Error Recognition Utilized to Improve Written Language in a Head Injured Patient

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In 1978 Benton stated that, "...the remarkable increase in the rate of survival from severe head injury in recent years can mean only that there is, and will continue to be, a steadily increasing number of patients with significant behavioral deficits who must be helped toward satisfactory life adjustment" (p. 221). Speech and language pathologists who provide clinical services for neurologically impaired individuals should therefore continue to expect an increasing number of head injury patients with communication deficits secondary to focal and diffuse cerebral damage in their caseloads. For those of us working clinically, one major problem in serving this population is the lack of assessment procedures which can lead to pinpointing socially relevant therapy goals. As Benton (1978) indicated, the results from a variety of standardized assessment procedures used to measure cognitive and related deficits do not necessarily relate to behavioral or "real life" competence. A second problem is the absence of research evaluating the effectiveness of specific treatment strategies with the head injury population. This void in the literature continues despite the recognition that little is known about the training characteristics of head injured patients (Miller, 1980), and the awareness that specially tailored training programs are needed for these individuals (Yorkston, Stanton, and Beukelman, 1981).

"Error recognition" is one treatment strategy which we have found to be effective in the clinical training of head injury patients with communication deficits. Interest in evaluating this strategy comes from at least three sources. First, there is evidence that patients with severe head injury have difficulty recognizing their errors. Gronwall (1976) reported that self-ratings of "problem" symptoms from "severely" versus "mildly" concussed patients did not correlate with their scores on an information processing test, nor their performance in therapy. Patients reported experiencing few problems when their actual performance was poor. Gronwall hypothesized that severely involved patients had reduced ability to process simultaneous information, and therefore were unable to use feedback from their actions to accurately evaluate performance. Second, training of error recognition has been found to be effective with another type of neurologically impaired patient. Tonkovich and Berman (1981) reported increased written language performance in a patient with Wernicke's aphasia secondary to left cerebral vascular accident (CVA) who was taught to recognize his written language errors using a two-alternative forced choice paradigm (Green and Swets, 1966). Finally, if found to be effective in improving communicative skills in head injured patients, error recognition could be evaluated as a treatment strategy for changing a variety of behaviors which could help lead to "satisfactory life adjustment" for these individuals.

The purposes of this paper are to 1) describe a clinical attempt to identify deficits and measure change in written language performance of a head injured patient, 2) evaluate the effectiveness of error recognition training on improving selected aspects of this patient's written language, and 3) suggest changes in measurement and experimental design which could enhance the effectiveness of error recognition as a treatment strategy for improving written language production.

CASE HISTORY

The patient is a 38-year-old highly educated pilot and flight instructor who sustained a severe head injury with brain stem contusion in a helicopter accident on 2/27/80. The injury left him with diffuse cerebral damage in addition to bilateral temporal lobe involvement. Extreme agitation and confusion prevented him from actively participating in a rehabilitation program until 7 months post onset (MPO). At that time, he remained moderately agitated and confused, but new learning was occurring in highly structured therapy situations.

Initial speech and language treatment goals included increasing orientation and improving functional reading skills (e.g., written information needed for orientation and safety). Over the ensuing months of therapy, goals included retraining letter recognition, decoding, and reading comprehension skills. Speech and language treatment also focused on increasing the frequency of socially appropriate utterances, while decreasing perseverative, unrelated and socially inappropriate verbalizations.

At the time the treatment program was initiated (17 MPO), the patient had been living in an apartment for 3 months with attendant supervision 12 hours each day. His verbal expression and auditory and reading comprehension skills were adequate for his living situation. In an attempt to teach the patient to compensate for his severe memory deficit, the rehabilitation team began training him to record "memory" notes and to keep a log of his daily events. It became apparent that the patient's written language deficits interfered significantly with his ability to make use of the notes which he recorded. Increasing written language skills therefore became the major focus of speech and language therapy.

METHODS

Assessment

Written Language Task. In choosing a task for assessing deficits and measuring change in written language performance, we wanted 1) a sample containing enough similar items so that some could be used in training and others retained for evaluating generalization, and 2) a task for which the "content" of the response would be specified by the instructions. Using a procedure described by Tonkovich and Berman (1981), the patient was asked to write a three-sentence paragraph description for each of a series of 20 magazine pictures. Although the patient was required to read each paragraph aloud after writing it, he made no revisions in his responses. As a measure of "normal" performance, a sample similar to that elicited from the patient was obtained from a 19 year old college student.

Variables Measured. Based on clinical experience with head injured patients and a review of past research evaluating written expression in CVA patients, the two lead authors, who served as Judges 1 and 2, selected 13 written language variables to evaluate. These variables included:

- number of T-Units per sentence (i.e., minimal terminable units or independent clauses - Hunt, 1965),
- total number of each of the following per sample:
  - words
  - incomplete sentences
  - functor deletions
  - noun phrase deletions
  - verb phrase deletions
  - ambiguous sentences
  - run-on sentences
  - subject-verb agreement errors
  - punctuation errors
  - spelling errors,
- total number of"logical flow" errors, which rated the "flow" of content for consecutive sentence pairs within each paragraph (i.e., 40 ratings per sample), and
- a rating of the "communicative adequacy" of each paragraph, using Ulatowska, Hildebrand, and Haynes' (1978) definition of, "successful transfer of meaning despite disruption of the surface structure of language" (p. 224), and an adaptation of their 6-point scale.

Scoring. After agreeing on definitions for the variables, Judges 1 and 2 selected three written paragraphs from the sample obtained from the patient and three from the normal sample. The two judges scored each of these paragraphs together and came to mutual agreement on the scores for each variable. The judges then independently scored the remainder of the samples. All subsequent assessments were scored as they were obtained.

Design. The following assessment and treatment sequence was followed to evaluate the effectiveness of error recognition training to improve written language skills in this case, and to evaluate generalization and maintenance of training:

Pretest
Treatment Phase 1
Posttest 1
No Treatment Phase 1
Posttest 2
Treatment Phase 2
Posttest 3
No Treatment Phase 2
Posttest 4

Each assessment utilized the same 20 pictures as stimuli and the three-sentence written description task. Five novel pictures were added to Posttest 4 to allow for evaluation of practice effect. During Treatment Phase 1, five pictures were randomly drawn from the total 20-picture sample and used in training error recognition. During Treatment Phase 2, a different set of five pictures was drawn from the total sample and trained. This resulted in a total of 10 assessment stimuli being "trained" and 10 "untrained." All treatment and no treatment phases were equal in length.

Training

Item Selection. The frequency of error types in Pretest and Posttest 2 assessments (i.e., samples collected immediately prior to the two treatment phases) served as a guide to generate "training" items. There were several variables scored which were not mutually exclusive. For example, there was a relationship between the reduced number of words and T-Units in the samples and the large number of incomplete sentences and noun phrase, verb phrase and functor deletions. For this cluster of variables it was decided that "incomplete sentence" errors would be used as a source for selecting "training" items and for measuring changes in written language performance. Because "logical flow" errors were prominent, and "communicative adequacy" was significantly lower than normal performance, these variables were also used to generate training items and as a measure of change. Spelling, punctuation, and subject-verb agreement errors seldom occurred, and ambiguous sentence errors were difficult to define. These errors were, therefore, infrequently used in training.

Procedure. Error recognition was trained using the two-alternative forced choice paradigm employed by Tonkovich and Berman (1981). The patient was presented with a picture and two alternative written descriptions of the picture. One alternative contained an error from the patient's written language sample. The second alternative was a well-formed contrast for the error. The patient was asked to read each pair of alternatives aloud and indicate which "sounded better" or "best described" the picture. Immediately following each choice the patient received feedback on the accuracy of his response and the reason for his accuracy (e.g., "That's correct. This one is the best choice because it is a complete sentence"). The patient's task throughout training sessions was solely to identify errors. He was never asked to write well-formed contrasts.

As in the Tonkovich and Berman (1981) study, training progressed through three levels. The patient initially chose between a well-formed contrast and his single sentence errors. When he achieved 90% accuracy over two consecutive sessions, he was required to analyze contrasts two sentences in length. After reaching 90% criterion with two sentence contrasts he proceeded to three sentence error recognition. There were 15 contrastive pairs presented each session.

RESULTS

Training

Performance on Error Recognition Tasks. The patient had no difficulty quickly and accurately identifying the well-formed contrasts on the error recognition task. He was able to reach criterion for each session of training during both treatment phases. Figure 1 shows his performance for individual sessions.

The types of errors shown to the patient during error recognition training were dictated by the frequency of errors which occurred in written language assessments prior to each treatment phase (i.e., Pretest and Posttest 2). During Treatment Phase 1, 36% of contrastive pairs presented contained incomplete sentences, 20% focused on logical flow errors, 33% on communicative adequacy and 11% were scattered among the remaining errors. During Treatment Phase 2 the percentages of error recognition tasks presented were; 17% incomplete sentences, 38% logical flow errors, 17% communicative adequacy and 28% scattered among other variables.

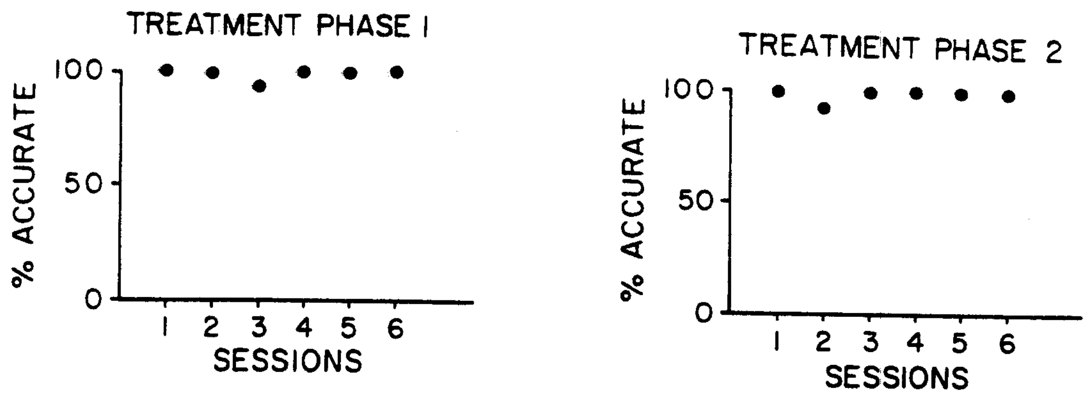

Figure 1. The patient's average performance on 15 error recognition tasks for individual sessions during Treatment Phases 1 and 2.

Written Language Variables

Improvement on Incomplete Sentences. Two aspects of change in the patient's production of incomplete sentences following error recognition training were analyzed: 1) the overall decrease in incomplete sentences across assessments and treatment phases and 2) the decrease in incomplete sentences on trained versus untrained stimuli. Visual inspection of the data were used in both analyses. Figure 2 depicts the average number of incomplete sentences rated by the two judges across treatment phases for each assessment sample obtained. As can be seen, following the first treatment phase the number of incomplete sentences decreased from 55.5 (60 possible) to 3.5. Following the first no treatment phase an increase to 17.5 errors was observed, yet following the second treatment phase errors decreased to 4.0. After the second no treatment phase, errors had increased to 21, but were well below pretest measurement of 55.5 errors.

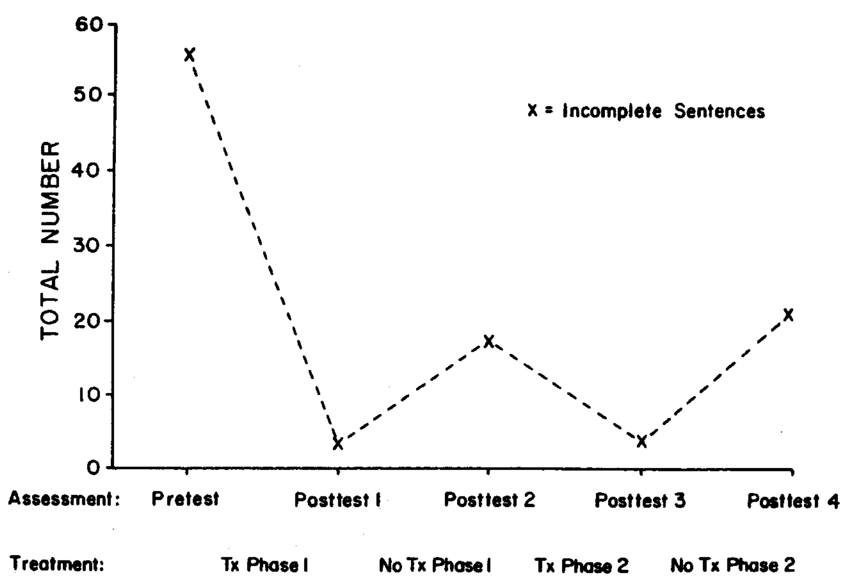

Figure 2. The average number of incomplete sentences rated by Judges 1 and 2 for each of the patient's written language assessments.

To examine the effects of treatment on individual sets of trained and untrained stimuli it was necessary to divide the 10 untrained items into two groups of five so they would be equivalent in number to the two sets of trained stimuli. Therefore, five stimulus pictures were randomly assigned to Set A and five to Set B. Figure 3 illustrates the change in incomplete sentences across assessments as a function of trained versus untrained stimuli. As can be seen, incomplete sentence errors decreased for all stimuli following the first treatment phase. Following the first no treatment phase there was some increase in errors for all stimuli, but the increase was greater for the three sets of untrained items. After the second treatment phase there was again a general decrease in errors for all sets of stimuli, with greater change on the untrained items than the set of currently trained stimuli. The results after the second no treatment phase were similar to the pattern of the first no treatment phase. Namely, there was an increase in errors, but less of an increase on previously trained than on untrained items. Scoring the five items included for "practice effect" yielded seven incomplete sentences. This performance was more similar to untrained stimuli than to Pretest functioning.

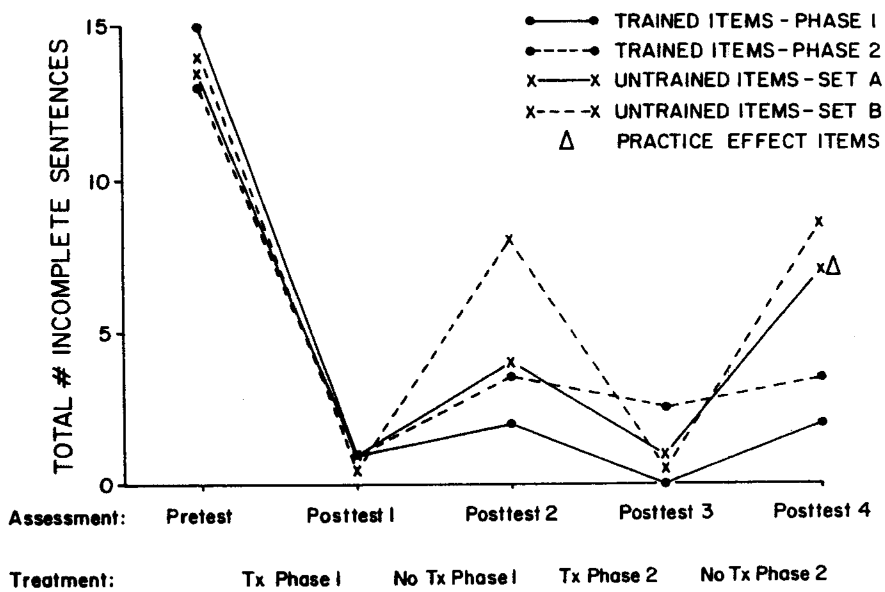

Figure 3. The average number of incomplete sentences rated by Judges 1 and 2 for trained versus untrained stimuli for each of the patient's written language assessments.

Reliability. During assessment and training phases of this case, formal reliability scores were not calculated. A cursory inspection of the judges' composite scores for the three variables which were the major thrust of treatment (incomplete sentences, logical flow errors, communicative adequacy) suggested "fair" agreement. However, when the decision was made to present the results of this case, a quote from last year's Clinical Aphasiology Conference came to mind. Kearns (1981) stated, "...compilation of a large number of studies whose apparent statistical or clinical significance is artifactually related to inadequate reliability procedures may lead to the adoption of weak or ineffective therapeutic techniques" (p. 26).

Retrospectively, then, interjudge reliability was calculated using the Hopkins and Hermann (1977) formula:

$$\text{Reliability} = \frac{\text{Total \# of Agreements}}{\text{Total \# of Agreements + Disagreements}}$$

Point-to-point agreement was tallied for the variables "incomplete sentences" and "logical flow errors." For "communicative adequacy," which was rated on a 6-point scale, interjudge reliability was defined as scores within one point of each other. Intrajudge reliability was assessed by having each judge rescore one sample selected randomly, and was calculated in the same manner as interjudge reliability. Finally, interjudge reliability was calculated for the "normal" sample on the three variables. Chance levels of agreement (Hopkins and Hermann, 1977) were calculated for incomplete sentences and logical flow errors because occurrence and nonoccurrence agreement scores were available.

Table 1 depicts the results of interjudge and intrajudge reliability scores for the three variables under study over all assessments of the patient's written language. The results indicated acceptable levels of reliability (i.e., the 80% minimum acceptable level indicated by Kazdin, 1977a) for incomplete sentences, but marginal and inconsistent reliability scores for logical flow errors and communicative adequacy. In contrast, interjudge reliability measures were consistently between 90% and 100% for all variables in the normal sample.

Table 1. Interjudge and intrajudge reliability scores for ratings by Judges 1 and 2 of the patient's written language samples, with chance levels of agreement in parentheses.

	Pretest	Posttest 1	Posttest 2	Posttest 3	Posttest 4
INTERJUDGE					
Incomplete Sentences	98% (86%)	98% (89%)	95% (47%)	93% (87%)	97% (55%)
Logical Flow Errors	83% (50%)	78% (50%)	65% (52%)	75% (63%)	64% (50%)
Communicative Adequacy	65%	70%	70%	85%	80%

INTRAJUDGE	Judge 1	Judge 2
Incomplete Sentences	88% (61%)	100% (69%)
Logical Flow Errors	73% (50%)	83% (53%)
Communicative Adequacy	95%	70%

Since reliability on two of the variables was marginal, and the possibility for experimenter bias was strong, a "blind" judge (Judge 3) was obtained. She received the same training as Judges 1 and 2 and scored the samples with all identifying information removed, in random order. Table 2 shows the results of interjudge reliability between the blind judge and Judges 1 and 2. The results verified the suspect reliabilitv of logical flow errors and communicative adequacy. Intrajudge reliability, and inerjudge reliability between Judge 3 and both Judges 1 and 2 on incomplete sentences and on all three variables for the normal sample, were consistent with those reported for Judges 1 and 2. Because onlv incomplete sentences were measured reliably no additional results will be presented.

Table 2. Interjudge reliability scores between Judges 1 and 3 and Judges 2 and 3 for ratings of the patient's written language samples, with chance levels of agreement in parentheses.

	Pretest	Posttest 1	Posttest 2	Posttest 3	Posttest 4
JUDGES 1 & 3					
Incomplete Sentences	95% (89%)	97% (91%)	87% (60%)	100% (94%)	97% (54%)
Logical Flow Errors	63% (63%)	50% (44%)	73% (53%)	75% (55%)	38% (64%)
Communicative Adequacy	85%	50%	50%	90%	40%
JUDGES 2 & 3					
Incomplete Sentences	97% (90%)	98% (89%)	92% (63%)	93% (87%)	97% (56%)
Logical Flow Errors	50% (50%)	58% (52%)	73% (61%)	50% (55%)	40% (50%)
Communicative Adequacy	60%	60%	55%	80%	40%

Summary

The effectiveness of error recognition training on a head injured patient's written language skills can be summarized as follows:

1. A dramatic decrease in production of incomplete sentences was observed immediately following both treatment phases.
2. The effect of both treatment phases generalized to untrained items.
3. Some degree of maintenance of training was observed during both no treatment phases.
4. Maintenance of training was most predominant for trained stimuli.

Limitations and Suggestions for Change. The limitations of the current study fall within the areas of reliability of measurement, sampling of dependent variables,and experimental design. First,because of the poor reliability of two of the dependent variables, only the results for one dependent variable were presented, in spite of the fact that some interesting changes appeared to have taken place in the content of the patient's written samples. Table 3 shows selected samples of the patient's written language from assessments during this study. Because repeated measurements of the dependent variables were not obtained, the validity of this case study was weakened. Without establishing a stable baseline, nor evaluating the variability of the patient's performance throughout the study, attributing the written language changes observed to the treatment the patient received is suspect. Finally, because of the modified ABAB design used, the factors of generalization and maintenance greatly interfered with our ability to draw conclusions from these data.

Table 3. Selected samples of the patient's written paragraph descriptions obtained during Pretest, Posttest 1, and Posttest 2 assessments.

Pretest	Posttest 1 - after Tx	Posttest 2 - No Tx
(Trained Item)		
Woman at nightclub. Laughing. Listening to music	A woman with some friends is served a glass of wine. They all look happy. They are listening to an accordionist.	It is somebody's birthday party. Wine is being consumed. An accordion is being played.
(Untrained Item)		
Woman with bowl over fruit. New recipe. Nice day.	The lady is cooking from a recipe book. This is her first time for this dish. The goodies are laid out.	Woman cooking a magazine recipe. It contains eggs and fruit. No telling what it is.

The limitations of the current study could be overcome in future attempts to evaluate the effectiveness of error recognition in improving written language skills in head injury patients. First, reliability of measurement could be improved by following some of the guidelines raised by Kazdin (1977b). Specifically, defining the relevant written language variables precisely, training judges to criteria prior to their rating of written samples, monitoring of continued adherence to definitions agreed on, and using only "blind" judges would all be beneficial. Second, the issue of repeated measurement throughout the baseline and treatment phases of the investigation could be accomplished by limiting the number of items within each sample and sampling more frequently. Finally, employing a multiple-baseline design across behaviors would allow evaluation of the controlling effect of the treatment on each target behavior (Hersen and Barlow, 1976).

DISCUSSION

The results of the current study support the findings of Tonkovich and Berman (1981) by replicating the effectiveness of an error recognition technique and by extending its application to a different clinical population (head injury versus CVA). We believe that error recognition is a promising treatment strategy that merits continued investigation. A number of potential advantages of this technique may be cited. First, for behaviors such as written language, which may be excessively slow in many head injured patients, the relatively rapid error recognition task provides the opportunity for a large number of responses per treatment session. Second, error recognition may be focusing on a fundamental deficit of many head injured patients. Namely, some head injured patients may be unable accurately to judge their performance at a time close to their performance because of the intense concentration required to execute the response. With their attention focused on "performance" they may be unable to evaluate or modify their inadequate performance. Third, heightening awareness of the specific behaviors to be changed, as well as providing a model of target performance, is an important aspect of the treatment of many communication disorders, including stuttering, dysphonia and articulation deficits. A forced choice error recognition paradigm allows the patient to see his or her errors as well as a model of target performance. This could lead to more rapid acquisition of desired behaviors than the traditional model used with language-impaired adults, which shapes error recognition indirectly (Tonkovich and Berman, 1981). Finally, error recognition is a treatment strategy that need not be limited to the training of communication related behaviors. Rather, it may be a generalizable treatment strategy for other socially relevant behaviors which may limit the functionality of head injured patients.

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DISCUSSION

Q: Karen, I think you are awfully hard on yourself. Since you brought the point up I'm curious to know. You said you don't believe you can be sure that your treatment effects are what caused the change in this patient. At 23 months post-onset of head injury I'm dying to know what you think the other variables might be.

A: My point is that with the head-injury population there is so much literature coming out that is not based on solid data. I think we need to be hard on ourselves so that we don't end up making a lot of assumptions and devising treatment strategies to use with these patients based only on our clinical intuitions and unproven theories. Rather, I'd like to see our decisions regarding treatment strategies based on results of studies designed to test the effectiveness of specific, well-defined treatment strategies. If we are going to claim that a treatment strategy is effective, we had better be sure that what we claim our treatment has changed are behaviors that can be reliably defined and communicated to others. In the current case, if we were unable to come to agreement between two or three of us who spent time "defining" the dependent variables studied, then I would hate to see how the definitions of these variables would deviate among clinicians who might attempt to use this treatment strategy and measure these dependent variables with patients in their caseloads.

C: I agree with you but I think you did a very nice job demonstrating the effectiveness of your treatment. I can't believe that you shouldn't be more positive about your results. I also think it would be very interesting to go back and look at the entries the patient made in his log and analyze those writing samples.
R: I agree. We haven't done that but I think it would be very interesting.

Q: Will you comment further on any changes you saw in either self-correction behaviors or the tempo with which the patient approached the tasks? As his performance improved, were there changes in the number of self-corrections or the speed with which he completed the assessment tasks?
A: I don't have that information with me, but if I remember correctly, there was essentially no change in self-corrections and an increase in the speed with which the patient responded to the assessments. Because of the differences in motor abilities it was hard for me to compare this patient's performance with our normal sample. Without repeated baseline measurements it's difficult to say what sort of variability there was in the patient's rate of responding prior to treatment, making comparisons with post-treatment measurements meaningless.

C: I'd like to congratulate you on your study and to reinforce that being conservative regarding your outcome is probably a good idea. Anyone who has tried to obtain baseline data with head injured patients on many tasks realizes the extreme variability you can run into. It is really necessary to be cautious and conservative given this sort of variability in performance.
R: I agree that because of the variability we are likely to run into with these patients, it is essential that we obtain a substantial number of repeated measurements throughout baseline and treatment intervention.

Q: I was impressed with your reliability data. I think that it is good that we be that rigorous in reliability measurement. It shows that sometimes when we don't take good reliability measures we are led to see changes that aren't there; for example, with your "logical flow" measure. These types of variables are probably intuitively good things to look at and it would be nice to say that we could effect change in those variables but unless you have the reliability data to support it, I think you can't make those sorts of assumptions. Did you look at overall reliability and compare it to point-to-point reliability?
A: Yes. One of the reasons we didn't calculate reliability throughout the investigation was that we were really pretty close in our composite scores. I know for one assessment we both came up with the same score for "communicative adequacy," but when we went back and calculated point-to-point reliability it didn't reach the 80% minimum level of acceptability.

Q: Now that you've gone through the whole study, do you have any ideas about the changes you might make in those parameters that might help you describe communicative adequacy better?
A: Defining communicative adequacy better is really not what I would do differently about this study in the future. I think that I would not teach or train on pictures. Rather I would take a more functional task for the patient, like his memory book and look at his performance on that task. It would be from those observations that I would define the patient's problems and generate my dependent variables based upon the patient's needs.

Q: How much language could the patient use? You see, if output is greatly reduced, it makes it difficult to rate communicative adequacy, and that might account for the inconsistencies you found. Regarding logical flow, I see this variable and communicative adequacy as connected concepts. I assume that logical flow is probably data related to discourse errors which the patient made.

A: Your points are both well taken. The patient's first sample was, in fact, greatly reduced compared with the normal sample, in terms of number of words and number of T-units that he used. Yet we still had difficulty rating communicative adequacy on those samples that were quite similar to normal performance, in terms of sentence length. I would agree with your second comment. I too think that logical flow and communicative adequacy are interrelated. In future studies I think the relationship should be looked at more closely.