The Effect of Syntax Training on "Adequacy" of Communication in Broca's Aphasia: A Social Validation Study

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One of the primary functional deficits seen in patients with Broca's aphasia is motor agrammatism (Goodglass, 1968). These patients are unable to formulate syntactic patterns of speech. Their verbal output consists primarily of substantive words and stereotypic phrases with omission of articles, pronouns, prepositions and inflectional endings. While syntactic comprehension deficits have been shown to parallel syntactic expressive deficits in these patients (Caramazza et al., 1981), most clinicians focus their therapeutic efforts on facilitating verbal expressive skills.

A review of the intervention literature reveals that a variety of grammatical structures have been targeted for training including (a) active declarative sentences with transitive, intransitive, copula and auxiliary verb forms (Helm-Estabrooks, Fitzpatrick and Barresi, 1981; Holland and Levy, 1971; Kearns and Salmon, 1984; Loverso, Selinger and Prescott, 1979; Naeser, 1975; Prescott, Selinger and Loverso, 1982; Wiegel-Crump, 1976), (b) prepositional phrases (Crystal, Fletcher and Garman, 1976; Shewan, 1976; Thompson, McReynolds and Vance, 1982) and (c) wh-interrogatives (Thompson and McReynolds, 1986). Similarly, diverse approaches to treatment have been employed including programmed instruction (Holland and Levy, 1971), auditory-visual stimulation (Helm-Estabrooks et al., 1981; Thompson and McReynolds, 1986; Wiegel-Crump, 1976), operant learning procedures (Kearns and Salmon, 1984; Thompson and McReynolds, 1986), and matrix training (Thompson et al., 1982).

It must be assumed that the rationale for attempting to retrain specific morpho-syntactic structures in patients with chronic Broca's aphasia is that improved grammatical skills will necessarily result in improved functional communication. Rarely, as pointed out by Horner (1983) is it expected that such training will result in "normalization" of expressive language functions. Nevertheless, studies that have examined the effects of syntax training procedures have failed to show that the successful completion of such programs results in more adequate communication skills.

In this investigation we examined changes in adequacy, accuracy, and grammaticality of responses, as well as changes in MLU, for four patients with chronic Broca's aphasia who had participated in a separate functional analysis investigation (Doyle and Goldstein, 1985; Doyle, Goldstein and Bourgeois, In preparation) of a syntax training program (Helm-Estabrooks, 1981). Appendix A contains subject description data. The data base for this investigation consisted of an equal number of exemplars of the interrogative form (sentence type 3) and of the declarative form (sentence type 5) of the HELPSS program, randomly selected from each phase (baseline and post-treatment) of the primary investigation. The purpose of the current investigation was to determine whether naive judges could reliably perceive a difference in the "adequacy" of subjects' responses before and following treatment in the original study.

METHOD

Judges. Five VA employees (4 female, 1 male) who ranged in age from 25 to 50 years volunteered to serve as judges for this study. The judges were naive to the purpose of the investigation and had no previous contact with any of the subjects in the original study. All judges had visual and auditory acuity within normal limits and were native speakers of English.

Stimuli. Four 30-min. audiotapes were copied from master tapes of subjects' baseline and post-treatment probe sessions from the primary investigation. Each experimental tape consisted of 40 items which represented the random selection of 10 baseline and 10 post-treatment probe trials for each of four subjects for both wh-interrogative and declarative intransitive sentence types. These sentence types were chosen for analysis because (a) each subject received training on both wh-interrogative and declarative intransitive sentences and (b) these sentence types represent communicative functions that occur frequently in normal communicative interactions. Each stimulus item on the tape consisted of the experimenter's antecedent Level B stimulus prompt and the subject's verbal response to that stimulus. A 10-sec. interval of silence separated each item on the tape.

Procedures. The judges participated separately in four experimental sessions, during which one of the four tapes was presented to them in a counterbalanced fashion. The judge and one experimenter sat at a table in a sound booth; the judge listened to the tape presented at a comfortable listening level on a SONY TCM-5000 EV desktop tape recorder while concurrently viewing the appropriate HELPSS visual stimulus card. The experimenter stopped the tape after each trial to allow the judge to write down his or her response. Judges were asked to transcribe each response orthographically, and then to judge the adequacy of the response with a "+" (adequate) or "-" (inadequate). An "adequate" response was defined as one that communicated an unambiguous message that was appropriate to the context (i.e., the experimenter's question and the corresponding picture). Appendix B contains the instructions to the judges.

The experimenters (M.B. and P.D.) also listened to the four tapes and independently rated each item for accuracy and grammaticality, and counted the MLU. An accurate response was defined as an utterance that contained all grammatical elements of the target form and was appropriate to the verbal and visual stimulus context. A grammatical response was defined as any utterance that was appropriate with regard to the ordering of all free morphemes, whether or not it was semantically appropriate to the context. Mean length of utterance (MLU) was the sum of all free and bound morphemes in the utterance.

Additionally, subjects' pre- and post-treatment descriptions of the Cookie Theft Picture from the original study were analyzed for number of content units (Yorkston and Beukelman, 1980) and for MLU. These measures were obtained to compare changes in syntactic performance (MLU) with the amount of information conveyed (content units) under less restricted stimulus conditions.

Reliability. Responses were considered adequate when four of the five judges agreed that they were. Inadequate responses were those for which four of the five judges agreed that the response was inadequate, or for which the judges could not agree reliably that the response was adequate or inadequate. Overall interobserver reliability for the adequacy judgments was calculated by dividing the total number of responses for which four of the five judges agreed that the response was adequate or inadequate by the total number of

agreements plus disagreements multiplied by 100; this yielded reliability ranging from 85% to 92.5% for the four tapes. Table 1 gives the overall reliability for each tape.

Table 1. Overall reliability for judgments of adequacy.

	Tape			
	1	2	3	4
100% Agreement	75.0%	75.0%	67.5%	67.5%
80% Agreement	17.5%	17.5%	22.5%	17.5%

Interobserver agreement was calculated for judgments of accuracy, grammaticality, and MLU. The two experimenters' independent ratings of each trial for each of the three variables were entered into the following formula: total number of agreements divided by the total number of agreements plus disagreements multiplied by 100. These analyses yielded reliability scores of 98.1%, 99.4%, and 97.5% for the judgments of accuracy, grammaticality, and MLU, respectively.

RESULTS

Subjects' individual scores for baseline and post-treatment probe conditions are presented for each variable in Table 2. Mean percentage scores across conditions with their associated T-values and levels of significance as determined by the Wilcoxon Matched-Pairs Signed-Ranks Test for small samples (Siegel, 1951) are presented below.

Adequacy. Judgments of adequacy did not change significantly from pre- to post-treatment. For the question forms, 37.5% were judged adequate in baseline and 65% were deemed adequate following treatment ($T=1$, $p>.05$). For the declarative sentence type, scores of 75% and 80% ($T=2$, $p>.05$) were obtained for baseline and post-treatment conditions respectively.

Accuracy. Subjects' mean accuracy improved from 10% to 67.5% ($T=0$, $p<.05$) from baseline to the post-treatment condition for question forms and from 2.5% to 52.5% ($T=0$, $p<.05$) for declaratives.

Grammaticality. Similarly, mean grammaticality scores improved from 12.5% to 77.5% ($T=0$, $p<.05$) from baseline to the post-treatment probe condition for question forms, and from 2.5% to 77.5% ($T=0$, $p<.05$) for declaratives.

Table 2. Pre- and Post-treatment percentages and means on measures of adequacy, accuracy, and grammaticality, and mean length of utterance.

	Adequacy		Accuracy		Grammaticality		MLU	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
				Wh-interrogatives				
Subj 1	40	90	10	90	10	90	3.4	4.6
Subj 2	0	40	0	60	0	60	4.3	4.8
Subj 3	40	80	0	70	10	70	2.5	4.1
Subj 4	70	50	30	50	30	90	3.6	5.0
Mean	37.5	65	10	67.5	12.5	77.5	3.45	4.62
				Declarative Intransitive				
Subj 1	70	90	0	60	0	60	2.0	2.9
Subj 2	90	70	0	10	0	90	1.3	2.2
Subj 3	70	70	10	40	10	60	2.2	3.1
Subj 4	70	90	0	100	0	100	1.5	3.0
Mean	75	80	2.5	52.5	2.5	77.5	1.75	2.8

MLU. The baseline and post-treatment mean MLU scores for question forms were 3.45 and 4.62 ($T=0$, $p<.05$), respectively. Mean scores for the baseline and post-treatment conditions for the declarative form were 1.75 and 2.80 ($T=0$, $p<.05$), respectively.

Boston Cookie Theft Picture Description. The mean pre- and post-treatment content unit scores (Table 3) also did not differ significantly (9.75 and 13.25, $T=1.5$, $p>.05$). However, the mean MLU pre- and post-treatment scores did differ significantly (2.05 and 2.76, $T=0$, $p<.05$).

DISCUSSION

All subjects demonstrated significant improvement on measures of accuracy, grammaticality and MLU for both sentence constructions. These findings are consistent with those of Helm-Estabrooks et al. (1981) who reported mastery of the target forms under training conditions, as well as increased phrase length and a greater variety of grammatical constructions on the BDAE picture description task. Nevertheless, adequacy judgments did not change from baseline to post-treatment probes, nor did a measure of information (content units) conveyed in picture description. This suggests that adults with chronic Broca's aphasia may become more grammatical following syntax training, but that they may not necessarily become more

Table 3. Analysis of content units and MLU for each subject's pre- and post-treatment description of the Boston Cookie Theft picture.

	Content Units		MLU	
	Pre	Post	Pre	Post
Subject 1	10	16	1.6	2.8
Subject 2	10	12	2.45	2.56
Subject 3	8	16	1.73	2.25
Subject 4	11	9	2.4	3.44
Mean	9.75	13.25	2.05	2.76

adequate communicators. However, close inspection of individual performance shows that the non-significant changes for the wh-interrogative adequacy data and the content unit analysis are the result of the failure of subject number 4 to improve. All other subjects improved markedly in both response adequacy and information conveyed.

These individual data show that the training procedures resulted in three of four subjects becoming more adequate at asking wh-interrogative type questions, and being more informative on a picture description task. The effect of training on the adequacy of subjects' simple declarative responses, however, was negligible for all subjects. Social validation measures similar to the adequacy measure used in the present study are crucial to evaluating the effectiveness of treatment programs. Such data need to be collected on larger numbers of subjects following syntax training procedures.

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APPENDIX A

Subject Descriptions

	Subjects			
	1	2	3	4
Age	42	61	58	62
Gender	M	M	M	F
Education	H.S.	H.S.	H.S.	H.S.
Handedness	R	R	R	R
Etiology	CVA	CVA	CVA	CVA
Months Post Onset	88	177	175	30
WAB AQ	61	62	71	69

Pre- and Post-test Percentage Scores on Standard Measures

	Subjects							
	1		2		3		4	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
WAB Subtest Scores								
Spon. Speech	13.0	13.0	13.0	13.0	12.0	12.0	12.0	12.0
Aud. Comp.	7.6	7.7	6.9	8.3	9.5	9.6	8.3	8.4
Repetition	5.3	6.0	3.8	3.2	6.5	7.2	6.3	8.0
Naming	4.5	6.5	7.3	8.0	7.5	8.1	7.7	7.5
AQ	61.0	66.5	62.0	65.0	71.0	73.8	68.7	71.8
NSST								
Receptive	34	35	26	28	27	30	20	32
Expressive	1	6	0	1	1	3	3	13

APPENDIX B

Judges' Instructions for Adequacy Task

You are going to be listening to a tape recording of a clinician asking aphasic subjects some simple questions. Listen carefully to both the question and the subject's response. At the same time, look at the picture I place in front of you. Following each item the tape will be stopped and you will have time to write down the subject's response. You will then be asked to judge the adequacy of the subject's response by marking a "+" for an adequate response, and a "-" for an inadequate response.

For the purposes of this investigation, an adequate response is one that sufficiently communicates a single unambiguous message that is appropriate to the context (i.e., the clinicians antecedent question and the picture before you). If a number of interpretations are possible, then the response is not adequate. If you would have felt inclined to ask the subject to clarify what he/she meant, then score the response not adequate. However, an adequate response does not necessarily have to be a complete or grammatically correct sentence.

DISCUSSION

Q: Can you explain the worsening of performance for Subject 4?
A: Subject 4 was probably the best communicator of the bunch. But on these tasks she communicated in a totally different way. Her attempts to do what we wanted her to do (i.e., give us a particular morpho-syntactic form) interfered with the good communication strategies that she otherwise used.

Q: Does that mean you shouldn't work on syntax in patients who are good functional communicators?
A: I think that our findings are suggestive of that, but we have not run enough patients at enough severity levels to draw any firm conclusions at this point.

C: We're learning that the linguistic devices we would like to see an agrammatic person use are useful for purposes of enhancing coherence in discourse, for distinguishing between given and new information, and so forth. It may be that the condition was just not established where the grammatical improvements could really work to improve the communicative adequacy of the person. In other words, there may have been another condition, such as an attempt to tell a story, in which the person's grammatical improvement may have improved their communicative adequacy.

Q: Was Subject 4 in treatment?
A: Yes. All subjects received training on five different sentence types from the HELPSS program; that was part of the original investigation. We selected a random sample of their responses from that primary investigation for analysis by the judges.

Q: Do you have any feelings about the constraints that are placed upon subjects in terms of allowable responses when using the HELPSS program?
A: Our subjects were definitely constrained to producing target responses of the program. The purpose of the primary investigation was to do a

functional analysis of the program itself. So, in fact, when subjects produced error responses we shaped and chained until they were able to produce the target response. One of the reasons why we used the picture description in this study was to examine how these patients performed under less restricted stimulus conditions. This is related to the earlier comment regarding the conditions necessary to see improved communicative adequacy. It should be understood that these items were taken right from the experimental situation. We did not find that subjects generalized the responses that they learned to other stimulus conditions in the primary investigation. It is unlikely that we would see generalized effects in telling a story or whatever.

Q: I'd like you to speculate for a moment on what happens when we intervene in the area of syntax with someone who's chronically agrammatic.

A: I think we trained our subjects to produce conditioned responses. These subjects were able to produce the target responses under the experimental conditions only. Otherwise, they were not able to produce these forms. In the absence of the experimental stimuli and condition, we saw very little effect. This is one of the reasons why we wanted to look at adequacy.

Q: How was it possible for a subject to score a 90 for adequacy, a 0 for accuracy, and a 0 for grammaticality.

A: That's a good question. If you look at Subject #2's baseline performance on the declarative intransitive sentence types, you can see she was considered to be 90% adequate, 0% accurate, and 0% grammatical. The way that could happen is that adequacy was defined as an utterance that communicated a single unambiguous idea given the context. The context was the Level B antecedent verbal stimulus prompt and the picture that the judge observed. So, for example, a subject could just say a one-word utterance that contained the main verb of the sentence and the judges reliably agreed that was an adequate response. However, it was not accurate because it did not have all of the grammatical elements of the target response and it was not grammatical because it had omitted the personal pronoun. Adequacy was measured by the judges according to the definition in your handout. An accurate response had to be the target response that we trained. A grammatical response was defined as a response that contained all of the free morphemes of the target form whether or not it was a semantically appropriate utterance. So it was indeed possible for a response to be rated adequate without it being accurate (i.e., the target response) or grammatical. Such cases support Holland's description of the Broca's aphasic patient as one who communicates much better than he or she talks.