Efficiency of Information Exchange
Between Aphasic Speakers and Communication Partners

Kathryn M. Yorkston, David R. Beukelman, and Charles R. Flowers

University of Washington, Seattle, Washington

Maximizing communication of information in natural settings is one of the primary goals of aphasia treatment. Traditionally, we have sought to achieve this goal by improving aphasia speakers' linguistic skills through extensive training programs. However, some writers, including Wepman (1972) and Wilcox and Davis (1978), have reminded us that communication is an interactive process between aphasic speakers and their communication partners and that treatment should focus on this process. Communication partners typically receive little formal training other than some general counseling and information about aphasia. This counseling usually takes the form of either giving communication partners general suggestions and reading material or training them to elicit words which are already known to them by using phonemic or semantic cues.

A variety of research is available which identifies techniques for eliciting verbal responses when the messages are known (Love and Webb, 1977; Brookshire, 1975; Rosenbek, Lemme, Ahern, Harris and Wertz, 1973; and Keenan, J.S., 1966). However, little research is available on the active role that communication partners play in facilitating or impeding aphasic speakers' communicative attempts when the message is not known to the communication partner. It might be predicted that communication partner strategies are more crucial for some aphasic speakers than for others. For example, some severely aphasic speakers with limited response options may transmit information equally well to a variety of partners. In this case, differences in communication partner strategies are relatively unimportant. On the other hand, moderately severe aphasic speakers may communicate more effectively with some communication partners than with others. If this is the case, it would be clinically useful to identify techniques used by the more efficient partners and to teach these techniques to other partners.

Several preliminary steps must be taken before detailed study of the differences in communication partner strategies can begin. One such preliminary step is the development of techniques to measure natural communication interactions. The purpose of this project was to develop and illustrate a system for quantifying efficiency of information exchange between aphasic speakers and their communication partners where efficiency is described as a combination of the duration and accuracy of information exchange.

Pairwise Comparisons of Communication Samples

Collection of Communication Samples

Information exchanges between aphasic speakers and their communication partners were video-tape-recorded through a one-way mirror. During the

series of exchanges, the communication partners were asked to elicit information from the aphasic speaker about a picture visible to the aphasic individual but concealed from the partner. The partners were instructed to elicit specific information about 15 different pictures in response to specific written questions. Pictures and questions were selected so that normal speakers could provide unambiguous answers after viewing the picture but were unable to answer the question if they had not seen the picture. Five of the pictures were designed to elicit a noun as primary information ("What are these women doing?") and five a description of why something had happened ("Why does the man look sad?"). The partners were instructed to ask the specific question written on the response sheet during the first exchange about a particular picture. After the initial question about each picture, aphasic speakers and partners were free to use any modes of communication or communication strategies they desired to use. When partners were satisfied that the desired information had been obtained, or after a time limit had elapsed, they wrote their answers on the response sheet. An interaction about a picture was terminated by the examiner after three minutes.

Measurement

Communication exchanges about each picture were quantified in terms of duration and accuracy of information. To measure duration, timing was begun at the end of the partner's first question and terminated when the partner began to write the answer on the response sheet. Communication time for a sample was defined as the mean duration across the 15 communication exchanges.

The answers written by the communication partners on the response sheet were scaled according to accuracy. The scale was as follows:

4 points for complete information
3 points for partially complete information
2 points for some relevant information
1 point for no relevant information but an attempt to answer the partner's questions
0 points if no attempt to answer was made

The accuracy score of a communication sample was the mean accuracy rating of the 15 exchanges.

Pairwise Comparisons

The basic measures of the efficiency of information exchange in this study were accuracy and duration of information exchange. A sampling and rank ordering procedure was developed which permitted a statistical, pairwise comparison of the relative efficiency of two communication samples. Table 1 contains duration and accuracy comparisons for two samples generated by Subject 1 and his communication partner at two different times during recovery. Although the details of this case will be discussed more thoroughly in another section of the paper, the technique of pairwise comparison will be described using these data as an example.

The duration of communication (in minutes) and scaled accuracy score are listed for a portion of the 15 communication exchanges recorded during Sessions One and Two. The mean duration and accuracy scores for each session are bracketed. Durational data from the two recording sessions

were pooled and ranked across sessions. A rank of "1" was assigned to the exchanges with the shortest duration and the rank of "30" was assigned to the exchange with the longest duration. The ranks assigned to durational data of Session One were compared to the ranks assigned to Session Two using the Mann-Whitney U-test. A similar pattern of ranking and comparing was employed for the accuracy data from Sessions One and Two. Results of comparisons are presented in Table 1.

A single index of efficiency (accuracy and duration) was developed in the following manner: (1) ranks assigned to duration and accuracy data for each exchange were added and listed as a "combined ranking" on Table 1; and (2) the combined ranks across both sessions were then re-ranked to achieve an "efficiency index" which is listed in Table 1. For example, the duration for Picture #1 of Session One was 2.9 minutes and was ranked 23rd. The scaled accuracy score for this exchange was 3 and was ranked as 25.5. The combined ranking for duration and accuracy was 48.5, and this was re-ranked and assigned a communication efficiency ranking of "28." The efficiency rankings for Session One and Session Two were statistically compared via the Mann-Whitney U-test to identify differences in relative efficiency of the communication samples.

Case Illustrations

Subject 1

Subject 1 was a 55-year-old male with fluent aphasia secondary to a left cerebral vascular accident. A communication sample was video-tape-recorded as he interacted with his primary speech pathologist on two occasions. Recording Session One occurred two months post onset. At that time, results of the Porch Index of Communicative Ability (PICA) (1967) placed him at the 37th percentile overall. The second recording session occurred four months post-onset when the overall PICA percentile score was 61. (A videotaped sample of exchanges from Sessions One and Two was presented. See Appendix for transcript.) The results from Subject One's communication sample analysis are presented in Table 1. The mean duration of information exchange for Session One was 1.9 minutes while the mean accuracy score was 3.7. For Session Two, the mean duration was .88 minutes and the mean accuracy score was 3.7. The Mann-Whitney U comparisons between sessions revealed that duration of information exchange was significantly less for Session Two than for Session One; however, no differences were found between accuracy scores for the two sessions. Comparison of the combined efficiency index revealed significant differences between the two sessions. Since the accuracy scores for the two sessions were the same, the change in efficiency resulted from increased rate of information exchange or decreased communication time.

A variety of factors potentially influence differences in relative efficiency between two communication samples. Among these factors are aphasic speaker ability, communication partner performance, and the difficulty of the information exchange tasks themselves. The case of Subject One illustrates an instance in which the ability of the aphasic speaker obviously changed over time as measured by a 26 percentile increase in overall PICA scores. The communication partner was the same during both sessions, and an attempt was made to control task difficulty by randomly assigning a series of similar pictures to Sessions One and Two. This case documents the fact

Table 1. Analysis of information exchanges between aphasic Subject One and his primary clinician at two times during the course of recovery.

Picture	Duration (min.)	Rank Order Duration*	Scaled Accuracy Score	Rank Order Accuracy**	Efficiency Index Combined Ranking	Re-ranking***
#1	2.9	(23)	3	(25.5)	48.5	(28)
2	3.5	(29)	4	(11.0)	40.0	(23)
3	.6	(7.5)	4	(11.0)	18.5	(11.5)
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
14	1.4	(15)	3	(25.5)	40.5	(25)
15	.6	(15)	4	(11.0)	18.5	(11.5)
X̄	.6 [1.9]		4 [3.7]			
16	.3	(1)	4	(11)	12	(1)
17	.8	(11.5)	4	(11)	22.5	(15.5)
18	.4	(3)	3	(25.5)	28.5	(19)
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
29	.7	(11.5)	4	(11)	22.5	(15.5)
30	1.2	(14.0)	4	(11)	25.0	(17)
X̄	1.2 [.88]		4 [3.7]			

Session One

Session Two

Mann-Whitney U comparisons - Session One versus Two
*Duration - Significant at .05
**Accuracy - Non-significant
***Efficiency Index - Significant at .05

that when change is apparent in one of the factors that influence efficiency
of information exchange (in this case, improvement of the aphasic speaker's
performance), this change is also apparent in the index of efficiency de-
rived from the pairwise comparison of the communication samples.

The technique of pairwise comparison of efficiency of information
exchange can also be applied to the study of differences between communica-
tion partners. The following two cases illustrate instances where an
attempt was made to hold task difficulty and aphasic speaker performance
constant while examining differences between communication partners.

Subject 2

Subject 2 was a 42-year-old female with nonfluent aphasia secondary to
left cerebral vascular accident. The recordings were made five months
post-onset when her overall PICA percentile was 41. She was video-tape-
recorded as she interacted with her primary speech pathologist and an
inexperienced speech pathology student intern. The recording sessions
were separated by two hours, but occurred on the same day. The sample
with the experienced communication partner (Session One) was recorded first,
and the sample with the inexperienced partner was recorded second, using
the same 15 pictures and questions as stimuli. (Video-tape-recorded
samples taken from Sessions One and Two were presented. See Appendix for
transcripts.) The results of the efficiency analysis for Session One
(experienced clinician) and Session Two (inexperienced communication partner)
revealed that the mean duration was .6 minutes for Session One and 1.8
minutes for Session Two. The mean accuracy score for Session One was 3.5
and for Session Two was 3.3. The Mann-Whitney U-test comparisons between
sessions revealed that mean accuracy scores were not significantly different,
but that duration of information exchanges were significantly less (.05)
when Subject 2 communicated with the experienced partner, than when she
communicated with the inexperienced partner. The combined efficiency index
was also significantly different (.05) for the two sessions, with more
efficient communication occurring with the experienced partner than the
inexperienced one.

The pairwise comparison for Subject 2 was designed so that the primary
factor influencing efficiency of information exchange was the differences
between communication partners. After reviewing the video tapes, it
appeared that the two communication partners were using different strategies
to elicit information from Subject 2. Consequently, an attempt was made to
code communication partner strategies. The intents of all communication
partner strategies were coded into the following categories; request for
specific information, request for general information, confirmation of
previously established information, explanation, instruction, social or
neutral comments, simplification, and feedback to the aphasic speaker.
Results of this coding revealed that the experienced clinician tended to
use confirmation of previously established information as her primary
strategy. She in effect communicated, "This is what you have told me so
far," and then the interaction proceeded from there. The inexperienced
communication partner, on the other hand, often requested answers to
specific questions, usually yes/no questions. These questions seem to be
designed to elicit "new" information rather than confirming "old" informa-
tion.

Subject 3

Experienced communication partners are not always more successful in eliciting information from aphasic speakers than inexperienced partners. This can be illustrated with the case of Subject 3, who is a 55-year-old nonfluent aphasic female. Overall performance on the PICA placed her at the 50th percentile. She exhibited relatively good auditory comprehension, but severe apraxia of speech.

The results of the efficiency analysis (see Appendix for transcript) for Subject 3 revealed that the mean duration of information exchange was 1.1 minutes for Session One (experienced clinician) and 1.4 minutes for Session Two (inexperienced clinician). The mean accuracy scores for Session One and for Session Two were 3.2 and 3.0 respectively. None of the Mann-Whitney U comparisons between Session One and Session Two revelaed significant differences, despite the fact that communication partners who interacted with Subject 3 attempted quite different approaches in their communication with her. The experienced partner typically asked a single question and waited for a reply. The inexperienced partner, on the other hand, often asked two or three questions in rapid succession before allowing a response. The lack of difference in communication efficiency when exchanging information with different communication partners can be attributed to the subjects' relatively good auditory comprehension but severely limited repertoire of verbal responses. Since Subject 3 understood the questions asked, she did not produce irrelevant information. Rather, she provided the answers which were available to her, regardless of the efforts of her communication partner.

Comment

The authors recognize that efficiency, which we have defined as a combination of duration and accuracy of information exchange, is not the primary goal of all communication interactions. However, it appears to be a goal of sufficient importance that systems for quantifying efficiency of information exchanges should be developed. We also realize that much work needs to be completed before the identification of "the most efficient strategies" for interacting with aphasic speakers can be determined. Perhaps such overall strategies which can be applied to all aphasic speakers do not exist; instead there may be categories of patients who benefit from specific strategies. It may be advisable to identify those strategies and to train communication partners to use them as aspects of the rehabilitation program for aphasic individuals. A method for determining the relative efficiency of information exchange in two communication samples provides a basis upon which a selection of "successful" communication partner strategies can be identified or developed. Such a system may also be valuable in quantifying the progress of communication partners as they improve their interactive skills with an aphasic spouse, parent, colleague or friend.

REFERENCES

Brookshire, R.H., Effects of prompting in spontaneous naming of pictures by aphasic subjects. Human Communication, Autumn, 63-71 (1975).
Keenan, J.S., A method for eliciting naming behavior for aphasic patients. Journal of Speech and Hearing Disorders, 31, 261-266 (1966).

Love, R.J. and Webb, W.G., The efficacy of cueing techniques in Broca's aphasia. _Journal of Speech and Hearing Disorders_, 42, 170-178 (1977).

Porch, B.E., _Porch Index of Communicative Ability_. Palo Alto, CA: Consulting Psychologists Press (1967).

Rosenbek, J.C., Lemme, M.L., Ahern, M.B., Harris, E.H. and Wertz, R.T. A treatment for apraxia of speech in adults. _Journal of Speech and Hearing Disorders_, 38, 462-472 (1973).

Wepman, J.M., Aphasia Therapy: A new look. _Journal of Speech and Hearing Disorders_, 37(2), 203-214 (1972).

Wilcox, M.J. and Davis, G.A., Procedures for promoting communicative effectiveness in aphasic adults. Miniseminar presented at the Annual Convention of American Speech and Hearing Association, San Francisco, (1978).

ACKNOWLEDGMENTS

Discussion

Q: On your accuracy scale, how did you distinguish between a "3" (partially complete information) and "2" (some relevant information) and what was the reliability of your accuracy measure?

A: A "3" is analogous to a "12" on the PICA, that is, almost complete information. For example, suppose the question was "Why does the woman look surprised?" and the picture showed a skunk in the kitchen. The written response, "Because there's a wild animal in the kitchen." would have been scored as a "3." If the written response had been, "Because there is something unusual in the kitchen," the score given would have been a "2." Inter-judge reliability was high; two judges agreed on the score over 95% of the time. The high reliability was the result of the fact that the accuracy scores came from the written responses of the communication partners rather than from the interactions themselves. Since the majority of the scores for the subjects discussed here was "4," reliability was probably high as a function of the severity level of the aphasic speakers.

Q: Might the fact that the partners have a question supplied to them with some information in it make the task easier? The communication partner can, in fact lead the aphasic speaker to the answer.

A: Yes, by structuring the task this way, you lose some information about how the aphasic speaker transmits information without the aid of contextual cues. However, at the same time, this task allows for the study of the active process and focuses on the strategies used to elicit responses. We felt that in discourse, the communication partner often has some contextual information.

Q: Might the non-significant differences in accuracy scores be a function of the broad categories in your scale?

A: Perhaps. However, accuracy of information exchanges is often an all-or-nothing phenomenon. That is, the communication partner either understands or does not. We attempted to spread the scores out by incorporating some more difficult questions which could not be answered with a single noun or verb. The high proportion of accurate scores was a function of the severity of the aphasic individuals. The cases presented here represent a rather small range of severity (40th to 67th percentile overall). If we had included patients below the 40th percentile, accuracy scores may have been significantly different.

Subject 1 (55 y/o, male with fluent aphasia)

Session One: (2 months post onset: 37th %'tile overall on PICA)

Primary Clinician: Where are the two girls sitting?
Subject 1: Well the samfer, cra, santi, santi, santifry the
little children are holding this old grandpa like
PC: And they're, so there're some children with a grandpa.
S1: Not his own friends, this is somebody else, through the ah
PC: Where?
S1: That, well 9, 10 years or 10, 10, 11, 12 tenth eleventh,
twelfth year and then the father generally uh, ho, ho, ho,
ho, ho
PC: okay

Session Two: (4 months post onset: 61st %'tile overall on PICA)

Primary Clinician: Why does this woman look surprised?
Subject 1: Well this woman sees uh, open their own house.
There's a (gestures) s.
PC: Ok they look in their house.
S1: Sunk, snuck
PC: there's a skunk.
S1: yeah, that's right. Sitting right there. Isn't that
funny:
PC: Why are their mouths hidden?
SL: These two girls, just are letting their (blowing), trying
to say but, in their own mouth but there's (gestures)
It's big and they're chewing, get the chewing in there.
PC: Are they blowing bubbles?
S1: Yep two of them
PC: With bubble gum

Subject 2 (42 y/o female with non-fluent aphasia; 41st %'tile OA of PICA)

Session One:

Primary Clinician: What are the children on the sidewalk doing?
Subject 2: It is not ballet, no.
PC: Not ballet.
S2: No, kate
PC: Kate?
S2: no it's (gestures)
PC: Oh, it's s-kate.
S2: Yes but not no, but it's (gestures)
PC: Roller skates
S2: Yes - what is it?

<u>Session Two:</u>

Inexperienced Partner: Is it something you like to eat?
Subject 2: yes, really.
IP: Is it sweet?
S2: Yes.
IP: Cookie?
S2: No.
IP: Anything else?
S2: (gestures) what is that? man, I can't, oh boy what is it?
IP: Is it something that you bake? You make it?
S2: No
IP: You don't?

<u>Subject 3</u>   (55 y/o female with non-fluent aphasia: 50th %tile OA on
          the <u>PICA</u>)

<u>Session One:</u>

Primary Clinician: What is the man doing?
Subject 3: In this, dog into this.
PC: There's a dog.
S3: Well, yes and yes.
PC: Ok, there's a dog in the picture.
S3: Yes
PC: Is the man doing something with the dog?
S3: Yes
PC: Uh, is he washing the dog?
S3: No
PC: Can you tell me what it is he's doing with the dog?
S3: Yes, in the uh, in the....

<u>Session Two:</u>

Inexperienced Partner: Can you tell me what the man is doing?
                        Can you tell me? Is he sitting?
Subject 3: Uh?
IP: Is he standing up?
S3: Yes.
IP: He's standing up? Is he walking? Is he alone? Doesn't
     have anything with him.
S3: (gestures)
IP: Can you show me, can you show me yourself; using your hands?
     your fingers? Is the man walking?
S3: Yes, no I yes and no.