPILL WINE E
DRINK	DRINK MILK T	DRINK COKE I	DRINK TEA I	DRINK COFFEE I	DRINK JUICE E	DRINK WATER E	DRINK BEER E	DRINK WINE E
BUY	BUY MILK T	BUY COKE I	BUY TEA I	BUY COFFEE I	BUY JUICE E	BUY WATER E	BUY BEER E	BUY WINE E
POUR	POUR MILK T	POUR COKE I	POUR TEA I	POUR COFFEE I	POUR JUICE E	POUR WATER E	POUR BEER E	POUR WINE E

T = Training Items (7)
I = Intramatrix Generalization Items (9)
E = Extramatrix Generalization (16)

Figure 1. Verb + object pairs used to train gest and sign combinations wi aphasic clients.

Two types of generalization were of interest; 1) nine intramatrix generalization items in the first 4 x 4 matrix, and 2) the 16 remaining extramatrix generalization items. These latter items were of interest because none of the objects in the second matrix (juice, water, beer, wine) were to be trained in combination with any of the verbs. An a priori assumption, then, was that if subjects became able to produce these extramatrix combinations without direct training, they would have demonstrated training generalization outside the realm of the seven training items.

Experimental Design. A multiple baseline design across subjects was used (Hersen and Barlow, 1976). The study consisted of three experimental phases:

1. Baseline. In baseline condition, each subject's ability to perform gestural representations of each of the 32 verb + object combinations on command was assessed. The combinations were spoken one-by-one in random order by the clinician, and the subject was required to perform the corresponding gestural representations. No feedback was provided in baseline condition.

2. Treatment. During treatment condition, the seven training item combinations were presented one-by-one by the clinician, and contingent reinforcement was provided, using a 100% fixed ratio schedule. Following subjects' production of accurate gestural representations of verb + object combinations the clinician provided verbal praise (e.g., "good," "that's what I want," etc.). When an aphasic subject inaccurately produced a verb + object training combination, a verbal reproof (e.g., "no, that wasn't right") and the correct gestural representations were provided by the

clinician. During treatment, aphasic performance on the remaining 25 combinations was assessed without feedback from the clinician. These latter combinations continued to be presented in the same manner as they had been presented in the baseline condition. Training during treatment phase continued until the aphasic client achieved either training item accuracy of at least 90% of his attempts over five consecutive sessions, or completion of 12 training sessions. The maintenance of the twelve gestural representations (i.e., four verbs, eight nouns) in isolation was monitored at the end of each training session. Contingent reinforcement was provided for this task.

3. Follow-up phase. Following the treatment phase, subjects continued to receive speech and language therapy. Although two of the four subjects received training in the gestural mode, only new gestures were trained. At two or three months post-matrix training, baseline measures again were obtained.

Throughout all three of the experimental phases one repetition of each stimulus item was allowed, and if a client was unable to respond to the item after a second repetition, the response was considered inaccurate. None of the aphasic subjects received concurrent treatment of any kind during the course of the experiment.

Reliability. An independent observer scored the follow-up sessions for Clients #1 and #2 during these sessions. Point-to-point agreement was 100% for these two sessions.

RESULTS

Client #1. Client #1, age 56, was 77 months post onset of aphasia at the initiation of training. His Western Aphasia Battery AQ was 38.2 and his CQ was 58.6. While this man had received speech and language therapy intermittently for several years, treatment immediately preceding this investigation had focused on attempting to get him to use writing as a self-cueing strategy for speech. His training results are provided in Figure 2. Following a stable baseline phase, when the client was unable to perform any of the verb + object combinations, the training phase was implemented. By the fourth training session, the client had achieved 100% accuracy on the training items, and could accurately perform 89% of the intramatrix combinations and 44% of the extramatrix combinations. As training continued, there was a steady upward trend in the generalization data, and by the eighth training session, the client was able to produce all 32 verb + object combinations with 100% accuracy. A follow-up measure was obtained three months after the matrix training procedures, and the client demonstrated maintenance of all of the training items and the intramatrix generalization items.

Client #1 has continued to receive gestural training and has mastered verb + object, subject + verb, and subject + verb + object declarative sentence types. His wife has learned the gestural system, and they are reportedly using the gestural mode functionally in the home.

Client #2. Client #2, age 54, was 39 months post onset of aphasia at the beginning of this investigation. His Western Aphasia Battery AQ was 29.4 and his CQ was 35.4. Immediately following this man's CVA, he had speech and language symptomatology characteristic of global aphasia. His speech and language treatment had focused almost exclusively on improving auditory comprehension. His aphasia type at the onset of the investigation was the

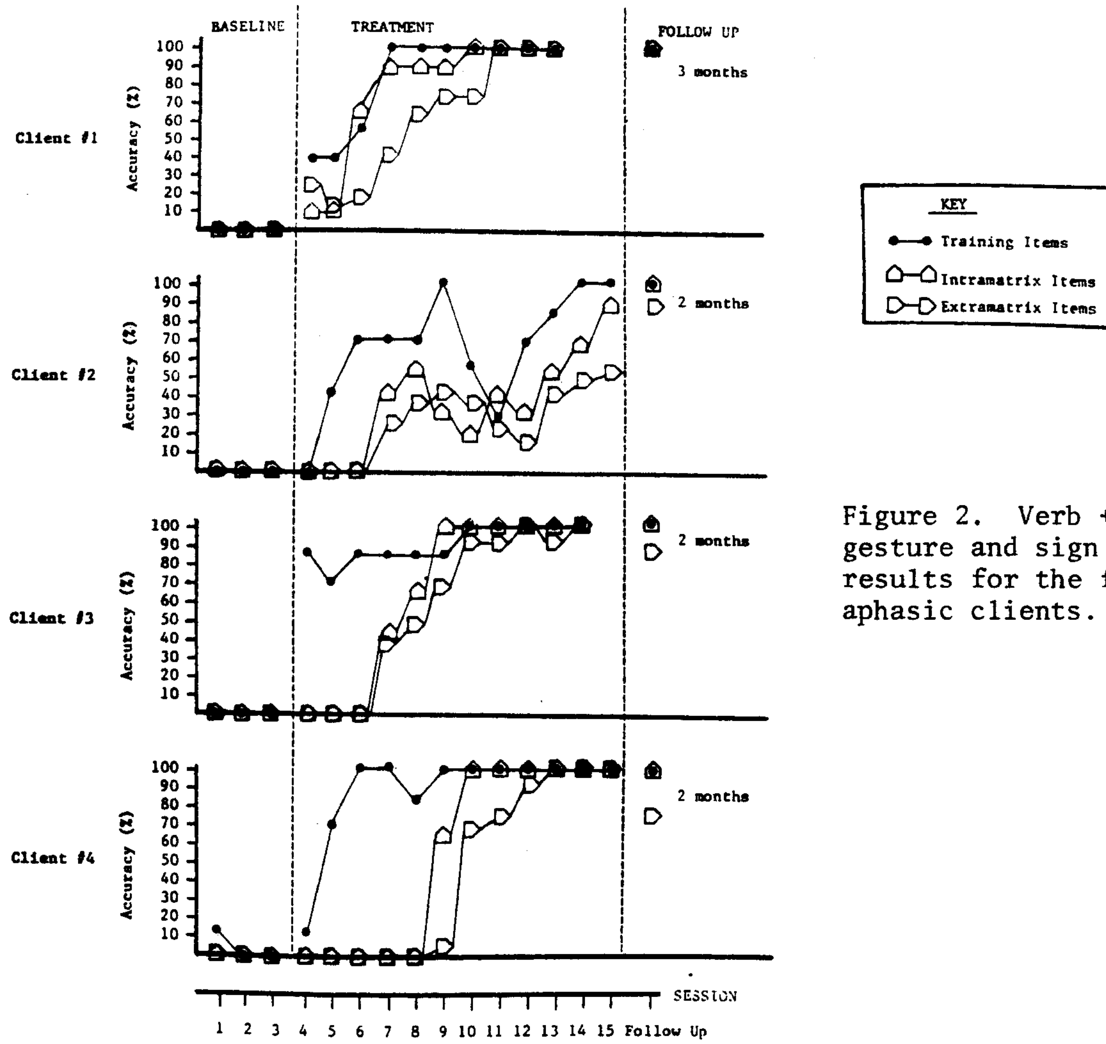

Figure 2. Verb + object gesture and sign training results for the four aphasic clients.

Broca variety. Despite a few automatic verbal stereotypies, this man was unable to use speech functionally, and was the least verbal of the four aphasic subjects in this investigation. His training results are also provided in Figure 2.

Following a stable baseline, training was implemented. This client seemed to be acquiring the training items, but by the third training session, he had demonstrated acquisition of 71% of the training combinations, and there was no generalization to the intramatrix or extramatrix items. By the fifth training session, when it appeared that the client's performance on the training items was stabilizing at 71% accuracy, he demonstrated generalization to 56% of the intramatrix items and to 38% of the extramatrix items. After the sixth training session, during which the client achieved 100% accuracy on the training items, there was a downward trend in the intramatrix data while the extramatrix data continued to course slowly upward. This was followed by a downward trend for all measures. After several additional sessions, there was again an upward trend in the data, and during the twelfth training session, the patient demonstrated acquisition of all of the training items, 89% of the intramatrix items, and 56% of the extramatrix items. Two months after training, when follow-up measures were obtained, the client demonstrated maintenance of all of the training items, all of the intramatrix items, and 88% of the extramatrix items. He, in fact, demonstrated improvement on the generalization items during the follow-up session.

Client #2 has continued to receive training in the gestural mode, and he has acquired numerous gestures and signs in a variety of syntactic combinations. After a recent disagreement with his wife, he gestured "I want to shoot my wife." This man and his wife use gestures functionally to communicate in the home.

Client #3. Client #3, age 59, was 26 months post onset of aphasia at the initiation of matrix training procedures. His PICA scores at the beginning of the investigation were at the 26th percentile overall, with a gestural score at the 23rd percentile, a verbal score at the 21st percentile, and a graphic score at the 43rd percentile. Just before participation in this study, Client #3 was enrolled only in group aphasia therapy, having been judged to have achieved maximum benefits from individual speech-language therapy.

Following stable baseline performance, the client demonstrated rapid acquisition of training items, although there was no generalization to intramatrix and extramatrix items until the fourth training session. There was an upward excursion of the data for generalization items, and at the eleventh training session, this man achieved 100% accuracy for all items. When a second baseline measure was obtained at two months after training, the client had maintained performance of all of the training items and the intramatrix generalization items, but performance on the extramatrix items dropped slightly, to 88% accuracy. Client #3 suffered another CVA, and is no longer receiving gestural training.

Client #4. Client #4, age 50, was 36 months post onset of aphasia at the beginning of matrix training procedures. At that time, his overall PICA score was at the 53rd percentile, with a gestural score at the 59th percentile, a verbal score at the 43rd percentile, and a graphic score at the 68th percentile. Immediately preceding this investigation, Client #4 was enrolled only in group speech-language therapy because he had plateaued in his previous individual speech and language treatment.

As can be seen in the training results for this client (Figure 2), he performed one of the seven training items correctly during the first baseline measure. However, in two subsequent baseline measures, he was unable to demonstrate appropriate performance of any of the verb + object combinations. Once training was implemented, Client #4 achieved rapid acquisition of the training items, although no substantial generalization was seen on the intramatrix items until the sixth training session and on the extramatrix items until the seventh training session. By the end of the training period, this man demonstrated stable acquisition of all of the verb + object combinations. A follow-up probe at two months subsequent to training revealed that this man had maintained performance on training items and intramatrix items, but performance on the extramatrix items dropped to 75% accuracy. Following participation in this investigation, Client #4 has continued to be enrolled in group speech and language therapy with no subsequent gestural training. However, he does occasionally use several of the gestures to supplement his verbal output.

DISCUSSION

On the surface, these data appear to support the notion that matrix training procedures may enhance training of syntax in chronic agrammatic aphasic patients. In this particular experiment, four such patients exhibited generalization to as many as 25 other verb + object constructions when only seven exemplars were trained. However, there are some experimental limitations which necessitate more cautious interpretation of these data:

1) That each of the aphasic subjects demonstrated rapid acquisition of verb + object gestural representations is not overwhelming nor unexpected. This is not a particularly complicated syntactic structure nor is it one that was unfamiliar or incomprehensible to patients. What they lacked initially was the method for transmittin this concept expressively in the gestural modality. Therefore, it is unremarkable that generalization was rapid and generally extensive.
2) Since each of the aphasic subjects had three probes during the baseline phase, there was insufficient control of number of probes during this phase of the experiment. This raises some doubts regarding whether behavioral change was secondary to treatment. Staggering the length of the baseline phase for the aphasic clients would have insured that the training itself precipitated the generalization.

What _is_ worth noting, is that these aphasic clients, in chronic stages of their disorder, were able to acquire novel gestures in a relatively short amount of time and to maintain these gestures over time. While matrix training procedures cannot be used to account for these experimental findings, they may be effective and efficient for structuring such training. The advantages of the matrix training model appear to lie in the fact that 1) it provides for consideration of generalization in treatment, and 2) efficient training of syntax in aphasic individuals can be accomplished by training only a small (but sufficient) number of exemplars.

In summary, the findings of this investigation lend support to the notions that:

1) Matrix training procedures might provide the clinical aphasiologist with a useful method of training for generalization.
2) Matrix training provides an efficient method for training syntactic combinations in the gestural mode, and may have other clinical applications for aphasic patients.
3) Even chronic aphasic individuals may enhance their expressive communication skills with gestural training.

REFERENCES

Davis, G.A. and Wilcox, M.J. Incorporating parameters of natural conversation in aphasia treatment. In Chapey, R. (Ed.), _Language Intervention Strategies in Adult Aphasia_. Baltimore: Williams and Wilkins, 1981.

Fant, L.J. _Say It with Hands_. Silver Spring, MD: National Association of the Deaf, 1971.

Hersen, M. and Barlow, D.H. _Single Case Experimental Designs: Strategies for Studying Behavior Change_. Pittsburgh: Pergamon Press, 1976.

Skelly, M., Schinsky, L., Smith, R., Donaldson, R. and Griffin, J. American Indian sign: A gestural communication system for the speechless. _Arch. Phys. Med. Rehab._, 56, 156-160, 1975.

Wetherby, B. and Striefel, S. Application of miniature linguistic system or matrix training procedures. In R.L. Schiefelbusch (Ed.), _Language Intervention Strategies_. Baltimore: University Park Press, 1978.