Repeated Trials of Words by Patients with Neurogenic Phonological Selection - Sequencing Impairment (Apraxia of Speech): Stimulus Mode and Response Condition Revisited

Leonard L. LaPointe, Ph.D.
and
Jennifer Horner, M.A.
Audiology and Speech Pathology Service
Veterans Administration Hospital
Gainesville, Florida

Introduction

The presence of phonological errors in brain-injured patients and characteristics of these errors are important to aphasiologists for a number of reasons. From a theoretical standpoint, the study of disrupted phonological systems may suggest the application of linguistic principles which bring order and predictability to seemingly patternless behavior. Among those generating neurolinguistic principles which relate phonological structure to the language system in general are Blumstein (1973) and Goodglass (1975).

From a clinical standpoint, the study of phonological disruption has enhanced our appreciation of some subtle and not so subtle distinctions among similar disorders and aided the process of differential appraisal and diagnosis (Johns and Darley, 1970). Further clinical relevance is evident in the work of Rosenbek, Lemme, Ahern, Harris and Wertz (1973), who outlined a number of phonological conditions from which therapeutic principles could be derived. Principles of treatment are dependent upon a thorough understanding of the conditions under which phonological impairment varies. Johns and Darley (1970) suggested that some subjects performed more accurately when stimulus words were presented by the auditory and visual modes combined than by auditory presentation alone. Further, these authors suggested that the condition of one stimulus model, followed by three successive responses, seemed to facilitate phonemic integrity, though these results were not statistically significant.

It would seem important to extend study of these conditions to include additional modes of stimulus presentation. Deal (1974) studied adaptation and consistency of phonological errors in a reading passage. As a group Deal's subjects made consistent word errors and demonstrated a significant adaptation effect. In a study of aphasic patients with concomitant phonological impairment, Lemme, Wertz, and Rosenbek (1974) found no differences in accuracy of responses between single words presented auditorily or visually. They found, however, that responses to words presented through the tactile modality were produced with less accuracy.

The differential effects of various cueing techniques with phonologically-impaired subjects were reported by Webb and Love (1974) who found whole word imitation to be superior, while reading the printed word was the least effective cue.

Further insight might be gained into variability and consistency of error pattern by analyzing performance on more extensive repeated trials of single words.

Therefore, the purpose of this study was to analyze and describe phonemic characteristics in seven subjects who presented neurogenic phonological selection-sequencing impairment. Specifically, the purposes were: (1) to describe error pattern and phonemic integrity over 10 trials for 10 single words, and (2) to determine the effect on error pattern and phonemic integrity of two response conditions and four modes of stimulus presentation.

Seven subjects were selected who presented characteristics of neurogenic phonological selection-sequencing impairment. These characteristics were determined from analysis of a recorded speech sample ranging from single word repetition to spontaneous speech. Criteria for acceptance included presentation of predominantly substitution errors, variability in error pattern on repeated trials of polysyllabic words, and/or difficulty in the initiation of speech.

Our subjects ranged in age from 50-64 years with a mean of 55.6 years; ranged in months post-onset from 1-63, with a mean of 15.9 months. Five subjects presented a history of left hemisphere cerebrovascular accidents; all were single episode with the exception of subject 7, who suffered two cerebrovascular accidents. Subjects 5 and 6 presented a history of single right hemisphere cerebrovascular accidents. All subjects demonstrated varying degrees of concomitant aphasic involvement; however, in all cases phonological deficit predominated.

The experimental tasks were then presented to each subject individually and responses were tape recorded for subsequent analysis.

Stimulus items included five monosyllabic and five polysyllabic words all of which were of high phonemic complexity: shrub, glass, thread, splash, scratch, Episcopalian, gingerbread, catastrophe, refrigerator, impossibility (see Figure 1).

Words were presented in the following four stimulus modes under two conditions (see Figure 2):

Mode 1: Auditory (A)
Mode 2: Auditory + Visual (watch clinician) (AV_1)
Mode 3: Visual (printed) (V_2)
Mode 4: Auditory + Visual (printed) (AV_2)

Condition I (1:10): One stimulus model and ten uninterrupted successive responses;
Condition II (1:1): Ten responses, each preceded by a stimulus model.

The design and procedures in the study are summarized as follows (see Figure 3).

We had 7 subjects, 10 stimulus words, 2 conditions and 4 modes per condition. Order of words, modes and conditions was counterbalanced and all responses were tape recorded. The corpus of data consisted of 800 responses per subject (10 words by 10 repetitions per word by 4 modes by 2 conditions). Our task was to analyze and score 5,600 responses.

Results

The first part of our analysis was concerned solely with the accuracy or inaccuracy of each response. Therefore, we used a plus-minus scoring system logged on eight Base-10 Response Forms ○ for each subject.

Group differences between Conditions I and II are shown in Figure 4. Condition I, you will recall, requires one stimulus presentation followed

REPEATED TRIALS: STIMULUS WORDS	
SHRUB	EPISCOPALIAN
GLASS	GINGERBREAD
THREAD	CATASTROPHE
SPLASH	REFRIGERATOR
SCRATCH	IMPOSSIBILITY

Figure 1. Repeated trials: Stimulus words.

REPEATED TRIALS: CONDITIONS AND MODES OF STIMULUS PRESENTATION

CONDITION I (1:10)

(one stimulus model and 10 uninterrupted successive responses)

Mode 1: Auditory (A)
Mode 2: Auditory + Visual (watch clinician) (AV_1)
Mode 3: Visual (V_2)
Mode 4: Auditory + Visual (printed) (AV_2)

CONDITION II (1:1)

(10 responses, each preceded by stimulus model)

Mode 1: Auditory (A)
Mode 2: Auditory + Visual (watch clinician) (AV_1)
Mode 3: Visual (V_2)
Mode 4: Auditory + Visual (printed) (AV_2)

Figure 2. Repeated trials: Conditions and modes of stimulus presentation.

REPEATED TRIALS: SUMMARY OF PROCEDURES

7 SUBJECTS
10 STIMULUS WORDS (5 MONO., 5 POLY.)
2 CONDITIONS (1:10, 1:1)
4 MODES PER CONDITION (A, AV_1, V_2, AV_2)
ORDER OF WORDS, CONDITIONS, MODES
COUNTERBALANCED
ALL RESPONSES TAPE RECORDED
CORPUS OF DATA: 800 RESPONSES PER
SUBJECT (10 WORDS x 10 REPETITIONS
PER WORD x 4 MODES x 2 CONDITIONS
ANALYZE AND SCORE 5,600 RESPONSES
(WHEW!)

Figure 3. Repeated trials: Summary of procedures.

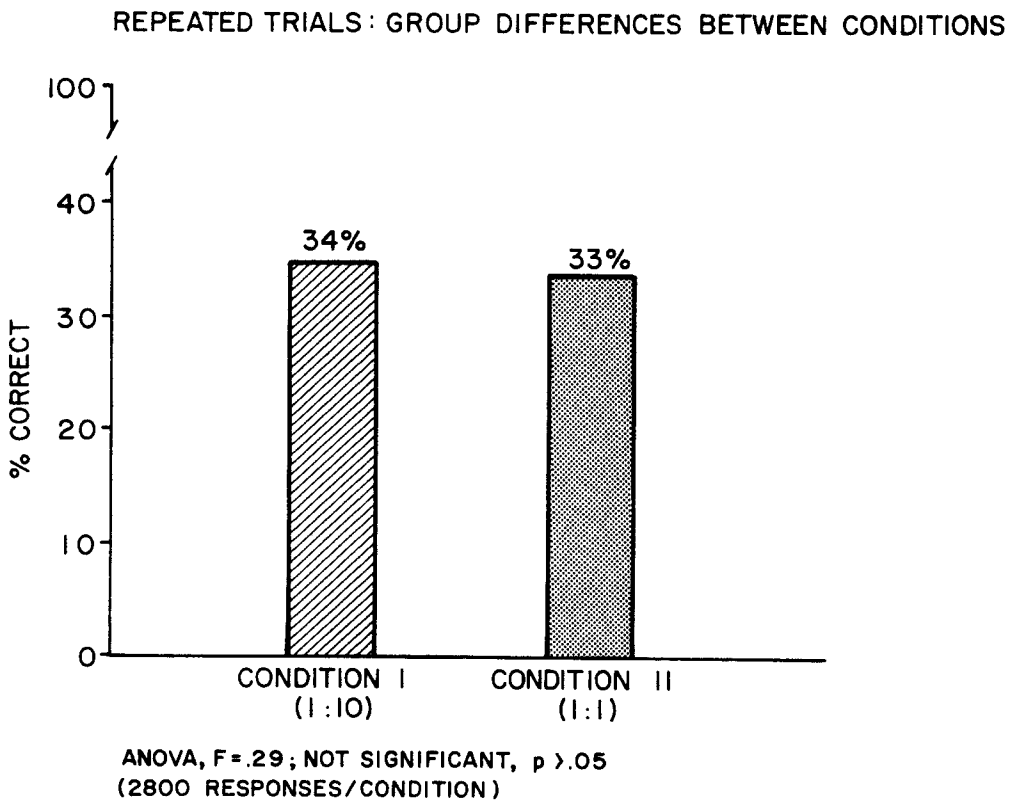

Figure 4. Repeated trials: Group differences between conditions.

by 10 uninterrupted subject responses, while in Condition II a model is presented prior to each response. For a pool of 2,800 responses per condition, percentages of correct responses were about equal for each condition; that is, 34% and 33%, respectively. Analysis of variance confirmed the obvious in that these differences were not significant.

Analysis of individual subject differences between conditions revealed the following (see Figure 5).

For a pool of 400 responses per condition per subject, no subject had a significant discrepancy between conditions. Of our 7 subjects, 4 performed slightly better on Condition I and 3 slightly better on Condition II.

You will recall that Johns and Darley (1970) suggested that the condition of one stimulus model, followed by uninterrupted successive responses seemed to facilitate phonemic integrity, though these results were not significant. Our data show that either a 1:10 or a 1:1 condition of stimulus presentation is equally facilitative of phonemic accuracy.

Group differences among our 4 modes for a pool of 1,400 responses per mode are shown in Figure 6. The auditory mode (A) alone provided the highest rate of phonemic accuracy. Analysis of variance revealed statistically significant differences between the auditory mode and all others. No significant differences existed among auditory plus watch clinician (AV_1) and auditory plus printed (AV_2).

Analysis of individual subject performance by mode revealed that it was not one subject who skewed the mode results, but that performance by the auditory mode was equal or better than by the other modes in 5 out of 7 subjects.

The literature dealing with subjects with phonological impairment rather strongly advocates the use of auditory plus watch clinician (AV_1) stimulation to facilitate phonemic accuracy (Johns and Darley, 1970; Rosenbek et al., 1973). As can be seen in Figure 6, not only was the auditory mode superior but the mode strongly suggested to be the most facilitative (AV_1) produced the least accurate performance among our four modes.

We would like to qualify this finding, however. Though the auditory mode was superior in this study, the differences among modes were not striking. For clinical purposes, we would suggest evaluating each patient's individual responsiveness to stimulus mode and using the most efficient. If our results are generalizeable, however, the auditory mode will most facilitate phonemic accuracy.

The importance of modality considerations led us to analyze our subjects' performance somewhat further. Questions relating to single versus bimodal presentation are unresolved in the literature. For our subjects, we analyzed the score of the single modes 1 and 3 combined (auditory alone combined with printed alone) and compared them with the score from bimodal presentation (auditory plus watch clinician combined with auditory plus printed). Figure 7 shows that the single modality score was significantly better than the bimodal score. This held true not only for the group but for 5 out of 7 individual subjects, as can be seen in Figure 8.

The nature of phonemic accuracy over repetition of a word 10 times was analyzed to determine if performance remained stable, approached the target, or deteriorated. We compared performance on the first half (repetitions 1 through 5) with performance on the second half(6 through 10) and our results are summarized in Figure 9. No significant difference existed between the first and second halves, but a strong trend toward deterioration is evident.

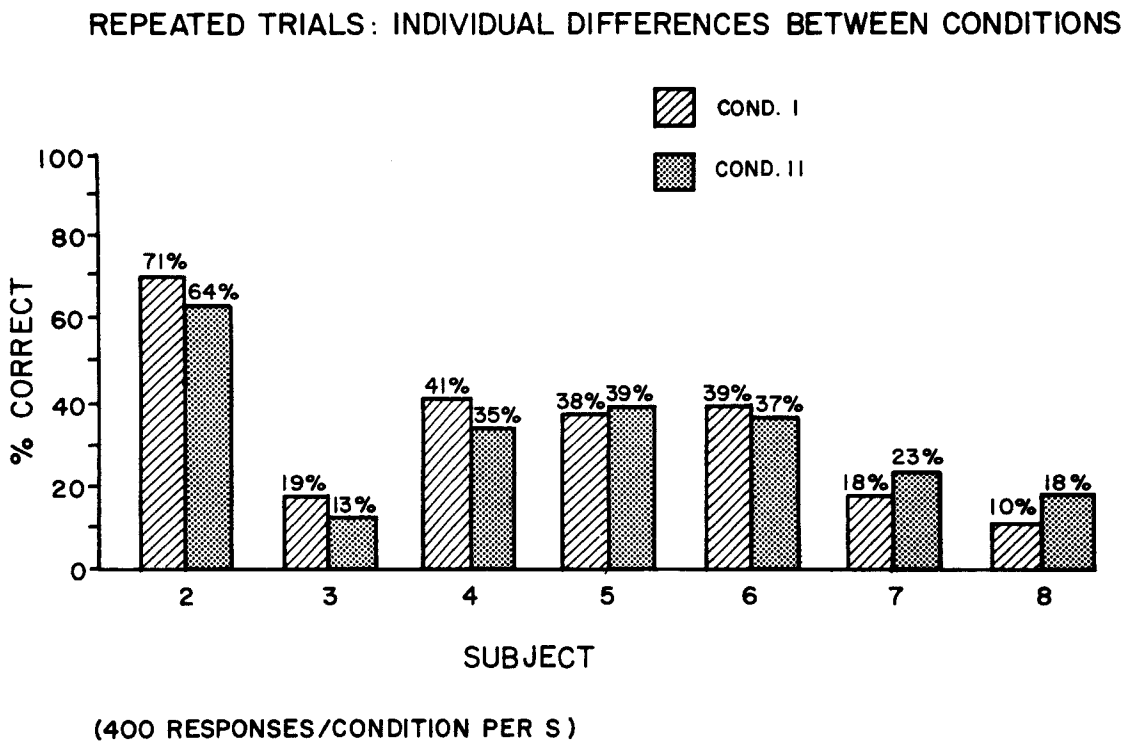

Figure 5. Repeated trials: Individual differences between conditions.

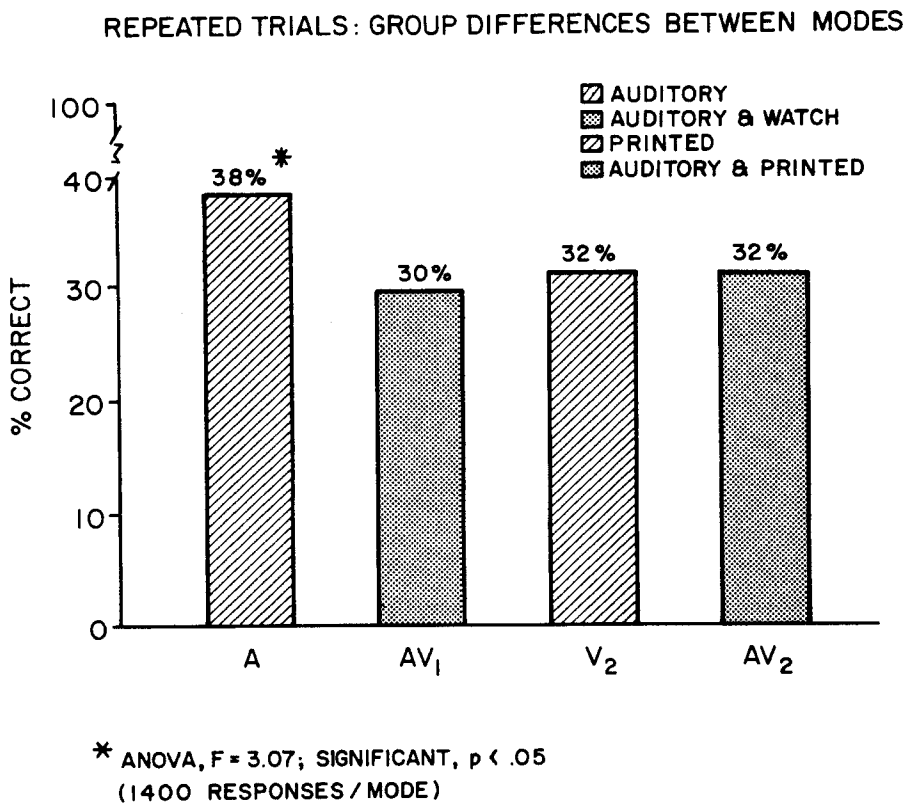

Figure 6. Repeated trials: Group differences between modes.

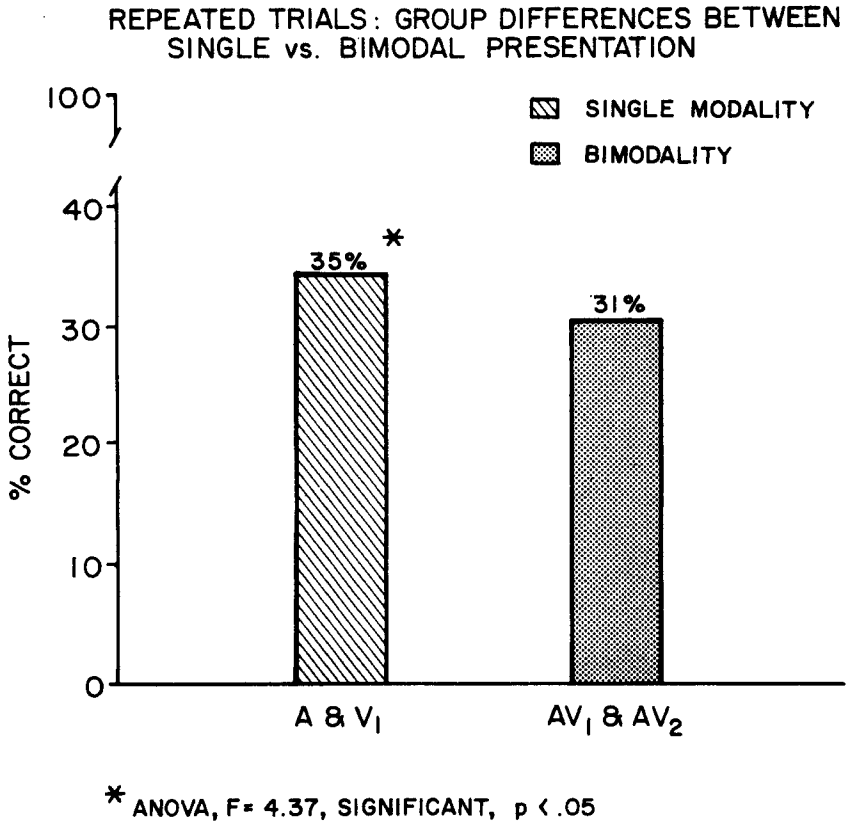

Figure 7. Repeated trials: Group differences between single vs. bimodal presentation.

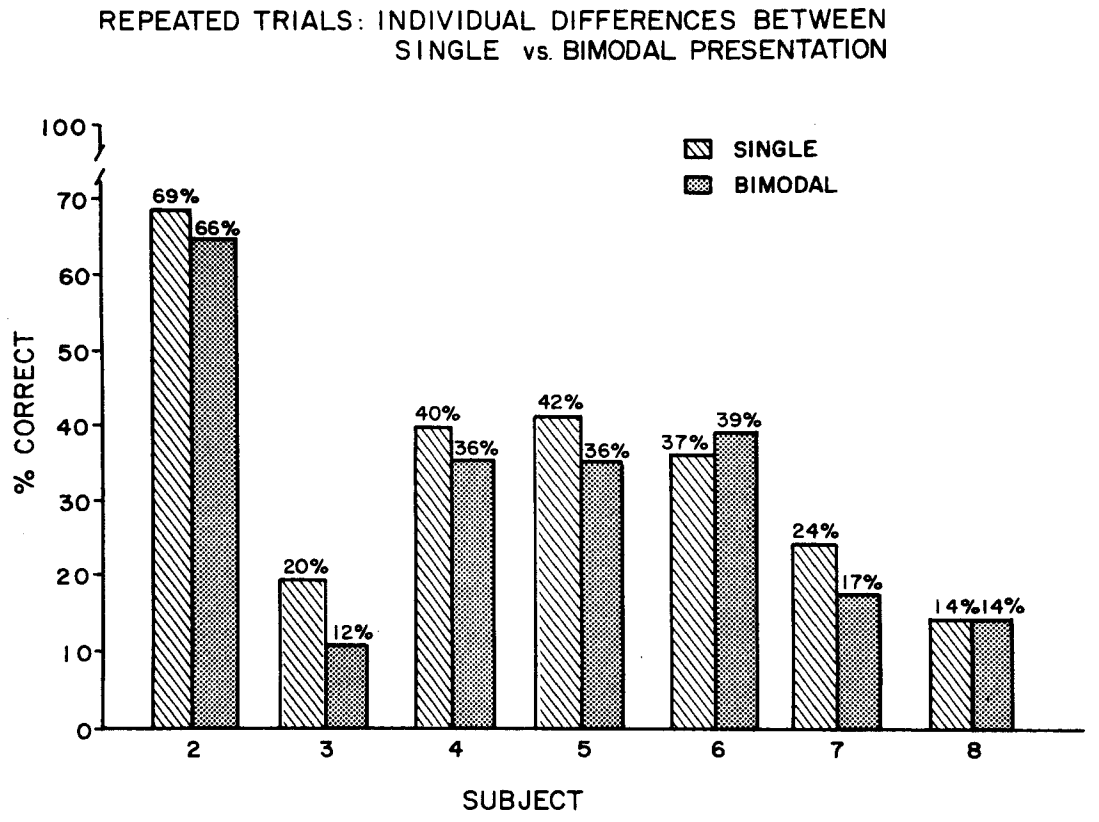

Figure 8. Repeated trials: Individual differences between single vs. bimodal presentation.

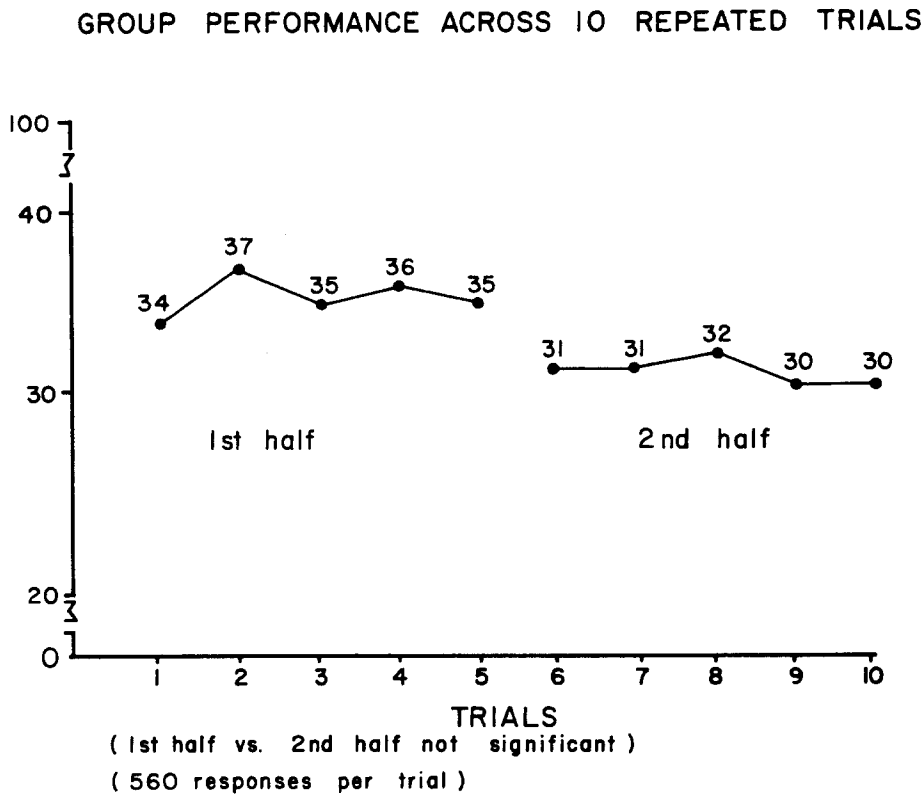

Figure 9. Group performance across 10 repeated trials.

Ranking of stimulus words in a hierarchy of difficulty is presented in Figure 10. As expected, most of the single syllable words were easier. At least two notable findings appear in this hierarchy, however. First, "gingerbread," in addition to being quite tasty, is also easy to say. In fact, when our 7 phonologically-impaired subjects produced the word 560 times, it was equally as likely to be produced accurately as inaccurately. This is somewhat surprising in light of the frequent appearance of the word "gingerbread" in batteries designed to elicit phonological impairment. Second, two words that had high error rates and may be useful clinically to elicit phonological impairment are "catastrophe" and "Episcopalian," the latter never being produced accurately by any subject in this study.

Another primary concern of this study was the variability of production over 10 repetitions of each word. Several researchers have suggested that one of the hallmarks of apraxia of speech is variability of error pattern over repeated trials of polysyllabic words (Johns and Darley, 1970; Johns and LaPointe, 1976). However, the extent and quality of this variability has not been reported. Therefore, we re-listened to 400 responses from each of the 7 subjects and judged each repetition as to:

(1) the presence or absence of variability relative to the immediately preceding response, and
(2) whether or not it was closer, further or the same distance from the target as the previous response in terms of phonologic integrity.

The range of variability for our group and the percentage of variability for each subject are shown in Figure 11. The least variable subject exhibited 23% variability while the most variable two subjects presented approximately 51% variability. Variability of 50% may not appear to be great at first glance, until one considers that in a string of repetitions, every other utterance is susceptible to variability of production. Clinically, this distinct characteristic contributes to a very unique type of phonological impairment. In fact in our view, this characteristic (that is, variability of production over repeated trials of words) may be the most potent discriminator of the patient with phonological selection and sequencing impairment or apraxia of speech.

Our last analysis was concerned with whether or not our subjects demonstrated any consistent pattern in their error variability. We scored each response as being either closer, further, or the same distance from the target, relative to the preceding response, to determine if our subjects produced errors which gradually approximated the target or got further and further away on successive utterances. No definite pattern of either deterioration or approximation emerged. Perhaps with a more refined analysis of error variability such as markedness or distinctive feature changes, a pattern could be discerned. We would encourage this type of analysis.

Summary

We tested 7 subjects with phonological selection-sequencing impairment and had them repeat 10 words 10 times each, under a variety of modes and conditions. We found:

1. No difference existed in accuracy between the condition of one stimulus followed by 10 uninterrupted responses and 10 responses each preceded by a model.
2. The auditory mode elicited significantly more accurate responses than AV_1, V_2 and AV_2.

REPEATED TRIALS: RANK ORDER OF WORD DIFFICULTY

RANK	WORD	% CORRECT
1	GLASS	66
2	THREAD	58
3	GINGERBREAD	50
4	SHRUB	44
5	SPLASH	33
6	SCRATCH	30
7	IMPOSSIBILITY	28
8	REFRIGERATOR	21
9	CATASTROPHE	.007
10	EPISCOPALIAN	0

(560 RESPONSES PER WORD)

Figure 10. Repeated trials: Rank order of word difficulty.

REPEATED TRIALS: ERROR VARIABILITY
(RANK ORDER OF SUBJECTS)

RANK	S#	% VARIABILITY
1	3	50.8
2	8	50.8
3	7	50.3
4	4	50.0
5	5	32.5
6	6	29.8
7	2	23.3

VARIABILITY RANGE = 23.3 - 50.8 %

VARIABILITY GROUP MEAN = 41.1 %

Figure 11. Repeated trials: Error variability (rank order of subjects).

3. Single modality stimulation elicited significantly more accurate performance than bimodal stimulation.
4. No significant difference emerged between the first and second halves of 10 repetitions, though a strong trend to deterioration appeared.
5. Variability of production ranged from approximately 20 to 51 percent.
6. No pattern of deterioration or approximation appeared relative to judged distance from the target over 10 repetitions.
7. "Gingerbread" is pretty easy to say.

References

Blumstein, S. Some phonological implications of aphasic speech. In Psycholinguistics and Aphasia, H. Goodglass and S. Blumstein (Eds.). Baltimore: Johns Hopkins University Press, 1973.

Deal, J.L. Consistency and adaptation in apraxia of speech. Journal of Communication Disorders, 7:135-340, 1974.

Goodglass, H. Phonological factors in aphasia. In Clinical Aphasiology Conference Proceedings: 1975, R.H. Brookshire (Ed.). Minneapolis: BRK Publishers, 1975.

Johns, D.F. and Darley, F.L. Phonemic variability in apraxia of speech. Journal of Speech and Hearing Research, 13:556-583, 1970.

Johns, D.F. and LaPointe, L.L. Neurogenic disorders of output processing: Apraxia of speech. In Current Trends in Neurolinguistics, H. Avakian-Whitaker and H.A. Whitaker (Eds.). New York: Academic Press, 1976.

Lemme, M.L., Wertz, R.T. and Rosenbek, J.C. The effects of stimulus modality on verbal output in brain-injured adults. Paper presented at the annual convention of the American Speech and Hearing Association, Las Vegas, Nevada, 1974.

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.

Webb, W.G. and Love, R.J. The efficacy of cueing techniques with apraxic-aphasics. Paper presented at the annual convention of the American Speech and Hearing Association, Las Vegas, Nevada, 1974.

Discussion

Q: In the slide where you showed the error rate across trials, did you find that there were any differences in the deterioration of the last 5 words versus the first 5 in the two conditions?

A: No variability differences were apparent between conditions. You might notice from that slide that there was a somewhat dramatic though not significant drop off from trials 5 to 6, and from trials 6 to 10; they kind of grouped around 30-31%, suggesting that perhaps 5 repetitions of a polysyllabic word is the limit if you want to achieve maximum phonemic integrity.

Q: Do you have any feelings about whether or not the difference in per cent of variability of patients' response in any way identified them as afferent versus efferent apraxia, or primary versus secondary?

A: I wouldn't want to speculate, since I really don't have a firm appreciation of some of the distinctions in the apraxias that have been suggested by a few people.

Q: I was thinking that a patient with higher variability in his productions would be more like a primary or afferent apraxia who has difficulty in actually selecting the phonemes, versus actually selecting features of it and executing them; that patient may have less variability in his output.

A: That's an interesting speculation. Perhaps it's related to Dr. Rosenbek's work on the oral sensory characteristics of some of the apraxic patients.

Q: In the auditory mode alone, were the stimuli presented by tape recorder or were they live clinicians?

A: As far as I could determine, the clinicians were alive. The stimuli were not presented via tape recorder.

Q: How does that compare then to the previous literature which you cited? Were those tape recorded presentations when they talk about auditory alone?

A: I believe in the Johns and Darley study, they were tape recorded; is that true, Dr. Darley? Dr. Darley: Yes.

Q: You see, it could make a difference because the patient could actually inadvertently watch you anyway, even though you didn't tell him to watch.

A: You mean watch your lips? No, we shielded them with a 4 x 7 card so no visual cues from the mouth were available during the auditory mode.