DOCUMENT RESUME

ED 024 199 40 EC 003 244

By-Webster, Ronald L.

Effects of Stutterers' Self-Monitoring on Retention of Fluency Generated by Delayed Auditory Feedback. Final Report.

Hollins Coll., Va.

Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.

Bureau No-BR-7-8290

Pub Date 4 Jul 68

Grant-OEG-2-078290-3550

Note-71p.

EDRS Price MF-$0.50 HC-$3.65

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FINAL REPORT
Project No. 7-8290
Grant No. OEG-2-078290-3550

EFFECTS OF STUTTERERS' SELF-MONITORING ON RETENTION OF FLUENCY GENERATED BY DELAYED AUDITORY FEEDBACK

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

EFFECTS OF STUTTERERS' SELF-MONITORING ON RETENTION OF FLUENCY GENERATED BY DELAYED AUDITORY FEEDBACK

Project No. 7-8290
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Ronald L. Webster

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Hollins College

Hollins College, Virginia

CONTENTS

ABSTRACT

Stuttering is an aberrant form of speech which is resistant to rapid elimination by traditional forms of speech therapy. The usual therapies based on the stutterer's "fear" of speaking, focus on modifying the attitudes of the stutterer toward his speech. In addition, these therapies seem to accept the inevitability of stuttering and seek to teach the stutterer "controls" which ease his blocking.

For a number of years it has been known that stuttering could be directly and immediately reduced by a number of variables. For example, rythmic stimuli, masking noise, whispering, choral reading, and prolongation of speech sounds are factors which can attenuate stuttering.

The present report deals with several experiments that manipulate stuttering by the use of delayed auditory feedback and the prolongation of speech. The report presents our laboratory's version of the effective fluency shaping procedures developed by Dr. Israel Goldiamond, at the Institute for Behavioral Research, Silver Spring, Maryland. In addition, the report presents a conceptional scheme which integrates information on those variables that modify stuttered speech. Section 1 of the report describes work done on the project outlined in the Grant application OE-78290, Section 2 presents an investigation of the effects of different intervals of delayed auditory feedback on stuttering, Section 3 describes the fluency shaping methods used in our laboratory for eliminating stuttering, Section 4 is an article which deals with how masking noise can function to eliminate stuttering, and Section 5 is an account that provides us with a way of understanding how various fluency producing variables operate. A video tape is included that shows the results of the fluency shaping program.

Chapter I

EFFECTS OF STUTTERERS' SELF-MONITORING ON RETENTION OF FLUENCY GENERATED BY DELAYED AUDITORY FEEDBACK

Ronald L. Webster

ABSTRACT

The present experiment was intended to evaluate the effects of stutterers' self-monitoring, via video tape play backs, on the retention of fluent speech that was generated by delayed auditory feedback (DAF). Preliminary results suggested that the carry-over of fluency generated by DAF was related to the amount of experience Ss had on DAF; i.e., fluency retention was judged to be greatest when Ss had experienced DAF for a period continuing over three to eight months. Therefore, the investigation of self-monitory in conjunction with DAF was abandoned. Other lines of research were initiated. The results of these researches are presented in subsequent sections of this report.

Studies on stuttering employing conditioning paradigms have shown that nonfluencies (stuttering episodes or blocks) in the speech of stutterers represent manipulatable response classes. The primary focus of these studies has been upon the reduction of nonfluencies through the application of punishment techniques. Flanagan, Goldiamond, and Azrin (1958) demonstrated suppression of stuttering responses through the use of response contingent aversive stimulation. Wingate (1959) reported analogous findings in a similar study. Later research by Goldiamond (1965) showed that delayed auditory feedback (DAF) with stutterers functioned to reduce the frequency of nonfluencies with DAF was made contingent upon the occurrence of stuttering. Goldiamond's findings were interpreted in terms of a punishment model. Results of a study performed by Martin and Siegel (1966a) using response contingent electric shock as a punisher showed decreases in stuttering episodes as a function of the experimental treatments. Quist (1966) succeeded in employing verbal punishers as a means of reducing the frequency of nonfluencies in stuttering. In another study Martin and Siegel (1966b) showed that response contingent electric shock reduced the frequency of stuttering and in addition showed that the new fluency levels which were obtained could be placed successfully under stimulus control.

A major objection to the use of punishment may be found in some of the early research performed by Skinner (1938) and Estes (1944). These investigators, and others since them, have shown that the suppressive effects of punishment are temporary. Following the removal of the punishing stimuli the punished responses recover their strength. The studies of Flanagan, Goldiamond, and Azrin (1958), Martin and Siegel (1966a & 1966b) and Quist (1966) have shown that the removal of the punishment contingency leads to a return to previous stuttering levels.

It seems evident that different experimental procedures might be more appropriate for manipulating response classes involved in stuttering. One study conducted by Rickard and Mundy (1965) employed conditioning procedures which used positive reinforcements. The results of their study suggested that additional important research remains to be done in this general area. New fluency levels achieved by positive reinforcement may turn out to be more stable than those achieved by punishment methods; however, this question remains to be examined at an empirical level.

In our laboratory some interesting effects have grown out of our manipulation of stuttering without employing punishment of nonfluent speech episodes. Goldiamond (1965) has reported that delayed auditory feedback, when used as the noxious stimulus in a punishment paradigm, reduces the number of stuttering instances. However, in our laboratory we have consistently observed that the noncontingent presentation of DAF produces striking decreases in the frequency of nonfluencies. That is, during the continuous presentation of DAF to the severe stutterer, the frequency of stuttering falls to very low levels. A reduction in the number and severity of nonfluencies is maintained for a period of time immediately following the subject's removal from DAF.

An interpretation of DAF generated fluency in terms of learning principles seems to be simultaneously parsimonious and heuristic. Such an interpretation would hold that DAF reduces stuttering frequency by acting upon "auditory input-speech output" mechanisms in the central nervous system which must act together in a particular relationship in order for fluent speech to result. According to this hypothesis, DAF forces a new relationship to occur between auditory input data and speech output mechanisms of the stutterer. Support for this particular hypothesis is found in the relative rapidity of the onset of fluency once the stutterer is placed on DAF. The fact that the increased fluency generated by DAF carries over into the period immediately following DAF, suggests that the relationships between auditory input and speech output mechanisms are modifiable.

A plausible hypothesis concerning the carry-over of fluency into the post-DAF period would hold that during DAF the increased ease of speech production may be sufficiently reinforcing to facilitate maintenance of new phase relationships between input and output mechanisms, thus permitting the continuation of fluency after removal from DAF. It is also possible that the subject's cognizance that his fluency has improved may be a supplementary reinforcer. The experiment repoıted here was designed to evaluate the relevance of self-monitoring as a possible source of reinforcement in the use of DAF witn severely stuttering Ss.

Method

Subjects. The Ss were six severe stutterers who ranged in age from 15 to 47 years. All Ss had stuttered for at least nine years.

Apparatus. The experimental apparatus consisted of a Lafayette modified Bell and Howell delayed feedback recorder with delay intervals that were continuously variable from 0.08 sec. to 3 sec. Speech signals which entered the microphone were delayed for a pre-set interval and were then returned to the Ss' ears through earphones. The equipment was adjusted so volume at the earphones at normal speech levels was approximately 65 decibels.

An Ampex video tape recording system V-R 7000 was used to record the behavior of Ss throughout experimental sessions. The camera was visible to the S at all times, but the picture which appeared on the monitor could only be seen by E. Selected articles from Reader's Digest were used as reading material.

Procedure. The Ss were randomly assigned to experimental and control groups. Each S participated in the program for 10 days. Experimental sessions on days 1 through 3 consisted of 3 min. of oral reading. Control and treatment conditions were in effect on days 4 through 10. Table 1 outlines the procedure for those days. The control condition consisted of Ss watching an ongoing television program on a local channel.

Table 1

Daily procedure, Days 4 - 10

Experimental Ss	Control Ss
5 min.	5 min.
Oral reading - warm-up Normal Auditory Feedback (NAF)	Oral reading - warm-up NAF
10 min.	10 min.
Oral reading - NAF	Oral reading - NAF
10 min.	10 min.
Video-audio self-monitoring	Watch television
20 min.	20 min.
Oral reading - DAF	Oral reading - DAF
10 min.	10 min.
Video-audio self-monitoring	Watch television
10 min.	10 min.
Oral reading - NAF	Oral reading - NAF

Results and Discussions

Reading rates and stuttering rates were measured during all but the daily warm-up periods. There was clear evidence that DAF enhanced the fluency of all Ss. However, there was no evidence at all that fluency carried over into the post-DAF reading.

As the present experiment progressed, it became apparent that there were some problems with it. First, prior work in our laboratory had used Ss on DAF over a period of from three to eight months. It seemed to us after running Ss in the present experiment that it was unlikely that the carry-over of fluency generated by DAF would show up until only after extremely lengthy experiences with DAF. Therefore, it was deemed impractical to continue with the present study until such a stage was reached. Second, it became apparent that the parameters of DAF were not well understood. Therefore, it seemed important to set up a study which explored the specific parameter of the duration of the DAF interval and its effect on fluency.

An experiment was conducted on the effects of different intervals of continuously presented DAF on the fluency of stutterers, and on the retention of fluency following the termination of DAF. The results of this experiment are described in Chapter 2.

A third factor led to the abandonment of the research on the self-monitoring problem. While probing the effects of DAF we observed that when Ss were instructed to speak slowly while on DAF they became totally fluent. In addition, this fluent speech persisted following the termination of DAF, providing the slow speech pattern was maintained. These observations were consistent with the results described in Goldiamond's (1965) report on fluency shaping. Following this initial systematic replication of Goldiamond's results, we set up a fluency shaping program modeled after the one he outlined. After some trial and error we arrived at a program that is described in Chapter 3.

Because of the logical primacy of the investigation of DAF, because of our high interest in the possibility of shaping fluent speech in stutterers, and because an explanatory schema for inter-relating variables which enhanced fluency was emerging, the self-monitoring research was terminated. A present evaluation of self-monitoring and its effects on the retention of DAF generated fluency would suggest that it is a relatively minor variable. DAF seems to generate fluency because it is a "special" stimulus that alters characteristics of auditory feedback in such a way that the usual interference in the auditory feedback system of the stutterer is eliminated or over-ridden. DAF, alone, does not seem to alter stuttering by any processes which involve learning. The probable action of DAF as a fluency enhancing variable is discussed in Chapter 5.

Chapter II

CHANGES IN STUTTERING FREQUENCY AS A FUNCTION OF VARIOUS INTERVALS OF DELAYED AUDITORY FEEDBACK

Ronald L. Webster, Susan J. Schumacher, _and_

Bobbie Boyd Lubker

ABSTRACT

Stuttering frequency was investigated as a function of various intervals of continuously presented delayed auditory feedback (DAF). Five different intervals of DAF were presented to six severe stutterers while they read aloud. Results indicated that the continuous presentation of DAF significantly reduced stuttering frequency. The effects of DAF magnitude were not systematically related to the amount of stuttering. No evidence was found for the carry-over of fluency generated by DAF into the period immediately following Ss' experience in DAF.

Auditory feedback is one of the variables involved in the control of speech (Black, 1955; Fairbanks, 1955; Lee, 1950a, 1950b; Melrose, 1953). Experimental manipulations of auditory cues have been shown to alter the speech of both normal speakers and stutterers (Black, 1955; Chase, Sutton & Rapin, 1961; Fairbanks, 1955; Goldiamond, 1965; Lee, 1950a, 1950b).

Lee (1950a) published a first account of the disruptive effects of delayed auditory feedback (DAF) upon normal speakers. Lee characterized the disruptions in normal speech resulting from DAF as "artificial stuttering" and pointed out that speech rate was reduced while volume or pitch was increased. Later studies have shown that other disturbances typically experienced by normal speakers during DAF include increased duration of reading time (Fairbanks, 1955; Lee, 1950b; Melrose, 1953; Zalosh & Salzman, 1965), increases in sound pressure (Chase et al., 1961; Fairbanks, 1955; Zalosh & Salzman, 1965), and higher fundamental voice frequencies (Fairbanks, 1955). DAF also has been shown to increase articulation errors (Fairbanks, 1955; Melrose, 1953).

Investigations of various intervals of DAF have shown that 0.2 sec. delay produces the maximum amount of disruption in normal speakers (Black, 1951; Fairbanks, 1955; Melrose, 1954). Shorter and longer intervals of delay also produce some disruption, but speech changes are not as great as at the 0.2 sec. interval.

During the presentation of DAF to 30 stutterers, Chase, et al., (1961) noted an improvement in the fluency of 10 of 30 Ss. Neelley (1961) compared the speech of normally fluent Ss and stutterers under DAF and concluded that articulation disturbances experienced by normal Ss and stutterers under DAF were very similar. The articulation disturbances generated by DAF consisted of sound substitutions and omissions in both groups of Ss. In addition, Neelley concluded that the disfluencies of normally fluent Ss under DAF were not similar to the usual disfluencies of stutterers as had been suggested by Lee (1950a). Neelley did not indicate that DAF improved the fluency of the speech of the stutterers.

Goldiamond (1965) found that the fluency of stutterers was enhanced by different contingencies that were set up between stuttered responses and DAF, and that the continuous presentation of DAF did not enhance fluency. It was indicated by Goldiamond that the use of contingent relationships between DAF and stuttered responses was important in reducing the frequency of stuttering.

The report by Chase, et al., (1961) and some observations made in our own laboratory have led us to conclude that DAF, when presented in a noncontingent relationship to stuttering, can effectively increase the fluency of stutterers. These observations are not consistent with Goldiamond's (1965) report which indicated that the continuous presentation of DAF did not increase fluency in stutterers. The differences between these conflicting reports remain to be explained.

One factor that may be implicated in the fluency enhancing effectiveness of DAF is the magnitude of the delay interval. Previous work (Fairbanks, 1955) has shown that the interval of DAF is an important variable in influencing the speech of normally fluent speakers. It is possible that the effectiveness of DAF as a fluency generating stimulus in stutterers is a function of the duration of the delay interval.

The purpose of the present investigation was to explore the nature of the relationship between stuttering frequency and different intervals of continuously presented DAF with individual Ss.

Method

Subjects. The Ss in this experiment were six severe stutterers, one female and five males, who ranged in age from 14 to 28 years. All Ss had stuttered at least seven years and had experienced various standard forms of speech therapy. No Ss were in therapy at the time of the research. No obvious hearing impairment was displayed by any S and DAF had not been experienced by any Ss prior to the initiation of the present study.

Apparatus. The experimental apparatus consisted of a Lafayette modified Bell and Howell delayed feedback recorder with delay intervals that were continuously variable from 0.08 sec. to 3 sec. Speech signals which entered the microphone were delayed for a pre-set interval and were then returned to Ss' ears through earphones. The equipment was adjusted so volume at the earphones at normal speech levels was approximately 65 decibels.

An Ampex video tape recording system V-R 7000 was used to record the behavior of Ss throughout experimental sessions. The camera was visible to S at all times, but the picture which appeared on the monitor could only be seen by E. Selected articles from Reader's Digest were used as reading material.

Procedure. In a preliminary interview before starting the experiment, each S read for two minutes with 0 sec. delay and for two minutes on DAF. The preliminary interview was to provide oral reading samples and to ascertain whether or not DAF had any influence on Ss speech.

Experimental sessions ran for six consecutive days. At the beginning of each session S was seated at a desk facing the video camera with reading material located before him on a reading stand. The earphones and the lavalier video tape recorder microphone were placed on S. The microphone for the DAF recorder was located approximately six inches from S's mouth. The intensity of the sound at the earphones was equalized for the delay and no-delay conditions.

Each S was run as a separate experiment in order to clearly define the effects of different DAF intervals on stuttered speech. Thus, each S was systematically exposed to the different intervals of DAF used in this experiment. Counterbalancing of DAF intervals was used to control for any possible order effects. Reading passages were randomly assigned to each treatment period in order to control for any possible differences in ease of reading. Ss were instructed to read the material aloud at a comfortable pace.

The first experimental session was a standard experience session consisting of three 15-min. periods of oral reading. The first 15-min. period of 0 sec. delay provided S with an opportunity to "warm-up." After a five-min. rest interval S was placed on DAF at 0.33 sec. delay for two successive 15-min. periods, each of which was separated by a five-min. rest interval. This procedure provided Ss with a standardized experience on DAF and allowed them to become somewhat accustomed to DAF prior to the manipulation of that variable.

For the next five days Ss experienced one experimental session a day. During each of the experimental sessions S was first given a five-min. "warm-up" of oral reading on 0 sec. delay which was not recorded. The "warm-up" was followed by a five-min. baseline period of oral reading on 0 sec. delay. The baseline was followed by five treatment periods. Each treatment period consisted of the presentation of a different interval of DAF for five min. while S read aloud. The delay intervals presented during each treatment period were 0.1, 0.2, 0.3, 0.4, and 0.5 sec. Each treatment period was followed by a four-min. interim period on 0 sec. delay and a one-min. period of rest before the next treatment period began in order to control for possible carry-over of effects between delay intervals. Thus, each S received a total of five presentations of each DAF interval.

The dependent variables were the number of words read and the number of blocks for each S. Measures were made for all periods of reading except for the daily "warm-up" period. Counts of blocks were made from the video tape record of each experimental session. A block was defined as a word on which stuttering occurred.

Reliability checks on block counts were made by E throughout the experiment and consisted of re-counting 45 treatment periods and 23 interim periods selected at random. The two counts were separated by at least 24 hours. Percent agreement for the 68 samples ranged from 100% to 67%, with a median of 95%. Five samples fell below 82% agreement. This procedure gives a high degree of reliability and yields agreement scores which are consistent with both intra- and inter-judge reliabilities reported in our laboratory (Webster, 1968).

Results

The mean number of blocks made by Ss in the first experimental session is shown in Figure 1. These data show that 0.33 sec. DAF produced reductions in the mean number of blocks made by Ss when compared with the 0 sec. delay condition. An A-test (McGuigan, 1960) showed the mean number of blocks produced by Ss during the first 0.33 sec. DAF period was significantly lower ($A = 0.221$, $p < .02$, $df = 5$) than during the 0 sec. delay condition. An A-test between the second 0.33 sec. DAF and the 0 sec. delay condition was also significant ($A = 0.210$, $p < .01$, $df = 5$). An A-test between the two DAF periods did not approach significance.

Insert Figure 1 about here

Individual blocking functions under different intervals of DAF are shown in Figure 2. The vertical lines at each data point represent the standard deviation of the measures at that DAF value. An A-test used to test the difference between the pooled mean scores of Ss during baseline and during the 0.1 sec. delay was significant ($A = 0.238$, $p < .02$, df = 5). Although measures of stuttering duration were not made, it was observed that decreases in stuttering duration took place while Ss were on all of the DAF intervals.

Insert Figure 2 about here

Figure 3 shows the number of words read by Ss during the experimental conditions. Again, the vertical lines at each data point represent the standard deviations of the measures at that point. While some Ss showed consistent changes in the number of words read as a function of the DAF interval, there are great individual differences in the way this measure changed. An A-test used to test the difference between pooled mean reading scores of Ss during baseline and during 0.1 sec. delay did not approach significance.

Insert Figure 3 about here

A-tests on measures of number of blocks and number of words read in the interim periods following DAF intervals showed no significant changes from baseline levels. Figures 3 and 4 show how DAF generated fluency carried over into the interim periods.

Fig. 1. Mean number of blocks made by Ss during the three 15 min. period of the standard experience session (Session 1).

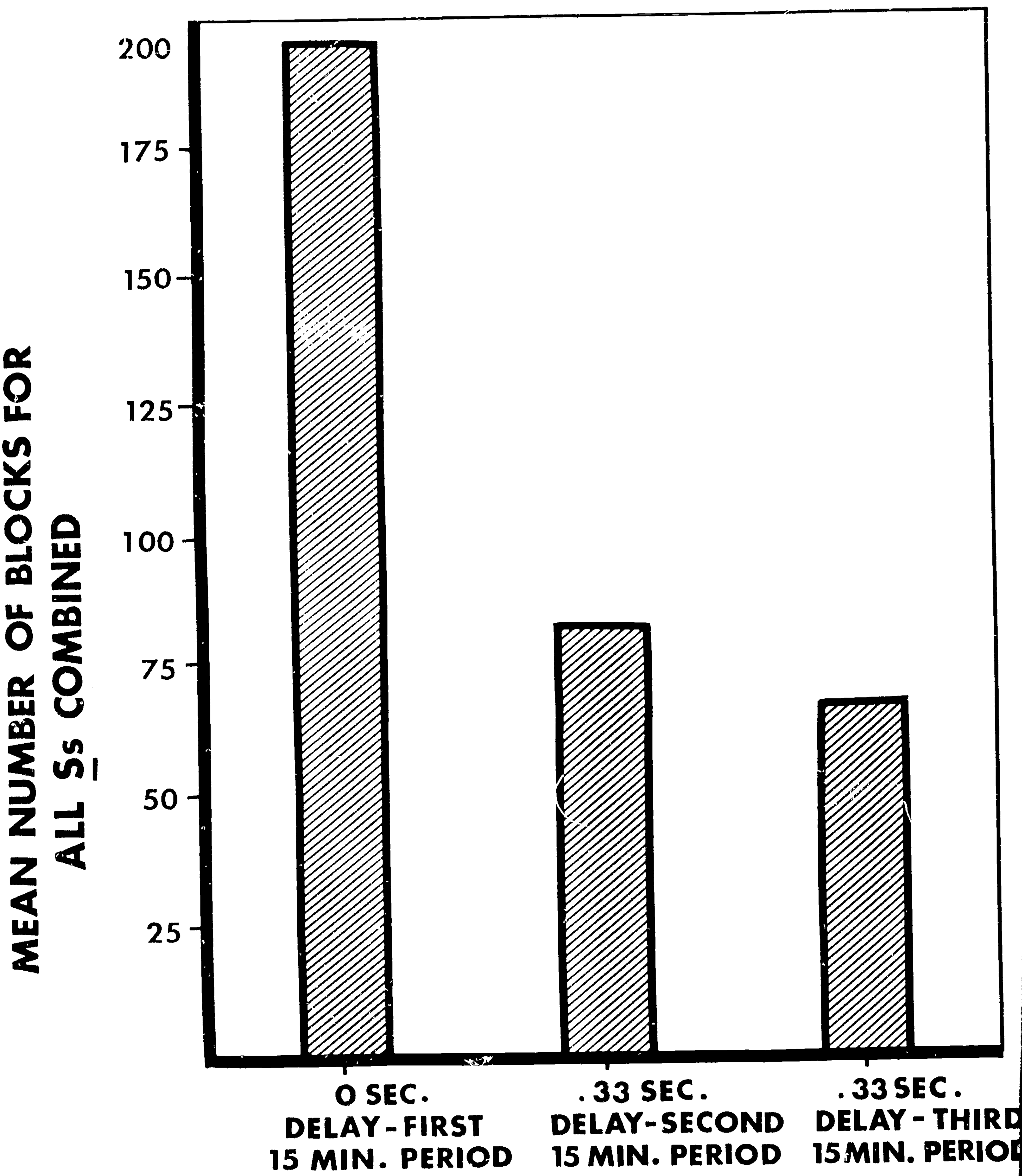
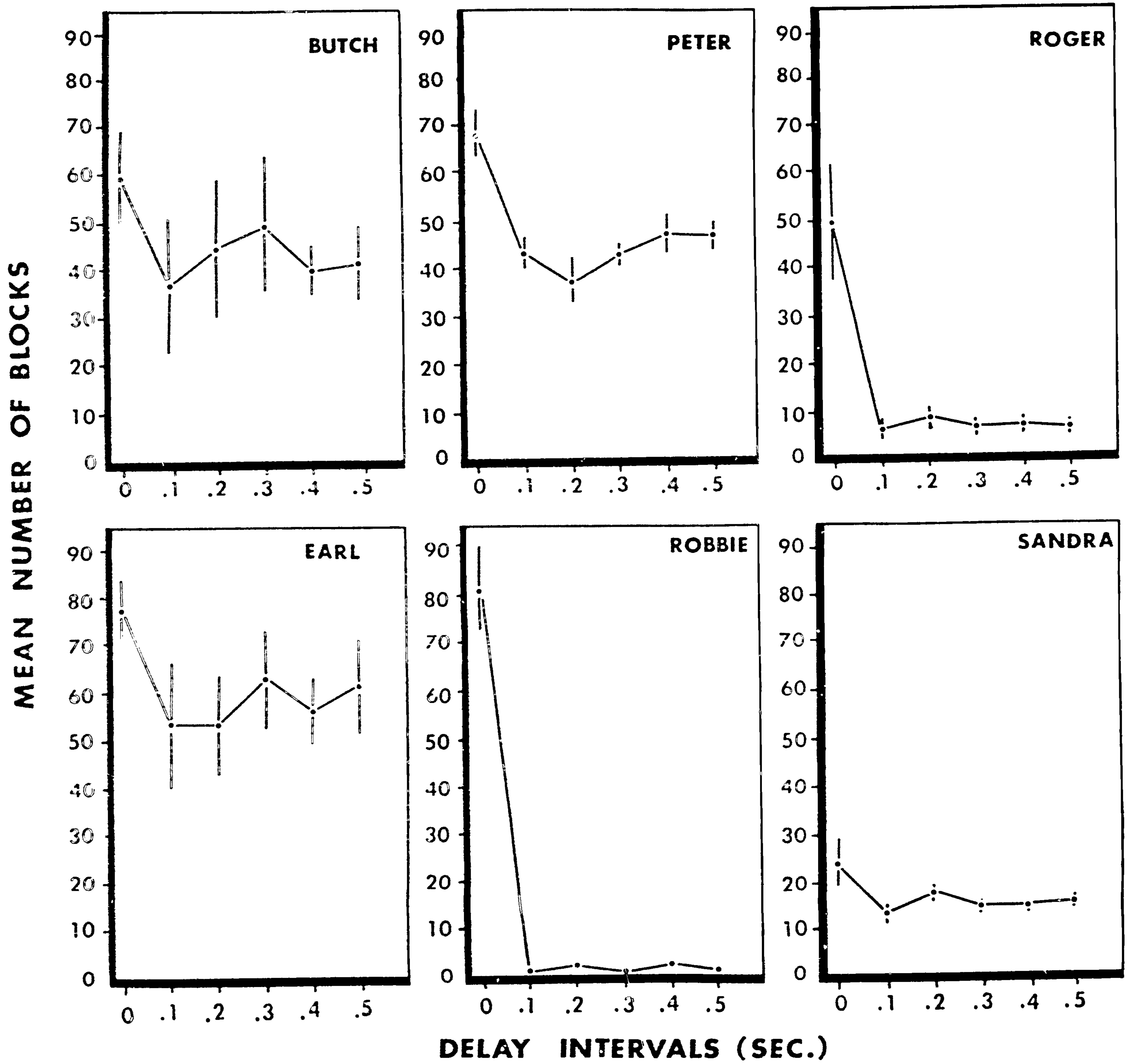

MEAN NUMBER OF BLOCKS FOR ALL Ss COMBINED
200
175
150
125
100
75
50
25
O SEC. DELAY-FIRST 15 MIN. PERIOD
.33 SEC. DELAY-SECOND 15 MIN. PERIOD
.33 SEC. DELAY-THIRD 15 MIN. PERIOD

Fig. 2. Mean number of blocks made by each S during treatment periods.



MEAN NUMBER OF BLOCKS
BUTCH
PETER
ROGER
EARL
ROBBIE
SANDRA
0 10 20 30 40 50 60 70 80 90
0 .1 .2 .3 .4 .5
DELAY INTERVALS (SEC.)

Fig. 3. Mean number of words read by each S during treatment periods.

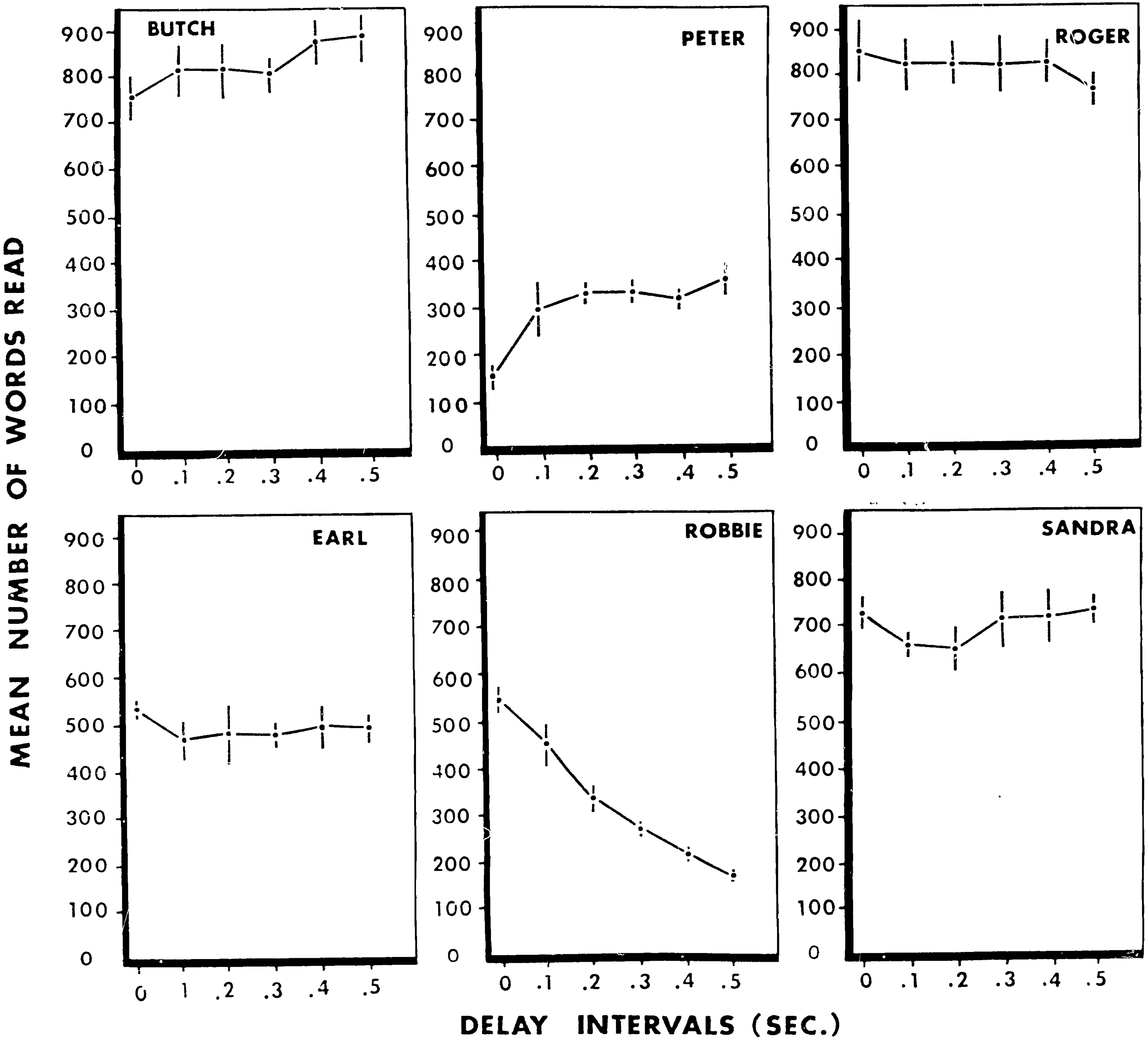
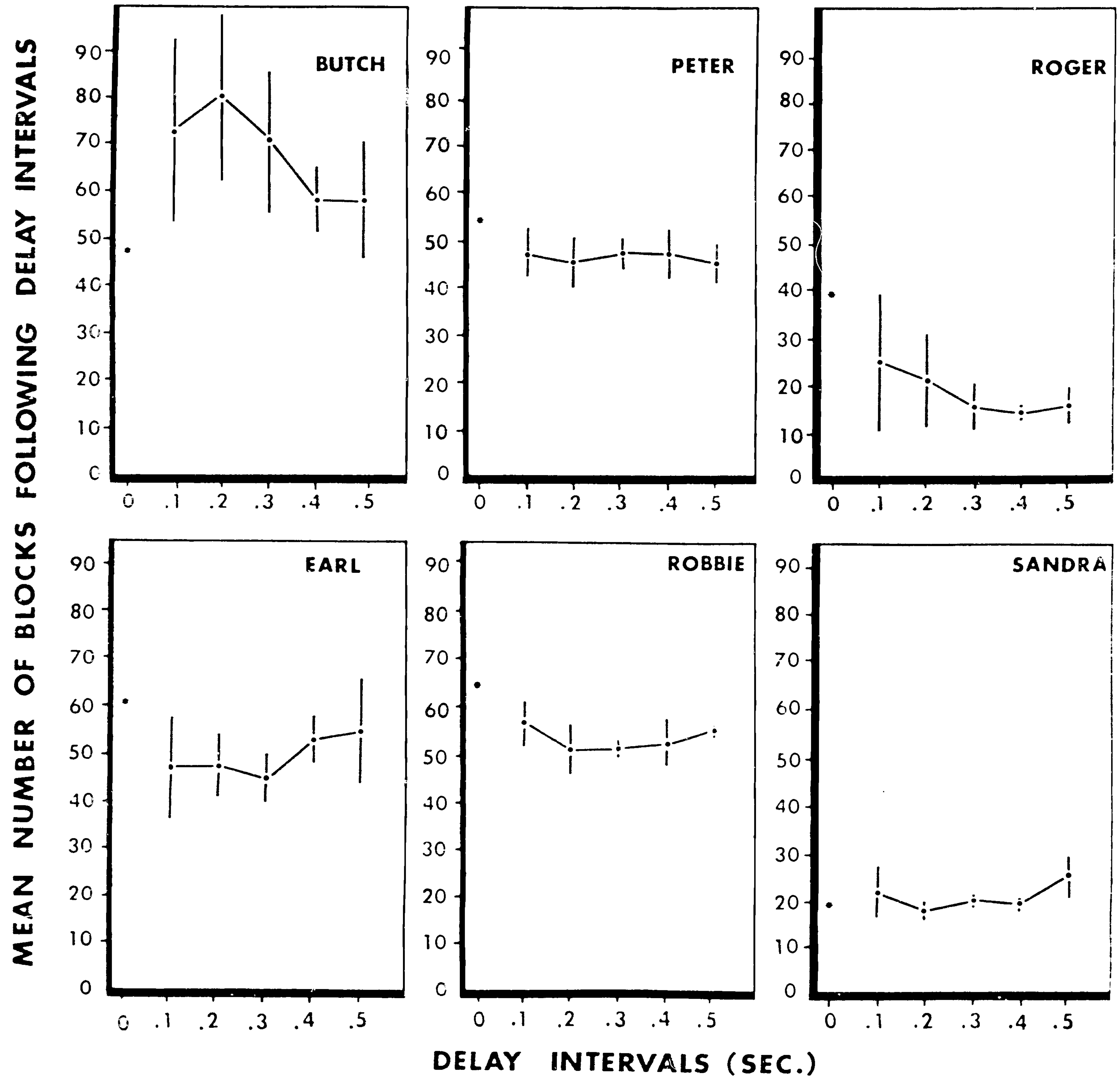
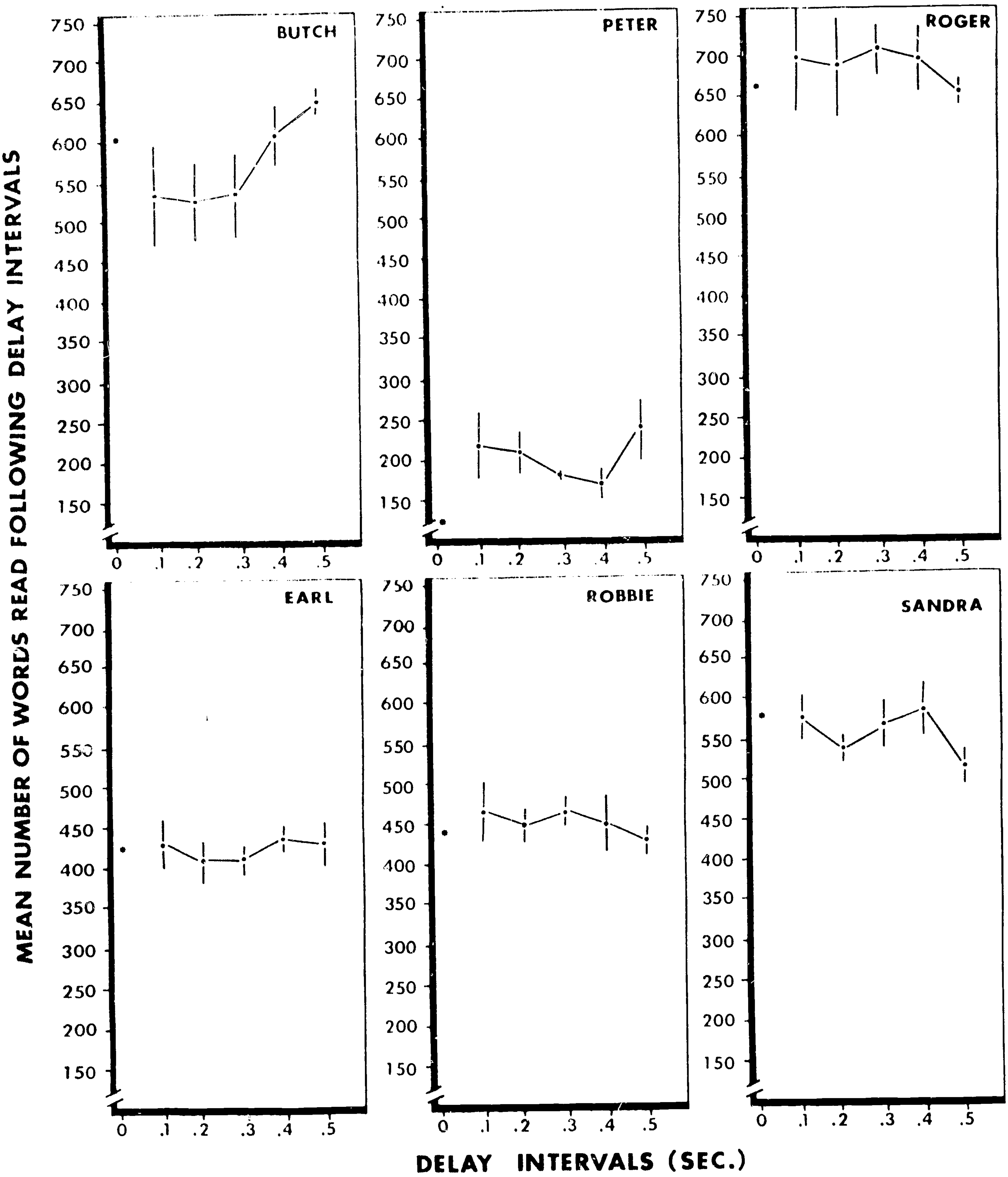

MEAN NUMBER OF WORDS READ
BUTCH
PETER
ROGER
EARL
ROBBIE
SANDRA
0
100
200
300
400
500
600
700
800
900
0
.1
.2
.3
.4
.5
DELAY INTERVALS (SEC.)

Fig. 4. Mean number of blocks made by each S following treatment periods.



MEAN NUMBER OF BLOCKS FOLLOWING DELAY INTERVALS
BUTCH
PETER
ROGER
EARL
ROBBIE
SANDRA
0 10 20 30 40 50 60 70 80 90
0 .1 .2 .3 .4 .5
DELAY INTERVALS (SEC.)

Fig. 5. Mean number of words read by each S following treatment periods.


MEAN NUMBER OF WORDS READ FOLLOWING DELAY INTERVALS
BUTCH
PETER
ROGER
EARL
ROBBIE
SANDRA
750
700
650
600
550
500
450
400
350
300
250
200
150
0
.1
.2
.3
.4
.5
DELAY INTERVALS (SEC.)

Discussion

The results of the present study show that the continuous presentation of DAF improved the fluency of stutterers. It can be concluded that special contingencies between stuttering and DAF are not necessary for the occurrence of a reduction in stuttering frequency. The findings of this study confirm the report of Chase, Sutton and Rapin (1961) that continuously presented DAF can reduce stuttering frequency. DAF appears to be a "special" stimulus that possesses fluency producing properties.

It should be pointed out that Ss were not instructed to alter their speech while they were on DAF. Goldiamond (1965) has shown that when Ss were instructed to prolong speech sounds in conjunction with DAF, an elimination of stuttering results. Inspection of Figures 2 and 3 shows that DAF enhanced the fluency of all Ss at all intervals and that there was no consistent relationship between the reduction in blocking and the number of words read by the Ss. Thus, it may be concluded that in the present study DAF did not produce its fluency enhancing effects by reducing the speech rates of Ss.

Inspection of curves for the individual Ss shows that, when compared with baseline stuttering levels, all Ss increased their fluency while on all intervals of DAF. Figure 2 shows that there was little difference in the blocking levels as a function of the particular interval of DAF that was in effect. These data lead to the suggestion that the particular values of DAF, as tested in the present experiment, had little relationship to the actual decrement in stuttering. The lack of different effects at different DAF intervals is contrary to the effects reported for DAF intervals on normal speakers (Fairbanks, 1955). It is possible that any interval of DAF, above a certain critical value, has the effect of altering aberrant characteristics of auditory feedback in the speech of stutterers. The lack of any carry-over effect of the DAF treatment periods suggests that DAF operates to alter some component of ongoing speech behavior that does not involve a form of learning.

The fluency generated in stutterers by DAF provides support for an interpretation of stuttering as a phenomenon that is based on some aberration in the characteristics of auditory feedback associated with speech, or in the mechanisms which process auditory feedback. An interpretation of this sort would hold that DAF produces improved fluency in stutterers because it alters the properties of auditory feedback. This form of interpretation is consistent with the results of studies on auditory masking in stutterers (Cherry and Sayers, 1956; Sutton and Chase, 1961). These experiments show that white noise presented to stutterers through earphones at levels of from 80 to 100 decibels will significantly improve fluency. Masking noise acts to reduce the intensity of auditory feedback.

A mechanism has been suggested by Webster and Lubker (1968) that could be involved in the production of a disruption or a distortion in the auditory feedback of the stutterer. These investigators indicate that auditory feedback may be distorted by the operation of middle ear muscle reflexes. Disruption of auditory feedback is thus regarded to be the stimulus for speech blockage. The topography of stuttered speech is postulated to represent escape and/or avoidance responses which reduce auditory feedback disruption and the concomitant speech blockage.

The relative ease with which stuttering may be directly manipulated by masking noise and by DAF contra-indicates emotional factors as the primary maintaining variables in stuttering.

Chapter III

PROCEDURES FOR FLUENCY SHAPING IN STUTTERERS

Ronald L. Webster

This section of the final report presents a summary of the procedures used in the Hollins laboratories to generate fluent speech in severe stutterers. These procedures were effective in producing fluent speech that carried over from the laboratory into the every day speech situations of the Ss.

It should be emphasized that the research summarized here did not use the conventional control group vs. experimental group paradigm. Each S served as his own control. Comparisons were made between the stuttering frequency of Ss prior to and after the fluency shaping procedures. Dramatic improvements in speech fluency took place for every S. The present procedures clearly show that fluency can be obtained in a laboratory setting. As such, the research demonstrates the existence of an important behavioral phenomenon. Clinical evidence suggests that other forms of speech therapy do not come close to the results that are derived from the present methods. The idiographic approach used in the research reported here seems to be especially relevant when dealing with phenomena which are as highly individualistic and yet as lawful as stuttering patterns seem to be. This point was well made in an editorial which appeared in the Journal of Speech and Hearing Research (1964).

The fluency shaping procedures described in this section were modeled after those of Goldiamond (1965). Several changes were made in order to accommodate Goldiamond's procedures to our laboratory setting. First, as has been pointed out in Chapter 2, we were aware that the continuous presentation of DAF was effective in generating increased fluency in stutterers. We decided to use DAF without the special contingent relationships specified by Goldiamond. Second, because apparatus was not available for controlling reading rates we did not exert direct manipulative control over the Ss' reading rate with apparatus, instead, we relied on the instructions given to S by E who monitored experimental sessions. Third, we instituted an addition to the fluency shaping procedures outlined by Goldiamond. The modification consisted of adding a section in the fluency shaping program that involved rate discrimination training. In the course of our initial work with these procedures it became apparent that Ss had difficulty in discriminating their own speech rate. Therefore, we introduced a procedure that was designed to facilitate Ss' discrimination of their speech rate. We found that this step seemed to enhance the effectiveness of the procedures we were using in our laboratory.

Method

Subject. The Ss consisted of eight severe stutterers who ranged in age from 15 to 47 years. Each S was run as an individual experiment.

Apparatus. The experimental apparatus consisted of a Lafayette modified Bell and Howell delayed feedback recorder with delay intervals that were continuously variable from 0.08 sec. to 3 sec. Speech signals which entered the microphone were delayed for a pre-set interval and were then returned to the Ss' ears through earphones. The equipment was adjusted so volume at the earphones at normal speech levels was approximately 65 decibels.

An Ampex video tape recording system V-R 7000 was used to record the behavior of Ss throughout experimental sessions. The camera was visible to the S at all times, but the picture which appeared on the monitor could only be seen by E. Selected articles from Reader's Digest were used as reading material.

Procedure. On each of the first three days 40-man sessions of all readers were recorded. Video tape recordings were made of all sessions.

Two Es independently counted stuttering responses (blocks) during video tape replays. Each word on which a nonfluency occurred was scored as a block. Agreement on counts by two Es ranged from 96% to 100%.

It is important to note that Ss were advanced through the fluency shaping program on the basis of their own progress at each of the steps of the program. Therefore, the general steps used in the fluency shaping procedures are outlined below. The amount of time spent at any one point in the program was different for different Ss.

The second step in the fluency shaping process was self-definition. On day 4, at the start of the session, S was instructed to press a hand counter whenever he blocked. E recorded blocks at the same time. When the block counts agreed S went on to the next step in the program. Self-definition occurred for all Ss in about half of one experimental session.

The next portion of the fluency shaping program involved the use of DAF. At the beginning of the second half of day 4, S was put on continuous DAF and was instructed to prolong his speech. The correct responses were illustrated for S by E. DAF was faded out after a period of 30 min. simply by turning down the volumn control knob on the DAF recorder. From day 5 on, Ss produced self-maintained fluent speech. The speech rate at this time was approximately 30 - 35 words a minute.

The next step in our procedures involved smoothing out the slow speech which had been established. This was probably the most important step in the entire procedure. The smoothing process involved instructing S to simultaneously decrease the speed and amplitude with which he made consonant sounds while simultaneously prolonging the vowel sounds. In addition, Ss were instructed to make smooth transitions from one speech sound to another within a word. When suitable smoothness was achieved in the speech of S, his speech rate was gradually increased to approximately

80 to 100 words a minute. During this time, S continued to concentrate on smoothness both within words and within sentences. Evenness of production of individual words was found to be important in generating smooth flowing speech. If stuttering occurred at any point in the program, S was first instructed to smooth his speech rate. If this step did not immediately produce fluency S was instructed to slow his speech. Then, following the attainment of fluency, S's speech rate was gradually increased and the program was continued.

The next step was labeled rate discrimination training. This portion of the procedure involved instructing S to speak at approximately 80 words a minute, for two minutes. Then S was instructed to increase his speech rate to approximately 110 words a minute for two minutes. S was cued every two minutes to switch from one rate to the other. Speech rate was monitored by E, who with the aid of a specially constructed speech rate meter, periodically signalled S when he was speaking at the correct rate. Once rate discrimination was developed, conversation began. S was given a magazine and was told to describe in one sentence a picture from an advertisement. Thus, it was possible to generate a large amount of spontaneous speech which simulated conversation. When S was able to describe pictures with single sentences spoken with fluent speech, he was then instructed to describe the picture or advertisement with several sentences. When performance at this point in the program was judged to be smooth and correct, then actual conversation began between E and S. In this segment of fluency shaping, S used fluent speech in conversation in the laboratory. After a few days of conversation in the laboratory, S was instructed to begin to use his fluent speech in settings outside the laboratory.

Ss were asked to use their new fluent speech pattern for a short period of time in their homes. Ss were instructed that if they were successful in using this new speech pattern, they were to continue using it. If they had any trouble with it, they were to do one of two things - 1) either go completely to the new speech pattern which they had been using in the laboratory, or 2) return to their usual nonfluent speech pattern. We found that, once S began to use the fluent speech pattern in the home, fluency rapidly extended to other areas of conversation. During the portion of the program in which fluent speech was being transferred to settings outside of the laboratory Ss continued training in conversation in the laboratory. When the subjects reported to us that they had less than five blocks a day, we released them from the program.

Results

The total time in the program for eight Ss ranged from 10 - 40 hours. A summary of data derived from baseline and experimental sessions is shown in Table 1. The summary of experimental sessions does not include the periods of conversation. Blocking levels for Ss were essentially zero by the time they were in the portion of the program that involved conversation.

By the 14th day of their participation in the fluency shaping program four Ss reported their speech was fluent outside the laboratory. The other Ss reported that their speech was markedly improved. Following additional laboratory sessions, these Ss reported their speech became fluent.

It is important to point out that the fluency generated by the present program has persisted in all eight Ss up to the time of this report, that is, approximately six months. Only one S, the first one through the program, reported any recurrance of stuttering. He was returned to the laboratory, run through rate discrimination and conversation steps, and released. He has not reported any further difficulty with his speech.

Table 1

Total Number of Words Read and Total Number of Words Stuttered During Baseline Reading (B.L.) and During Experimental Sessions (Exp).

	S-1		S-2		S-3		S-4	
	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.
Total words read	9699	25401	11893	25739	2738	8608	3386	5581
Total words stuttered	4363	32	3684	115	459	2	1977	48
Percentage words stuttered	45	.001	31	.004	16	.0002	57	.008

	S-5		S-6		S-7		S-8	
	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.	B.L.	Exp.
Total words read	4300	12471	23956	11984	11805	21406	13425	2283
Total words stuttered	1765	7	424	3	3176	427	2578	27
Percentage words stuttered	41	.0005	2	.0002	27	.02	19	.01

Discussion

The procedures reported in this paper and those reported by Goldiamond (1965) are effective in replacing stuttered speech with fluent speech. Questions remain about what constitutes the optimal fluency shaping procedures. For example, we are presently setting up an experiment to test the effectiveness of fluency shaping when the self-definition phase is omitted. In addition, we are attempting to objectively specify the criteria used for advancing Ss from one step to another within the program. Finally, we are attempting to devise methods of fluency shaping that do not require elaborate apparatus. If the use of these methods is to become widespread, they must be applicable even in those situations where costly apparatus is not available.

One very basic question remains to be answered. Why does Goldiamond's fluency shaping procedure work? Chapter 5 of the present report suggests an answer.

Briefly, the basic stimulus for stuttering is regarded to be interference in auditory feedback that is associated with speech responses. A mechanism which may mediate the nature of auditory feedback in the stutterer is the operation of middle-ear muscle reflexes. An account of how this mechanism could function to produce interference in auditory feedback is presented in Chapter 5. The fluency shaping methods outlined by Goldiamond (1965), and presented in this chapter, are thought to be effective because temporal relationships may be altered between the speech responses and middle ear muscle reflexes.

Chapter IV

MASKING OF AUDITORY FEEDBACK IN STUTTERERS' SPEECH

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Published in:

JOURNAL OF SPEECH and HEARING RESEARCH, 1968, 11, 221-222

ABSTRACT

A number of investigators have suggested the importance of auditory feedback as a controlling stimulus in the speech of stutterers. Sutton and Chase (1961) indicated that stuttering was significantly reduced when white noise was presented during silent periods in speech sequences, as well as when white noise was presented during phonation. A reexamination of the Sutton and Chase report leads to a new interpretation supporting the critical nature of auditory feedback in stuttering.

A report by Cherry and Sayers (1956) suggested that auditory feedback may be implicated as a controlling variable in stuttering by showing that the frequency of stuttering was attenuated when continuous masking noise was presented through earphones. Similarly, Maraist and Hutton (1957) showed that auditory masking with white noise produced decrements in stuttering.

Further information on the significance of auditory feedback in the speech of stutterers has been presented by Sutton and Chase (1961). These investigators used three conditions of white noise in their experiment: (1) continuous white noise, (2) white noise presented during phonation, and (3) white noise during silent periods in speech sequences. Stuttering was significantly reduced during all noise conditions. Sutton and Chase indicated that condition three, white noise presented in silent periods, was just as effective in suppressing the frequency of stuttering as the other two conditions. The Sutton and Chase report would suggest, at first inspection, that auditory feedback of stutterers' speech was not a critical factor in stuttering since white noise presented in silent periods could not have masked the subjects' speech.

A careful reexamination of the Sutton and Chase article leads to a more accurate interpretation regarding the importance of auditory feedback in the control of stuttering. The experimental apparatus used by Sutton and Chase to control the presentation of white noise in conditions two and three was described as a "voice-actuated relay." The nature of such relays requires that the subjects' phonation occur at a level and duration sufficient for the relay to be operated. Thus, in the Sutton and Chase experiment, phonation had to occur in order for the white noise to the stutterers' ear phones to be turned off. It would follow that during the fraction of a second in which phonation was initiated, white noise was present at the ears of the subjects in the Sutton and Chase experiment and that the initial auditory feedback was effectively masked. In the light of this interpretation, the Sutton and Chase data show that the critical portion of auditory feedback in stuttered speech is that which occurs with the initiation of phonation.

The available data on the masking of auditory feedback in stuttered speech support an interpretation that the acoustic signal is a critical controlling variable in the production of stuttering.

Chapter V

INTERRELATIONSHIPS AMONG FLUENCY PRODUCING VARIABLES IN STUTTERED SPEECH

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In press,

Journal of Speech and Hearing Research, 1968

ABSTRACT

Several variables including rhythm, masking noise, whispering, choral reading, prolongation of speech sounds, delayed auditory feedback, and others, have been shown to improve fluency in stutterers. These fluency producing variables seem to share the property of modifying critical aspects of temporal relationships within speech processes. This report presents a limited theory (Auditory Interference Theory) which integrates data on fluency producing variables in terms of modified temporal aspects of auditory feedback in stuttered speech. The probable basis for stuttering is inferred to involve interference between air conducted and bone conducted auditory feedback. Middle ear muscle reflexes are suggested as a possible mechanism for the mediation of interference between components of auditory feedback.

Conspicuous by its absence in current stuttering theories is an adequate explanation of how certain conditions function to attenuate or eliminate stuttering. Variables such as rhythm, masking noise, choral reading, prolongation of speech sounds, whispering, delayed auditory feedback, and others, act to improve fluency in stutterers. The traditional ways of accounting for the effects of most of these fluency improving variables have been to label them as "distractions" or to discard the variables as lacking permanence in producing fluency. Both of these approaches to fluency enhancing factors are clearly unsatisfactory for they fail to focus on the vital question of how these variables produce their effects. Fransella and Beech (1965) and Beech (1967) have suggested that the concept ot distraction has little explanatory usefulness because of its limited relationship to observable behavior. A reliance on the traditional interpretation of distraction and the abandonment of study on variables which even temporarily improve fluency, eliminate opportunities to derive quantitative information about the nature and duration of observed increases in fluency and close some of the avenues by which further understanding of stuttering may be achieved.

The very fact that stuttering can be modified by empirically manipulatable factors raises some important questions. What do these variables have in common? Can the study of fluency production by these variables suggest mechanisms involved in stuttering? Can these variables serve as a foundation for building procedures to generate lasting fluency in stutterers?

The present article provides a preliminary statement on the nature of fluency enhancing variables and accounts for stuttering decrements produced by these variables primarily in terms of modified temporal aspects of speech-hearing processes. The theory presented here has developed as a result of our efforts to account for attenuated stuttering under conditions of delayed auditory feedback (DAF), rhythmic speech, unusual speech patterns, including prolonged speech, whispering, masking noise, adaptation, and spontaneous recovery from stuttering

A careful examination of these fluency producing variables suggests that they share one property: in some way they alter the nature of existing temporal relationships within speech processes. Temporal relationships seem to be altered by these variables in three ways: 1) Temporal relationships between auditory feedback and motor activity involved in speech production may be modified. 2) Temporal relationships may be established between speech production and external cueing stimuli. 3) There may be temporal modification of the interaction between air and bone conducted auditory feedback. Data supporting these generalizations and a theory which integrates the data comprise the body of this report.

Three points should be clearly stated at the outset. First, the limited theory presented here deals only with established stuttering behavior and does not attempt to account for the ontogeny of stuttering, although the theory itself does not conflict with existing ideas about the climate for the development of stuttering. Second, the major tenets of the present theory are consistent with established empirical information on the phenomenon of stuttering. Third, the limited theory does not discount the possible contributions of learned avoidance responses or fear responses to stuttering.

STATEMENT OF THEORY

The Auditory Interference Theory (AIT) states that the stutterer's own auditory feedback provides a source of interference with his control of speech. AIT emerged from data which strongly indicate that during stuttering, aberrant temporal relationships exist between some aspects of auditory feedback and speech activity The theory employs feedback principles similar to those described by Fairbanks (1954), Gruber (1965), and Mysak (1959, 1960), but AIT differs from their presentations in two important ways. First, it is relatively uncomplicated, and second, it is derived from and based on existing empirical data on stuttering

A schematic representation of AIT is shown in Figure 1. Functions of AIT's components are outlined below, and specific data which bear on interrelationships of these components are discussed in subsequent sections.

AIT assumes that central nervous system mechanisms govern the flow of neural impulses to the speech musculature. In Figure 1 a hypothetical entity labeled Speech Output Control represents these central nervous system mechanisms. The strength and duration of signals which directly activate speech muscles are regulated by Speech Output Control. The primary input source for Speech Output Control is not shown in the figure, but input would involve mechanisms which process, sequence, and store signals soon to be manifested in speech forms.

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Insert Figure 1 about here

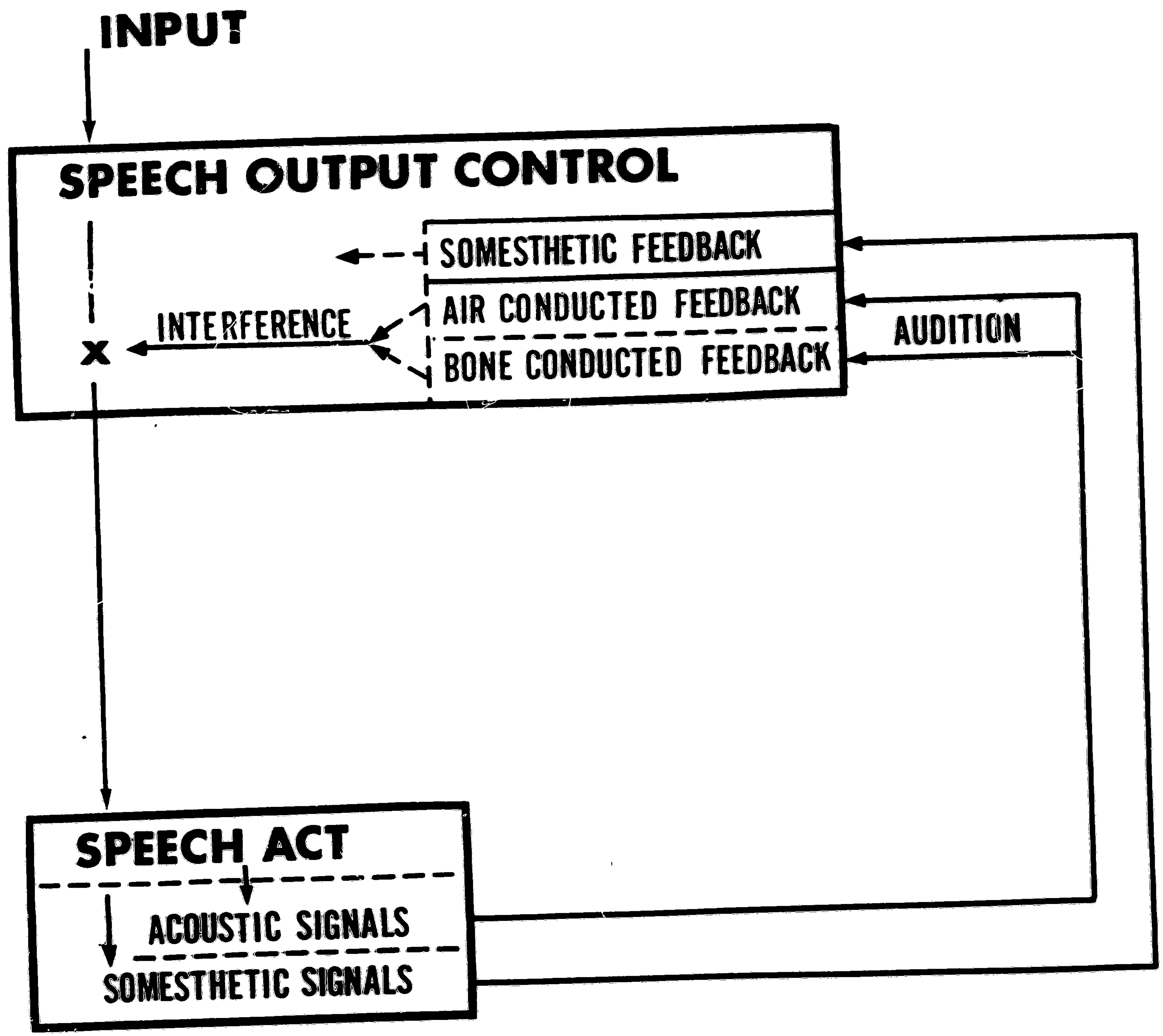
- - - - - - - - - - - - - - - -

Auditory and somesthetic stimuli arise from motor activities which comprise the physical act of speech. These stimuli are fed back through sensory channels having inputs into Speech Output Control and are then integrated by Speech Output Control functions to regulate the release of nerve impulses that produce the motor responses of speech.

In AIT, stuttering occurs when returning auditory feedback blocks the output signals of Speech Output Control. The interference with the function of Speech Output Control is manifested in the abnormal speech behaviors of stutterers. It is possible that the interference with Speech

Figure Captions

Figure 1. Schematic representation of components in the Auditory Interference Theory.



INPUT
SPEECH OUTPUT CONTROL
SOMESTHETIC FEEDBACK
AIR CONDUCTED FEEDBACK
BONE CONDUCTED FEEDBACK
INTERFERENCE
X
AUDITION
SPEECH ACT
ACOUSTIC SIGNALS
SOMESTHETIC SIGNALS

Output Control is related to characteristics of the interaction between air conducted and bone conducted components of auditory feedback. Secondary symptoms which develop may be learned responses used to assist stutterers in getting through or avoiding interference produced by auditory feedback from their own vocal activity.

Some conditions during which stuttering is consistently attenuated and their relationships to the Auditory Interference Theory are presented in the following sections of this report.

Attenuation of Auditory Feedback

The importance of auditory feedback as a critical variable in stuttered speech is illustrated by investigations involving the attenuation of auditory feedback. When the intensity of stutterers' own auditory feedback is reduced or eliminated, marked decreases occur in frequency of stuttering. The intensity of auditory feedback may be diminished by masking noise, by whispering, or by deafness.

Reports on auditory masking with stutterers (Cherry and Sayers, 1956; Maraist and Hutton, 1957; Sutton and Chase, 1961) indicate that masking with white noise produces significant decrements in stuttering. Apparently, in these studies the reduction of auditory feedback by masking noise was sufficient to diminish the interference which may be associated with the presentation of the auditory signal to the ears of the stutterer.

Sutton and Chase (1961) indicated that stuttering was significantly reduced when masking noise was presented during silent periods of speech as well as when masking noise was presented during phonation. Because masking noise presented in silent periods could not serve to mask stutterers' speech, the Sutton and Chase report led to a conclusion that auditory feedback is not a critical factor in stuttering. Webster and Lubker (1967), in a reinterpretation of the Sutton and Chase data, noted that the experimenters used a voice operated relay to control offset of masking noise to Ss. Webster and Lubker pointed out that in the Sutton and Chase experiment, speech sounds had to be produced in order for the voice operated relay to be activated and thus turn off the masking noise coming to the Ss' earphones. Therefore, during the short period when speech was initiated, masking noise was indeed present in Ss' ears. Webster and Lubker suggested that the crucial portion of auditory feedback in stuttering may occur in the initial milliseconds of speech sounds.

Johnson and Rosen (1937) observed that fluency improved when stutterers whispered. Cherry and Sayers (1956) also reported that fluency improved when stutterers whispered, and in addition, suggested that bone conducted feedback is of primary importance in mediating stuttering. According to Cherry and Sayers, whispering was effective in reducing stuttering because it severely reduced bone conducted auditory feedback. This interpretation is consistent with AIT. When interpreted in terms of AIT, stuttering decrements which occur during whispering result from a reduction in interference associated with auditory feedback.

Other information suggesting the importance of reduced intensity of auditory feedback as a means of attenuating stuttering comes from reports of the low incidence of stuttering found among deaf children (Backus, 1938; Harms and Malone, 1939; Albright and Malone, 1942). A reasonable interpretation of these data is that the severe attenuation of auditory feedback in the speech of the deaf removes the possibility for the auditory feedback to interfere with Speech Output Control mechanisms.

In terms of the diagram presented in Figure 1, the interference in Speech Output Control produced by the returning auditory signal is decreased or eliminated by auditory masking, deafness, and whispering. AIT represents a parsimonious means of accounting for the effects of attenuated auditory feedback on stuttered speech.

Delayed Auditory Feedback

Delayed Auditory Feedback with Normal Speakers. Experiments which have manipulated auditory feedback in normally fluent Ss have shown that this variable is a controlling factor in speech. Reports by Lee (1950a, 1950b, 1951), Fairbanks (1954, 1955), Fairbanks and Guttman (1958), Black (1954, 1955), Chase, Sutton, First and Zubin (1961), and Goldiamond, Atkinson and Bilger (1962) have shown that normal speech was disrupted by delaying feedback of the air conducted auditory signal produced during speech. The disruptions included changes in voice quality, intensity, and fundamental frequency. Other changes included speech which approximated stuttering, increases in the number of articulation errors, and an overall slowing of speech rate.

It was suggested by Yates (1965) that the various amounts of speech disruption shown by different Ss during DAF are probably a function of the relative degree to which Ss depend upon auditory feedback for the normal control of speech. In our laboratory we have observed that during DAF, normally fluent Ss often alter voice quality by increasing harshness and intensity. These changes may represent efforts on the part of Ss to decrease the relative importance of auditory feedback in speech guidance, while simultaneously increasing the importance of somesthetic feedback.

In a related report, McCroskey (1958) indicated that disruption of somesthetic feedback by anesthetizing articulators produced significant decreases in intelligibility and articulation accuracy while disruption of auditory feedback with DAF significantly retarded speech response rates.

Peters (1954) and Davidson (1959) have shown that speech response rates increase when auditory feedback is accelerated beyond normal feedback time. These reports are consistent with the data in this section which suggest that auditory feedback is important in controlling the rate at which speech is produced.

Delayed Auditory Feedback with Stutterers. Several studies have shown that DAF improves the fluency of stutterers (Chase, Sutton, & Rapin, 1961; Goldiamond, 1965; Schumacher, 1967). When DAF was presented to 30 stutterers, Chase, Sutton and Rapin noted that 10 of their Ss showed improved fluency. The experimenters did not dwell on the nature of the improved fluency nor on why changes did not occur with other Ss.

Goldiamond (1965) reported that several different DAF conditions were found to reduce stuttering frequency. The effectiveness of one condition, the presentation of DAF contingent on a stuttering block, was interpreted in terms of a traditional punishment paradigm, that is, the presentation of noxious stimulation (DAF) made contingent upon a response (stuttering) reduced the rate of the response.

A second condition consisted of the offset of DAF for 10 sec. whenever a block occurred. Contingent removal of DAF produced the "anomolous effects" of initial high oral reading and stuttering rates which were later replaced under the same condition by slow, prolonged fluent speech. This condition, labeled elimination-avoidance, was interpreted to be effective because prolonged fluent speech was presumed to be a less aversive response alternative than other available response alternatives. What Ss avoided during the elimination-avoidance procedure was not made clear. Possibly, it was meant that Ss prolonged in order to avoid delayed feedback of stuttering, or Ss prolonged in order to avoid the disruptive influence of delayed feedback on fluent speech episodes. A third possible meaning may have been that Ss prolonged to avoid the offset of DAF because the offset would permit immediate feedback of stuttering. How the presumed aversive properties of DAF function in the elimination-avoidance condition was not clearly stated by Goldiamond.

Recent data from our laboratory lead to a more parsimonious interpretation of the fluency improving aspects of DAF. DAF appears to be a stimulus which, for stutterers, has special fluency producing effects of is own. Schumacher (1967) demonstrated that the simple continuous presentation of DAF was also effective in reducing or eliminating stuttering while permitting Ss to maintain normal oral reading rates. These data lead us to suggest that the different contingencies of DAF used by Goldiamond may not be especially critical for fluency improvement to occur.

Schumacher's data on continuous DAF make it possible to reinterpret Goldiamond's findings in a more unified manner. First, in Goldiamond s study fluency improvement during contingent presentations of DAF may have been a function of the inherent fluency enhancing effects of DAF rather than a function of a punishment situation. Secondly, fluency improvement during the elimination-avoidance condition can be interpreted as a joint function of the fluency enhancing effects of DAF in conjunction with avoidance of DAF offset which then permitted the aversive consequences of immediate feedback of stuttered speech. The transition from rapid stuttered speech to slow fluent speech during the condition of contingent removal of DAF may have reflected Ss attempts to minimize time off of DAF. Thus, the condition avoided in the elimination-avoidance procedure could have been stuttered speech.

Goldiamond (1965) reported that continuous DAF was tried for a short time with one S, but no improvement in stuttering was noted. In our labboratory four of 14 stutterers did not show immediate improvement in fluency when they first experienced continuous DAF. These were Ss whose stuttering patterns seemed to be comprised of strong anticipatory struggle responses. We discovered that while Ss were on DAF, they could follow instructions to drop out the struggle responses and could then successfully emit words they initiated. Ss found that if speech was initiated without struggle, DAF permitted fluency. The 14 Ss used to date in our laboratory have shown marked improvements in fluency while on continuous DAF.

An interpretation accounting for decreased stuttering during DAF can be derived from AIT. This interpretation holds that feedback of the auditory signal produced during the first portion of speech propagation results in a form of interference in Speech Output Control which is manifested in the stuttering block. The improved fluency seen on DAF can occur because the delay interval serves to hold back the return of the interfering air conducted auditory signal until the speech act which originated the signal is well underway or completed. This interpretation would also account for the rapid onset of fluency with continuous DAF and for the rapid decrease in fluency when DAF is discontinued.

Rhythmic Cueing Stimulation

A long known but little understood variable that produces fluency in stutterers is the use of rhythmic or predictable cueing stimuli. Stutterers speaking chorally or in time with a metronome, arm swings, finger tapping or similar cueing stimulus are able to speak fluently (Barber, 1939, 1940; Bloodstein, 1950; Blumel, 1960; Van Dantzig, 1940). These effects have been attributed to the "distracting" influence of the cueing stimuli. Fransella and Beech (1965) suggested that any simple conception of ryhthm acting as a "distractor" is untenable. These investigators presented Ss with controlled sets of cueing stimuli in an attempt to distract them from stuttering and found that arhythmic stimulation had no effect on the amount of stuttering. In order to produce increased fluency, the cueing stimulus had to have definite rhythmic properties.

Beech (1967) suggested that the concept of "distraction" has little to recommend it because of its lack of definition. In order to test the distraction hypothesis various conditions were designed to distract the stutterer. Distracting conditions included buzzers, writing while speaking and a metronome. Again, only the condition with the element of rhythm produced fluency increases. Distraction, as tested, seemed not to affect the amount of stuttering produced.

Rhythmic cueing stimuli or predictable cueing stimuli such as those in choral reading, when viewed in terms of AIT, provide sensory stimulation which enables the stutterer to produce speech output signals that have little or no interference from the returning auditory signal. Apparently, the cueing stimulus governs the initial release rate of syllables to be produced by the stutterer thus removing the rate control function from guidance by auditory feedback. AIT leads to a suggestion that the cueing properties of rhythmic stimuli permit Speech Output Control signals to override any interference that may occur from auditory feedback.

Unusual Speech Patterns

Bloodstein (1949, 1950) reported that unusual speech patterns have been used to increase fluency in stutterers. Some of the patterns mentioned were imitating dialects, using altered voice quality, speaking through clenched teeth, using unusual inflections, and using slower speech rates.

A speech pattern employing marked lengthening of syllabic elements has been shown to improve fluency (Sheehan and Voas, 1957; Goldiamond, 1965). In an experiment investigating three kinds of negative practice techniques, Sheehan and Voas found that slide, the voluntary prolongation of speech sounds, was more effective in producing fluency than were bounce or Dunlap's traditional negative practice techniques.

In a more comprehensive study of prolonged speech, Goldiamond (1965) found that stuttering could be greatly reduced or eliminated when Ss used an on-going speech pattern in which syllabic elements were markedly lengthened. In the Goldiamond procedure, DAF was used to help establish a prolonged speech pattern as Ss read orally. Then DAF was gradually faded out and the prolonged speech pattern remained. By using equipment to control reading rate, Goldiamond succeeded in gradually accelerating Ss' fluent speech rate to normal limits. Goldiamond's procedures were based on careful experimental control of Ss' prolonged speech patterns, training Ss to define their nonfluencies, and the use of S controlled DAF contingencies. Rapid, fluent reading was obtained in all instances. Procedures are being developed to facilitate carryover of fluent speech patterns into situations outside the laboratory (Goldiamond, personal communication, 1967).

When interpreted in terms of AIT, prolongation changes the temporal relationships in speech output-auditory input mechanism. Prolongation may help to establish proper relationships between articulatory movements and auditory feedback which guides the movements. Goldiamond, Atkinson, and Bilger (1962) suggested that in fluent speech this proper relationship may be a specific temporal overlap between a speech sound and the articulatory movements involved in producing the sound. It is possible that in stuttering the first portion of auditory feedback causes the stutterer to inhibit Speech Output Control signals, thus halting the speech act. One way in which AIT accounts for fluency during prolongation is by assuming that the functions of Speech Output Control are strengthened to the extent that auditory feedback does not disrupt control of speech. Apparently, during prolonged speech the stutterer "voluntarily" guides the release rate of syllables. This change to deliberate voluntary control would mean that the stutterer may also change the way in which auditory feedback is used as a cue for speech guidance, probably by decreasing his reliance on the cue properties of the early portion of auditory feedback in the words of his speech.

Another factor that may help to account for fluency during prolonged speech is that as prolongation of syllables occurs, there is a concommitant lowering of vocal pitch. Although this pitch change has not yet been studied systematically, we have observed that during prolongation at a rate of 30-40 words per minute, decreases in pitch are in a range approximately three tones lower than pitch at normal rates. A change in voice pitch during prolongation may alter the nature of the interaction between air and bone conducted auditory feedback in such a way that interference in auditory feedback is reduced or eliminated.

Though they have not been as thoroughly investigated and at this point seem to be less efficacious than prolongation in producing fluency, other unusual speech patterns may share the characteristic of changing temporal relationships within speech processes.

<u>Adaptation</u>

AIT helps to account for adaptation effects which occur when stutterers repeat material previously spoken or read. Adaptation studies have shown that the frequency of stuttering rapidly decreases as the stutterer continues to re-read a text or to repeat self-generated sentences (Tate, Cullinian, and Ahlstrand, 1961; Trotter, 1955; Newman, 1954; Wingate, 1966b). AIT points to the possibility that during adaptation Speech Output Control is strengthened by successive repetition of words or sentences. On successive trials the cumulative effect is to strengthen Speech Output Control to the extent that interference caused by returning auditory feedback is overridden. In effect, AIT holds that during adaptation auditory feedback becomes relatively less important in guiding speech.

Self-Recovery from Stuttering

Another set of studies relevant for AIT deals with stutterers' reports of self-recovery (Shearer & Williams, 1965; Sheehan & Martyn, 1966, 1967; Wingate, 1964, 1966a). Although these studies employed ex post facto methods, they provide information bearing on concepts outlined in AIT. Shearer and Williams (1965) found that most stutterers (69%) who had achieved normal speech indicated that speaking more slowly was a critical factor. Sheehan and Martyn (1966) also presented evidence that slowing down and relaxing were contributing factors in spontaneous recovery from stuttering. It seems evident that slowing of speech for recovered Ss probably entailed some prolongation of speech sounds. If prolongation occured as Ss slowed down, this change would serve the same function as using experimentally established prolongation patterns.

A POSSIBLE MECHANISM MEDIATING AUDITORY INTERFERENCE

It was suggested by Cherry and Sayers (1956) that stuttering may be mediated by bone conducted auditory feedback. It was also noted that bone conducted sounds display a strong low frequency emphasis not shown by air conducted sounds. These investigators reported that fluency improvement in stutterers was greatest when both air and bone conducted feedback were masked by low frequency sounds rather than by high frequency sounds. In addition, Cherry and Sayers pointed out that most stutterers can whisper fluently, and that whispered speech drastically reduces bone conducted feedback. The interpretation by Cherry and Sayers of the importance of bone conducted auditory feedback becomes increasingly meaningful for an understanding of stuttering in terms of AIT when other reports are considered.

The possible importance of phase relationships between air and bone conducted auditory feedback in stutterers was reported by Stromsta (1956) who found significant differences between stutterers and nonstutterers in the phase angle shifts and amplitude adjustments needed to produce cancellation between air conducted and bone conducted pure tone signals. In a later study Stromsta (1959) reported that distortion of air conducted sidetone resulted in phonatory blockage in normal speakers. Stromsta (1959) also cited a study by Dolch and Schubert (1954) in which they reported that manipulation of phase relationships of accelerated air conducted sidetone modified both the rate and quality of speech.

If the interaction between air and bone conducted auditory feedback is involved in stuttering, then a mechanism is required by which such an interaction could be mediated. Any mechanism which is postulated to mediate the interaction between air and bone conducted feedback in stutterers must not be a steady state property of the auditory system of the stutterer. Instead, such a mechanism must be able to show variation of action across the range of stuttering severity witnessed under a wide variety of conditions which vary in communication difficulty or emotional content.

One mechanism that could mediate the nature of the interaction between components of auditory feedback and which would be representative of the requirements just presented could involve the reflex responses of the middle ear. Jepsen (1963) reported that one theory regarding middle ear reflex functions is based on data which show overtone patterns to be modified by changes in middle ear reflex action. In a more recent report on middle ear reflex action, Shearer and Simmons (1965) indicated that increases in acoustic impedence preceded the initiation of speech sounds by 65 to 100 milliseconds. Shearer and Simmons concluded that the action of middle ear muscle contractions served to attenuate the input of speech sounds. It is possible that variations induced in air conducted sidetone by impedence changes in the ear could produce aberrant forms of interaction between air and bone conducted auditory feedback.

When examined within the framework of AIT, the nature of the interaction between air and bone conducted auditory feedback in the ear of the stutterer assumes increased importance. If interaction between air and bone conducted feedback components produces momentary phase or frequency induced distortion, it is possible that the resultant signal can be a sufficient stimulus to interfere with speech control. The studies cited in this presentation of AIT lead rather strongly to the suggestion that aberrant temporal interactions between components of auditory feedback underlie stuttered speech.

CONCLUSION

The present report emphasizes the possibility of increasing the understanding of the nature of stuttering by focusing on variables which, when directly manipulated, alter the topography of stuttered speech. Even though it is not a new approach, it is apparent that there is still much to be learned by investigating the direct manipulation of stuttering. Indeed, direct alteration of stuttering appears to be a most efficacious approach to its elinination.

A promising development based on the direct manipulation of stuttering is Goldiamond's (1965) successful use of prolonged speech as the basis for shaping normally fluent speech in stutterers. We have found that Goldiamond's procedures are effective in producing fluent speech which transfers to conversational settings outside the laboratory. It is important to understand how these procedures produce fluency. Parameters which control stuttered speech and the transition from stuttering to fluent speech must be identified and investigated. For example, what factors initiate stuttered responses, do speech rates bear any relationship to stuttering, and how does prolongation of syllables function to produce fluency?

The Auditory Interference Theory indicates that the acoustic properties of phonetic elements and the transmission of acoustic energy to the ear are important variables in the production of stuttering. In addition, the interaction of acoustic variables with different speech rates must be studied as possible factors involved in stuttering. Research needs to be performed on the mediation of the interaction between air and bone conducted auditory feedback. Further emphasis must be placed on the nature of middle ear muscle activity and on the amplitude and latency of middle ear muscle reflexes during stuttering and after the establishment of fluency. Finally, it would be useful to examine the relationship of AIT to the development of auditory perception and to the development of stuttering. Results of future research on these problems should enhance our understanding of stuttering.

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TITLE

EFFECTS OF STUTTERERS' SELF-MONITORING ON RETENTION OF FLUENCY GENERATED BY DELAYED AUDITORY FEEDBACK

FINAL REPORT

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INSTITUTION (SOURCE)	SOURCE CODE
Hollins College Hollins College, Virginia 24020	

REPORT/SERIES NO.

OTHER SOURCE	SOURCE CODE

OTHER REPORT NO.

OTHER SOURCE	SOURCE CODE

OTHER REPORT NO.

PUB'L. DATE	CONTRACT/GRANT NUMBER
4 July 1968	OEG 2-078290-3550

PAGINATION, ETC.

67 pages

RETRIEVAL TERMS

Stuttering
Delayed auditory feedback and stuttering
Rate control and stuttering
Theories of stuttering

IDENTIFIERS

Hollins College Stuttering Research Laboratory

ABSTRACT

Several variables including rhythm, masking noise, whispering, choral reading, prolongation of speech sounds, delayed auditory feedback, and others, have been shown to improve fluency in stutterers. These fluency producing variables seem to share the property of modifying critical aspects of temporal relationships within speech processes. This report presents 1) a method for shaping fluent speech in stutterers and, 2) a limited theory (Auditory Interference Theory) which integrates data on fluency producing variables in terms of modified temporal aspects of auditory feedback in stuttered speech. The probable basis for stuttering is inferred to involve interference in auditory feedback. Middle ear muscle reflexes are suggested as a possible mechanism for the mediation of interference between components of auditory feedback.