A System For Quantifying Verbal Output Of High-Level Aphasic Patients

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Speech Pathologists are often called upon to evaluate the verbal output of "high-level" aphasic patients. Standardized aphasia tests often provide incomplete information. In some tests, the most difficult verbal items are not sufficiently difficult to challenge high level aphasic patients or to differentiate their performance from that of normal individuals. In other tests, the scoring systems used for the most difficult verbal items are too gross to allow for measurement of subtle changes in performance over time. In an effort to solve this problem, we have begun to develop a system for quantifying verbal performance from a sample of connected speech. This system is seen as a supplement to other standardized tests, in that it extends the range of task difficulty so that information can be obtained from extended speech samples. The purpose of this presentation is to describe the system developed to quantify samples of connected speech, to present data from normal speakers, and to give initial results on a group of aphasic speakers.

Speech Sample

When quantifying the efficiency of verbal output, it is necessary to find a task on which performance of normal speakers is relatively consistent and predictable in order to provide a point of comparison. A variety of different speaking tasks were evaluated, including describing sequenced actions, e.g. making a cup of coffee or changing a tire. We found that performance of normal speakers on these tasks varied extensively in terms of content, complexity and detail of material expressed. The decision was made to use a picture description task because a set number of "countable" concepts was elicited, thus insuring a relatively predictable performance by normal speakers. A widely available picture, the "Cookie Theft" picture from the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) was used as stimulus material. This picture depicts sufficient action so that normal speakers were able to talk about the picture for 30 to 45 seconds and the content of speech produced was relatively predictable.

Normative Data

Thirty-one samples of normal speakers (mean age = 33 yrs.) describing the "Cookie Theft" picture were recorded, timed and transcribed verbatim. From these samples, three measures were obtained; number of syllables, number of concepts expressed, and time (minutes).

The notion of "concepts communicated" requires some explanation. From the samples of normal speakers, a list of 68 different concepts mentioned by at least one speaker was constructed (Appendix I). Excluded from this list

were; (1) concepts judged not to be related to the task (e.g., comments about the quality of the artistry) and (2) concepts which make assumptions beyond what is evident in the picture, (e.g., "It must be Thursday today"). Each concept was counted only one time, thus eliminating credit for redundant information. The following sentence was produced by one of the speakers and the six concepts conveyed are underlined. "The little boy is on the stool and reaching up for a cookie and he's going to fall over." The average number of concepts communicated by normal speakers was 18.

Interjudge reliability was assessed by having a group of four judges score a series of both normal and aphasic speech samples. After a one-hour training session, judges were within a range of plus or minus one concept 95% of the time. Syllable counts by the four judges fell within a range of plus or minus 5%.

The three measures obtained from each speech sample, i.e. syllables, concepts and time, can be combined in a variety of ways. For example, such measures as syllables per minute, concepts per minutes and syllables per concept can be generated for each speech sample. The most acceptable presentation system was found to be a plot of syllables per minute versus concepts per minute. Data from the normal population are presented in Figure I. Each point of the graph represents one speech sample plotted as syllables per minute and concepts per minute. Average speaking rate for the group of normal speakers was 108 syllables per minute with a standard deviation of 42. Thus, 96% of the normal population would be expected to fall within a range from 124 to 292 syllables per minute. Average concepts per minute was 45 with a standard deviation of 10. Ninety-six percent of the normal population would be expected to fall within a range from 25 to 65 concepts per minute.

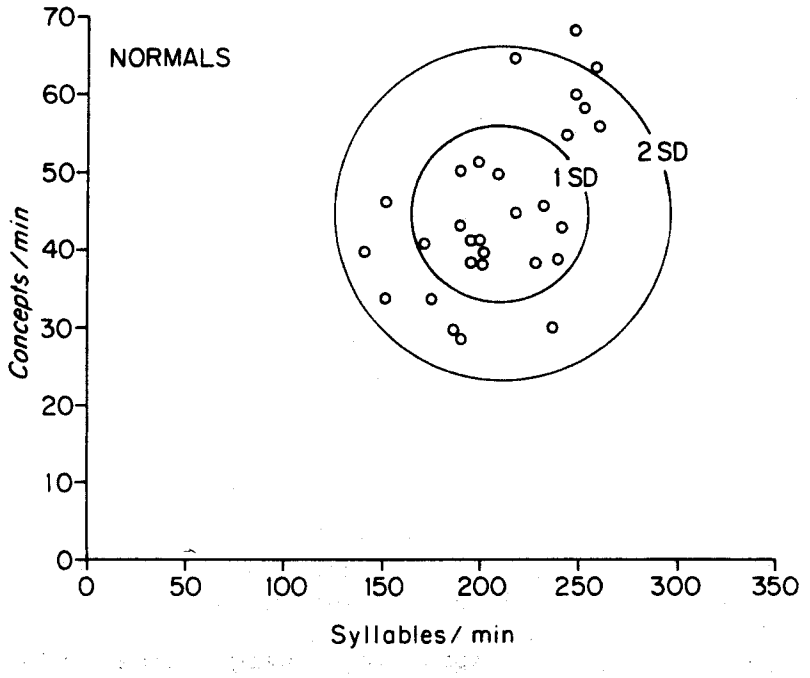

Figure 1. Syllables per minute and concepts per minute produced by normal speakers on a picture description task.

Aphasic Subjects' Performance

At present, speech samples have been obtained from 33 aphasic individuals whose verbal scores on the Porch Index of Communicative Ability (PICA) (Porch, 1967), ranged from the 41st to the 99th percentile: They have been divided into four groups according to verbal PICA percentiles; 85 to 99th percentile (N = 10), 79-84th percentile (N = 7), 55-69th percentile (N = 11), and 40-54th percentile (N = 5). Each sample was transcribed and measures of concepts per minute and syllables per minute were computed.

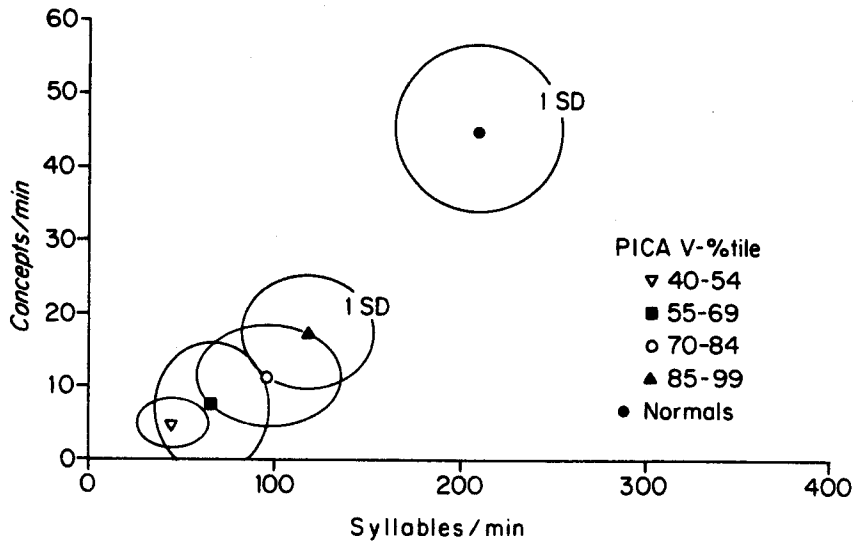

Figure 2. Mean syllables per minute and concepts per minute scores for normals and aphasics on a picture description task.

Figure 2 presents a comparison of normal performance with that of aphasic speakers. The geometric symbols represent the mean performance for each group and are encompassed by a line enclosing one standard deviation around the mean. Table 1 presents the mean and standard deviations for the normal and aphasic populations.

Table 1. Means And Standard Deviation Of Scores Obtained From Samples Of Connected Speech.

Speakers	PICA V-%'tile	Concepts/Minute		Syllables/Minute	
		Mean	S.D.	Mean	S.D.
Normals	--	45.3	10.8	208.8	42.5
Aphasics	85-99	17.1	6.6	116.6	37.6
	70-84	10.9	6.1	98.0	40.2
	55-69	8.3	8.3	67.9	28.2
	40-54	5.2	2.9	45.7	21.2

Two tendencies are apparent after examination of Fig. 2. The first is that this measure of efficiency, defined in terms of concepts per minute and syllables per minute, correlates at least grossly with severity of verbal deficits as measured with the PICA. Thus, as the verbal deficits measured by the PICA become less severe, speaking rate and concepts per minute also move toward the normal range. The second is that this measure of communicative efficiency seems to separate normal from aphasic samples. In fact, for the speakers presented in Fig. 2, there was no overlap between normal and aphasic subjects; i.e., the number of concepts per minute conveyed by the highest level aphasic speaker was lower than the number conveyed by the lowest normal speaker.

Preliminary data for fluent and non-fluent "high-level" (65-99th percentile) aphasic speakers are presented in Fig. 3. The sample contained 3 aphasic patients who were clearly non-fluent and 7 who were judged by four staff speech pathologists to be fluent aphasics (Geschwind, 1971). Mean speaking rate and concepts per minute were computed for each group and are presented in Fig. 3. For the fluent group, mean number of concepts per minute was 17.6, for the non-fluent it was 15.9. For the fluent group, mean number of syllables per minute was 132 and for the non-fluent it was 80. The area encompassing these points is 1 standard deviation from the mean of the highest aphasic group. It is apparent from Fig. 3 that the number of concepts per minute generated by each group was essentially the same but speaking rate (syllables per minute) tended to be higher for the fluent than the non-fluent speakers.

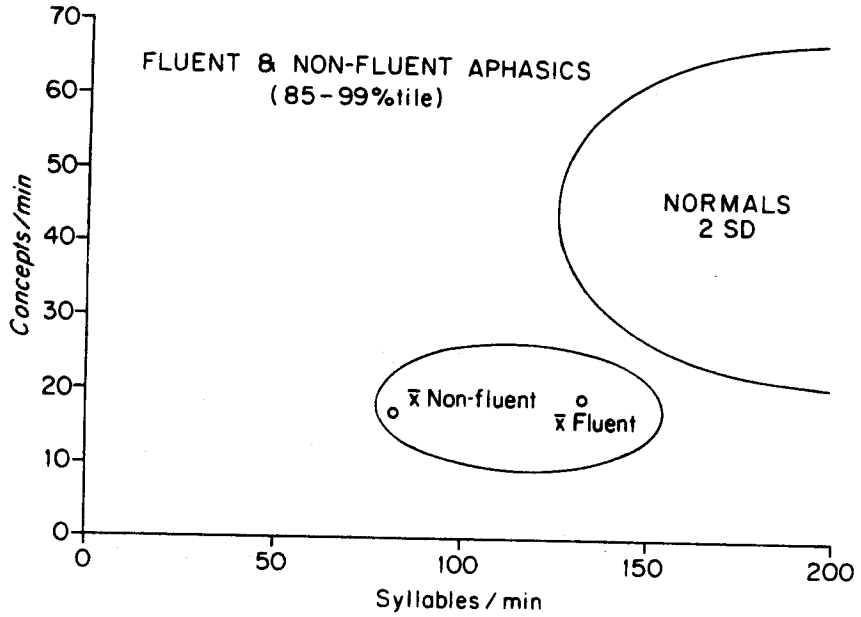

Figure 3. Comparison of fluent and non-fluent aphasics on a picture description task.

Another measure of efficiency that can be obtained from our samples is the measure of the number of syllables per concept expressed, i.e. the number of syllables required to convey one concept. Normal speakers took on the

the average 4.8 syllables to convey one concept. High-level non-fluent aphasics were very similar (4.9 syllables per concept). High-level fluent aphasics, on the other hand, required 7.8 syllables to express one concept.

In closing, it should be reiterated that a system for quantifying efficiency of verbal output of high-level aphasics is needed. What has been presented here are initial steps toward that system. It may be useful in differentiating high-level aphasic performance from that of normal and may have some interesting applications when considering the fluent versus non-fluent distinction. There are, however, a list of questions that need to be addressed as more data are gathered. For example, does the relationship seen here between normal speakers and aphasic speakers hold for tasks other than picture description? Does the geriatric population perform similarly to the normal speakers (mean age = 33) included in the present study? Series of samples from aphasic patients over the course of recovery need be gathered in order to see if this quantification system reflects other standard measures of recovery.

Acknowledgment

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Appendix A

Concepts Elicited From Normal Speakers Describing The "Cookie Theft" Picture

Two
children
little
boy
brother
standing
on stool
wobbling
(off balance)
3-legged
falling over
on the floor
hurt himself
reaching up
taking (stealing)
cookies
for himself
for his sister
from the jar
on the high shelf
in the cupboard
with the open door
handing to sister
little
girl
sister
standing
by boy
reaching up
asking for
cookie
has finger
to mouth
saying "shhh"
(keeping him
quiet)
trying to help
(not trying to
help)
laughing
mother
woman (lady)
children behind
her
standing
by sink
washing (doing)
dishes
drying
faucet on
full blast
ignoring
(daydreaming)
water
overflowing
onto floor
feet getting wet
dirty dishes left
puddle
in the kitchen
(indoors)
general statement
about disaster
lawn
sidewalk
house next door
open window
curtains

References

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

Goodglass, H., and Kaplan, E., Boston Diagnostic Aphasia Examination. PA: Lea and Febiger, (1972).

Geschwind, N., Current concepts Aphasia. New England Journal of Medicine, 284:654-656 (1971).

Discussion

Q. Is the time required to analyze these samples reasonable for clinical use?

A. Yes, we are presently using this analysis as part of our standard evaluation battery. Recording time is approximately 2-3 minutes. The process of counting the concepts and syllables requires listening to the tape 3 or 4 times. The analysis then involves some simple computations using the data obtained i.e., time number of syllables and number of concepts. The total analysis time is 10-15 minutes. For purposes of this research, all of the samples were transcribed. But this is not necessary for clinical use, especially if you are familiar with the concepts to be counted. We found that the syllable counts were most accurate if they were done directly from the tapes.

Q. Do you have trouble identifying concepts given by fluent, jargon aphasic patients?

A. We see this tool for use primarily with high-level aphasic patients where we need a system for quantifying their verbal output. With our high-level patients, identifying the concepts they generated was no more difficult than identifying concepts generated by normal speakers. With the lower-level speakers, especially the fluent patients, many more decisions needed to be made about whether or not a particular concept had been communicated. When a decision was required, we used a rule of thumb that in order to be counted as a concept it would have to be intelligible to a listener who had not seen the picture.

Comment: I think the system is very useful and a good, innovative way of quantifying verbal output.

Q. Do you have any feeling about what the learning factor may be for high-level aphasic patients?

A. We gathered our samples at one-month intervals, so we were not particularly concerned about the effects of learning the task. It has been suggested that we could address the learning problem at least in part by taking a series of samples from normal speakers over a period of time and looking at the variability there. I think this is an interesting suggestion and we will be gathering that type of data.

Q. Could you comment on the unit of syllables, i.e., syllable as opposed to word.

A. The decision to count syllables rather than words was made because it was so very difficult to count the words produced by the low-level fluent aphasic speaker. By counting the syllables we were able to include all of the filler syllables and all of the syllables of jargon.