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The Effect of Alpha Brain-Wave Control on the Speech of Two Adult Stutterers

Randall J. Bjork

THE EFFECT OF ALPHA BRAIN-WAVE CONTROL ON THE SPEECH OF TWO ADULT STUTTERERS

by
Randall J. Bjork

Bachelor of Science, University of North Dakota, 1972

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THE EFFECT OF ALPHA BRAIN-WAVE CONTROL ON

THE SPEECH OF TWO ADULT STUTTERERS

Randall J. Bjork, M.S.

The University of North Dakota, 1974

Faculty Advisor: Professor Dean C. Engel

The purpose of this study was to examine, compare and describe the effect of alpha brain-wave conditioning upon the speech of two adult stutterers.

Five sessions of baserate measurement were followed by a sequence of conditioning sessions (in which an electronic brain-wave monitor was used to train subjects to control their alpha rhythms), after which the speech of the stutterers was re-evaluated by a procedure which was identical to the baserate procedure. The four speech activities which were investigated were: reading without feedback of alpha-band brain activity from the monitor, monologue without feedback from the monitor, reading with feedback from the monitor, and monologue with feedback from the monitor.

Subject I displayed a significant decrease in the number of stuttered words and severity ratings in monologue without feedback from the monitor when the re-evaluation measures were compared with baserate measures. Number of stuttered words and severity ratings were not significantly affected in the three other speech activities

for Subject I. However, Subject II exhibited a significant increase in the number of stuttered words in both unmonitored and monitored reading samples when the re-evaluation measures were compared with baserate. Severity ratings were not significantly affected in either unmonitored or monitored reading samples. There were also no significant differences between baserate and re-evaluation measures of number of stuttered words and severity in either unmonitored or monitored monologues for Subject II.

This procedure showed that a significant relationship exists between the number of stuttered words and the combined effect of session number, total time for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm in monitored reading samples for both subjects. There was no significant relationship, however, between severity rating and the combined effect of session number, total time for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm in monitored reading samples for either subject. There were also no significant relationships among the variables for the monitored monologue speech activity for either subject.

This thesis submitted by Randall J. Bjork in partial fulfillment of the requirements for the degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

Dean C. Engel
(Chairman)

George W. Schubert

Edward J. Halas

A William Johnson
Dean of the Graduate School

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Title The Effect of Alpha Brain-Wave Control on the Speech of Two Adult Stutterers

Department Speech Pathology and Audiology

Degree Master of Science

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Date July 24, 1974

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ABSTRACT

The purpose of this study was to examine, compare and describe the effect of alpha brain-wave conditioning upon the speech of two adult stutterers.

Five sessions of baserate measurement were followed by a sequence of conditioning sessions (in which an electronic brain-wave monitor was used to train subjects to control their alpha rhythms), after which the speech of the stutterers was re-evaluated by a procedure which was identical to the baserate procedure. The four speech activities which were investigated were: reading without feedback of alpha-band brain activity from the monitor, monologue without feedback from the monitor, reading with feedback from the monitor, and monologue with feedback from the monitor.

Subject I displayed a significant decrease in the number of stuttered words and severity ratings in monologue without feedback from the monitor when the re-evaluation measures were compared with baserate measures. Number of stuttered words and severity ratings were not significantly affected in the three other speech activities for Subject I. However, Subject II exhibited a significant increase in the number of stuttered words in both unmonitored and monitored reading samples when the re-evaluation measures were compared with baserate. Severity ratings were not significantly affected in either unmonitored or monitored reading samples. There were also no

significant differences between baserate and re-evaluation measures of number of stuttered words and severity in either unmonitored or monitored monologues for Subject II.

This procedure showed that a significant relationship exists between the number of stuttered words and the combined effect of session number, total time for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm in monitored reading samples for both subjects. There was no significant relationship, however, between severity rating and the combined effect of session number, total time for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm in monitored reading samples for either subject. There were also no significant relationships among the variables for the monitored monologue speech activity for either subject.

CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

A major assumption of most considerations of the relationship between stuttering and relaxation is that the two are incompatible. That is, the stutterer probably will not stutter if sufficient relaxation can be maintained.

Relaxation has been used as a basic treatment for stuttering for many years. In the late 1800's, Sandow trained his stuttering patients to achieve states of relaxation and serenity and found that much of their stuttering disappeared in the clinical setting. However, his method did not afford much carryover to the stutterers' environments (Van Riper, 1972). More recently, Jacobson (1938) developed a series of relaxing exercises called progressive relaxation. Wolpe (1958) used these progressive relaxation techniques as well as hypnosis to develop a technique of reciprocal inhibition in the treatment of anxiety, widely thought to be a major component in the make-up of stuttering. Brutten and Shoemaker (1967) used this procedure to help stutterers inhibit anxiety in the presence of feared speech situations. They reported that this technique has resulted in marked improvement for most stutterers with whom they have worked.

Bloodstein (1969, p. 241) stated a pervasive feeling concerning relaxation therapy for stuttering:

> Relaxation would seem to have certain basic appropriateness in the case of a disorder consisting essentially of struggle behavior. It is almost impossible to be relaxed and to stutter in the usual sense at the same time. Like distraction and suggestion, however, relaxation is a very old expedient, and in the course of time considerable dissatisfaction with it has arisen among clinical workers. An occasional stutterer seems to learn the trick of relaxing his muscles so effectively that he has little further difficulty with his speech. But such persons appear to be rare. In the usual case the stutterer tends to speak better in the speech clinic while practicing relaxation, but outside the clinic it is precisely in those situations in which it is most important for him to relax that he is likely to find it impossible to do so, anxiety and tension being difficult to separate.

West (1958, p. 217) recommended formal relaxation techniques provided the patient has sufficient insight into what is intended by this type of therapy. He described what is meant by relaxation in this context:

> By relaxation we do not mean a somnolant or hypnoidal state, or a condition of sleepiness. Quite the contrary; we mean a status that depends upon mental alertness and a keen awareness of the whole environment. We mean also a voluntary control that quite supersedes any volition that is involved in an overt motor process. In the central nervous system the functions of the spinal centers are largely positive and exitatory, while those of the highest gradients of the cerebrum are negative and inhibitory. These latter functions are employed in relaxation. Relaxation is the highest form of voluntary control. It is difficult for many persons to learn.

Berger (cited in Thompson, 1967), who first described the human electroencephalogram, observed that if subjects rested quietly with eyes open or closed, bursts of regular waves at a frequency of 8-13 Hz. with an amplitude of 10-100 microvolts appeared in the tracings. He called this wave pattern the "alpha rhythm" (p. 212). The official definition of the alpha rhythm was put forth by Storm van Leeuwen (cited in Mulholland and Evans, 1969, p. 100)--"alpha rhythm: rhythm, usually with frequency 8-13 Hz. in adults, most prominent in the posterior areas, present most markedly when eyes are closed and attenuated during attention, especially visual." Mulholland (1969, p. 100) described this rhythm as being associated with "relaxed wakefulness."

Kamiya (1969, p. 514), in a brain-wave discrimination procedure, recorded subjective descriptions of the alpha rhythm. The most common response among his subjects was that it involved "relaxation of the mental apparatus . . . a general calming-down of the mind." Some subjects in Kamiya's study described alpha rhythm as "a state in which one stops being critical about anything."

It has been shown by Jasper and Shagass (1941), Mulholland (1968), and Kamiya (1967) that the alpha rhythm is responsive to classical and operant methodology. These studies have demonstrated that the alpha rhythm can be conditioned.

Kamiya (1969) has demonstrated that subjects could successfully discriminate between brain-wave states (presence or absence of alpha rhythm). He has also shown that by feeding back information concerning their alpha rhythms, subjects could learn to control them by modifying their subjective states.

Nall (1972) has used alpha brain-wave training as a substitute for tranquilizers in hyperactive children. She has also reported having used alpha-wave conditioning as a therapeutic technique for a child who stuttered in addition to being hyperactive. The child's stuttering was reported to have decreased in frequency.

With alpha rhythm being a phenomenon which co-exists with relaxed wakefulness and also a function which can be controlled, the present study was designed in which subjects were conditioned by means of the servomechanistic principle of feedback, to produce alpha brain waves while talking and reading by the use of an electronic brain-wave monitor, which provided biofeedback to the subject concerning his production of this specific type of electrical activity so that he could learn to modify this behavior (Kamiya, 1969; Mulholland, 1968; and Green, 1971). Answers to the following questions were sought:

1. In unmonitored reading samples, is there a significant difference between the number of stuttered words in the baserate condition and the re-evaluation condition for each subject?
2. In monitored reading samples, is there a significant difference between the number of stuttered words in the baserate condition and the re-evaluation condition for each subject?
3. In unmonitored reading samples, is there a significant difference between the mean severity ratings of stuttering in the baserate condition and the re-evaluation condition for each subject?
4. In monitored reading samples, is there a significant difference between the mean severity ratings of stuttering in the baserate condition and the re-evaluation condition for each subject?
5. In unmonitored monologue, is there a significant difference between the number of stuttered words in the baserate condition and the re-evaluation condition for each subject?

6. In monitored monologue, is there a significant difference between the number of stuttered words in the baserate condition and the re-evaluation condition for each subject?

7. In unmonitored monologue, is there a significant difference between the mean severity ratings of stuttering in the baserate condition and the re-evaluation condition for each subject?

8. In monitored monologue, is there a significant difference between the mean severity ratings of stuttering in the baserate condition and the re-evaluation condition for each subject?

9. In monitored reading samples, is there a significant relationship between the number of stuttered words and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample, mean severity rating of stuttering, and control of alpha rhythm for each subject?

10. In monitored reading samples, is there a significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample, number of stuttered words in reading sample, and control of alpha rhythm for each subject?

11. In monitored monologue, is there a significant relationship between the number of stuttered words and the combined effect of session number, total time of monologue, duration

of alpha rhythm for monologue, mean severity rating of stuttering in monologue, and control of alpha rhythm for each subject?

12. In monitored monologue, is there a significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of monologue, duration of alpha rhythm for monologue, number of stuttered words in monologue, and control of alpha rhythm for each subject?

CHAPTER II

PROCEDURES

Subjects

Two adult male stutterers, both 22 years of age, served as subjects for this study. Both had been diagnosed as stutterers at the University of North Dakota Speech and Hearing Clinic, Grand Forks, North Dakota. Both had had previous therapy for their stuttering.

Apparatus

A Toomim Alpha Pacer, Model 421 (hereinafter referred to as "monitor"), was used to monitor the subjects' alpha-band electrical activity in this experiment. The alpha monitor is a miniature electroencephalophone which senses and amplifies brain waves in the frequency band 6-13 Hz. (this frequency band includes theta waves, at 6-7 Hz., but these waves are slower and their amplified signals are distinct from the signals which mark alpha waves). Three electrodes detect these electrical impulses which are transformed into audible signals which correspond to the frequency of the electrical impulses. It provides a calibrated variable threshold control as a means of measuring the amplitude of these waves, e.g., if the variable threshold is set at 15 microvolts, only those waves of 15 microvolts and above will activate the audible signal. The electrodes also detect muscular activity in the brow and scalp. The audible response to muscular activity is a shrill, high-pitched tone which can be differentiated from alpha waves, which are lower in pitch and rhythmic. The electrodes contact the scalp in the occipital, right temporal, and frontal areas. An electrode cream is applied to increase the conductivity of the scalp.

The monitor also possesses a pacing mechanism which emits an independent pulsating tone that can be set at frequencies ranging from 6-13 Hz. The pacer allows subjects to hear a model of the alpha rhythm at each frequency. This pacing function was useful in the initial phase of training because it provided an example which the subjects attempted to reproduce.

To establish the validity of the monitor, an electronics engineer activated the input mode with a frequency generator. The frequency response was verified at 100 microvolts (the subjects were conditioned to control alpha waves of 15 to 25 microvolts).

Each session was conducted in a quiet setting (an individual speech therapy room and an audiometry suite were the two settings used) to minimize distraction. The experimenter was in the same room as the subject for all sessions except those which involved generalization of the alpha rhythm to the "eyes open" condition (step 4 of conditioning sequence).

Additional equipment was a Panasonic Cassette tape recorder, Model RQ-420S, with which all sessions were recorded. The tape recorder was always within full sight of the subject. Subjects were aware of the activation of the tape recorder.

Procedure

Baserates of stuttering were obtained from five 300-word reading passages which were unmonitored by the electronic device, five unmonitored 300-word monologues, five monitored 300-word reading passages, and five monitored 300-word monologues for each subject. All reading passages were selected from a current issue of the Reader's Digest. All monologues were spontaneous and unstimulated. Each speech sample was audiorecorded. Stuttered words and severity were determined by means of the recordings. The severity measures were taken in case there were changes in stuttering which raw number of stuttered words did not reveal. According to MacDonald and Martin (1973), those words which were perceived to be stuttered were counted by the experimenter. The following measures for each subject for each speech mode (monitored and unmonitored reading and monologue) were computed from the five daily baserate and re-evaluation sessions: number of stuttered words in each of the four speech activities, mean rating of severity of stuttering for each of the speech activities, and the duration of alpha rhythm in the monitored speech activities only.

After the baserates had been established for each subject, the conditioning sequence began. The conditioning sequence consisted of five steps. Each step had to be completed before the subject advanced to the next step. No time limitations were placed upon the subject; each subject proceeded through the conditioning sequence at his own rate (which accounts for the unequal number of conditioning sessions for each subject). The five steps of the conditioning sequence were as follows:

1. Orientation to the alpha brain-wave monitor
2. Identification of alpha brain-wave rhythm
3. Control of alpha rhythm with eyes closed
4. Control of alpha rhythm with eyes open
5. Production of continuous alpha rhythm with eyes open while speaking

The first of the individual treatment sessions consisted mainly of the subject's becoming oriented to the monitor, i.e., wearing the electrode headband, listening to his own brain-waves, etc. Each subject was told to close his eyes and relax as completely as possible (see Appendix B).

The second step of the conditioning sequence, which was completed during the first session for both subjects, was the identification of the alpha rhythm. The subjects were instructed to identify the physical state which accompanied the production of these waves and were told to try to produce them again. If a subject was not producing even, sporadic bursts of alpha rhythm, the initial instructions were paraphrased in an effort to help the subject relax. During this phase, the subjects' eyes were closed, facilitating the production of the unconditioned bursts of alpha rhythm.

After the subjects had identified their alpha rhythms and were consistent at their production (typically after two or three hours of feedback), they were instructed to keep the tone on for as long as possible, as in the previous step, the subjects' eyes remained closed to facilitate production of the alpha rhythm. The criterion for advancement to the next step was the subjects' production of continuous alpha rhythm for one minute.

The next step in the conditioning sequence consisted of the subjects' generalizing the alpha rhythm to the "eyes open" condition. This was achieved by seating the subjects in a darkened testing booth of an audiometry suite. Each subject was instructed to produce the alpha rhythm with his eyes closed and then to open his eyes slowly, attempting to keep the tone on. As the subjects became able to produce the alpha rhythm with their eyes open in total darkness, light was gradually introduced from the control room of the suite. As the subjects became able to sustain the rhythm with minimal visual stimulation, the illumination of the room was gradually brought up to a normally lighted level.

The criterion for advancement to the final step in the conditioning sequence was the subjects' production of continuous alpha rhythm for two minutes with the eyes open in normally illuminated conditions.

After the subjects met the criterion for advancement from the generalization phase, they were instructed to speak during the production of the alpha rhythm. No limitations were placed upon the subjects concerning topic or paragraphic organization. The subjects were directed to talk about anything they wished. During this phase, the subjects received auditory and visual feedback from the monitor. When each subject had demonstrated control of alpha rhythm, i.e., had spoken for two minutes while producing continuous alpha rhythm, the conditioning procedure was terminated.

The speech samples which were taken in the five baserate sessions were also taken in each of the conditioning sessions, i.e., reading without alpha monitor, monologue without alpha monitor, reading with alpha monitor, and monologue with alpha monitor. During these speech activities, the subjects were instructed to try to produce the alpha rhythm. The four speech activities always occurred in the same sequence within each session. Each session lasted for approximately ninety minutes, of which approximately sixty minutes was spent obtaining speech samples. Approximately thirty minutes of each conditioning session was allotted to alpha-wave training.

Re-evaluation of the subjects' stuttering occurred the next session following the termination of the conditioning sequence. Re-evaluation was a duplication of the baserate procedure. During the re-evaluation sequence, the subjects were not told to try to produce the alpha rhythm.

To obtain the number of stuttered words per 300-word sample, the experimenter re-played the tape recordings and counted words on which the subject stuttered.

Ratings of severity of stuttering were obtained by assembling a panel of judges to assign severity values to each sample. The panel consisted of three graduate students majoring in speech pathology. The panel listened to randomized one-minute segments of each speech sample for both subjects. The one-minute segments were arbitrarily chosen from the whole 300-word sample. These segments were placed in numerical order and were randomized using a table of random numbers. The panel was instructed beforehand to listen carefully to the tape and at the conclusion of each segment (marked by a pause in the tape), individually rated the overall severity of the stuttering in that segment. The judges could differentiate among the various speech activities, i.e., unmonitored reading and monologue, and monitored reading and monologue, but they could not differentiate samples taken early in the procedure from those taken later on the basis of presentation.

Reliability

To establish that the experimenter could reliably count the number of stuttered words in the running speech of stutterers, the following procedure was devised. The experimenter listened to ten recordings of the subjects reading 300-word passages. The number of stuttered words was determined for each recording. Within forty-eight hours, the experimenter again listened to the same tape recordings and counted stuttered words for each recording. A Pearson product-moment correlation coefficient was calculated between the frequencies obtained by the experimenter on the two separate occasions. The two counts of stuttering correlated .96. Experimenter reliability for timing alpha rhythm was established in the same way as reliability for counting stuttered words was determined. The times of alpha rhythm obtained by the experimenter on the two separate occasions correlated .91. It was concluded that the experimenter could count instances of stuttering and time alpha reliably.

Regarding judges' reliability, Young (1969) has shown that observer agreement (level of rating, patterns of errors) remains moderately stable within and over sessions.

Pearson product-moment correlation coefficients were calculated to determine inter-judge reliability. The mean of these correlation coefficients was .57.

CHAPTER III

RESULTS AND DISCUSSION

During each baserate, conditioning and re-evaluation session, four speech samples were obtained: reading without alpha monitor, monologue without alpha monitor, reading with alpha monitor, and monologue with alpha monitor. The following measures were obtained from the tape recordings of the sessions: number of stuttered words in each 300-word speech sample, ratings of severity by three judges (from which a mean severity rating was derived for each speech sample), duration of alpha rhythm for each monitored speech sample, and the total elapsed time for 300 words in each monitored speech sample.

Means were computed for number of stuttered words and mean severity ratings for each speech activity throughout the procedure for each subject. These means are found in Tables 1-4. Number of stuttered words and mean severity ratings for each speech activity for each subject are graphically illustrated in Figures 1-16.

The mean number of stuttered words steadily decreased in all speech activities for Subject I (Table 1, Figures 1-4). The greatest absolute decrease was noted in the unmonitored monologue speech activity, where the difference between baserate and re-evaluation measures was 29.6 stuttered words. This was the speech activity which most closely resembles conversational speech.

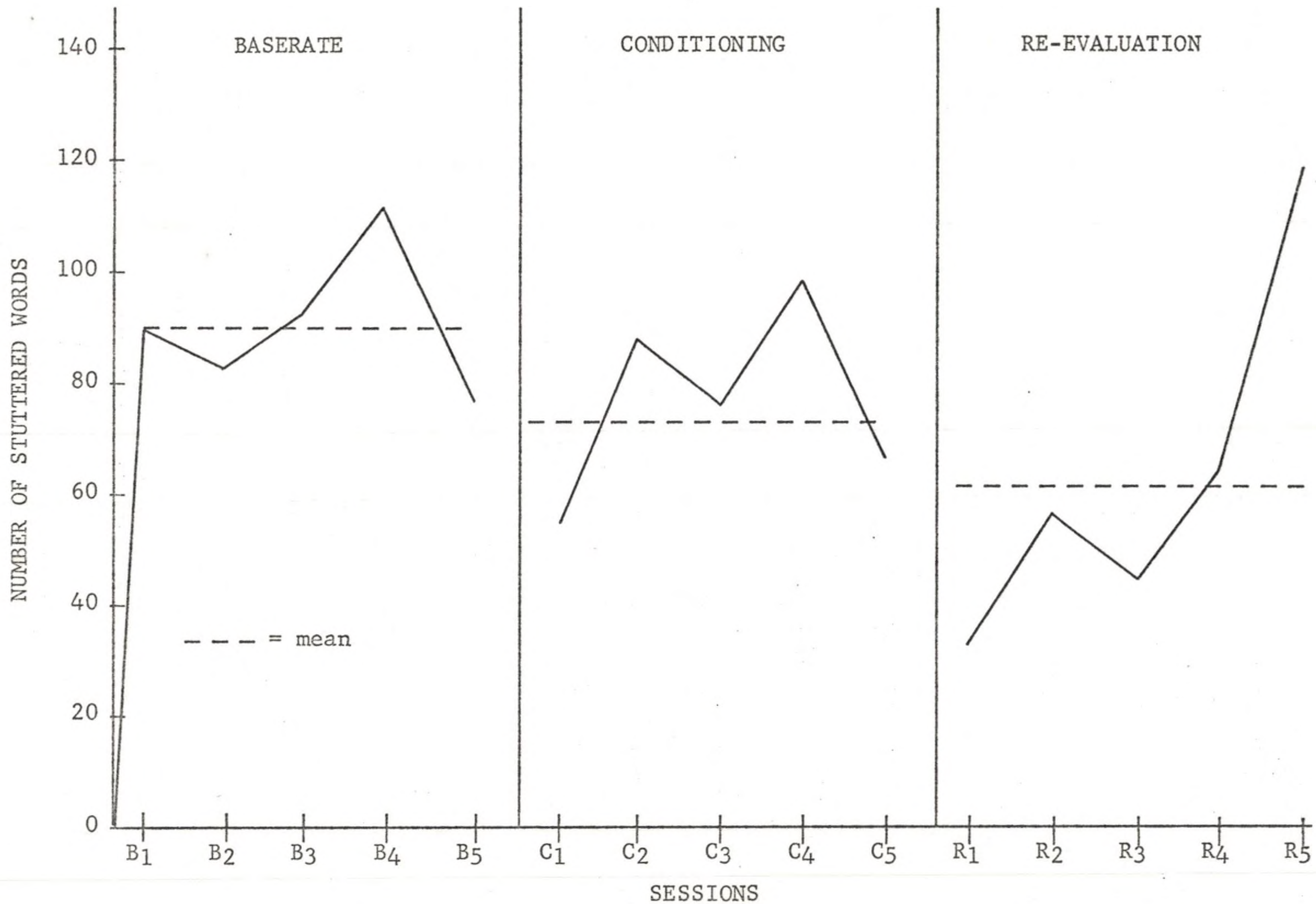

Fig. 1.--Number of stuttered words in 300-word reading samples without alpha monitor for all sessions for subject I.

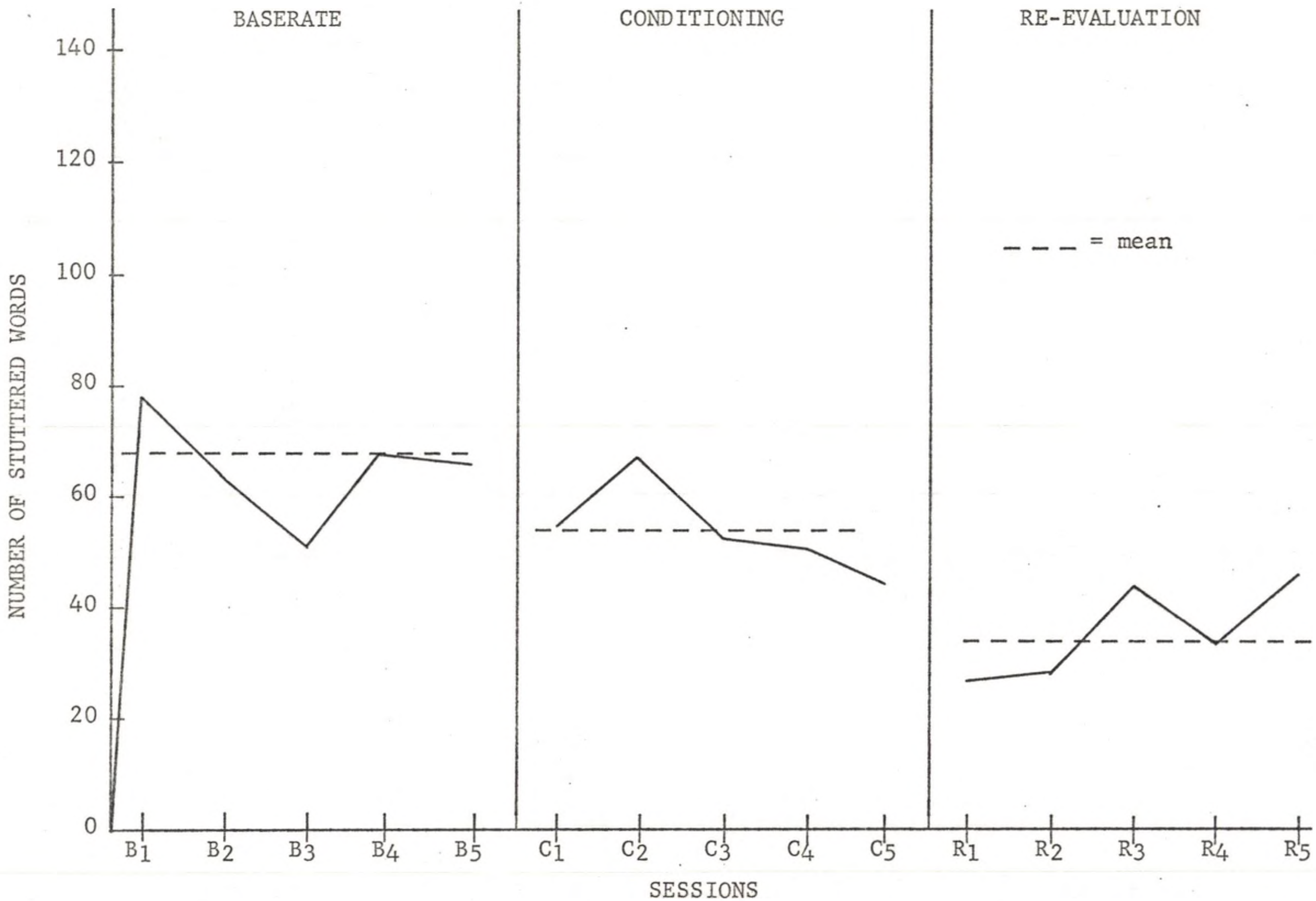

Fig. 2.--Number of stuttered words in 300-word monologues without alpha monitor for all sessions for subject I.

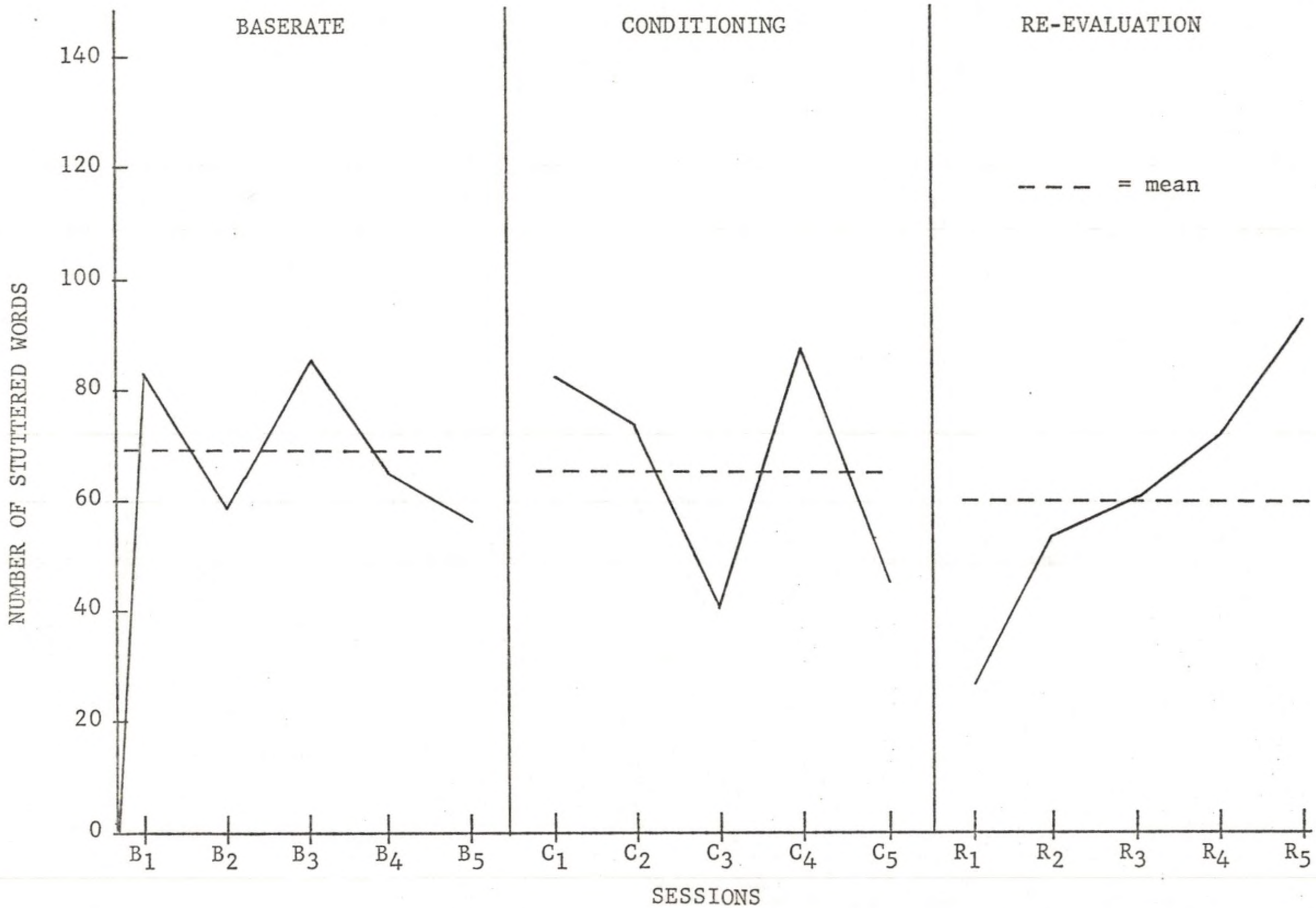

Fig. 3.--Number of stuttered words in 300-word reading samples with alpha monitor for all sessions for subject I.

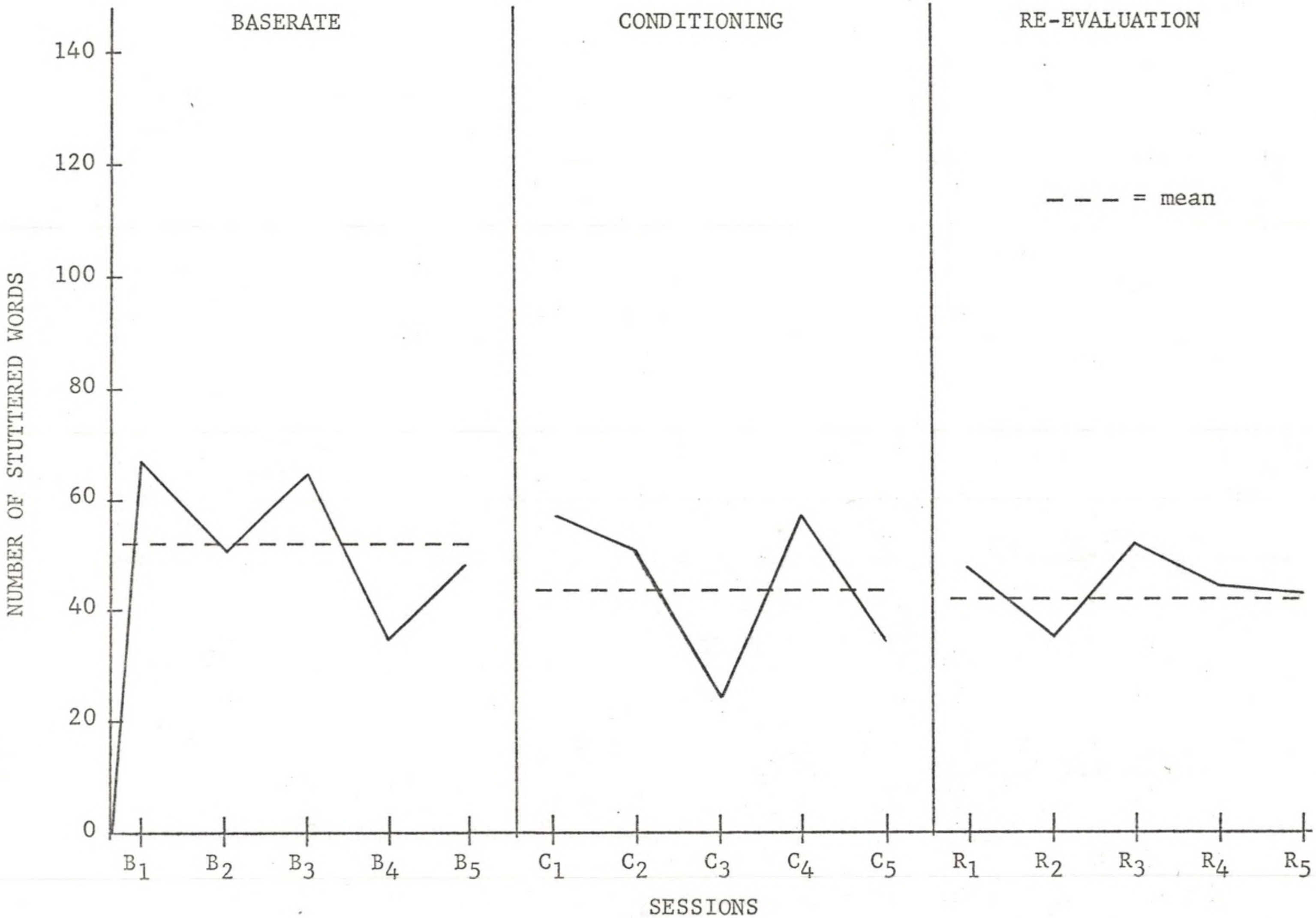

Fig. 4.--Number of stuttered words in 300-word monologues with alpha monitor for all sessions for subject I.

TABLE 1

MEAN NUMBER OF STUTTERED WORDS PER 300-WORD SPEECH SAMPLES FOR SUBJECT I

Speech Activity	Baserate	Conditioning	Re-evaluation
Unmonitored Reading	91.0	76.4	61.8
Unmonitored Monologue	64.8	53.4	35.2
Monitored Reading	69.4	65.2	60.2
Monitored Monologue	52.6	43.8	43.0

Table 2 (Figures 5-8) shows the mean number of stuttered words for Subject II. All speech activities, except for unmonitored monologue, yielded a net increase in number of stuttered words, with the most pronounced increase in the reading activities. The decrease in number of stuttered words in unmonitored monologue was similar to, but not as great as the decrease reported for Subject I.

TABLE 2

MEAN NUMBER OF STUTTERED WORDS PER 300-WORD SPEECH SAMPLES FOR SUBJECT II

Speech Activity	Baserate	Conditioning	Re-evaluation
Unmonitored Reading	33.2	34.1	50.6
Unmonitored Monologue	23.0	27.2	19.0
Monitored Reading	34.0	40.3	61.6
Monitored Monologue	25.2	33.6	29.8

The means of mean severity ratings for Subject I are found in Table 3 (Figures 9-12). All speech activities, except monitored reading, reflected a net decrease in perceived severity of stuttering.

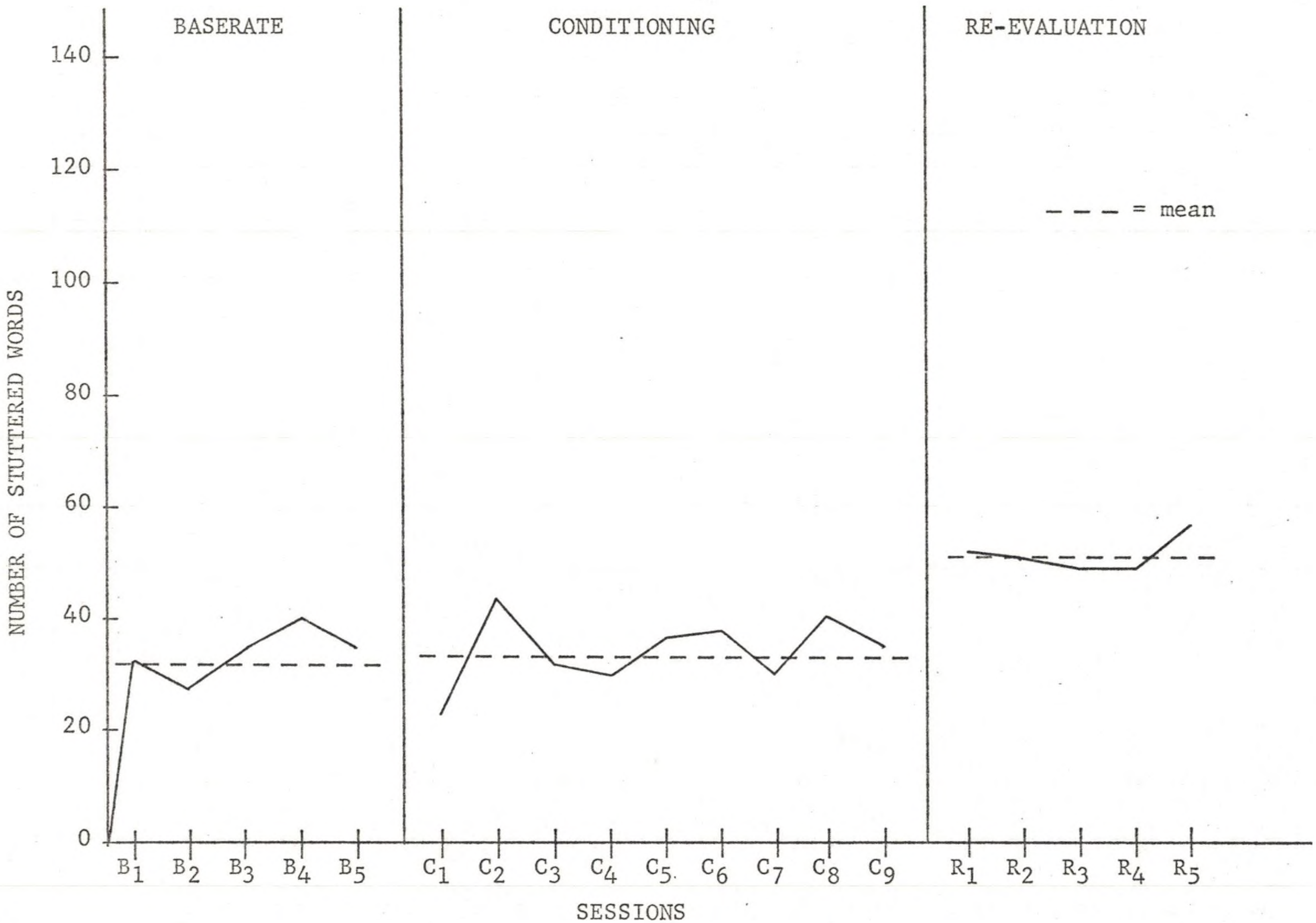

Fig. 5.--Number of stuttered words in 300-word reading samples without alpha monitor for all session for subject II.

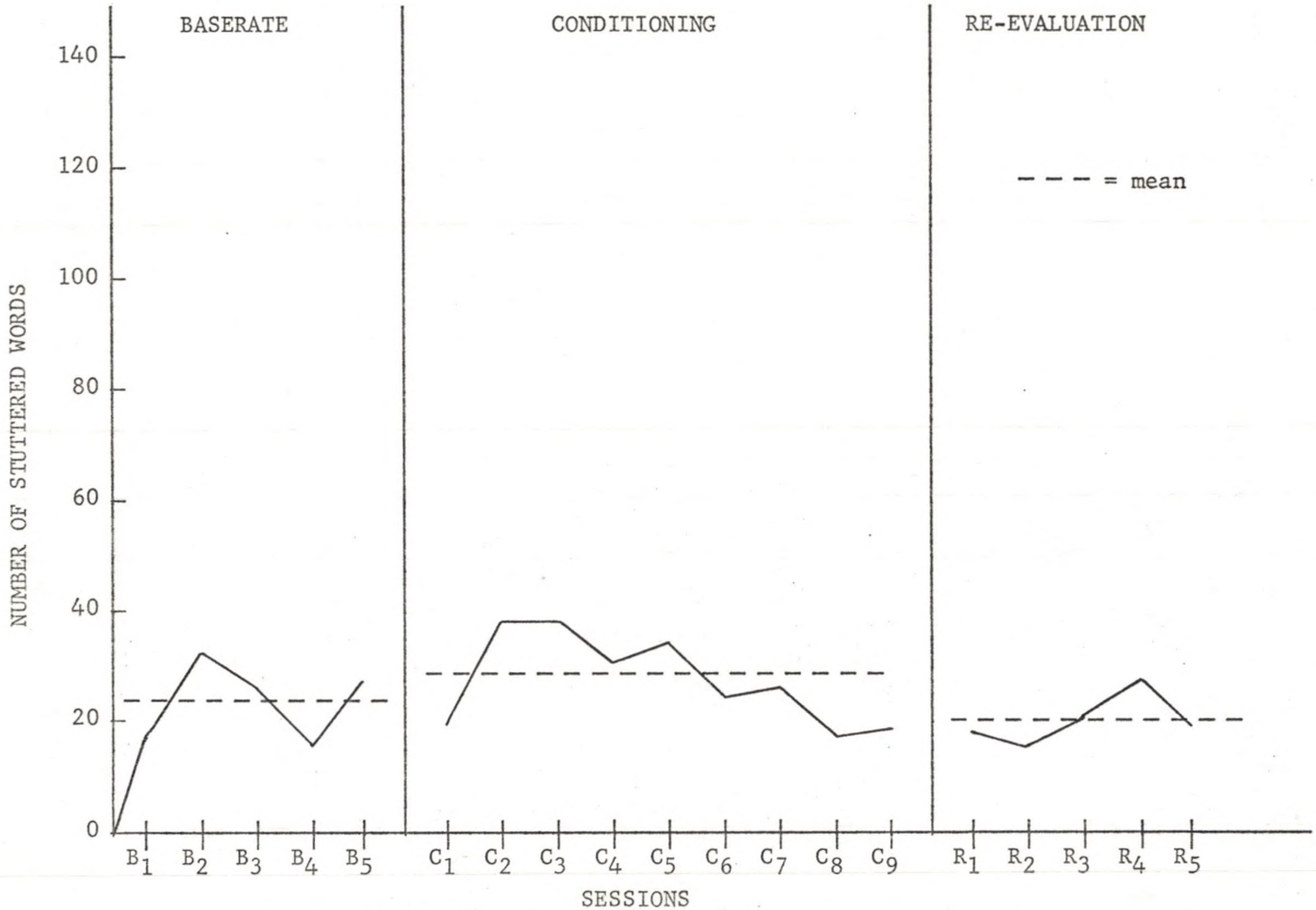

Fig. 6.--Number of stuttered words in 300-word monologues without alpha monitor for all sessions for subject II.

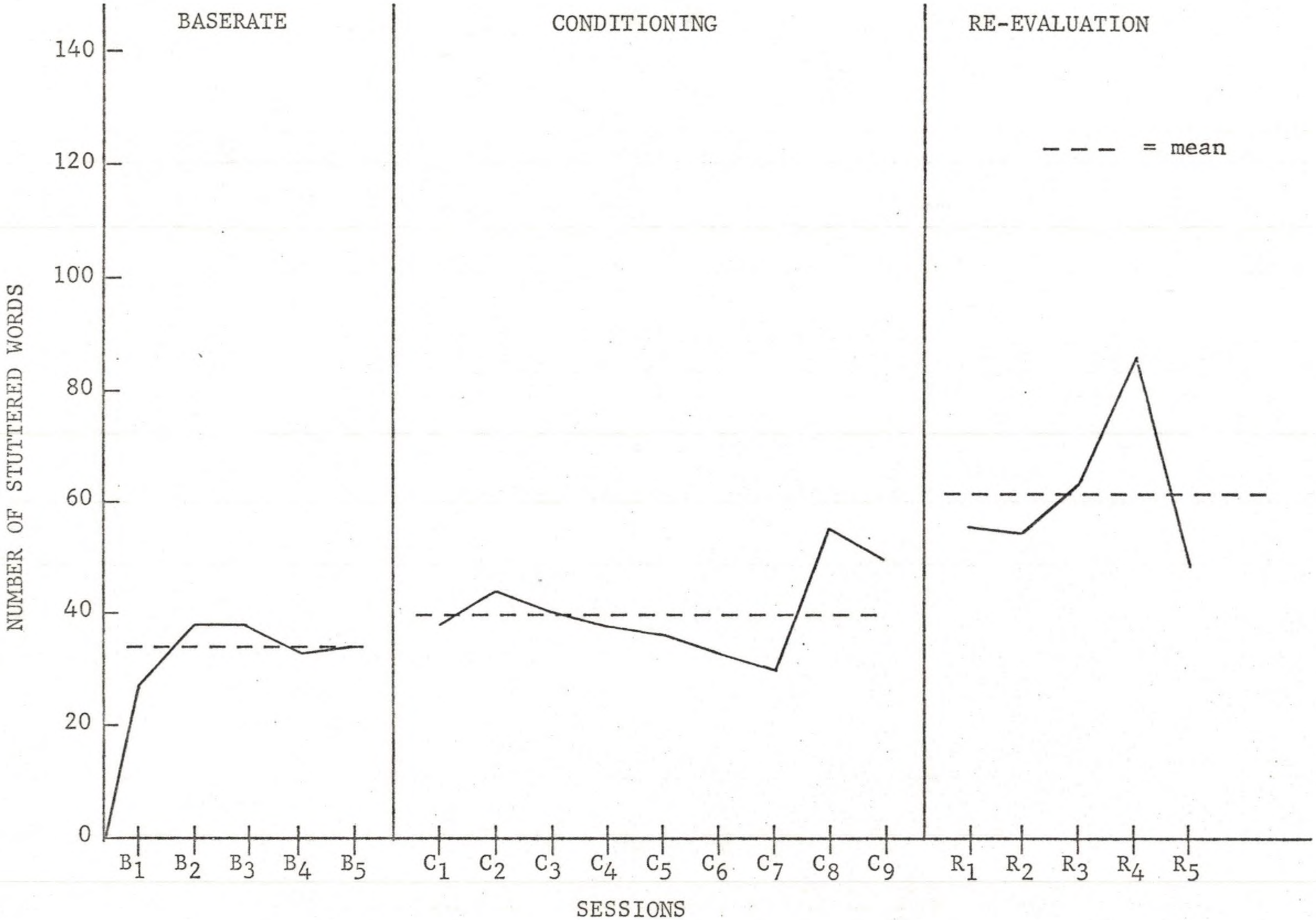

Fig. 7.--Number of stuttered words in 300-word reading samples with alpha monitor for all sessions for subject II.

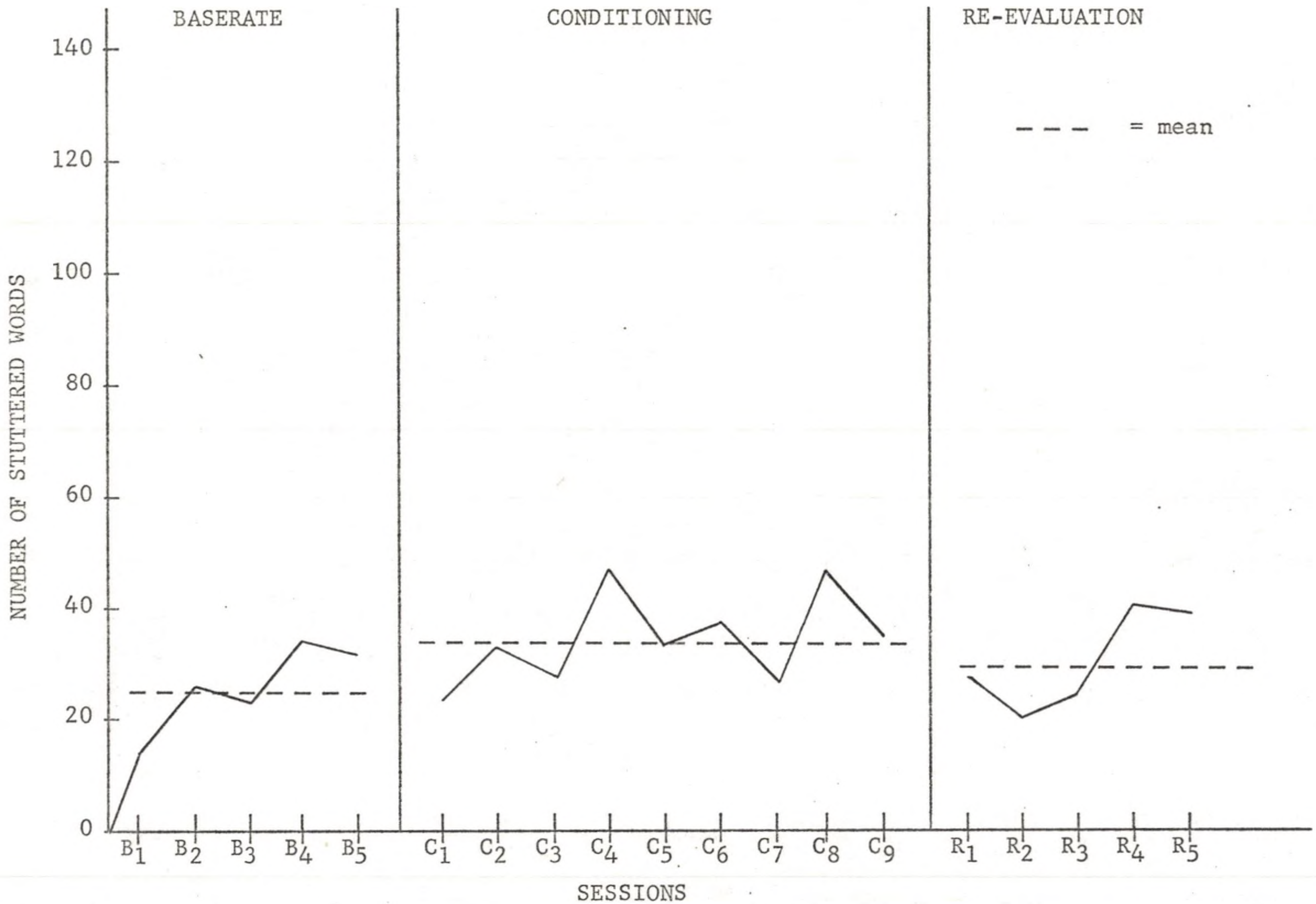

Fig. 8.--Number of stuttered words in 300-word monologues with alpha monitor for all sessions for Subject II.

The largest decrease in severity was found in the unmonitored monologue speech activity.

TABLE 3

MEAN OF MEAN SEVERITY RATINGS OF STUTTERING FOR 300-WORD SPEECH SAMPLES FOR SUBJECT I

Speech Activity	Baserate	Conditioning	Re-evaluation
Unmonitored Reading	6.0	6.2	5.2
Unmonitored Monologue	6.4	4.0	3.6
Monitored Reading	5.6	4.8	5.6
Monitored Monologue	4.6	4.2	3.8

Table 4 (Figures 13-16) contains the means of mean severity ratings for Subject II. Two speech activities showed a net increase in perceived severity: unmonitored reading and monitored reading. Both monologues, however, showed a net decrease in severity, the larger decrease was noted in the unmonitored monologue speech activity.

TABLE 4

MEAN OF MEAN SEVERITY RATINGS OF STUTTERING FOR 300-WORD SPEECH SAMPLES FOR SUBJECT II

Speech Activity	Baserate	Conditioning	Re-evaluation
Unmonitored Reading	7.4	6.9	7.6
Unmonitored Monologue	5.8	5.2	4.8
Monitored Reading	7.0	7.5	7.6
Monitored Monologue	6.4	7.1	6.0

Related <u>t</u>-tests were applied to the baserate and re-evaluation measures of number of stuttered words and mean severity ratings for

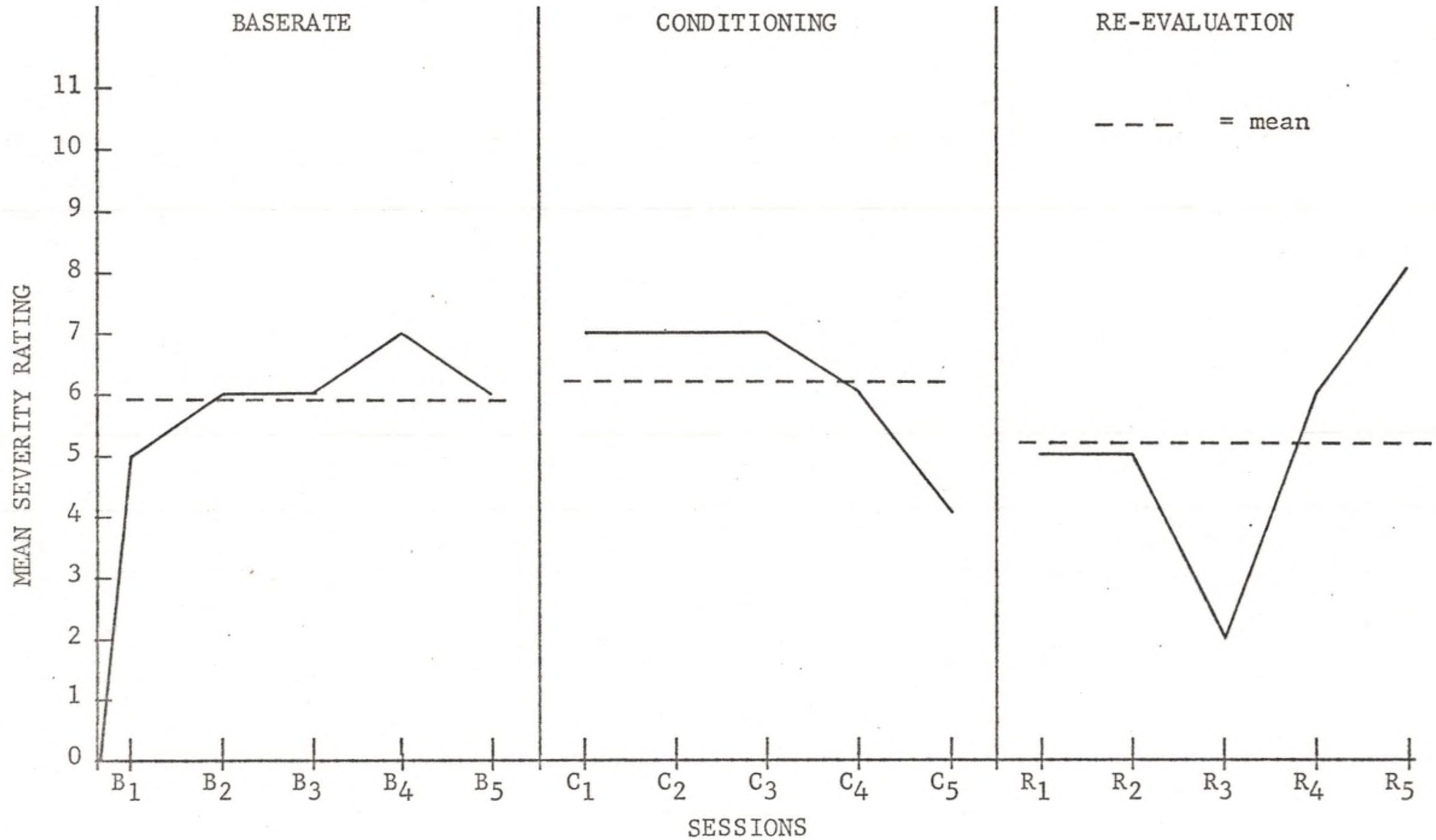

Fig. 9.--Mean severity ratings for 300-word reading samples without alpha monitor for all sessions for subject I.

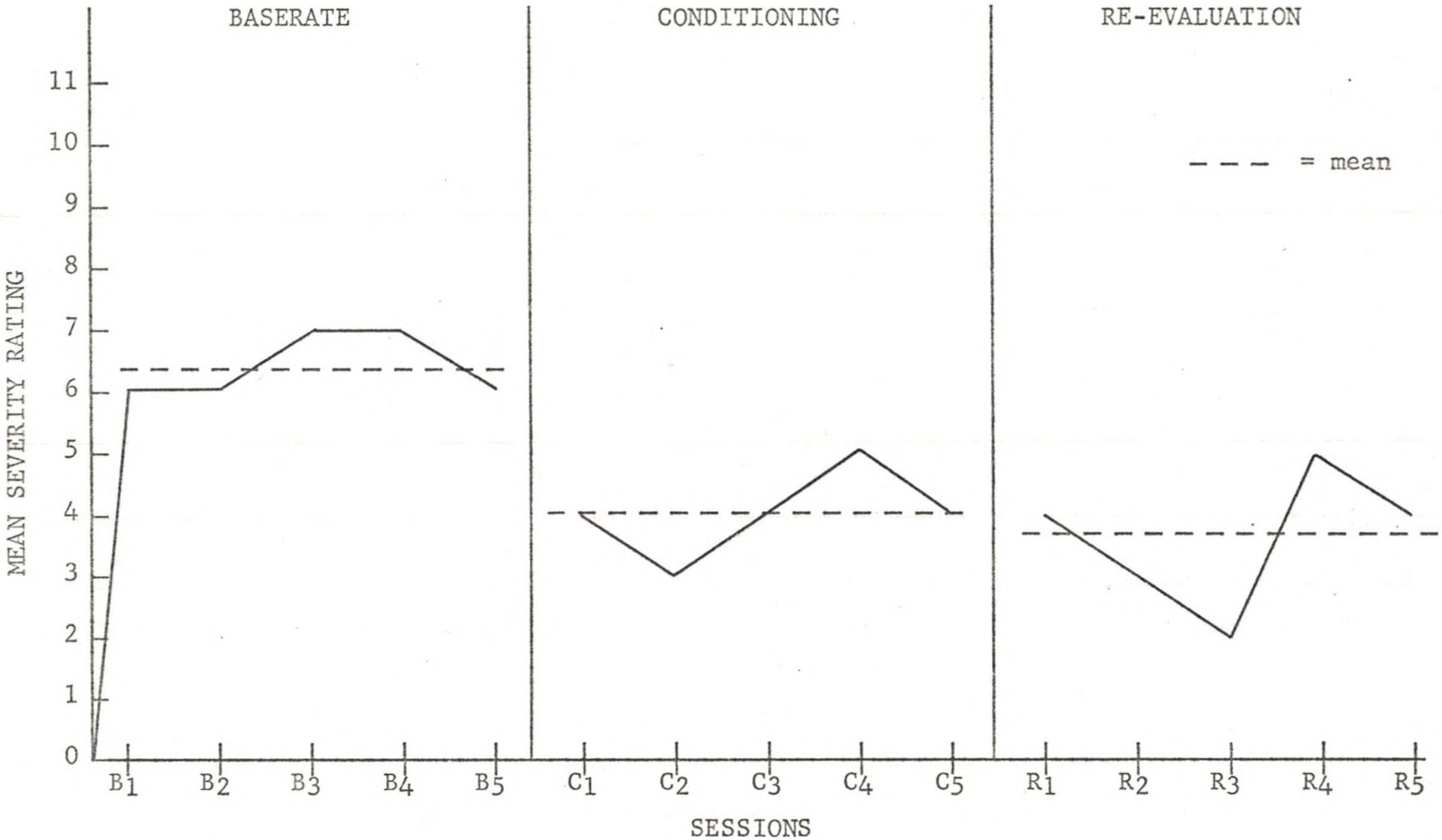

Fig. 10.--Mean severity ratings for 300-word monologues without alpha monitor for all sessions for subject I.

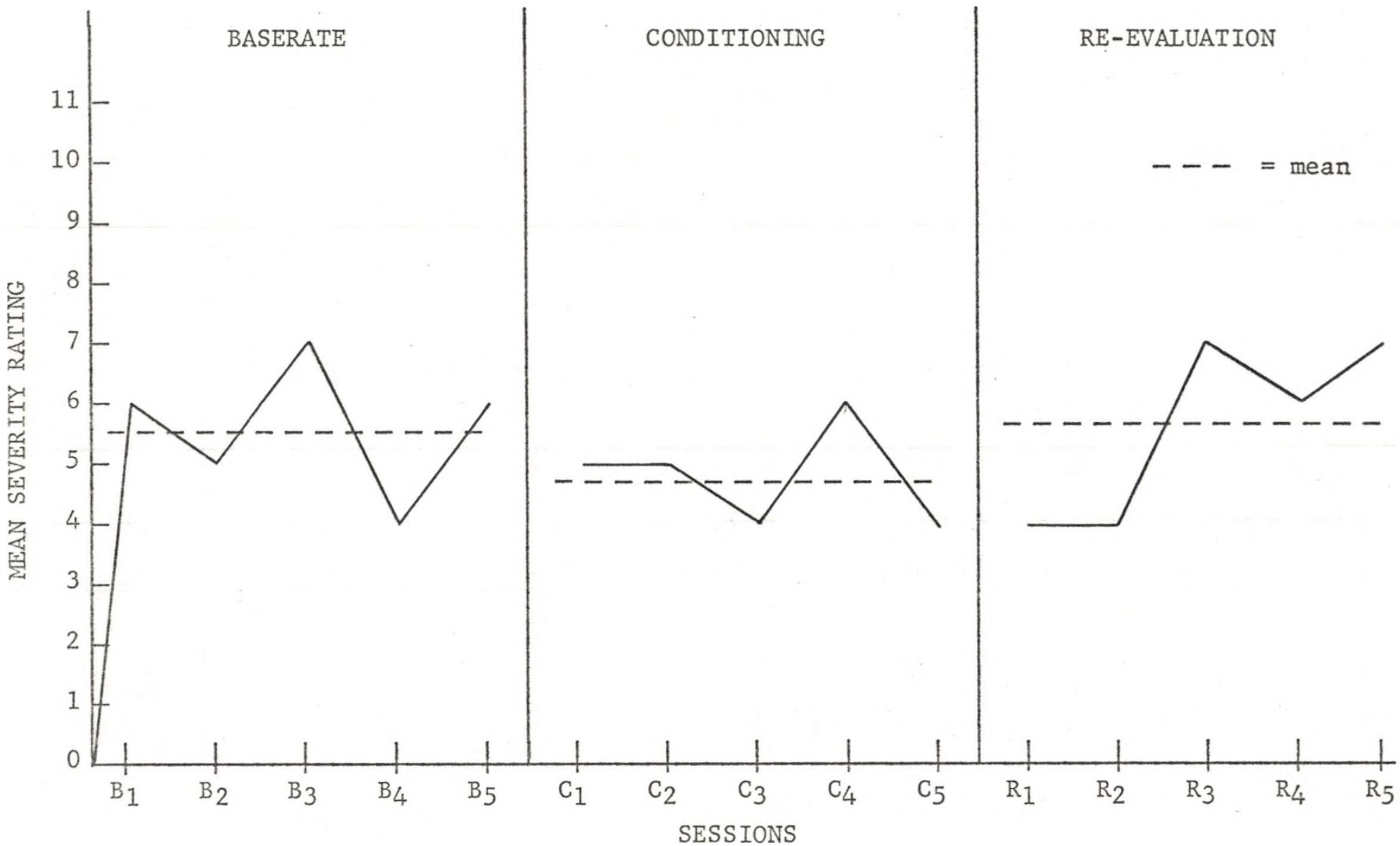

Fig. 11.--Mean severity ratings for 300-word reading samples with alpha monitor for all sessions for subject I.

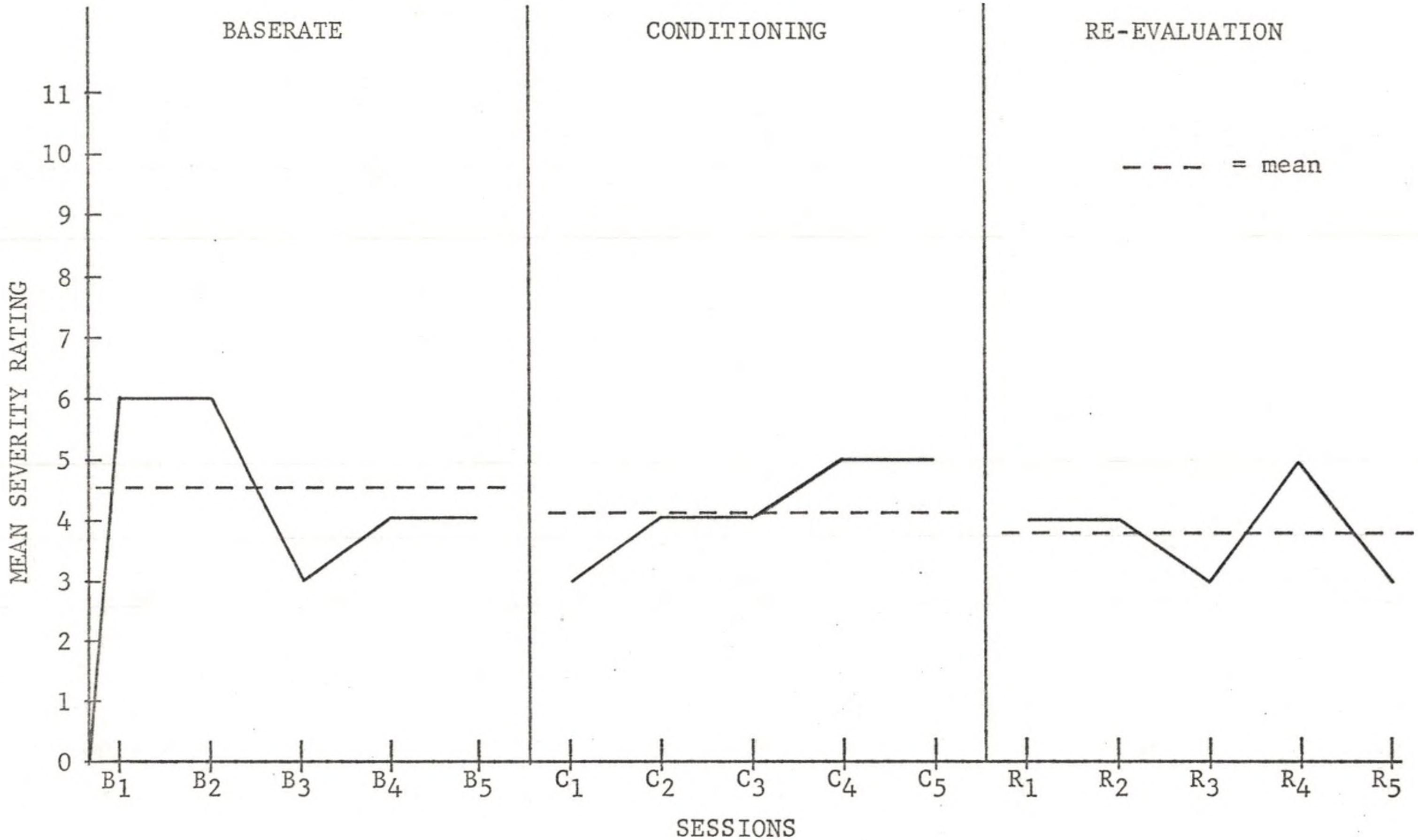

Fig. 12.--Mean severity ratings for 300-word monologues with alpha monitor for all sessions for subject I.

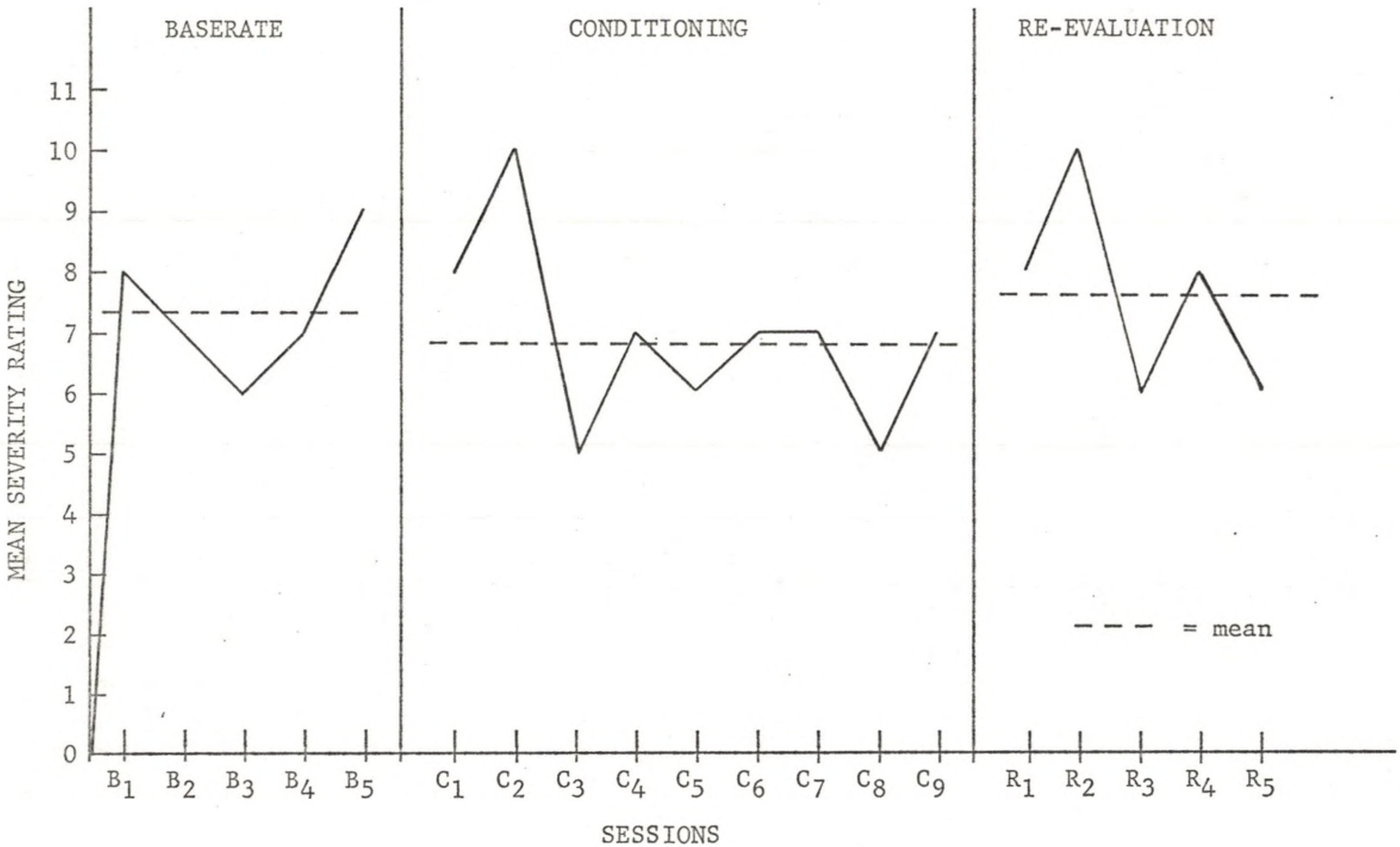

Fig. 13.--Mean severity ratings for 300-word reading samples without alpha monitor for all sessions for subject II.

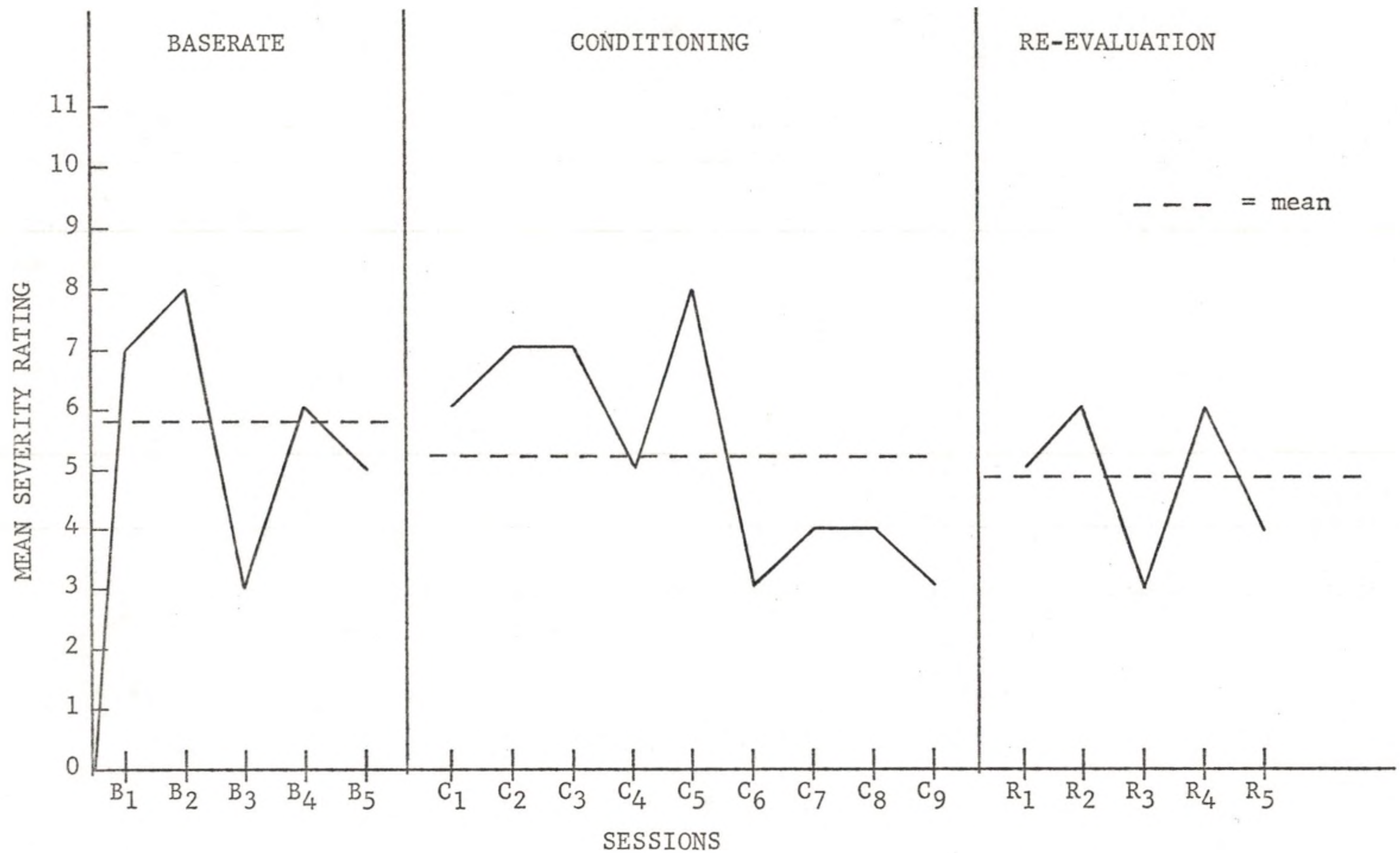

Fig. 14.--Mean severity ratings for 300-word monologues without alpha monitor for all sessions for subject II.

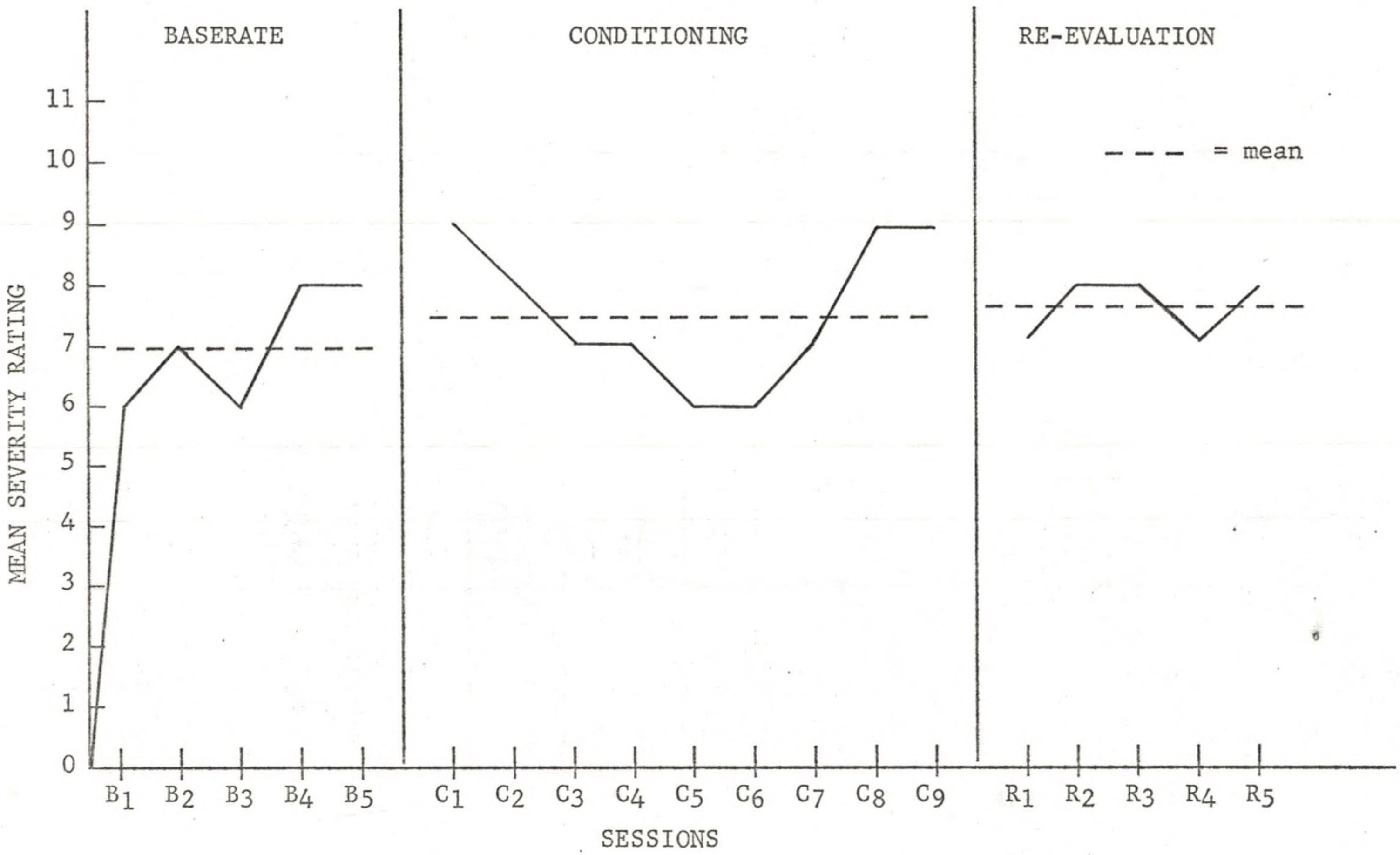

Fig. 15.--Mean severity ratings for 300-word reading samples with alpha monitor for all sessions for subject II.

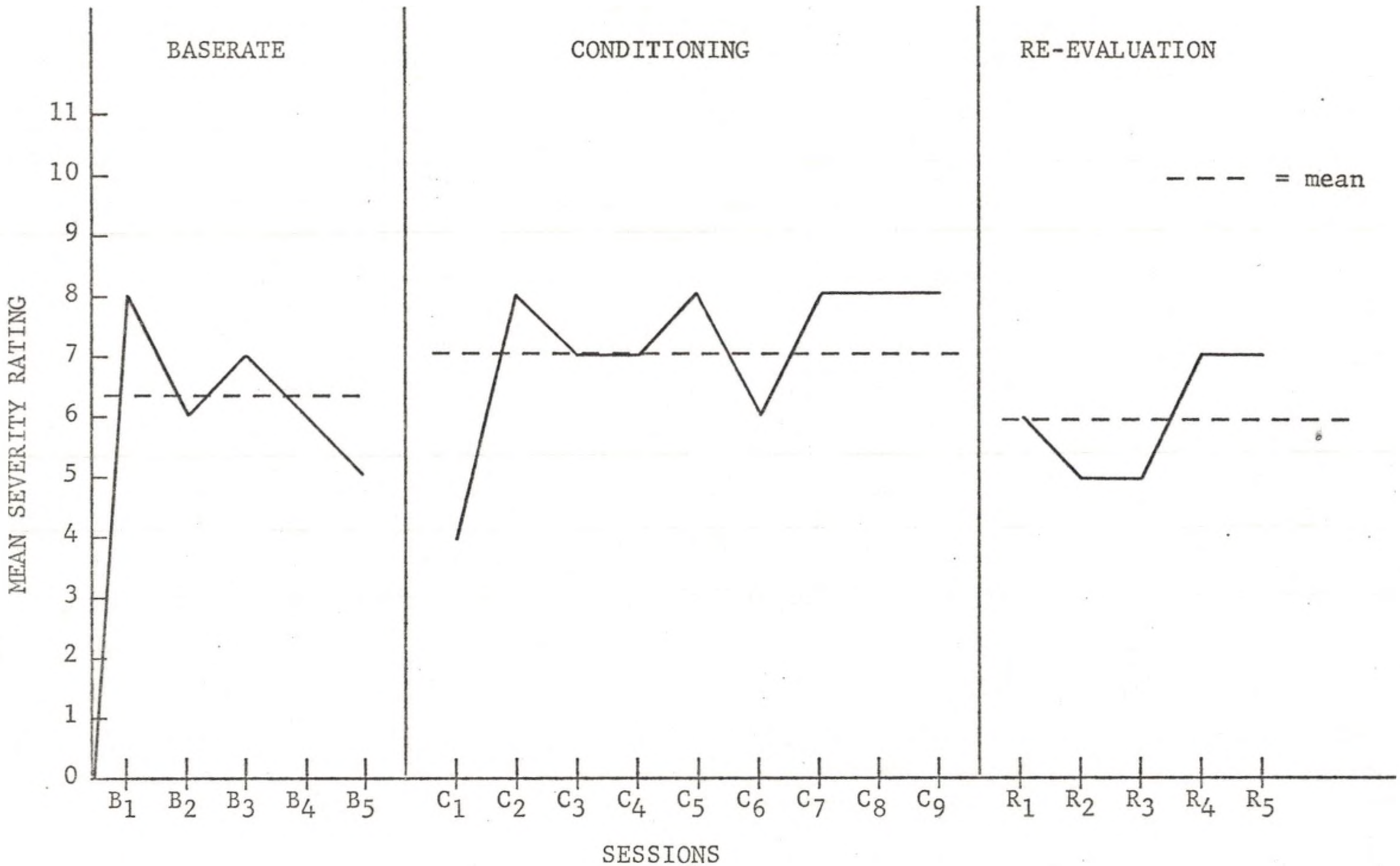

Fig. 16.--Mean severity rating for 300-word monologues with alpha monitor for all sessions for subject II.

each speech activity for each subject. To make statistical comparisons of number of stuttered words between baserate and re-evaluation for Subjects I and II, see Tables 5 and 6, respectively. To make comparisons of mean severity ratings of stuttering for Subjects I and II, see Tables 7 and 8, respectively.

In Table 5 (Figures 1-4) the number of stuttered words in each speech activity in baserate is compared with re-evaluation for Subject I. Only the unmonitored monologue speech activity showed a statistically significant decrease between baserate and re-evaluation measures of number of stuttered words (t = 3.713, significant at the .05 level). The other speech activities did not show statistically significant differences although the means showed a net decrease in each activity (Table 1).

TABLE 5

STATISTICAL COMPARISONS OF NUMBER OF STUTTERED WORDS IN BASERATE AND RE-EVALUATION FOR SUBJECT I

Speech Activity	Mean Baserate	Mean Re-evaluation	df	t Value
Unmonitored Reading	91.0	61.8	4	1.577[a]
Unmonitored Monologue	64.8	35.2	4	3.713[b]
Monitored Reading	69.4	60.2	4	.593[a]
Monitored Monologue	52.6	43.0	4	1.739[a]

[a]No significant difference at the .05 level
[b]Significant difference at the .05 level

The comparisons of number of stuttered words in baserate and re-evaluation for Subject II appear in Table 6 (Figures 5-8). There were significant increases in the number of stuttered words in unmonitored reading ($\underline{t}$ = -6.371, significant at the .01 level) and in monitored reading ($\underline{t}$ = -3.965, significant at the .05 level). Although there was an increase in number of stuttered words in the monitored monologue, the difference was not statistically significant at the .05 level ($\underline{t}$ = 1.443). These differences were opposite from the expected direction. In the unmonitored monologue, the activity most like conversation, there was a decrease in stuttered words, but the difference was not statistically significant ($\underline{t}$ = .085).

TABLE 6

STATISTICAL COMPARISONS OF NUMBER OF STUTTERED WORDS IN BASERATE AND RE-EVALUATION FOR SUBJECT II

Speech Activity	Mean Baserate	Mean Re-evaluation	df	$\underline{t}$ Value
Unmonitored Reading	33.2	50.6	4	-6.371[c]
Unmonitored Monologue	23.0	19.0	4	.805[a]
Monitored Reading	34.0	61.6	4	-3.965[b]
Monitored Monologue	25.2	29.8	4	-1.443[a]

[a]No significant difference at the .05 level
[b]Significant difference at the .05 level
[c]Significant difference at the .01 level

In Table 7 (Figures 9-12), mean severity ratings in baserate and re-evaluation speech activities are compared for Subject I. Only in unmonitored monologue was there a significant decrease in perceived severity of stuttering between baserate and re-evaluation ($\underline{t}$ = 4.802, significant at the .01 level). In the other speech activities, there were decreases in severity, but none were statistically significant.

TABLE 7

STATISTICAL COMPARISONS OF MEAN SEVERITY RATINGS IN BASERATE AND RE-EVALUATION FOR SUBJECT I

Speech Activity	Mean Baserate	Mean Re-evaluation	df	*t* Value
Unmonitored Reading	6.0	5.2	4	.825[a]
Unmonitored Monologue	6.4	3.6	4	4.802[b]
Monitored Reading	5.6	5.6	4	.232[a]
Monitored Monologue	4.6	3.8	4	1.372[a]

[a]No significant difference at the .05 level
[b]Significant difference at the .01 level

The mean severity ratings in baserate and re-evaluation for Subject II are compared in Table 8 (Figures 13-16). There were no statistically significant differences in any speech activity; however, the unmonitored monologue activity yielded the highest *t* value, 2.236.

TABLE 8

STATISTICAL COMPARISONS OF MEAN SEVERITY RATINGS IN BASERATE AND RE-EVALUATION FOR SUBJECT II

Speech Activity	Mean Baserate	Mean Re-evaluation	df	*t* Value
Unmonitored Reading	7.4	7.6	4	.206[a]
Unmonitored Monologue	5.8	4.8	4	2.236[a]
Monitored Reading	7.0	7.6	4	-.784[a]
Monitored Monologue	6.4	6.0	4	.688[a]

[a]No significant difference at the .05 level

The *t* values which showed statistically significant differences were: number of stuttered words for unmonitored monologue in baserate and re-evaluation for Subject I (t = 3.713, significant at the .05 level); number of stuttered words for unmonitored reading in baserate and re-evaluation for Subject II (t = 6.371, significant at the .01 level, opposite from expected direction); number of stuttered words for monitored reading in baserate and re-evaluation for Subject II (t = -3.965, significant at the .05 level, opposite from expected direction); mean severity rating for unmonitored monologue in baserate and re-evaluation for Subject I (t = 4.802, significant at the .01 level).

The results for Subject I show that, as a consequence of this procedure, number of stuttered words and mean severity rating decreased significantly in the unmonitored monologue speech activity, the speech behavior which most closely resembles conversational speech. The differences in the other speech activities unmonitored reading, monitored reading, and monitored monologue, were not statistically significant.

Subject II exhibited a significant increase in number of stuttered words in unmonitored and monitored reading at the end of this procedure. It is of interest to note, however, that in unmonitored monologues for Subject II, there is a net decrease in the mean number of stuttered words (Table 2) and in mean severity ratings of stuttering (Table 4). As previously stated, this speech activity closely parallels conversational speech in that the speaker is simply speaking without the alpha monitor providing feedback of brain activity.

Some changes in stuttering not well-represented by number of stuttered words or by severity ratings were noted by the experimenter.

At the beginning of the experimental procedure, the stuttering exhibited by Subject I was marked mainly by phonemic prolongations and secondary mannerisms involving the eyes, hands and feet. The stuttering exhibited by Subject II was characterized by fixed articulatory postures, clonic gasps, throwing back the head and blinking the eyes, with few gross secondary mannerisms. As the procedure progressed, Subject I exhibited less tense prolongations of shorter duration than before conditioning, and gestures were less pronounced. Subject II displayed less pronounced head movements and eye blinking, but no perceivable change in the fixed articulatory postures or gasping.

Because each subject proceeded through the conditioning sequence at different rates, the actual number of conditioning sessions is not the same for each subject.

Multiple correlations and analyses of variance were computed on the data obtained from the monitored reading and monologue speech samples for each subject. The following variables were used in these computations: number of stuttered words for each monitored sample, mean severity rating for each monitored sample, duration of alpha rhythm for each monitored sample, total elapsed time for 300-word sample, session number, and control of alpha rhythm (whether or not the subject had met the final conditioning criterion).

In the monitored reading speech activity for Subject I, there was a significant relationship (Table 11) between number of stuttered words and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample (Figure 17), mean severity rating of stuttering in reading sample, and control of alpha rhythm (R = .818; R^2 = .66901; F = 3.63818, significant at the .05 level). Individual correlation coefficients are found in Table 9 (for interpretation of correlation coefficients, see Appendix C).

In the monitored reading speech activity for Subject II, there was a significant relationship (Table 12) between number of stuttered words and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample (Figure 18), mean severity rating of stuttering in reading sample, and control of alpha rhythm (R = .933; R^2 = .87123; F = 17.59048, significant at the .001 level). Individual correlation coefficients are found in Table 10.

In the monitored reading speech activity for Subject I, there was no significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample, number of stuttered words, and control of alpha rhythm (R = .777; R^2 = .60430; F = 2.74895, not significant at the .05 level). Individual correlation coefficients are found in Table 9.

In the monitored reading speech activity for Subject II, there was no significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of reading sample, duration of alpha rhythm for reading sample, number of stuttered words, and control of alpha rhythm (R = .541; R^2 = .29235; F = 1.07415, not significant at the .05 level). Individual correlation coefficients are found in Table 10.

TABLE 9

CORRELATION COEFFICIENT MATRIX FOR SUBJECT I

	1	2	3	4	5	6	7	8	9	10
1		.070	.838[c]	.037	-.155	-.051	.833[c]	-.346	-.438	.818[c]
2			.106	.377	.450					.206
3				.110	-.054					.682[a]
4					.754[b]					.076
5										.179
6							-.329	.138	.434	-.226
7								-.245	-.312	.867[c]
8									.090	-.289
9										-.207
10										

[a]Significant at the .05 level
[b]Significant at the .02 level
[c]Significant at the .01 level

Notes:

The ten variables in the above matrix are identified as follows:

1 = session number
2 = total time for reading sample
3 = duration of alpha rhythm for reading
4 = mean severity rating of reading
5 = number of stuttered words in reading
6 = total time for monologue
7 = duration of alpha rhythm for monologue
8 = mean severity rating of monologue
9 = number of stuttered words in monologue
10 = control of alpha rhythm

TABLE 10

CORRELATION COEFFICIENT MATRIX FOR SUBJECT II

	1	2	3	4	5	6	7	8	9	10
1		.696[a]	.687[a]	.203	.724[b]	.656[a]	.791[c]	-.055	.373	.763[b]
2			.563	.020	.884[c]					.729[b]
3				.245	.662[a]					.651[a]
4					.253					.076
5										.755[b]
6							.424	.129	.592	.382
7								-.051	.158	.807[c]
8									.296	-.337
9										.043
10										

[a]Significant at the .05 level
[b]Significant at the .02 level
[c]Significant at the .01 level

Note:

The ten variables in the above matrix are identified as follows:

1 = session number
2 = total time for reading sample
3 = duration of alpha rhythm for reading
4 = mean severity rating of reading
5 = number of stuttered words in reading
6 = total time for monologue
7 = duration of alpha rhythm for monologue
8 = mean severity rating of monologue
9 = number of stuttered words in monologue
10 = control of alpha rhythm

TABLE 11

F-RATIOS FOR MONITORED SPEECH ACTIVITIES
FOR SUBJECT I

Speech Activity--Dependent Variable	F Value
Monitored Reading--Number of Stuttered Words	3.63818[b]
Monitored Reading--Severity Rating	2.74895[a]
Monitored Monologue--Number of Stuttered Words	2.61767[a]
Monitored Monologue--Severity Rating	.50908[a]

[a]Not statistically significant at the .05 level
[b]Statistically significant at the .05 level

TABLE 12

F-RATIOS FOR MONITORED SPEECH ACTIVITIES
FOR SUBJECT II

Speech Activity--Dependent Variable	F Value
Monitored Reading--Number of Stuttered Words	17.59048[b]
Monitored Reading--Severity Rating	1.07415[a]
Monitored Monologue--Number of Stuttered Words	2.85426[a]
Monitored Monologue--Severity Rating	1.10074[a]

[a]Not statistically significant at the .05 level
[b]Statistically significant at the .001 level

In the monitored monologue speech activity for Subject I, there was no significant relationship between the number of stuttered words and the combined effect of session number, total time of monologue, duration of alpha rhythm for monologue (Figure 17), mean severity rating of stuttering for monologue, and control of alpha rhythm ($R = .770$; $R^2 = .59255$; $F = 2.61767$, not significant at the .05 level). Individual correlation coefficients are found in Table 9.

In the monitored monologue speech activity for Subject II, there was no significant relationship between the number of stuttered words and the combined effect of session number, total time of monologue, duration of alpha rhythm for monologue (Figure 18), mean severity rating of stuttering for monologue, and control of alpha rhythm (R = .723; R^2 = .52330; F = 2.85416, not significant at the .05 level). Individual correlation coefficients can be found in Table 10.

In the monitored monologue speech activity for Subject I, there was no significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of monologue, duration of alpha rhythm for monologue, number of stuttered words, and control of alpha rhythm (R = .470; R^2 = .22047; F = .50908, not significant at the .05 level). Individual correlation coefficients can be found in Table 9.

In the monitored monologue speech activity for Subject II, there was no significant relationship between the mean severity rating of stuttering and the combined effect of session number, total time of monologue, duration of alpha rhythm for monologue, number of stuttered words, and control of alpha rhythm (R = .545; R^2 = .29744; F = 1.10074, not significant at the .05 level). Individual correlation coefficients can be found in Table 10.

The F-ratios which reached significance were both in the monitored reading speech activity with the number of stuttered words being the dependent variable in each case (Subject I: F = 3.63818, significant at the .05 level; Subject II: F = 17.59048, significant at the .001 level). The multiple correlation coefficient in each case (Subject I: R = .81793; Subject II: R = .93340) suggests that session number, total time for reading sample, duration of alpha rhythm, mean severity rating of stuttering, and control of alpha rhythm are highly related to number of stuttered words in monitored reading samples. For Subject I, the experimental procedure yielded a significant decrease in number of stuttered words in monitored reading samples as a function of the above-mentioned variables. For Subject II, the procedure resulted in a significant increase in number of stuttered words in monitored reading samples as a function of these variables.

All other F-ratios indicated that the experimental procedure failed to show a significant relationship among the above-stated variables.

Concerning alpha activity during the experimental procedure, it was noted that both subjects had similar graphic profiles in both speech activities (Figures 17 and 18). The relatively depressed alpha graph during reading results from focused visual activity which tends to block the alpha rhythm. The graph for monologue indicates a greater degree of alpha activity for both subjects. An explanation for this phenomenon is that monologue usually involves a lesser degree of visual focus than reading.

It was also noted that both subjects could continue to stutter producing uninterrupted alpha rhythm. Gross secondary mannerisms, e.g., arm or leg movements, jerking of the head and blinking of the eyes, did not accompany these instances of stuttering.

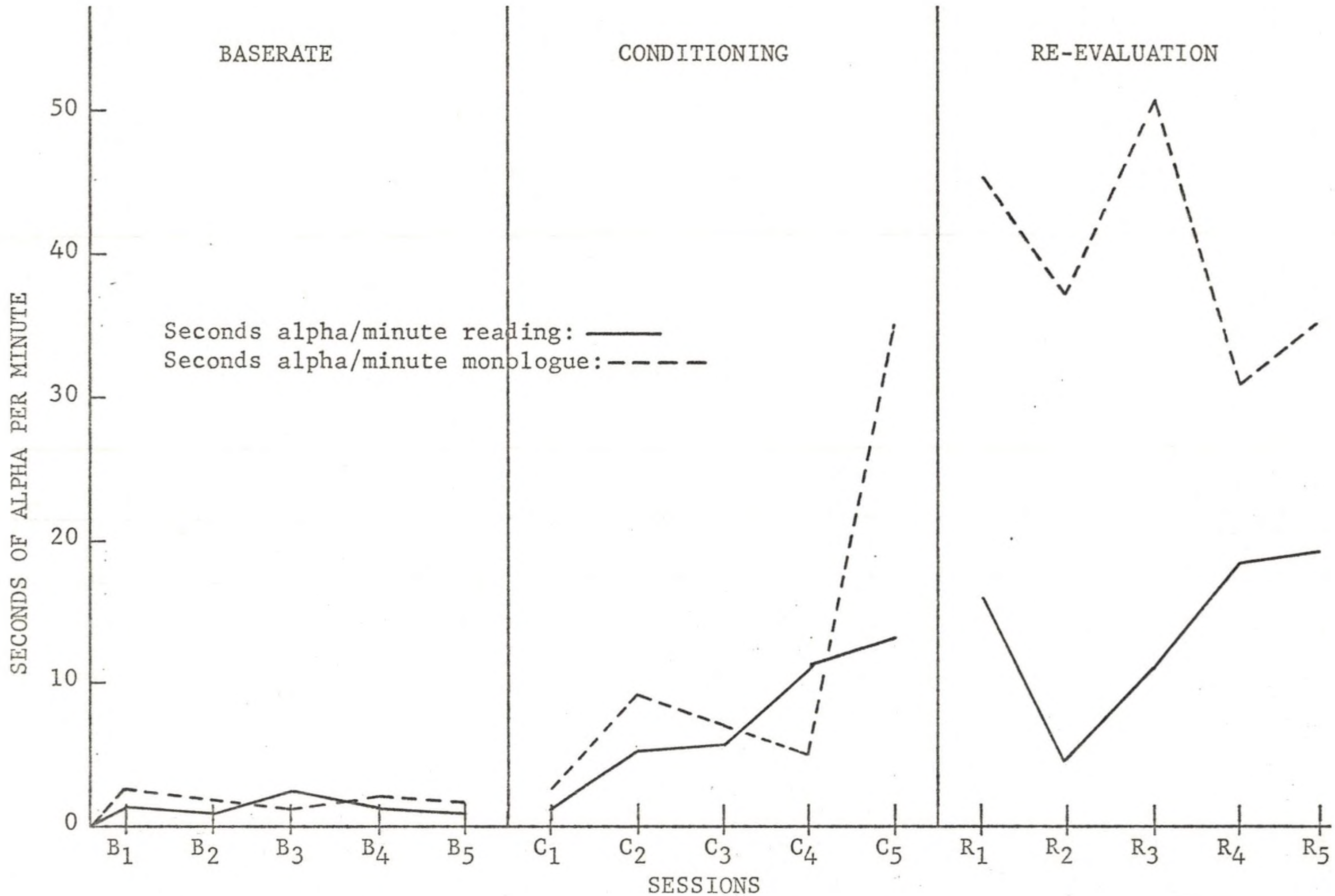

Fig. 17.--Number of seconds of alpha rhythm per minute for reading and monologue with alpha monitor for all sessions for subject I.

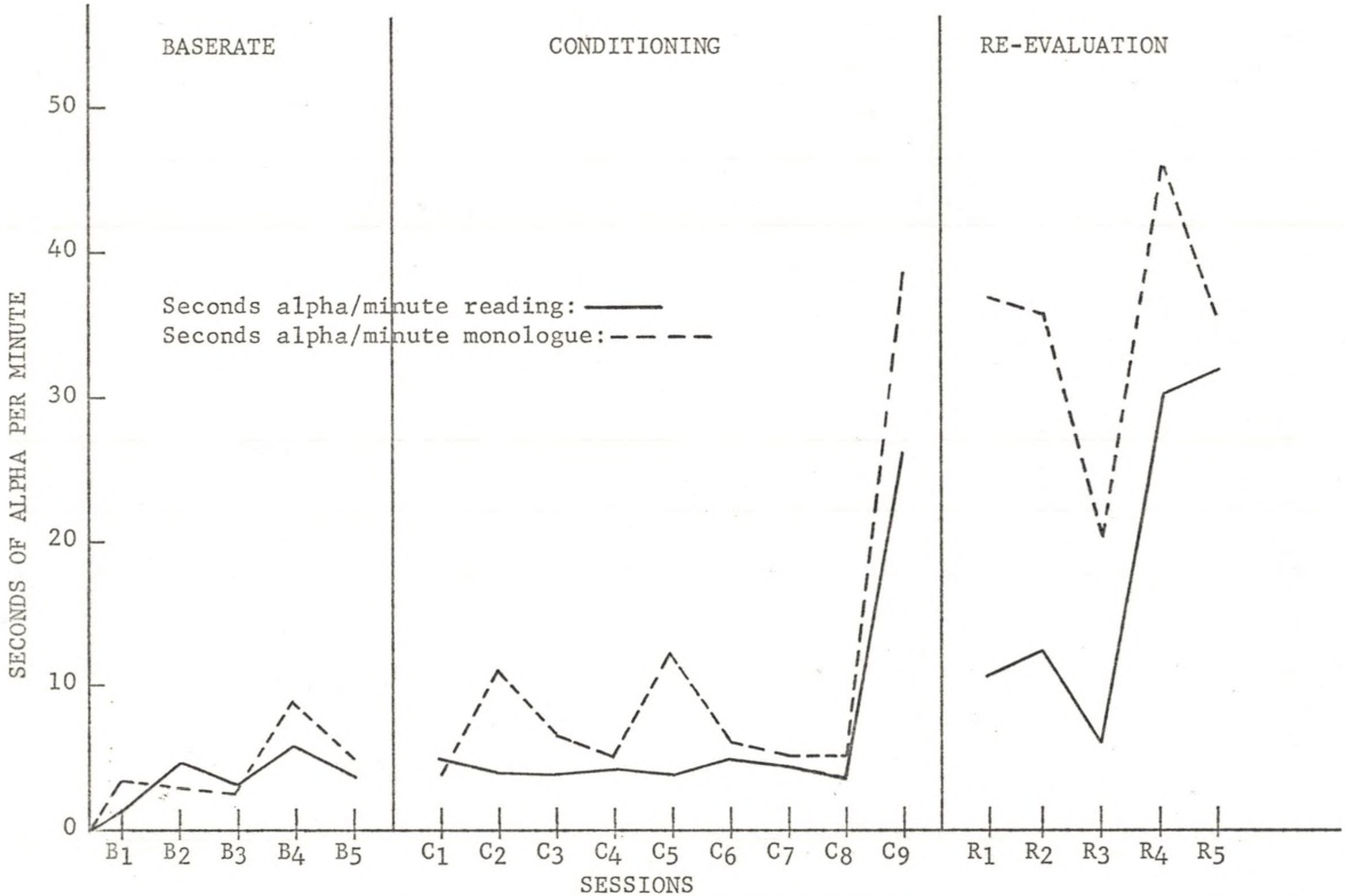

Fig. 18.--Number of seconds of alpha rhythm per minute for reading and monologue with alpha monitor for all sessions for subject II.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Two single-subject studies were carried out in which the effect of alpha brain-wave activity was investigated for four types of speech activity. Two adult male stutterers served as subjects.

Before alpha-wave conditioning began, baserates of stuttering in each speech activity were taken for each subject. After the subjects met all conditioning criteria, re-evaluation measures were taken. The re-evaluation procedure was a duplication of the baserate procedure.

The following results were obtained for Subject I:

1. Alpha-wave conditioning resulted in a significant decrease in the number of stuttered words in unmonitored monologue.
2. Alpha-wave conditioning results in a significant decrease in severity rating in unmonitored monologue.
3. Alpha-wave conditioning failed to produce a significant difference in either number of stuttered words or severity rating for unmonitored reading, monitored reading and monitored monologue when baserate was compared with re-evaluation.
4. Alpha-wave conditioning has shown that a significant relationship exists between the number of stuttered words and the combined effect of session number, total time

for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm for monitored reading samples. This relationship is consistent with early expectations, i.e., stuttering decreased as a function of the other variables.

5. Alpha-wave conditioning failed to show that a significant relationship exists between the number of stuttered words and the combined effect of session number, total time for monologue, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm for monitored monologue samples.
6. Alpha-wave conditioning failed to show that a significant relationship exists between the severity rating of stuttering and the combined effect of session number, total time of reading sample, duration of alpha rhythm, number of stuttered words in reading sample, and control of alpha rhythm for monitored reading samples.
7. Alpha-wave conditioning failed to show that a significant relationship exists between the severity rating of stuttering and the combined effect of session number, total time of monologue, duration of alpha rhythm, number of stuttered words in monologue, and control of alpha rhythm for monitored monologues.

The following results were obtained for Subject II:

1. Alpha-wave conditioning resulted in a significant increase in number of stuttered words in both unmonitored and monitored reading samples.

2. Alpha-wave conditioning failed to produce a significant difference in severity rating in either unmonitored or monitored reading samples when baserate was compared with re-evaluation.

3. Alpha-wave conditioning failed to produce a significant difference in either number of stuttered words or severity rating for unmonitored and monitored monologues when baserate was compared with re-evaluation.

4. Alpha-wave conditioning has shown that a significant relationship exists between number of stuttered words and the combined effect of session number, total time for reading sample, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm for monitored reading samples. This relationship is not consistent with early expectations, i.e., stuttering increased as a function of the other variables.

5. Alpha-wave conditioning failed to show that a significant relationship exists between the number of stuttered words and the combined effect of session number, total time for monologue, duration of alpha rhythm, severity rating of stuttering, and control of alpha rhythm for monitored monologue samples.

6. Alpha-wave conditioning failed to show that a significant relationship exists between the severity rating of stuttering and the combined effect of session number, total time of reading sample, duration of alpha rhythm, number

of stuttered words in reading sample, and control of alpha rhythm for monitored reading samples.

7. Alpha-wave conditioning failed to show that a significant relationship exists between the severity rating of stuttering and the combined effect of session number, total time of monologue, duration of alpha rhythm, number of stuttered words in monologue, and control of alpha rhythm for monitored monologues.

It was concluded that the inconsistency of the results between subjects limits the generalizations which can be drawn from the results. Because of this inconsistency, this procedure cannot be recommended as a practical technique in the therapeutic regimen for stuttering. This is a promising area of research, however, and it warrants further investigation.

Suggestions for Further Research

1. Research should be extended to a larger population.
2. A similar study should be conducted in which alpha-wave conditioning is more intense (e.g., an hour of feedback per day), with more stringent criteria (speaking for longer periods of time during continuous production of alpha rhythm).
3. Research should be conducted with more sophisticated electroencephalographic equipment which would yield a written record of alpha activity during the moment of

stuttering. Comparisons could then be made of type of alpha activity before conditioning and after conditioning.

4. A video-tape study should be conducted investigating the visual, as well as auditory, aspects of subjects' stuttering throughout a conditioning procedure similar to the one described above. Perhaps the observation that both subjects in the present study could stutter while producing continuous alpha rhythm could be better understood through visual inspection of the manner of stuttering while producing alpha rhythm.

APPENDIX A

GLOSSARY

Continuous alpha rhythm: bursts of alpha waves at least five seconds in duration separated by pauses of not less than three seconds.

Control of alpha rhythm: production of continuous alpha rhythm for two minutes with eyes open while speaking

Duration of alpha rhythm: raw number of seconds of alpha rhythm in a speech sample divided by the total time for that sample; expressed as number of seconds of alpha rhythm per minute

Monitor: Toomin Alpha Pacer, Model 421; used to monitor subjects' alphaband brain activity

Monitored monologue: spontaneous, unstimulated monologue recorded while monitor was providing feedback or subjects' alpha activity.

Monitored reading: reading samples recorded while monitor was providing feedback of subjects' alpha activity

Unmonitored monologue: spontaneous, unstimulated monologue recorded while electrodes of monitor were applied to subjects' scalps; monitor not activated during monologue, i.e., not providing feedback of subjects' alpha activity

Unmonitored reading: reading samples recorded while electrodes of monitor were applied to subjects' scalps; monitor not activated during reading samples, i.e., not providing feedback of subjects' alpha activity

APPENDIX B

INSTRUCTIONS TO SUBJECTS

The subject was seated in a comfortable chair. The electrodes were placed on the scalp in the frontal, right temporal, and occipital areas. Before the monitor was turned on, the following instructions were paraphrased for each subject:

> You are now going to hear some tones as you have in the previous five (baserate) sessions. As I told you before, these tones are amplified brain waves. What I did not tell you is that some of these brain waves are associated with relaxation and that you are going to try to control the production of these waves, which are called alpha waves. If you will wrinkle your brow and blink your eyes you will hear a high-pitched squeal. The untrained alpha rhythm often appears when a person is relaxed and has his eyes closed. Close your eyes and try to relax as completely as possible.

If the subject did not have a distinct unconditioned alpha rhythm, the following instructions were paraphrased:

> The alpha brain-wave rhythm sounds like this (the monitor and the pacer mechanism are then activated, with the pacer set at 8 Hz.). That's the rhythm we want to hear from you (then the other frequencies on the pacer dial are demonstrated up to and including 13 Hz.). The tone "beeps" and the red light flashes with every wave of sufficient intensity that is detected by the electrodes. The main objective of this experiment is to keep the tone beeping. Close your eyes again and relax your muscles as completely as possible (the pacer mechanism is then turned off but the monitor is left on to provide feedback of the subject's alpha activity).

APPENDIX C

GUIDE TO INTERPRETATION OF CORRELATION COEFFICIENTS

The following descriptions serve to guide the reader in the interpretation of the correlation coefficients found in this study (Guilford, 1956):

< .20--slight; almost negligible relationship
.20 - .40--low correlation; definite but small relationship
.40 - .70--moderate correlation; substantial relationship
.70 - .90--high correlation; marked relationship
> .90--very high correlation; very dependable relationship

REFERENCES CITED

Berger, H. Uber das elecktrenkephalogramm des menschen. Arch. Psychiat. Nervenkr., 1929, 87, 527-570. Cited by Richard F. Thompson, Foundations of Physiological Psychology. New York: Harper and Row, 1967.

Bloodstein, O. A Handbook on Stuttering. Chicago: National Easter Seal Society for Crippled Children and Adults, 1969.

Brutten, E., and Shoemaker, D. The Modification of Stuttering. Engelwood Cliffs, New Jersey: Prentice-Hall, 1967.

Green, E. Biofeedback for mind-body self-regulation: healing and creativity. The Varieties of Healing Experience: Exploring Psychic Phenomena in Healing. Interdisciplinary Symposium of the Academy of Parapsychology and Medicine, 1971.

Gilford, J. Fundamental Statistics in Psychology and Education. New York: McGraw-Hill Book Co., Inc., 1956.

Jacobson, E. Progressive Relaxation. Chicago: University of Chicago Press, 1938.

Jasper, H., and Shagass, C. Conditioning the occipital alpha rhythm in man. Journal of Experimental Psychology, 1941, 28, 373-388.

Kamiya, J. EEG operant conditioning and the study of states of consciousness. In D. X. Freedman (Chm.) Laboratory studies of altered psychological states. Symposium presented at the meeting of the American Psychological Association, Washington, D. C., 1967.

Kamiya, J. Operant control of the EEG alpha rhythm and some of its reported effects on consciousness. In Charles Tart (Ed.), Altered States of Consciousness. New York: John Wiley & Sons, 1969.

MacDonald, J., and Martin, R. Stuttering and disfluency as two reliable and unambiguous response classes. Journal of Speech and Hearing Research, 1973, 16, 691-699.

Mulholland, T. Feedback electroencephalography. Activitas Nervosa Superior, 1968, 10, 410-438.

Mulholland, T. The concept of attention and the EEG alpha rhythm. In Charles Evans and Thomas Mulholland (Eds.) Attention in Neurophysiology. London: Butterworths, 1969.

Nall, A. Alpha Training and the Hyperkinetic Child. (pamphlet) Beaumont, Texas: Angie Nall Hospital for Learning Disabilities, 1972.

Storm van Leeuwen, W. Electroencephalography and Clinical Neurophysiology, 1966, 20, 306. Cited by Charles Evans and Thomas Mulholland, Attention in Neurophysiology. London: Butterworths, 1969.

Van Riper, C. Speech Correction: Principles and Methods. Engelwood Cliffs, New Jersey: Prentice-Hall, 1972.

West, R. An agnostic's speculations about stuttering. In Jon Eisenson (Ed.) Stuttering: A Symposium. New York: Harper and Brothers, 1958.

Wolpe, J. Psychotherapy by Reciprocal Inhibition. Stanford, California: Stanford University Press, 1958.

Young, M. Observer agreement: cumulative effects of rating many samples. Journal of Speech and Hearing Research, 1969, 12, 135-143.