A COMPARISON BETWEEN THE ADAPTATION AND RECOVERY OF CUTANEOUS SENSATION AND THE ADAPTATION AND RECOVERY OF STUTTERING BEHAVIOR

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Patricia Katz Klein

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SIGNED: Patricia Katz Klein

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Burl B. Gray

BURL B. GRAY, Ph.D.
Assistant Professor of Speech

7/20/69
Date

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ABSTRACT

Extensive research has revealed two phenomena in stuttering behavior--adaptation and spontaneous recovery. Adaptation refers to the reduction in stuttering during repeated readings of a passage. Spontaneous recovery refers to the increase in stuttering, in time, following adaptation.

It appeared that from the many response behaviors demonstrating adaptation and recovery, Wischner selected two--stuttering and learning--and experimentally compared them. His findings revealed both behaviors to be similar. In light of Wischner's construct, the present investigation was designed to investigate the similarities between stuttering adaptation and touch adaptation. Also the investigation was designed to compare the similarities in response patterns between stutterers and non-stutterers.

Twenty-nine stutterers and 29 non-stutterers participated in six successive trials. The duration of weight sensation in seconds was measured in each trial. The findings from this task were analyzed and compared to the findings from a concurrent study, consisting of six successive oral reading trials.

The results of this investigation revealed that both stutterers and non-stutterers (to a lesser extent) exhibited similarily significant adaptation and recovery in an oral reading and touch task. It was hypothesized that the course of both behaviors, stuttering and touch, were similar. It was further hypothesized that a common biological mechanism was underlying all adaptational behaviors.

CHAPTER I

INTRODUCTION

Investigation of the various forms of animal life has revealed a class of behavior characterized by a decrement in response strength upon repeated stimulation. This response decrement has been termed adaptation. Harris (13) noted this process as:

> . . . the most ubiquitous phenomenon in all animal behavior . . . as the result of repeated stimulation. For all animal forms, practically every stimulus-response relationship is subject to one or more types of decremental modification in consequence of continued stimulatory activation (13, p. 385).

In the investigation of adaptation, investigators discovered a counterpart to this response decrement. They observed that if a rest interval followed the repeated elicitation of a response, an increase in response strength occurred when the stimulus was again presented. This return in response strength, in time, following adaptation has been called spontaneous recovery.

These two phenomena, adaptation and recovery, have been investigated in many of the behavioral sciences. In 1961, Gray (11) reviewed the occurrence of adaptation and recovery in the sciences of physiology, psychology, and speech pathology. He found the phenomena to be manifested

in muscular, auditory, visual, neural, and verbal behavior. His cumulative review indicated these phenomena not to be "a direct manifestation of a particular behavioral syndrome" (11, p. 46), but to be manifestations common to all behavior--verbal and non-verbal. Although Gray revealed that the phenomena of adaptation and recovery were common to many behaviors, no common causal agent has been theorized. The causal agent has been interpreted and theorized independently within each behavior.

For the past thirty years, there has been extensive research of stuttering behavior. This research has directed considerable attention to the oral performance of stutterers. Investigators found that when stutterers read aloud the same passage a number of times in succession, there was an observable decrement in the frequency of stuttering moments on each reading. They termed this decrement in stuttering responses adaptation or the adaptation effect.

Stuttering Adaptation

The first investigation of this decrement in stuttering was conducted by Van Riper and Hull (32) in 1934. They observed a decrease in stuttering moments when stutterers read a passage several times. In their study, 31 stutterers read the same 133-word passage five times in succession. They found the decrease to be more rapid on

the earlier readings as compared to the later readings. Computation of their data revealed that 94 per cent of the 133 words were stuttered in the first reading, 70 per cent in the second reading, and then they gradually declined "to a relatively constant plateau" (32, p. 200).

In 1939, Johnson and Inness (17) observed adaptation through a statistical analysis of the data collected by Johnson and Knott (18), Maddox (23), and Johnson and Brown (16). In the study by Johnson and Knott, 16 adult stutterers read a 180-word passage ten times. The percentage of stuttered words declined 46 per cent between the first and fifth reading and 49.5 per cent between the first and tenth reading. In the study by Maddox, 25 stutterers read five times in succession the same passage that was used by Johnson and Knott. His results showed a 50 per cent reduction between the first and fifth reading. In the study by Johnson and Brown, 31 stutterers read five successive 180-word segments of a 900-word passage. Their results showed an 18.9 per cent reduction in stuttering moments between the first and fifth reading. Compiling the data from Johnson and Knott's study and Maddox' study, Johnson and Inness reported that the 48.9 per cent reduction in stuttering moments for 41 stutterers was adequate to obtain a significant adaptation effect.

Jamison (14) conducted a study in 1949 to investigate the number of successive trials necessary to reach a criterion of three or less stuttering responses. In her investigation, ten subjects read an 80-word passage several times until they reached the predetermined criterion of stuttering responses. Her results indicated that the mean number of trials to reach this criterion was ten readings. However, nine of the ten subjects reached the predetermined criterion in a mean number of 6.5 trials. From these findings, Jamison concluded that three or less stuttered words could be evoked in 6.5 readings.

These studies have shown adaptation to occur in stuttering behavior under controlled conditions. Additional research has also investigated the adaptation effect under varied experimental conditions.

Influencing Variables

After observing adaptation when stutterers read the same material several times in succession, investigation was conducted to observe the rate, amount, and degree of adaptation that occurred when independent variables were altered in the reading situation. Shulman (29), in a systematic approach, observed the course of adaptation as affected by three variables. These variables were: (1) audience size, (2) passage length, and (3) delay intervals between readings.

In order to ascertain the effect of audience size, he designed two different situations. In the first, a group of sixteen stutterers read a 500-word passage five times in succession. The initial reading was performed before a single listener. On each successive reading, the audience was increased by one, making a total of five listeners present on the fifth reading. In the second situation, the stutterers performed all five successive readings before a single listener. Shulman's findings showed adaptation to be present in both groups. However, by comparing the two adaptation curves, he found adaptation to occur to a greater degree and more rapidly in the single listener situation than in the audience situation. In order to observe the effect of varying passage lengths on adaptation, fifteen subjects read each of three passages five times in succession. The passages were in lengths of 200, 500, and 1,000 words. Adaptation was observed in the readings of all three passages; however, no significant differences were found between the amounts of the resultant adaptation. Shulman also designed four situations to determine the effect of a passage with different time intervals between five readings on adaptation. The time intervals were three seconds, fifteen minutes, thirty minutes, and 24 hours for each situation respectively. Comparing the decrements of stuttering in the four situations, Shulman found greater adaptation with

intervals of three seconds and fifteen minutes between readings than for the intervals of thirty minutes and 24 hours. These findings led Shulman to conclude that: (1) adaptation was greater and more rapid in the simple audience situation than in the complex audience situation, (2) passage length did not affect adaptation, and (3) greater adaptation occurred with shorter rather than longer time periods between readings.

Johnson and Inness (17) analyzed the stuttering measured in trials one and five in Johnson and Knott's (18) study and Johnson and Brown's (16) study. They found a 48.9 per cent difference between trials one and five when the subjects in Johnson and Knott's study read the same passage five times in succession. In Johnson and Brown's study, the subjects read five successive 180-word segments of a 900-word passage. A difference of 18.9 per cent was obtained between trials one and five. A comparison between the two reading situations led Johnson and Inness to conclude that "greater adaptation occurred when the word content remained constant" (17, p. 85).

Golub (10), in a study designed to investigate the effect of the content of the reading material on stuttering adaptation, had thirty stutterers read orally a 100-word list five successive times. The word list was composed of fifty words that were kept constant during the readings, and fifty words that were varied. The fifty constant words were kept

in the same position for each reading. After each reading, fifty new words were combined with the fifty constant words. The adaptation obtained on the fifty constant words was found to be 46 per cent as compared to 10 per cent obtained on the fifty varying words. Golub attributed the greater reduction for the constant words to be "a direct function of the degree of the repetition of the oral reading material" (10, p. 244).

To determine whether anxiety was an integral part of or a significant contributor to the adaptation phenomenon, Dixon (6) designed three reading situations for 24 stutterers. Each stutterer read a different 180-word passage five times in succession in each of three situations. The situations were: (1) reading to the examiner alone, (2) reading to an audience of five students, and (3) reading over a field telephone connected to an adjoining room where the examiner could record the stuttering moments. A pre- and post-experimental judgment by each subject was made by ranking the situations in order of increasing difficulty or in order of the assumed level of anxiety. Both judgments were found to be in agreement in that the telephone situation was ranked most difficult, the audience situation next difficult, and the examiner situation the least difficult. When the adaptation in all three anxiety situations was observed, Dixon found the greatest adaptation in the audience

situation, next greatest in the telephone, and the least adaptation in the examiner situation. He also noted that "the mean frequency of stuttered words for the audience situation is consistently the highest, that for the telephone situation is next highest, and the mean for the examiner situation is lowest" (6, p. 236). After observing Dixon's results, Wischner (36, p. 326) asserted that anxiety "appears to fix the height of the adaptation curve." Dixon assumed, then, that the initial level of the curve indicated the amount of anxiety as well as the number of stuttering moments. Since he observed a progressive reduction in stuttering moments, he hypothesized that anxiety reduction accompanied the decreased stuttering.

Two studies were conducted to test the hypothesis that the more fatigued a stutterer becomes the more stuttering he experiences (33, p. 355). Both studies were designed to observe whether a decrease in the course of adaptation occurred when a fatiguing situation was introduced.

Curtis (5) designed two conditions for 21 stutterers. In each condition the stutterers read six 500-word passages. In the experimental condition, the subjects performed strenuous physical exercise for fifteen minutes after the reading of every two passages. A control condition substituted a rest or "neutral activity" for the exercise. Adaptation was obtained in both conditions, and results revealed no

increase in stuttering frequency in the exercise group. In fact, the physical fatigue interpolated between each two readings in the experimental group caused a slightly greater decrease in stuttering moments than the decrement obtained from the control group. These results led Curtis to conclude that fatigue resulting from muscular exercise tends to decrease rather than increase stuttering.

Donohue (8), in an extension of the above investigation, had ten stutterers perform continuous oral reading over a fatiguing amount of time. All subjects read magazine articles for a three-hour period. At the completion of the three hours, results showed a "consistent decrement in the percentage of stuttering words" (8, p. 266). Her study suggested, as did that of Curtis, that "within designated experimental limits, frequency of stuttering tends to decrease rather than increase with presumably increasing fatigue" (8, p. 266).

Fierman (9) initiated a study for the purpose of exploring and demonstrating whether a cue presented during the stuttering adaptation process becomes associated with the process and effects "a reduction in the frequency of stuttering when a subsequent passage is read" (9, p. 256). Four different 200-word passages were prepared for twelve adult stutterers. Each passage was typed both on white bond paper and white paper with a red one-inch border.

Two sessions were conducted with approximately 48 hours between the sessions. During the first session, the subjects read a passage with a red-border twenty successive times and then a second red-border passage ten times. The second session presented a different red-border passage for twenty successive readings and a new passage without the border for ten readings. There was a period of approximately sixty seconds between the reading of the two passages in both sessions. Fierman labeled the first passage in each session as the control and the second passage as the test or experimental passage. In the first session, results showed less stuttering on the test passage in the first reading than had occurred in the first reading of the control passage. The stuttering on successive readings of the test passage continued to progressively decrease below the stuttering recorded on the control passage. In the second session, there was more stuttering on the test passage in the initial reading as compared with the initial reading of the control passage. Successive readings maintained a higher curve on all readings of the test passage except for the fourth, fifth, and sixth readings, which fell below the control. The collected data enabled her to conclude that the cue did have some effect in reducing stuttering during the readings of a subsequent passage.

Most research available on stuttering adaptation describes the course of adaptation when a subject read the same passage a number of times in succession. Newman (27), in 1954, designed an experiment to observe whether subjects using self-formulated speech exhibited adaptation similar to that observed in the usual research procedure. Newman designed two situations for twenty stutterers. In the first, an oral reading task was performed. In order to maintain "communicative purpose," the subjects were informed that recordings of their readings would be used later as directions for a drawing task for other subjects. In the second situation, the subjects were instructed to formulate descriptions of a sketch. In both situations, the descriptions were given five times consecutively, with a sixth description recorded after a 24-hour delay interval. Newman found significant adaptation to occur in both conditions, although the course of adaptation did not begin in the self-formulated speech condition until trial three. In the reading task, however, the reduction of stuttering began in the second trial. Newman discussed this difference in regard to the self-formulated speech:

> An individual acquires a degree of familiarity with a reading passage on the first of several successive readings. The acquired familiarity with the passage supposedly reduces anxiety with a consequent decrease of frequency and severity of stuttering in the second reading. In the reading condition then, the first reading might be considered

> a familiarization trial, while in the self-formulated speech condition the pattern of utterance is being formed in the first trial. In the latter condition, therefore, the second trial is probably a trial of editing and revising and at the same time also a familiarization trial. . . . Hence, in the self-formulated speech condition, the subject approaches trial 3, rather than trial 2 as in the reading condition, with reduced anxiety as a result of familiarization with the material (27, p. 456).

Therefore, Newman concluded that the results provided evidence that the general pattern of adaptation and recovery for recurring self-formulated speech was similar in nature to that obtained in the oral reading situation.

Starbuck and Steer (31), in 1953, were the first to investigate the adaptation behavior of stutterers and non-stutterers. Their experiment was designed to observe whether the non-fluency of normal speakers appeared similar to the non-fluency of stutterers. In their study 22 stutterers and 22 non-stutterers (normal speakers) read the same passage five consecutive times. Any visual or audible interruptions in the continuity of the reading performance for all subjects were recorded as moments of stuttering. Adaptation was exhibited by both groups, but a significant difference was shown to exist between them. This difference was the number of non-fluencies manifested in both groups. The stutterers, as expected, had a greater number of stuttering moments on all five readings. To determine if there were any differences in the groups, an analysis of variance test was employed. The results revealed that the groups by trial

interaction were significantly different. From these results, Starbuck and Steer concluded that both stutterers and non-stutterers "demonstrate an adaptation phenomenon in successive oral readings of the same passage," but," . . . the phenomena in stutterers and non-stutterers are not the same" (31, p. 255).

Spontaneous Recovery

While investigators were involved in research of the adaptation effect, they noted another response phenomenon. They reported an increase in the frequency of stuttering to occur subsequent to an interval of time following adaptation. Johnson (15, p. 16) noted that Wischner was the first investigator to observe a similar phenomenon to be exhibited in a delay following experimental extinction of learned responses. He borrowed the term spontaneous recovery from psychology and applied it to the phenomenon exhibited in stuttering behavior.

Jones (19) conducted a study for the purpose of investigating this phenomenon in stuttering behavior. In his investigation, 24 stutterers read the same 250-word passage five times on each of five successive days. Approximately 24 hours elapsed between each series of five readings. A sixth session was conducted ten days after the fifth day, and the subjects again read the same passage five times.

When Jones examined the data for the first five days, he found that the mean frequency of stuttering on the initial reading of any day was greater than the mean frequency of stuttering on the last trial of the previous day. The initial reading on the sixth day approximated the initial reading on the third day. The mean frequency of stuttering in the sixth session showed an increment as compared to the last trial of any earlier session. The results showed, therefore, that recovery in the strength of the response can be exhibited after a period of 24 hours or ten days following adaptation.

Jamison (14) conducted a study to observe whether a gradient of spontaneous recovery occurred as a function of time between the last adaptation reading and a recovery reading. Three situations were designed for ten stutterers. Adaptation was determined by the reading which contained three or less stuttering moments. After adaptation was obtained, delays of thirty minutes, 1-1/2 hours, and 4-1/2 hours were introduced in each situation respectively. A reading to observe recovery was recorded after the delay intervals. Her results revealed a 54.8 per cent increment in the mean number of stutterings between the first reading and recovery reading when a thirty-minute delay interval followed adaptation. When an hour and a half delay occurred between the last adaptation reading and the recovery reading, a 55 per cent difference was found to occur between the

recovery reading and the initial reading. However, in the third condition, the response showed a 100 per cent recovery between the first reading and the recovery reading. She concluded that the amount of stuttering following the delay intervals showed a "simple accelerated positive growth function" (14, p. 248), indicating that full recovery could be achieved within as short a period as four and a half hours.

In Newman's (27) study of oral reading and self-formulated speech, twenty stutterers performed each task five successive times. A sixth reading was recorded 24 hours later for the purposes of observing spontaneous recovery. A significant increase in stuttering was noted on the sixth trial for both tasks. Thus, Newman noted an increase in stuttering after a delay of 24 hours following adaptation in both an oral reading and a self-formulated speech situation.

In 1957, Leutenegger (21) conducted a study to determine if a relationship existed between the length of the delay interval following adaptation and the amount of the stuttering response after the delay. Thirty-six stutterers read a 240-word passage in three conditions. In each condition, the stutterers read the passage for five trials. Each trial consisted of two consecutive readings. In each condition, a different delay time was introduced between the trials. The delay times were twenty minutes, sixty minutes,

and 24 hours respectively. Analysis of the stuttering on the reading following the time delay revealed progressively increasing amounts of adaptation and recovery from trial to trial in all conditions. There was no evidence to support the original hypothesis that longer delays were followed by greater strength in recovery of the stuttering response. These results led Leutenegger to interpret the data within a learning frame of reference. He concluded from his findings that stuttering was a learned and lawful behavior.

Learning Theory of Stuttering Adaptation

The lack of pertinent research in the area of stuttering adaptation has not enabled investigators to denote a single causative agent. However, within the science of speech pathology, several theories have indicated possible antecedent factors of adaptation. One widely accepted theory was proposed by Wischner (35).

In 1947, Wischner theorized the causal factor in stuttering adaptation within a learning frame of reference. After observing the response pattern exhibited in stuttering behavior, he projected a likeness to a similar response decrement seen in unconditioned and conditioned learning responses. He found the stuttering adaptation curve to resemble "a curve of experimental extinction" (35, p. 60). His dissertation presented a systematic investigation of

the two behavioral responses found in "two presumably disparate areas," stuttering and learning.

In learning, "when a learned response is repeated without reinforcement, the strength of the tendency to perform that response undergoes a progressive decrease. This decrement is called experimental extinction" (7, p. 48). In stuttering, when an oral response (reading or speech) is repeated several times in succession, the frequency of stuttered words undergoes a progressive decrease. This decrement is called adaptation. Superficially, both behaviors exhibited a progressive response decrement, appearing to be "negative growth curves characterized by a relatively more rapid rate of fall in the earlier as compared with later trials" (35, p. 59). Reviewing the curves more closely, Wischner noted that the necessary condition which perpetuated both behaviors was the "repeated elicitation of the response by appropriate stimulation under relatively constant conditions" (35, p. 60).

Since the curves appeared similar in form, Wischner questioned "whether similar processes are responsible for the event of the two curves" (35, p. 61). Investigation in learning has revealed that a reinforcement mechanism is withdrawn during the extinquishing of a learned response. However, research in stuttering has not provided evidence to identify that a reinforcement mechanism is withdrawn

during the decrement of the stuttering response. Wischner assumed, therefore, that "the mechanisms underlying stuttering adaptation and extinction are similar in some degree . . . whatever the nature of these fundamental mechanisms may be" (35, p. 61).

In his systematic review of experimental extinction, Wischner reported that certain characteristics were inherent in this condition. These characteristics were: spontaneous recovery, external inhibition, conditioned inhibition, and disinhibition (35, p. 57-77).

A program of research was then initiated to investigate to what extent the stuttering adaptation curve behaved like the experimental extinction curve. He prefaced this research by assuming two basic precepts: (1) stuttering was lawful and (2) stuttering was learned (35, p. 23).

With experimental support by others (19, 9, 2, 1), and through his own experimental pursuit, he found that the characteristics inherent in experimental extinction were inherent in stuttering. Thus, his research program revealed stuttering adaptation to be analogous to experimental extinction. The similarities in course and characteristics led him to assume that the mechanisms underlying stuttering adaptation and experimental extinction were similar in nature.

Experimental support can be given to Wischner's research findings that both behaviors have common

characteristics and a similarity in form. This support is "attested to by the findings that both adaptational classes are cumulative [Donahue (8)], are a function of the rate of response elicitation [Shulman (29)], recover response-strength spontaneously [Jones (19)], and generalize [Fierman (29)]" (12, p. 16-17).

A systematic review of response behavior has shown adaptation and recovery to occur in many behavioral classes (11). Within each behavioral class, the course of the response upon repeated stimulation has been described as a progressively decreasing function. Recovery has been described as an increase in response strength, over time, following the response decrement. It appears, then, that if the behavioral classes demonstrating these phenomena were collectively viewed, each response pattern would be similar in course to the other response patterns. For a program of research, it appears that Wischner selected two of these behaviors--stuttering and learning. He demonstrated experimentally that the two behaviors had common correlates and were similar in form. His findings led him to describe stuttering in terms of learning. He hypothesized stuttering adaptation to be representative of an experimental extinction process. However, since he was unable to identify the reinforcement which was withdrawn during the extinction of stuttering responses, support for his hypothesis was

inconclusive. He assumed, therefore, that the mechanisms underlying both behaviors were similar. From the many response behaviors demonstrating adaptation, it appears that stuttering adaptation may be similar to any other adaptational behavior. If there is experimental support for this latter view, it may necessitate a re-evaluation of the antecedent factors currently hypothesized to govern stuttering adaptation. This re-evaluation may be suggestive of a common mechanism underlying all adaptational behaviors. Thus, the need is pointed up for an experimental investigation initiated in an effort to explore similarities between stuttering adaptation and another adaptational behavior.

Summary

Extensive investigation in the past thirty years has revealed two phenomena in stuttering behavior. Investigators have observed a decrement in stuttering frequency to occur when stutterers read the same passage a number of times in succession. This stuttering decrement has been termed the adaptation effect. This adaptation effect has been shown to occur in self-formulated speech and in the speech of stutterers and non-stutterers. It has also been shown to vary in amount or rate when certain independent variables are introduced into the situation.

Another response phenomenon has been observed during the research of adaptation. When a time period ranging from

twenty minutes to ten days has elapsed following adaptation, an increment in stuttering frequency occurs. This response increment has been viewed as similar to a response increment elicited in learning responses--spontaneous recovery. Wischner borrowed this term from psychology and used it to label the response increment in stuttering. Spontaneous recovery has been exhibited following adaptation of the same reading material and of self-formulated speech.

Many theories have evolved from this research hypothesizing the causal factor in stuttering adaptation. One major theory proposed by Wischner interpreted stuttering adaptation to be an experimental extinction process. Since investigation to date cannot identify the reinforcing agent withdrawn during the course of stuttering adaptation, Wischner assumed that a similar mechanism was underlying both behaviors--stuttering adaptation and experimental extinction. With the occurrence of adaptation in many behavioral classes, it appeared that stuttering adaptation could be compared to the adaptation of another response behavior. This experimental investigation would reveal whether there are similarities between these two adaptational behaviors. If similarities are found to exist, a re-evaluation of the theories of stuttering adaptation would appear warranted. Thus, if stuttering adaptation is found to be similar to another adaptational behavior, and it has previously been

found to be similar to experimental extinction, then possibly a common mechanism is underlying all behavioral classes, including these three behaviors.

CHAPTER II

PURPOSE

For many years, speech pathologists have directed considerable attention to the oral performance of stutterers. Investigation has revealed two fundamental phenomena in stuttering behavior. One phenomenon, termed the adaptation effect, refers to the reduction in stuttering moments when a stutterer reads the same passage consecutively several times. Investigators noted this reduction to be a progressively decreasing function with a more rapid decline in the earlier as compared with later readings. The adaptation effect was also found to occur when certain independent variables were introduced into the reading situation. Investigators reported adaptation to occur when the reading material was varied in length, was kept constant or varied, and when the speech was self-formulated. Certain situational variables, such as audience size, fatigue, a telephone, and a cue stimulus, were found to alter the rate or amount of adaptation in varying degrees. Non-fluency adaptation was evidenced in the speech behavior of non-stutterers as well as stutterers.

The other phenomenon, termed spontaneous recovery, refers to the return in response strength, in time, subsequent

to its diminution. Investigators noted an increase in stuttering moments after a twenty-minute, an hour, a 24-hour, and a ten-day time interval followed adaptation. Spontaneous recovery was also found to occur after the adaptation of the same reading material and of self-formulated speech.

A similarity between the stuttering adaptation curve and the experimental extinction of learned responses was noted by Wischner (35). Through a systematic investigation, he found certain characteristics manifested in both behaviors. He hypothesized from his findings that stuttering adaptation represented an experimental extinction process. However, since he was unable to identify the reinforcing agent withheld during the extinction of the stuttering response, he assumed that the mechanisms underlying experimental extinction and stuttering adaptation were similar in nature.

From the many behavioral classes demonstrating adaptation and recovery, it appears that Wischner chose two--stuttering and learning. His research program revealed these behaviors to be similar, although he was unable to obtain experimental support for his hypothesis. Since many behavioral classes have been found to demonstrate adaptation, there appeared to be a need to compare stuttering adaptation to another adaptational behavior, i.e. cutaneous adaptation. An experimental investigation of these two behaviors would

determine if similarities exist. If similarities are found to exist, and stuttering has previously been found to be similar to experimental extinction, it would appear, then, that there is a commonality not only in the course of adaptation but in the underlying mechanisms as well. Thus, a need for an investigation of the similarities between the response patterns of cutaneous adaptation and stuttering adaptation appears necessary for further consideration of stuttering adaptation. A second value of this investigation would be to determine if there are any inherent differences in the response patterns exhibited by stutterers and non-stutterers.

Therefore, the purposes of this investigation are to:

1. Investigate, through successive application of weight, the characteristic response pattern of cutaneous stimulation for a matched group of stutterers and non-stutterers.
2. Investigate, through repeated readings of the same passage, the adaptation effect of stutterers and non-stutterers.
3. Investigate the similarity between the adaptation pattern of cutaneous stimulation and the adaptation effect of oral readings for both stutterers and non-stutterers.

CHAPTER III

PROCEDURE

Stuttering adaptation has been described as the progressive reduction in stuttering moments during repeated readings of the same passage. The occurrence of the adaptation effect has been observed under many experimental conditions. During their investigation of stuttering adaptation, investigators found an increment in stuttering moments to occur when a time interval followed adaptation. When Wischner (35) observed this response increment, he termed it spontaneous recovery, borrowing the term from psychology.

It has been noted that these phenomena occur in many response behaviors, and that Wischner selected two, stuttering and learning, for a program of research. He compared stuttering adaptation to the experimental extinction of learned responses. His findings revealed that the course and characteristics exhibited in stuttering adaptation were analogous to those exhibited in experimental extinction. He assumed, from the similarities evidenced in both behavioral classes, that the underlying mechanism for both processes was similar.

It became apparent from Wischner's investigation that he was unable to support his position that stuttering

adaptation was an experimental extinction process. It appeared, however, that stuttering adaptation could be compared with the adaptation of another behavioral class to observe whether similarities also exist between them. It was noted that the findings from experimental investigation might be suggestive for a re-evaluation of the theories of stuttering adaptation. The response behavior demonstrating adaptation and recovery selected for this experiment was the cutaneous sensation of touch. This investigation was designed, therefore, to determine the similarities in response characteristics between stuttering adaptation and touch adaptation. A secondary purpose of the investigation was to determine the similarities in response characteristics between stutterers and non-stutterers with respect to these two adaptational behaviors.

Cutaneous Adaptation

Cutaneous adaptation has been defined as a "progressive decrease in the intensity of sensation with continued and unvarying stimulation" (28, p. 78). More specifically, "adaptation refers to the duration of experience when the application of the stimulus is continuous" (24, p. 408). The pressure sense, that is, "touch," has had less investigation and measurement of its adaptation process than any of the other sensations. Because of the limited research in

this area, and the inability of isolating one cutaneous sense, the literature that has been reviewed on adaptation will be reported for the tactile sense and the overlapping sensation of pressure. For efficiency and expediency, however, the adaptation under discussion in this chapter and later chapters will be termed touch adaptation.

Accounts of adaptation of the tactile sense date back to 1896, when Von Frey and Kiesow (3, p. 500) independently reported the diminishing course of the intensity of pressure sensation with the application of a continuing stimulus. They found that the rate of application of a tactile stimulus affected the sensation. Slow application appeared to raise the threshold of the sensation, thereby, causing longer duration of the experience. (32)

The few studies which have been conducted on touch or weight sensation have altered certain variables. For example, Zigler (37), in 1932, conducted an experiment with two situations to observe adaptation. In the first situation, he varied weights of 8, 28, 48, and 68 grams during four trials. In each trial, a weight of increasing intensity was applied to the volar surface of the arm and on the back of the hand. His findings revealed that heavier weights evoked longer adaptation-time than did the lighter weights. In the second situation, Zigler used a 500 milligram weight on each of five trials. The diameter of the weight was

varied for each trial, in the order of 5, 10, 15, 20, and 25 inches respectively. The weight was applied to the same areas as in the first situation. His findings showed that adaptation-time varied inversely with the area of stimulation; that is, the smaller the diameter of the weight the faster the receptor adapted. From his results, Zigler described touch adaptation as "the establishment of an equilibrium by the receptor," considering "both adaptation during the continued stimulation and the re-establishment of equilibrium after the sensation ceases" (37, p. 709-710).

Crook and Crook (4), in a comparison between intensity of the weight and time for complete adaptation in the field of cutaneous pressure, used an increasing series of weights. The weights were: 0.1, 0.3, 0.6, 1.0, 1.5, 2.5, 5.0, 10.0, 25.0, 50.0, 100.0, and 200.0 grams. In each trial, a weight of progressively increasing intensity was placed on the volar side of the right forearm about three inches below the elbow. Complete adaptation was measured in each trial as the time from the application of the weight to the response by the subject, signaling that he no longer felt the weight. Their results showed a decreasing response curve for all the weights. His findings agreed in some degree to those of Zigler's, that adaptation-time tended to be longer for stimulation by heavier weights than for stimulation by lighter weights.

Nafe and Wagoner (25) used three weights having ratios of 1:2:4 in intensity and diameter and measured the amount of movement and observable changes in the tissues. The weights were applied in 1:2:4 order with varying amounts of pressure to the knee-cap of the subjects. Their findings revealed that a change in the area of the stimulus, with the weight remaining constant, resulted in changes in the tissues as measured in adaptation. The tissues remained the same "in relation to the rate of movement of the stimulus" (25, p. 348). They concluded that the course of adaptation was a negatively accelerating curve, and that as a "weight of the stimulus is doubled, the rate of movement of the stimulus critical for sensation [adaptation] is reduced by about one-third" (25, p. 348).

Although little research is available on touch adaptation, it has been described as the cessation of the characteristic response in time under continuing unchanging application of a stimulus. Recovery has been described as the increase of the receptor's sensitivity after the stimulation has been discontinued.

In the present investigation, touch sensation was defined as the elapsed time in seconds in each trial from application of a weight to the subject's response that he no longer felt the weight. Touch adaptation was defined as the duration in seconds of weight or touch sensation for each subject over five successive trials.

Stuttering Adaptation

The subjects from this study also participated in an oral reading task that was conducted in a concurrent study. In the concurrent study, the subjects read a 300-word passage six times in succession, while the experimenter marked the non-fluencies on a duplicate copy of the passage. Any visual or audible interruptions during the readings were recorded as non-fluencies. The progressive decrement of non-fluencies over five trials was considered representative of the adaptation process. The time for the first five oral reading trials was measured in minutes. A rest interval of one-half of this total time was then introduced. Following the delay, a sixth or recovery trial was recorded.

To facilitate a comparison of the data, the present investigation incorporated a similar procedural format as that in the stuttering investigation. The resultant data and adaptation curves for both stutterers and non-stutterers were provided for comparison in statistical analysis in a later chapter in this investigation.

Procedural Rationale

Since several errors can occur during the course of touch adaptation, certain rules have been established by physiologists to insure that the obtained adaptation is as accurate as possible. These rules are that: (1) the

stimulus be constant in both intensity and quality during the period of stimulation, (2) the same receptor be stimulated throughout the course of adaptation, and (3) all possible bodily movements be inhibited or controlled during and between stimulations (28, p. 78). This investigation attempted to meet these criteria.

In an attempt to maintain constant weight stimulation, a 10.6 gram weight was applied to the arm by a mechanical device. A guide cylinder enabled the weight to be raised and lowered uniformly during each trial.

With regard to the receptors of a tactile stimulus, Troland (30) stated that "the structure of experience is determined by the distribution of pressures upon or within the skin" (30, p. 317). "The forearm has few 'touch' spots but high sensibility" (30, p. 315). Since all investigators have obtained adaptation on the volar surface of the forearm, and this area is easily accessible to stimulation by a weight, this area was considered to be appropriate for this experiment. A pillow, 13 inches by 13 inches, was used for stabilization of the subject's arm in an attempt to minimize any extraneous movement. The subject's arm rested on the pillow throughout the entire experiment.

Instrumentation

An instrument for constant weight application and accurate adaptation-time measurement was constructed for this

experiment. An adjustable microscope stand, commonly used for wide-field binocular microscopes, formed the base of the instrument. Mounted to the front surface of the stand, on which the microscope pod is normally mounted, was a jig consisting of a small metal box and metal plate. This box and plate were suitable for the mounting of a toggle switch and guide cylinder. Attached to the left of the box was a toggle switch (switch 1). Mechanically linked to the toggle switch by means of a thread was a 10.6 gram weight, 1/2 inch in diameter and 1-7/8 inches in length. A felt disc was placed on the contact surface of the weight, to minimize any possible thermal stimulation. The switch and weight were linked in such a manner that when the switch was in the up position, the weight was also in the up position, and vice versa. The path of the weight was made uniform and reproducible by a guide cylinder. An "off-on" switch (switch 2) was attached to a standard electric timer. The two switches, 1 and 2, were wired to the timer for the purposes of measuring the time of weight sensation. The switches were wired in series so that when switch 2 was in the "on" position, the electric current was allowed to flow through the circuit. When switch 1 was pushed down, it mechanically lowered the weight and simultaneously started the timer. The circuit was broken when switch 2 was pushed to the "off" position, thereby stopping the timer. Figure 1 shows the apparatus in use.

Fig. 1.--Touch Adaptation Apparatus

Experimental Procedure

Subjects

Fifty-eight individuals chosen from the University of Arizona students and faculty, and Tucson resident population participated as subjects in this study. The individuals were divided into two groups. An experimental group consisted of 29 stutterers and a control group consisted of 29 non-stutterers. Both groups were matched according to age (within six months), sex, and general educational background.[1] The ages of the fifty-two males and six females ranged from 13 years 7 months to 36 years 2 months, with a mean age of 22 years 2 months. All subjects were naive as to the purpose of this study.

Procedure

All subjects were tested in a sound treated room located in the Education Building at the University of Arizona.[2] After each subject entered the room he was seated in a comfortable chair at a table. At the subject's end of the table, the experimental equipment was concealed from the subject by a wood partition. An aperture, 6 inches by 4 inches, was cut in the partition for the subject's arm.

---

1. See Appendix A for the age, sex, and general educational background of the 58 subjects.

2. IAC room serial #2682B, model #400 special.

Two experimenters were at either end of the table. Experimenter A gave the instructions and operated the instrument, and Experimenter B sat at the other end of the table, parallel to the equipment, and recorded the time.

After the subject was seated at the table, he was asked which hand he used for writing. He was then given a button switch (switch 2) to hold in this preferred hand. The other hand and arm remained free for the experiment. The subject was asked to remove any jewelry and clothing covering this forearm. A few of the subjects who had excessive hair on their forearms had a small area shaved, since the hair would have been stimulated by the weight bringing fresh receptors into play.

The following instructions were then given:

> You are to sit quietly with both feet on the floor and your body balanced evenly in your chair. You will be asked to place your arm, palm side up, through this hole and rest it on the pillow. (demonstration). As soon as you are comfortable, you will be given the signal, "push the button." At this time, push the switch in your hand to "on." Upon the signal "begin," I will place a light weight on your arm. After the weight is on your arm, there will be a minute when you will no longer "feel" the weight. Don't wait for the feeling that the weight is being lifted off your arm. It won't be that kind of "feeling," however, there will be a minute when you no longer have the sensation of the weight. At that moment push the switch to "off" immediately. This same procedure will be conducted several times in succession. Each time we begin, you will be told when to push the switch to "on." After the experiment has begun, please refrain from any talking and movement until the experiment is over. During the activity, <u>please keep your arm perfectly still</u>! Are there any questions?

After his arm was placed on the pillow, he was told to relax. Experimenter A then adjusted the apparatus by means of a knurled knob on the microscope stand, so that when switch 1 was down, the weight would just touch the volar surface of the arm, three inches below the elbow. At the beginning of each trial the subject depressed switch 2 to the "on" position. Experimenter A then pushed down switch 1. When the subject no longer "felt" the weight, he depressed switch 2 to "off." Experimenter B recorded the time, while Experimenter A raised switch 1. Experimenter A then returned the timer to zero by a reset lever. Five trials were conducted in the same manner. After the fifth trial, Experimenter B started a stop watch, and timed the rest interval.

At the start of the rest interval, these instructions were given to the subject:

> Please do not move your arm, but there will now be a brief rest period. You may talk, but please refrain from any extraneous movement. You will be told when we are ready to begin again. When we do begin, we will proceed in the same manner as before.

The rest interval consisted of one-half the time necessary to complete the first five trials. At the end of the time period, the sixth trial was recorded in the same manner. At the end of this trial, the experiment was completed. The subject was instructed before he left not to relate the activities performed to any other members of the

experimental groups, to insure that their responses would not be influenced by prior knowledge.

Both situations--oral reading and touch sensation--were counterbalanced in this experiment to avoid order effects. Many of the subjects participated in both situations on the same day, with a minimum of thirty minutes between situations. The other subjects performed in each situation on two separate days. Many of the subjects used in this experiment had participated in similar studies being conducted by several graduate students in the Speech Department. These subjects expressed familiarity with the general format of the experimental procedure used in this experiment.

Statistical Analysis

All scores obtained from the oral reading and touch experiment were arranged into an ordinal scale. Since the data did not meet normal distribution requirements, the measurements were subjected to non-parametric statistical methods (22, pp. 89-90; 30, p. 6).

The Friedman Two-Way Analysis of Variance Test (30, pp. 166-173) and the Wilcoxon Matched-Pairs Signed-Ranks Test (30, pp. 75-83) were used to determine significant differences between trials and groups. Differences were considered significant at the .05 level of confidence.

CHAPTER IV

RESULTS

A review of the literature has shown that many behavioral classes demonstrate adaptation and recovery. It has been noted that if these classes were viewed collectively, the response patterns would bear similarities in form. It appears that from these classes of response behavior, Wischner selected two--stuttering and learning--and experimentally compared them. He found both behaviors to be similar in decremental course and response characteristics. From these findings, he described one behavioral class in terms of the other, that is, stuttering in terms of learning. Because he was unable to denote a reinforcement mechanism that was withdrawn during stuttering adaptation, he was unable to obtain support for his position. He assumed, therefore, that the mechanisms underlying both behaviors were similar in nature. In light of Wischner's construct, there appeared to be a need for an experimental investigation designed to determine if the response patterns of stuttering and touch adaptation were similar. If similarities are found, and stuttering adaptation and experimental extinction has previously demonstrated similarities, then experimental support of similar curves may be suggestive of a common causal

mechanism of adaptation. The present investigation was designed, therefore, to investigate the similarities between stuttering and touch adaptation. Also, it was designed to investigate the similarities in response patterns of stutterers and non-stutterers.

Twenty-nine stutterers and a matched group of 29 non-stutterers participated in this experiment. Touch adaptation and recovery were measured in time during six successive trials. During each trial, the time of weight sensation was recorded in seconds--from the onset of a weight to the subject's response that he no longer felt the weight. A delay interval of one-half the time taken to complete the first five trials was introduced after the fifth trial. Following the delay, a sixth or recovery trial was recorded. The subjects also participated in an oral reading task that was conducted in a concurrent study with procedures similar to this study. Comparisons between the stutterers and non-stutterers on stuttering adaptation and touch adaptation were subjected to statistical analysis. Inter-group and inter-trial comparisons on the response patterns during the six successive trials also were statistically analyzed in both tasks.

Raw Data

Touch Sensation

The raw scores for both stutterers and non-stutterers indicated an overall reduction in time of touch sensation from trial one to trial five. An increase in time indicating recovery in touch sensation was observed between trials five and six for both groups.[1] The sum and median values for each group over six trials are given in Table 1.

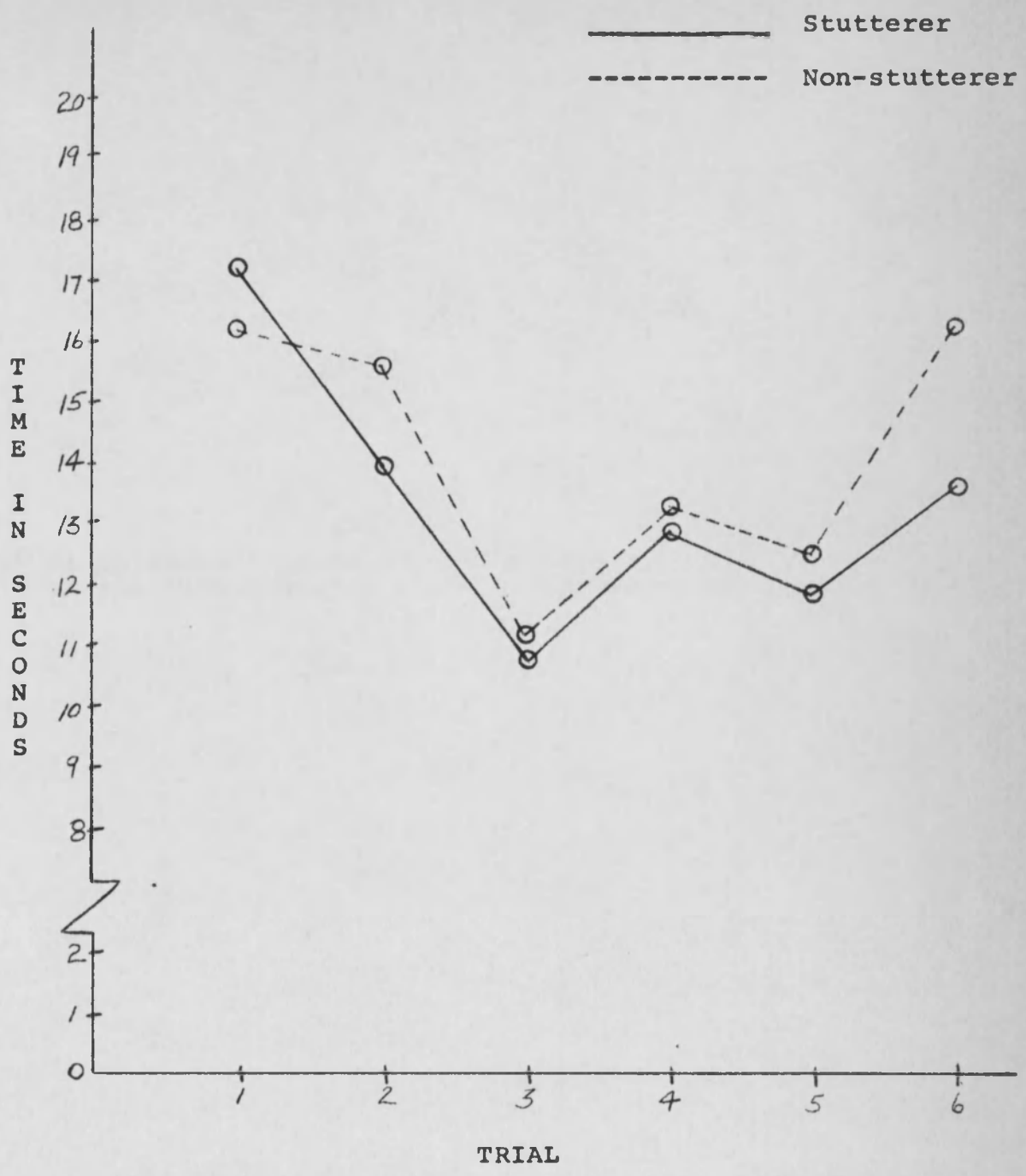
TABLE 1.--Sums and Median Values of Touch Adaptation in Seconds for 29 Stutterers and 29 Non-stutterers Over Six Trials

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Sums	601.07	810.79	532.89	622.97	535.92	787.88
(2) Medians	17.16	13.92	10.63	12.73	11.90	13.58
Non-stutterers						
(1) Sums	894.35	763.28	566.45	508.66	563.31	696.41
(2) Medians	16.02	15.70	11.08	13.37	12.38	16.22

The results presented in Table 1 are illustrated graphically in Figure 2. The results of statistical analysis revealed significant differences between trials one and

1. See Appendix B for raw scores of touch sensation for 58 subjects over six trials.

Fig. 2.--Median Time of Weight Sensation in Seconds for 29 Stutterers and 29 Non-stutterers over Six Trials.


Stutterer
Non-stutterer
TIME IN SECONDS
20
19
18
17
16
15
14
13
12
11
10
9
8
2
1
0
1
2
3
4
5
6
TRIAL

five for both groups, and between trials five and six for the stutterers. No significant differences were obtained between trials five and six for the non-stutterers, nor between the two groups on trials one, five, and six, as shown in Table 2.

TABLE 2.--Inter-trial and Inter-group Comparisons of Time of Weight Sensation for Stutterers and Non-stutterers via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Group	vs.	Trial	Group	Z-Score	P-Value
1	Stutterers		5	Stutterers	1.956	.0250[a]
1	Non-stutterers		5	Non-stutterers	2.594	.0048
5	Stutterers		6	Stutterers	1.870	.0307
5	Non-stutterers		6	Non-stutterers	1.156	.1230
1	Stutterers		1	Non-stutterers	.918	.1788
5	Stutterers		5	Non-stutterers	.335	.3669
6	Stutterers		6	Non-stutterers	.205	.4168

[a]Significance level set at .05

The stutterers and non-stutterers were then divided into three sub-groups each according to the subjects' times for weight sensation recorded on the initial trial. The sub-groups were: (1) Longest Duration, (2) Medium Duration, (3) Shortest Duration for stutterers; and (4) Longest Duration, (5) Medium Duration, (6) Shortest Duration for non-stutterers.

The nine subjects who sensed the weight for the shortest period of time were placed in the "shortest" group, the next ten in the "medium" group, and the remaining ten who sensed the weight for the longest period of time in the "longest" group. Table 3 gives the sum and median values for the six sub-groups over six trials.

When the median values for the six groups are plotted, as illustrated in Figure 3, it can be noted that the "longest" group for the non-stutterers appears as a distinct group from the other groups. Also, the "longest" and "medium" group of the non-stutterers and the "shortest" group of stutterers appear to demonstrate the classical adaptation curve.

Oral Readings

The raw scores for the 29 stutterers and 29 non-stutterers on five trials showed a progressive reduction in stuttering from trial one to trial five.[1] Table 4 gives the sum and median values for both groups over six trials.

---

1. See Appendix C for the raw scores of non-fluencies for 58 subjects over six oral reading trials.

TABLE 3.--Sum and Median Values of Weight Sensation in Seconds for 29 Stutterers and 29 Non-stutterers over Six Trials. The Time was Divided into: (1) Longest Duration, (2) Medium Duration, (3) Shortest Duration for the Stutterers; and (4) Longest Duration, (5) Medium Duration, (6) Shortest Duration for the Non-stutterers

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Longest Duration:						
Sums	377.04	422.50	295.09	321.05	263.67	421.20
Medians	29.79	20.71	18.41	34.69	21.34	41.51
(2) Medium Duration:						
Sums	163.57	300.35	189.03	257.25	206.10	289.45
Medians	16.10	21.25	10.82	13.86	11.48	15.30
(3) Shortest Duration:						
Sums	60.46	87.94	48.77	44.67	66.15	77.23
Medians	6.70	5.85	4.37	3.61	4.24	9.44
Non-stutterers						
(4) Longest Duration:						
Sums	623.61	476.85	350.86	258.77	301.52	382.46
Medians	47.67	44.96	28.44	23.49	23.23	34.03
(5) Medium Duration:						
Sums	192.84	195.33	156.36	177.19	219.05	185.13
Medians	15.73	12.20	11.91	11.59	12.58	16.18
(6) Shortest Duration:						
Sums	77.90	91.10	59.23	72.70	42.74	128.82
Medians	7.59	9.58	6.23	6.92	4.03	5.49

Fig. 3.--Median Time of Weight Sensation in Seconds for 29 Stutterers and 29 Non-stutterers Divided into Six Groups According to Initial Scores of Weight Sensation. The Groups Are: (1) Longest Duration, (2) Medium Duration, (3) Shortest Duration for Stutterers; and (4) Longest Duration, (5) Medium Duration, (6) Shortest Duration for Non-stutterers.

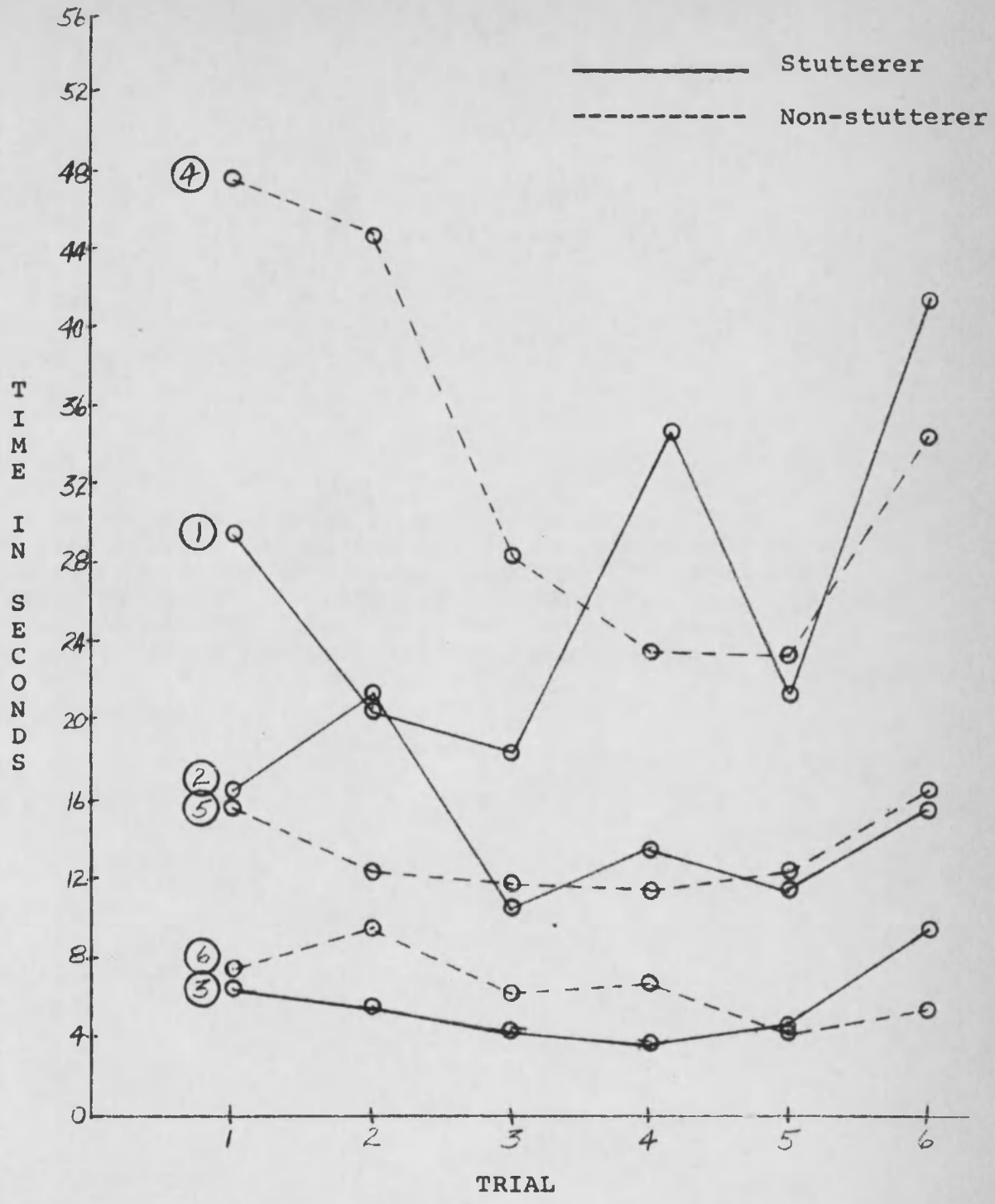

Stutterer
Non-stutterer
TIME IN SECONDS
TRIAL
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
1
2
3
4
5
6

TABLE 4.--Sum and Median Values of Non-fluency Scores for 29 Stutterers and 29 Non-stutterers over Six Trials

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Sums	1021	730	562	497	455	579
(2) Medians	18	11	10	7	6	9
Non-stutterers						
(1) Sums	136	83	51	59	45	58
(2) Medians	4	2	1	1	1	2

The medians for both groups are presented in Figure 4. The slope of the curve for the stutterers is much deeper with a greater reduction in non-fluencies from trials one to five than for the non-stutterers. Statistical analysis by the Wilcoxon Matched-Pairs Signed-Ranks Test revealed significant differences between trials one and five in both groups, and between the stutterers and non-stutterers on trials one, five, and six. The stutterers demonstrated a significant recovery between trials five and six; however, no significance was obtained for the non-stutterers between the same trials. The results of inter-trial and inter-group comparisons are summarized in Table 5.

Fig. 4.--Median Non-fluency Responses for 29 Stutterers and 29 Non-stutterers over Six Trials.

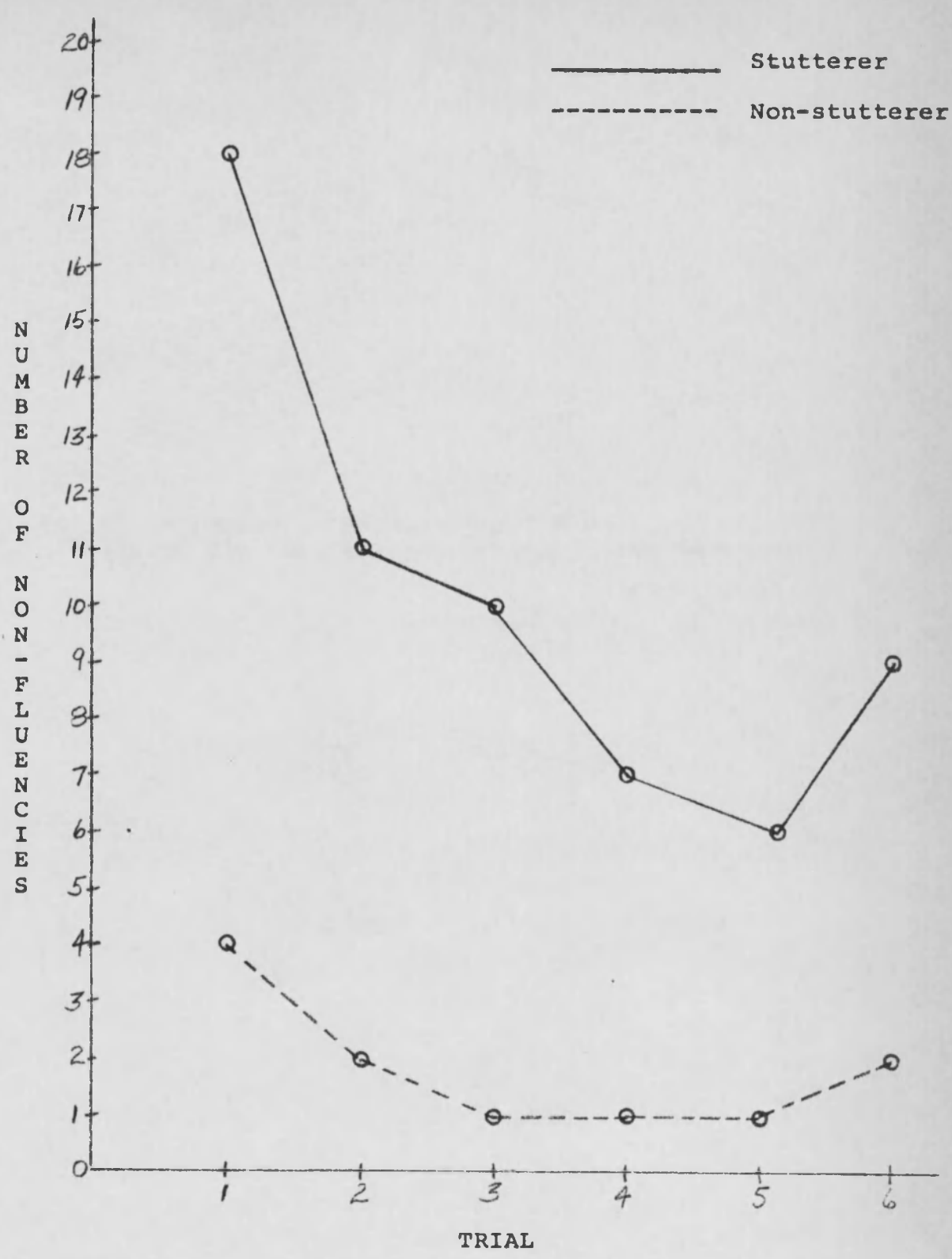

Stutterer
Non-stutterer
NUMBER OF NON-FLUENCIES
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
1
2
3
4
5
6
TRIAL

TABLE 5.--Inter-trial and Inter-group Comparisons of Oral Reading Non-fluencies for Stutterers and Non-stutterers via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Group	vs.	Trial	Group	T- or Z-Score	P-Value
1	Stutterers		5	Stutterers	T=0	.0001
1	Non-stutterers		5	Non-stutterers	Z=4.526	.0001
5	Stutterers		6	Stutterers	T=28	.01
5	Non-stutterers		6	Non-stutterers	T=70	--[a]
1	Stutterers		1	Non-stutterers	Z=4.518	.0001
5	Stutterers		5	Non-stutterers	Z=3.886	.0001
6	Stutterers		6	Non-stutterers	Z=4.099	.0001

[a]N insufficient to convert to Z-Score for P-Value via the Wilcoxon Test. T-Score of 66 or below needed for significance at .05 level of confidence.

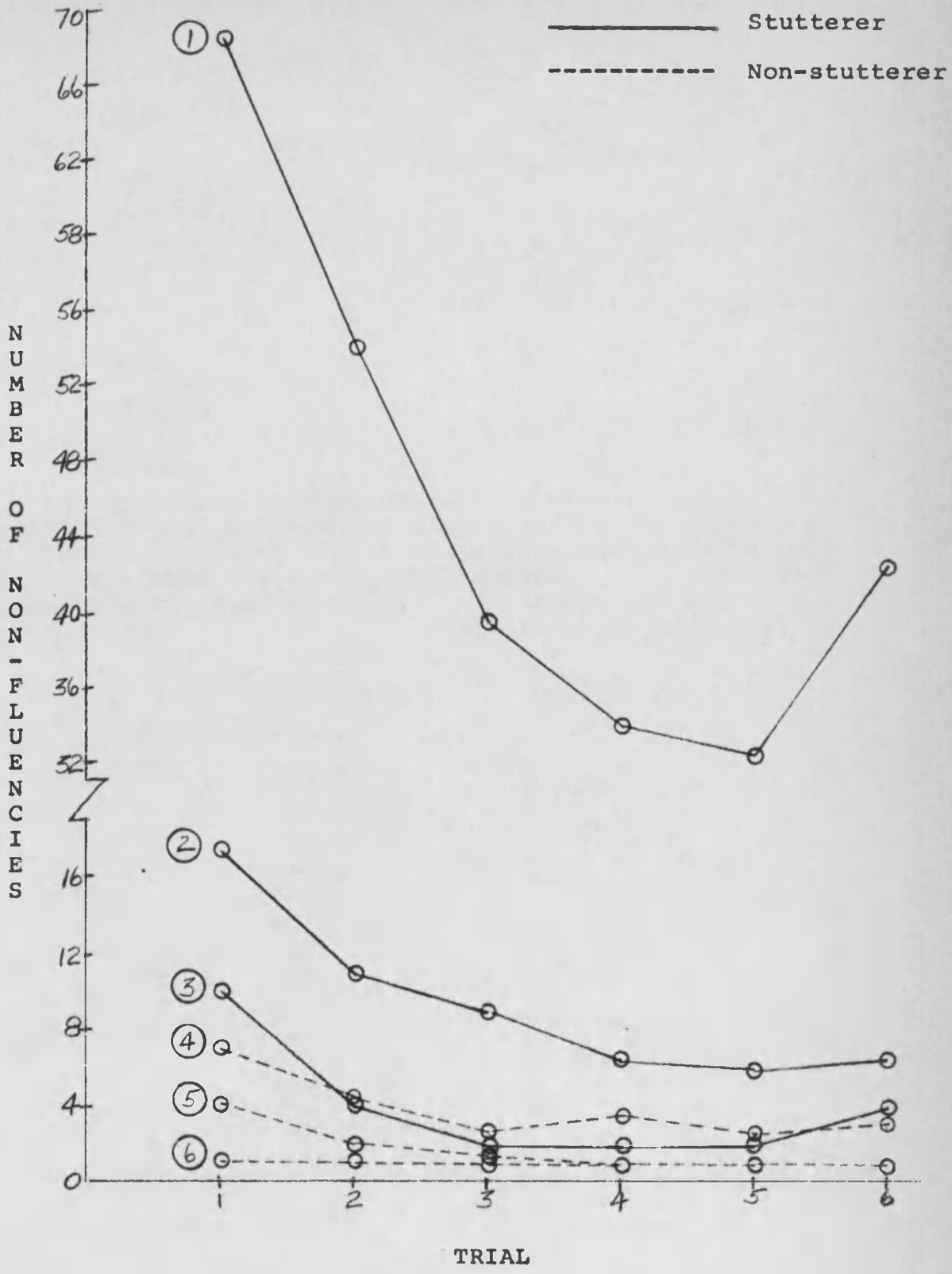
The groups were then divided into six sub-groups: mild, moderate, and severe stutterers, and mild, moderate, and severe non-stutterers. This classification was based on the frequency of non-fluencies on the initial reading trial. Table 6 presents the sum and median values for the six sub-groups. When plotted together, as in Figure 5, the six sub-groups appear to demonstrate that stuttering and non-fluencies lie on a continuum. The sub-groups are placed in order on the continuum as follows: (1) mild non-fluencies, (2) moderate non-fluencies, (3) severe non-fluencies, (4) mild

stuttering, (5) moderate stuttering, and (6) severe stuttering. It is interesting to note that the mild and moderate non-stutterers converged on the continuum after trial three. Also, the severe non-stutterers and mild stutterers appeared to occupy the same position on the continuum.

TABLE 6.--Sum and Median Values of Non-fluencies for 29 Stutterers and 29 Non-stutterers over Six Trials. Subjects Divided into Groups: (1) Severe Stutterers, (2) Moderate Stutterers, (3) Mild Stutterers, (4) Severe Non-stutterers, (5) Moderate Non-stutterers, and (6) Mild Non-stutterers

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Severe						
Sums	760.0	570.0	450.0	412.0	377.0	467.0
Medians	68.5	54.0	39.5	34.0	32.5	42.5
(2) Moderate						
Sums	187.0	116.0	85.0	68.0	64.0	79.0
Medians	17.5	11.0	9.0	6.5	6.0	6.5
(3) Mild						
Sums	74.0	44.0	27.0	17.0	14.0	33.0
Medians	10.0	4.0	2.0	2.0	2.0	4.0
Non-stutterers						
(4) Severe						
Sums	83.0	43.0	25.0	38.0	25.0	36.0
Medians	7.0	4.5	2.5	3.5	2.0	3.0
(5) Moderate						
Sums	39.0	27.0	16.0	13.0	13.0	12.0
Medians	4.0	2.0	1.5	1.0	1.0	1.0
(6) Mild						
Sums	14.0	13.0	10.0	8.0	7.0	10.0
Medians	1.0	1.0	1.0	1.0	1.0	1.0

Fig. 5.--Median Non-Fluency Responses for 29 Stutterers and 29 Non-stutterers Divided into Six Groups According to Initial Oral Reading Scores: (1) Severe Stutterers, (2) Moderate Stutterers, (3) Mild Stutterers, (4) Severe Non-Stutterers, (5) Moderate Non-stutterers, and (6) Mild Non-stutterers.


Stutterer
Non-stutterer
NUMBER OF NON-FLUENCIES
70
66
62
58
56
52
48
44
40
36
32
16
12
8
4
0
1
2
3
4
5
6
TRIAL

Further findings were revealed when the time of weight sensation was plotted for the mild, moderate, and severe sub-groups of stuttering and non-fluency. The results, as shown in Table 7, are plotted in seconds in Figures 6 and 7. In Figure 8, the sub-groups of stutterers are plotted for touch sensation time in sums, since they appeared to give a truer illustration of the process. They are, however, to represent quantitative, not qualitative, data. Inter-group comparisons between the groups were accomplished by randomly eliminating two stutterers and two non-stutterers, creating three groups of nine subjects each. Statistical analysis by the Friedman Two-Way Analysis of Variance and the Wilcoxon Matched-Pairs Signed-Ranks Test revealed significant differences between the moderate and severe stutterers on trial one and between the moderate and mild stutterers on trials one and five. No significant differences were found between any of the groups on trials five and six as shown in Table 8.

Inter-group comparisons of the non-stutterers revealed significant differences in weight adaptation between the mild and moderate and mild and severe non-fluency groups on trials three, four, five, and six. The time of weight adaptation for the moderate non-stutterers was found to be significantly shorter than that for the severe non-stutterers on trials four and six. These results are summarized in Table 9.

TABLE 7.--Sum and Median Values of Touch Adaptation in Seconds over Six Trials for 29 Stutterers and 29 Non-stutterers. Groups Divided According to Initial Oral Reading Trial: (1) Severe Stutterers, (2) Moderate Stutterers, (3) Mild Stutterers, (4) Severe Non-stutterers, (5) Moderate Non-stutterers, and (6) Mild Non-stutterers

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Severe:						
Sums	162.82	232.09	127.78	122.58	131.61	219.36
Medians	14.39	16.65	11.52	13.17	11.85	16.54
(2) Moderate:						
Sums	232.84	364.75	268.16	294.19	275.55	297.80
Medians	15.33	14.28	10.70	6.82	13.93	14.11
(3) Mild:						
Sums	205.41	213.95	136.95	206.20	128.76	270.72
Medians	17.29	11.75	10.41	18.83	15.84	10.98
Non-stutterers						
(4) Severe:						
Sums	315.72	266.08	156.60	126.84	132.54	174.04
Medians	22.29	16.80	7.87	12.71	10.56	13.28
(5) Moderate:						
Sums	213.23	185.93	163.22	106.43	187.39	204.00
Medians	15.73	13.93	10.23	10.02	11.15	14.19
(6) Mild:						
Sums	365.40	311.27	246.63	275.39	243.38	318.37
Medians	28.70	15.70	26.57	31.60	23.43	35.00

Fig. 6.--Median Time of Weight Sensation in Seconds for 29 Stutterers Divided into Groups According to Initial Oral Reading Trial: (1) Severe, (2) Moderate, and (3) Mild.

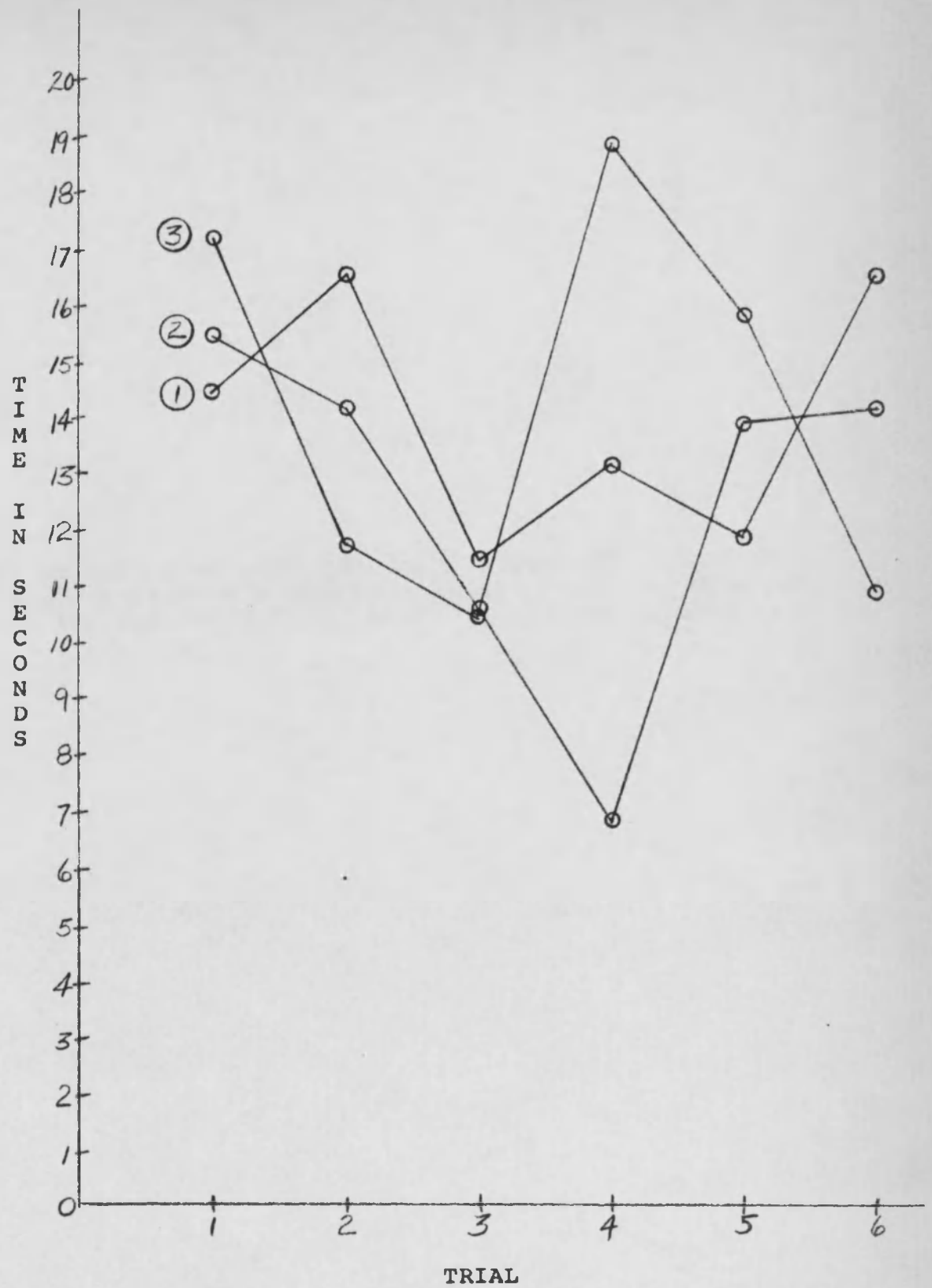

20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
TIME IN SECONDS
1
2
3
4
5
6
TRIAL
3
2
1

Fig. 7.--Median Time of Weight Sensation in Seconds for 29 Non-stutterers Divided into Groups According to Initial Oral Reading Trial: (1) Severe, (2) Moderate, and (3) Mild.

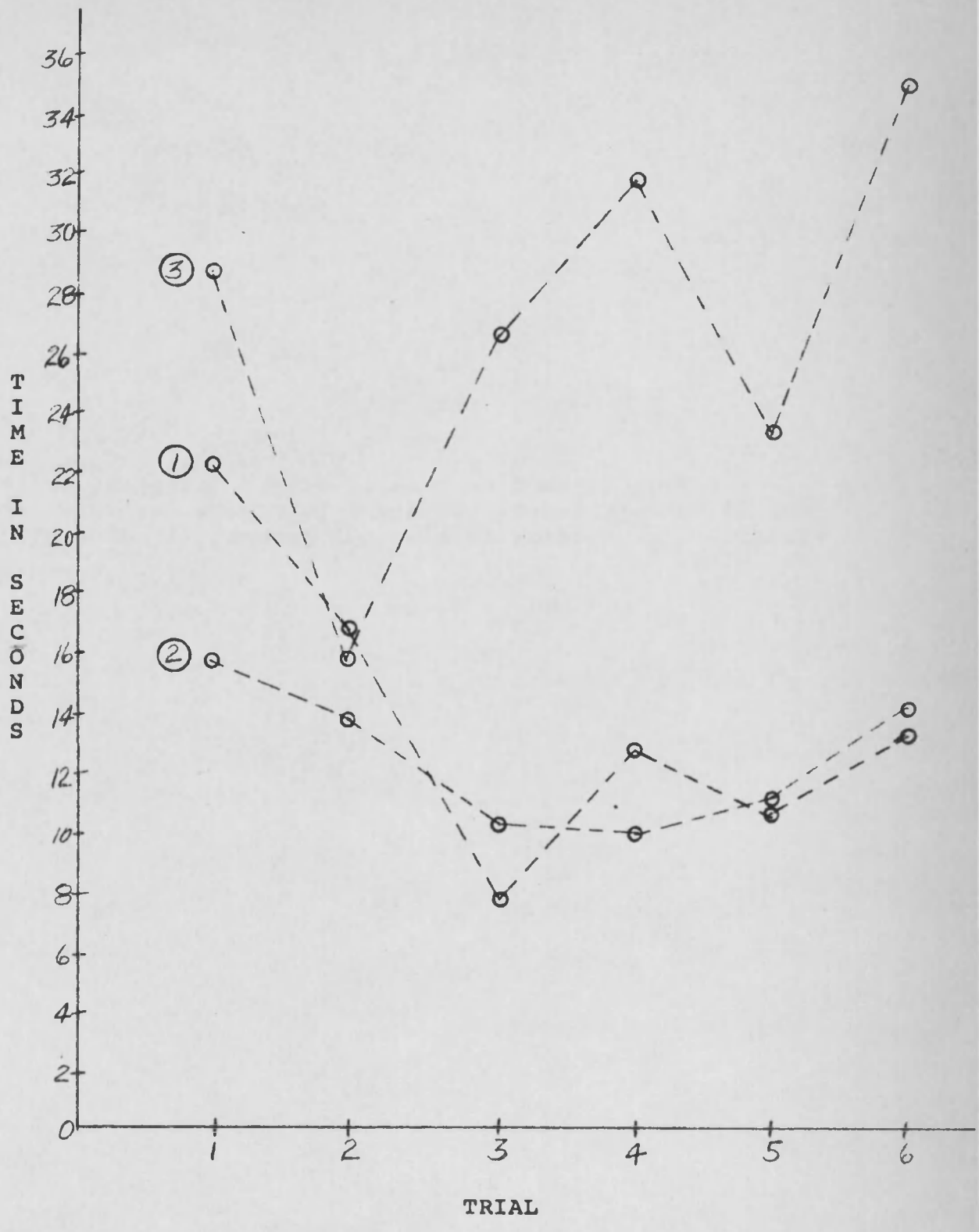

TIME IN SECONDS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
1
2
3
4
5
6
TRIAL
1
2
3

Fig. 8.--Sum Time of Weight Sensation in Seconds for 29 Stutterers Divided into Groups According to Initial Oral Reading Trial: (1) Severe, (2) Moderate, and (3) Mild.

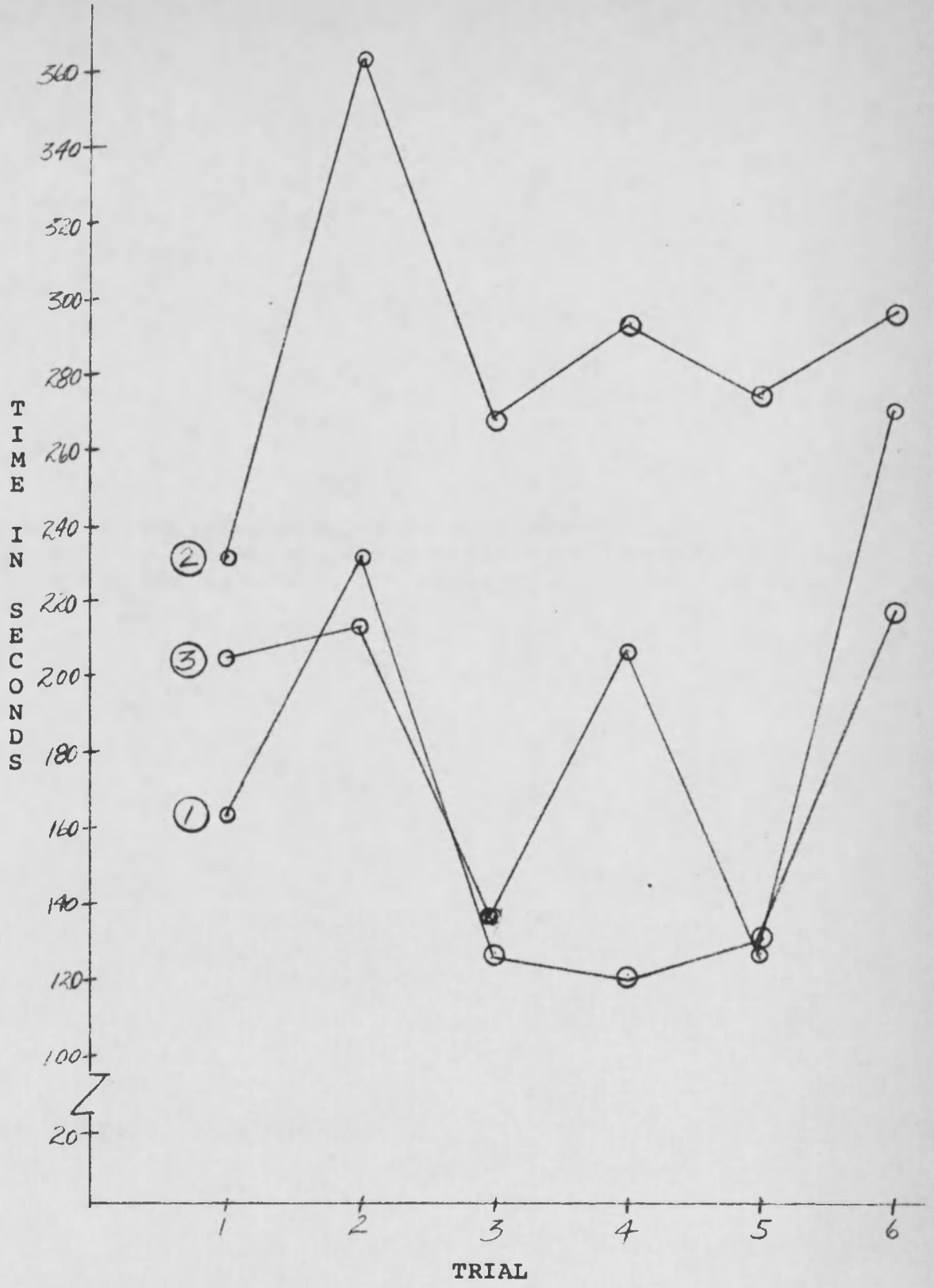

360
340
320
300
280
260
240
220
200
180
160
140
120
100
20
TIME IN SECONDS
2
3
1
1
2
3
4
5
6
TRIAL

TABLE 8.--Inter-group Comparison of Weight Sensation in Seconds for Severe, Moderate, and Mild Stutterers via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Groups	T-Score
1	Severe vs. Moderate	6[a]
1	Moderate vs. Mild	23
1	Severe vs. Mild	1
2	Severe vs. Moderate	30
2	Moderate vs. Mild	0
2	Severe vs. Mild	11
3	Severe vs. Moderate	13
3	Moderate vs. Mild	8
3	Severe vs. Mild	17
5	Severe vs. Moderate	8
5	Moderate vs. Mild	5
5	Severe vs. Mild	24
6	Severe vs. Moderate	13
6	Moderate vs. Mild	10
6	Severe vs. Mild	30

[a]Maximum T-Score for .05 level of significance is 6.

TABLE 9.--Inter-group Comparisons of Weight Sensation in Seconds for Severe, Moderate, and Mild Non-stutterers via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Groups	T-Score
1	Severe vs. Moderate	10[a]
1	Moderate vs. Mild	10
1	Severe vs. Mild	30
3	Severe vs. Moderate	15
3	Moderate vs. Mild	3
3	Severe vs. Mild	3
4	Severe vs. Moderate	2
4	Moderate vs. Mild	1
4	Severe vs. Mild	1
5	Severe vs. Moderate	13
5	Moderate vs. Mild	3
5	Severe vs. Mild	3
6	Severe vs. Moderate	1
6	Moderate vs. Mild	1
6	Severe vs. Mild	0

[a]Maximum T-Score for .05 level of significance is 6.

In Figures 9 and 10, the frequency of non-fluencies were plotted for the longest, medium, and shortest duration sub-groups of weight sensation. Table 10 presents the sum and median values for Figures 9 and 10. Statistical comparisons of the three sub-groups of stutterers and non-stutterers yielded non-significant differences except for the medium and shortest groups of non-stutterers on trial six. These results are summarized in Tables 11 and 12.

TABLE 10.--Sum and Median Values of Oral Reading Non-fluencies for 29 Stutterers and 29 Non-stutterers over Six Trials. Subjects Divided into Six Groups According to Initial Trial of Weight Sensation: (1) Longest Duration, (2) Medium Duration, (3) Shortest Duration for Stutterers; and (4) Longest Duration (5) Medium Duration, (6) Shortest Duration for Non-stutterers

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Stutterers						
(1) Longest Duration:						
Sums	349.0	244.0	179.0	162.0	160.0	197.0
Medians	15.0	13.0	9.5	5.5	5.0	7.5
(2) Medium Duration:						
Sums	352.0	272.0	213.0	185.0	161.0	207.0
Medians	18.5	13.0	11.0	10.0	7.5	10.5
(3) Shortest Duration:						
Sums	320.0	214.0	170.0	150.0	134.0	175.0
Medians	25.0	11.0	10.0	8.0	8.0	8.0
Non-stutterers						
(4) Longest Duration:						
Sums	40.0	27.0	21.0	18.0	15.0	20.0
Medians	4.0	2.0	2.0	1.0	1.5	2.0
(5) Medium Duration:						
Sums	51.0	30.0	13.0	20.0	19.0	13.0
Medians	4.0	1.5	1.0	1.0	1.0	1.0
(6) Shortest Duration:						
Sums	45.0	26.0	17.0	21.0	11.0	25.0
Medians	3.0	2.0	2.0	2.0	1.0	3.0

Fig. 9.--Median Non-fluency Responses for 29 Stutterers Divided into Groups According to Initial Touch Sensation Trial: (1) Longest Duration, (2) Medium Duration, and (3) Shortest Duration.

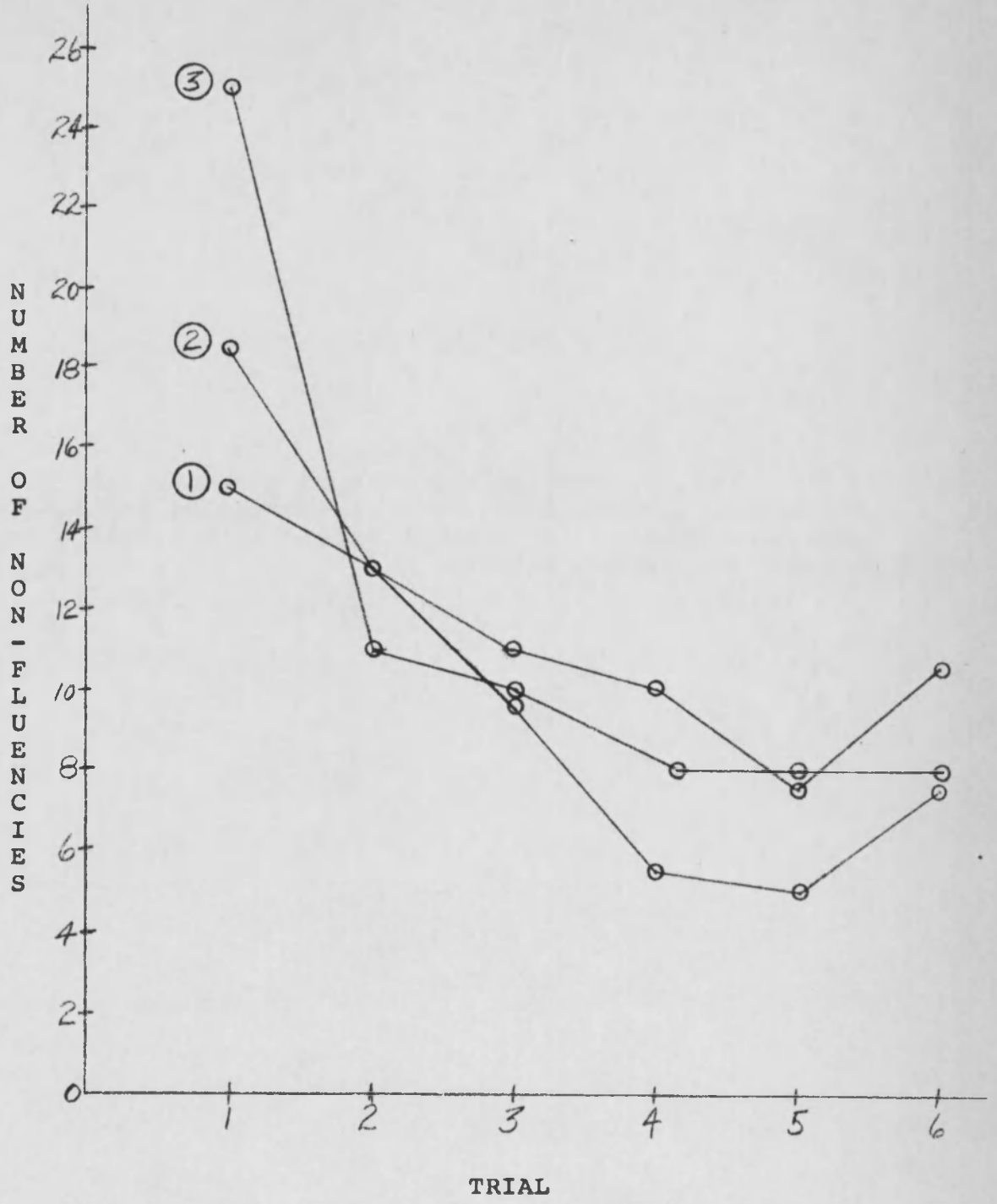

NUMBER OF NON-FLUENCIES
26
24
22
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
TRIAL
3
2
1

Fig. 10.--Median Non-fluency Responses for 29 Non-stutterers Divided into Groups According to Initial Touch Sensation Trial: (1) Longest Duration, (2) Medium Duration, and (3) Shortest Duration.

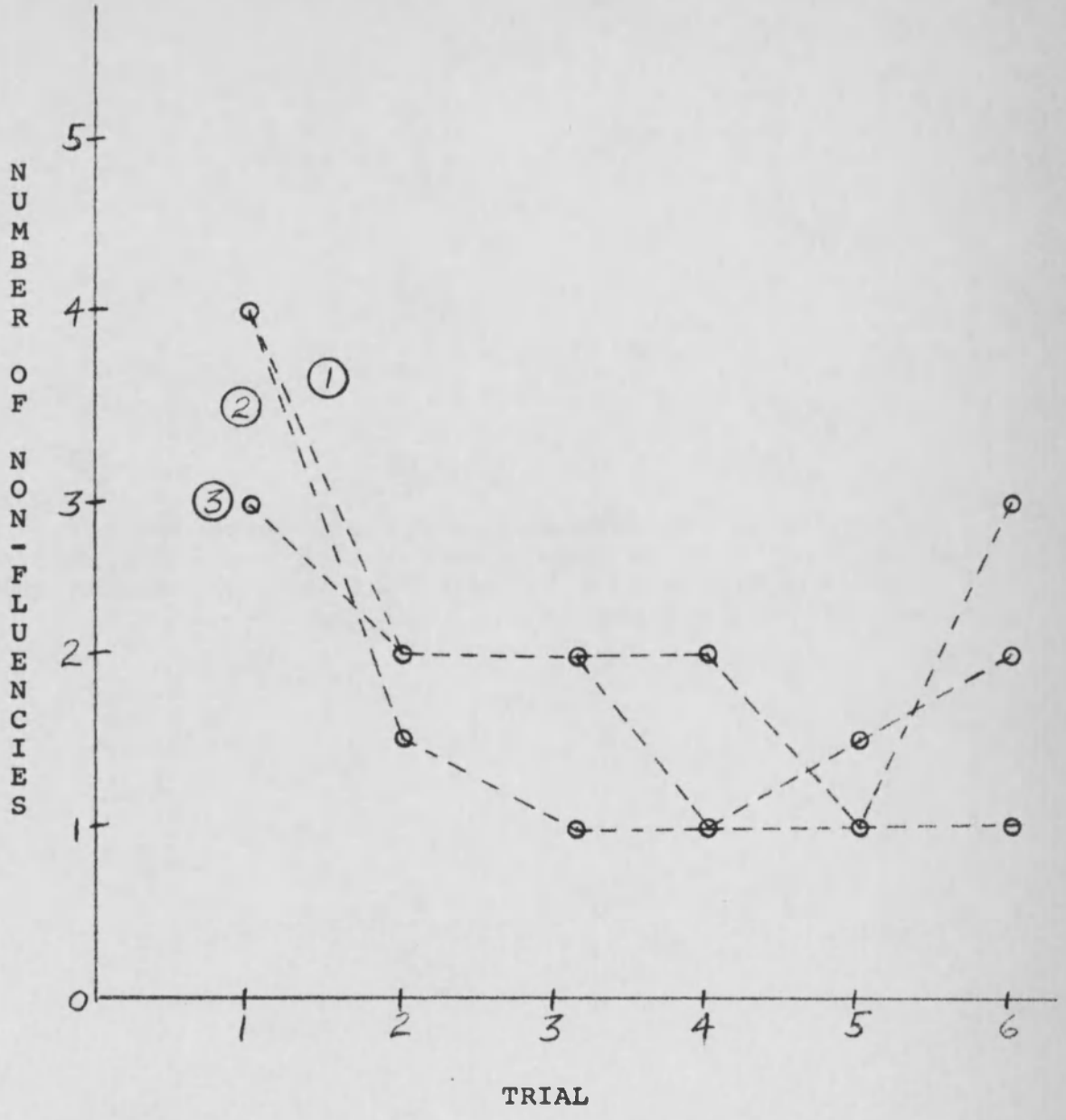

NUMBER OF NON-FLUENCIES
0
1
2
3
4
5
1
2
3
4
5
6
TRIAL
1
2
3

TABLE 11.--Inter-group Comparisons of Non-fluencies for Stutterers According to Longest, Medium, and Shortest Duration of Weight Sensation via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Groups	T-Score	Maximum T-Score for .05 level of significance
1	Longest vs. Medium	16.0	4
1	Medium vs. Shortest	25.0	6
1	Longest vs. Shortest	16.5	4
2	Longest vs. Medium	9.0	--[a]
2	Medium vs. Shortest	8.0	6
2	Longest vs. Shortest	5.5	4
5	Longest vs. Medium	11.0	4
5	Medium vs. Shortest	7.0	4
5	Longest vs. Shortest	9.5	6
6	Longest vs. Medium	8.0	6
6	Medium vs. Shortest	7.0	6
6	Longest vs. Shortest	12.0	6

[a]N insufficient for analysis via the Wilcoxon Test.

TABLE 12.--Inter-group Comparisons of Non-fluencies for Non-stutterers According to Longest, Medium, and Shortest Duration of Weight Sensation via the Wilcoxon Matched-Pairs Signed-Ranks Test

Trial	Groups	T-Score	Maximum T-Score for .05 level of significance
1	Longest vs. Medium	10.0	2
1	Medium vs. Shortest	16.0	4
1	Longest vs. Shortest	2.5	0
5	Longest vs. Medium	7.5	--[a]
5	Medium vs. Shortest	0	--
5	Longest vs. Shortest	9.0	4
6	Longest vs. Medium	9.0	6
6	Medium vs. Shortest	2.5	6
6	Longest vs. Shortest	0	--

[a]N insufficient for analysis via the Wilcoxon Test.

Discussion

An examination of the raw data from the six trials of touch stimulation revealed that both stutterers and non-stutterers exhibit a decreasing response pattern over the first five trials. This indicated that with each successive trial, the subjects sensed the weight for shorter periods of time or were adapting to the weight. Both groups generated similarly appearing curves, with non-significant reversals in direction on trials two and four. The stutterers exhibited a significant rise in time of weight sensation between trials five and six, indicative of spontaneous recovery of weight sensation. Although not statistically significant, the non-stutterers also demonstrated a rise in time following the rest interval. It can be concluded from the results of inter-trial and inter-group comparisons that both stutterers and non-stutterers exhibit a similar adaptation and recovery process for touch sensation over six trials.

From the available literature on touch adaptation, it is interesting to note that touch adaptation appears to never have been reported with a relatively constant situation. That is, a variable of weight diameter, weight pressure, body surface, or weight amount has been altered to obtain an adaptation process. However, the results of this study indicate that a significant reduction in time

of weight sensation for both stutterers and non-stutterers can be evoked with a relatively constant testing situation.

The raw scores on the oral readings over six trials indicated a progressive reduction in non-fluencies for both stutterers and non-stutterers. The course over the first five trials for the stutterers appeared to be a deep sloping curve with a rapid decrease in non-fluencies (stuttering moments) from trial one to trial two and a gradual decline from trials two to five. The non-stutterers demonstrated a much flatter curve over the first five trials as compared to the same curve of the stutterers. Statistical analysis between trials one and five yielded significant adaptation effects for both groups. The stutterers exhibited significant spontaneous recovery of non-fluencies between trials five and six. The non-stutterers appeared to manifest an increase in non-fluencies from trials five to six. However, analysis by the Wilcoxon Test revealed no significant difference.

When the stutterers and non-stutterers were divided into sub-groups of severe, moderate, and mild, and plotted graphically, an interesting detail was noted. The stuttering and non-fluencies of the subjects appeared to lie on a continuum in the following order: (1) mild non-stutterers, (2) moderate non-stutterers, (3) severe non-stutterers, (4) mild stutterers, (5) moderate stutterers,

and (6) severe stutterers. The severe and moderate stutterers appeared to have more non-fluencies than the other groups. The initial level of non-fluencies for the non-stutterers was lower than that for the stutterers. Since the initial level was so low for the non-stutterers, the non-fluencies on successive trials could not reduce or recover to any great extent. For this reason, the curves for the non-stutterers appeared much flatter than those for the stutterers. Thus, the depth of the curve appeared dependent upon the initial level of non-fluencies. It was also noted that the severe non-stutterers and mild stutterers appeared to occupy approximately the same position on the continuum, indicating that both groups manifested approximately the same number of non-fluencies over the six oral reading trials. It can be concluded from these findings that both stutterers and non-stutterers demonstrate significant adaptation effects, disparate only in the number of non-fluencies. These findings were found to be in complete agreement with Karmen's results (20, p. 69).

Comparisons were then made to observe how the groups of stutterers (mild, moderate, and severe) performed on the touch task. The raw scores in time of weight sensation were divided according to the initial reading scores. As shown in Figure 7, it appeared that the moderate stutterers displayed longer adaptation time than the severe or mild

stutterers and that the severe stutterers took the shortest time to adapt to the weight. Inter-group comparisons revealed that the moderate stutterers exhibited a significantly longer adaptation time than the mild stutterers on trial one. The severe and mild stutterers appeared to have similar curves, with a significant difference demonstrated only on the first trial. It is interesting to note that the curves from this study are remarkably similar in configuration to Karmen's same grouping on anxiety scores (20, p. 80). The differentiation between the moderate and mild and the moderate and severe stutterers found in both studies appears to have established some trend and disparity within the sub-groups of stutterers; setting apart the moderate group as a separate class.

In viewing the graphic illustration of the non-stutterers' time duration plotted according to severe, moderate, and mild non-fluencies, a similar disparity between groups was observed. The sub-groups appeared similar in direction on all trials, with an apparent separation of the mild non-stutterers from the severe and moderate non-stutterers on trials three to six. Inter-group comparisons indicated that the mild group displayed significantly longer adaptation time on trials three, four, five, and six than the moderate and severe group. The moderate non-stutterers, on the other hand, were found to be significantly faster in

touch adaptation than the severe non-stutterers on trials four and six. Thus, the sub-groups all appeared similar in form, with the mild non-stutterers set apart as a distinct class.

These experimental findings appear to warrant further investigation with the sub-groups of moderate stutterers and mild non-stutterers according to performance and behavioristic similarities. Further research in the area of stuttering appears warranted by the findings of this investigation and Karmen's. The findings that the moderate stutterers appear to be a disparate and distinct group indicate a possible diagnostic classification of stutterers. In addition, a diagnostic classification would appear to warrant consideration of therapy more accurately designed for individual differences.

From these experimental findings, it can be hypothesized that the adaptation and recovery evidenced in stuttering and touch sensation are similar in form. It can further be hypothesized that adaptation and recovery in these two behaviors are similar for stutterers and non-stutterers.

Since the findings of this study revealed that two independent behaviors bear similarities in form, perhaps a similarity also exists in the causal mechanism. Wischner also investigated two independent adaptational classes, stuttering and experimental extinction of learned responses,

but compared one in terms of the other--stuttering in terms of learning. He found certain characteristics evidenced in both behaviors. Restricted by his construct of describing stuttering in terms of learning, and unable to identify the reinforcement withdrawn during stuttering adaptation, he assumed that a common mechanism underlay both behaviors. This learning theory is one of the several theories within the science of speech pathology explaining the causal agent underlying stuttering adaptation.

The theoretical consideration of the causal factor underlying touch adaptation has been disputed and discussed by several investigators. Touch adaptation has generally been held to be a consequence of some modification of the sensory-end organs which is considered a fatigue process (26, p. 307). Some investigators believe that it is a fatigue phenomenon of the receptor or end-organ which causes adaptation. Nafe and Wagoner (27) have theorized adaptation to be due to the movement of the adjusting tissues to the stimulus. They reject fatigue as a feasible explanation and state that "adaptation is due to loss of effectiveness of the stimulus rather than to any loss on the part of the end-organ" (27, p. 320).

Many behavioral classes have been found to demonstrate adaptation and recovery. It was assumed that if these behavioral classes were viewed collectively, each response pattern

would be similar to the other response patterns. Based on the conclusions of this study and Wischner's research program, it appears that stuttering adaptation, experimental extinction, and touch adaptation are similar in form. The findings that similarities in course existed between these three adaptational behaviors and possibly all adaptational behaviors suggested that the antecedent factors currently thought to govern stuttering adaptation should be re-evaluated. That is, the lawful relationships which govern the dynamics of stuttering adaptation might be quite similar to those in experimental extinction, touch adaptation, and any other adaptational behavior. Therefore, it is hypothesized that there is a commonalty not only in course--adaptation and recovery--but in the basic behavioral laws underlying all adaptational behaviors.

Since adaptation is generally described as an adjustment process by an organism to a continuing stimulus, and it has been found in many forms of animal life, it is further hypothesized that the common causal agent is a basic biological mechanism. More specifically, this biological mechanism appears to be a homeostatic process, which acts as a balance mechanism allowing the organism to respond as efficiently as possible to an on-going stimulus situation. From this hypothesis, one might be led to speculate that measurement of this adjustment process may be the diagnostic

tool for future categorization of stutterers. Also, extensive investigation into this adjustment process may indicate a need for differential therapy techniques employed with an individual or group of stutterers.

Summary

From the data obtained in this study the following conclusions were made:

1. Both stutterers and non-stutterers demonstrated significant adaptation over five successive trials of touch sensation.

2. Both stutterers and non-stutterers (to a lesser extent) manifested spontaneous recovery of touch sensation.

3. Both stutterers and non-stutterers demonstrated a significant adaptation effect over five oral reading trials.

4. Spontaneous recovery was manifested by the stutterers and non-stutterers (to a lesser extent) on the sixth oral reading trial.

5. The moderate stutterers exhibited longer weight adaptation time than the severe and mild stutterers. In addition, the mild non-stutterers exhibited longer adaptation time for the weight than the moderate and severe non-stutterers.

Within the design of this study the following hypotheses were postulated:

1. Adaptation and recovery of stuttering and touch sensation over six successive trials are similar in form.

2. Adaptation and recovery in stuttering and touch sensation are similar for stutterers and non-stutterers.

3. A common biological mechanism determines not only the course of the adaptation and recovery processes for stuttering and touch adaptation, but for all adaptational behaviors as well.

CHAPTER V

SUMMARY

Research within the science of speech pathology has revealed two phenomena to occur in stuttering behavior. These phenomena have been termed the adaptation effect and spontaneous recovery. Stuttering adaptation refers to the progressive reduction in stuttering moments during repeated readings of the same passage. Spontaneous recovery refers to the increase in stuttering moments after a delay interval is introduced following adaptation. Investigators have found adaptation and recovery to occur in varying degrees when certain situational variables are altered. They have also found adaptation to be manifested in the speech of stutterers and non-stutterers.

A review of the literature has shown adaptation and recovery to occur in many behaviors. It has been noted that if these classes were viewed collectively, the response patterns would be similar in their course. From these behaviors, it appears that Wischner selected two--stuttering and experimental extinction--and investigated their course and characteristics. From his findings, he hypothesized that stuttering adaptation was representative of an experimental

extinction process. Since he was unable to identify the reinforcement withdrawn during the extinction of stuttering response, he was unable to obtain experimental support for his hypothesis. He assumed, therefore, that the mechanisms underlying both behaviors were similar. In light of Wischner's construct, it appeared that another response class demonstrating adaptation and recovery could be compared to stuttering to observe if similarities exist. Therefore, this investigation was designed to observe two independent adaptational classes--stuttering and touch--and to investigate their similarities. A second purpose was to compare the response patterns between stutterers and non-stutterers.

Twenty-nine stutterers and a matched group of 29 non-stutterers participated in two tasks for this study. Both tasks--oral reading and touch sensation--were conducted in a similar manner. Each task consisted of six successive trials. A delay interval of one-half the total time for the first five trials was introduced between the fifth and sixth trial. Touch adaptation was measured as the duration in seconds of weight or touch sensation for each subject over five trials. In the oral reading task, non-fluencies of both stutterers and non-stutterers were recorded as any visual or audible interruptions during the reading of a 300-word passage. The results of the touch sensation measurement and

the scores of the oral readings were both analyzed as separate processes.

The experimental findings of this study revealed that both stutterers and non-stutterers demonstrate a significant adaptation in both the oral reading and touch sensation tasks over five trials. The stutterers and, to a lesser extent, the non-stutterers also were found to exhibit spontaneous recovery in both tasks. When the oral reading scores were divided into six groups of mild, moderate, and severe stutterers and non-stutterers, stuttering and non-fluencies were found to lie on a continuum, with mild stutterers on one end and severe stutterers on the other.

When the sub-groups of stutterers (mild, moderate, and severe) were plotted according to their time of weight sensation, the moderate group appeared to be disparate. Statistical analysis revealed that the moderate group had significantly longer sensation time than did the severe and mild stutterers. These findings appeared to be in complete agreement with Karmen's grouping on anxiety. Further research in the diagnostic classification of stutterers appeared warranted from these findings.

From the data collected in this investigation and through statistical analysis, it was hypothesized that stuttering adaptation and touch adaptation were similar in course.

It was further hypothesized that the response patterns of stutterers and non-stutters were similar in both behaviors.

Since Wischner appeared to have inconclusive support for his hypothesis, and the response patterns of all adaptational behaviors appear similar in course, it was hypothesized that a common causal agent was underlying all adaptational classes. It was further hypothesized that this common causal agent was a biological mechanism. This hypothesis was based on the findings that adaptation and recovery have been found to occur in all form of animal life--vertebrate and invertebrate. It was suggested that the biological mechanism was a regulating mechanism which determined the adjustment of an organism to a continuous stimulus situation. It was also suggested that further research of the biological mechanisms may find it to be a necessary diagnostic tool for the categorization of stutterers.

APPENDIX A

NAME, AGE, SEX, AND GENERAL EDUCATIONAL BACKGROUND FOR 29 STUTTERERS AND 29 NON-STUTTERERS

Subj. No.	Name	Age	Sex	Group	Education
1	DB	22 yrs. 3 mos.	M	Stutterer	College
2	PC	22 yrs. 6 mos.	M	Non-stutterer	College
3	JB	21 yrs. 11 mos.	M	Stutterer	College
4	PD	21 yrs. 5 mos.	M	Non-stutterer	College
5	GC	20 yrs. 2 mos.	M	Stutterer	College
6	DY	21 yrs. 3 mos.	M	Non-stutterer	College
7	BC	15 yrs. 8 mos.	M	Stutterer	High School
8	DM	15 yrs. 8 mos.	M	Non-stutterer	High School
9	RC	29 yrs. 5 mos.	M	Stutterer	College
10	DP	29 yrs. 10 mos.	M	Non-stutterer	College
11	WD	26 yrs. 11 mos.	M	Stutterer	College
12	BD	26 yrs. 5 mos.	M	Non-stutterer	College
13	PF	29 yrs. 0 mos.	M	Stutterer	College
14	RM	29 yrs. 3 mos.	M	Non-stutterer	College
15	JF	20 yrs. 7 mos.	M	Stutterer	College
16	MM	20 yrs. 7 mos.	M	Non-stutterer	College
17	BF	28 yrs. 7 mos.	M	Stutterer	College
18	PL	28 yrs. 2 mos.	M	Non-Stutterer	College
19	AG	22 yrs. 1 mo.	M	Stutterer	College
20	JL	22 yrs. 4 mos.	M	Non-stutterer	College
21	LG	15 yrs. 3 mos.	M	Stutterer	High School
22	CA	15 yrs. 5 mos.	M	Non-stutterer	High School
23	AG	15 yrs. 8 mos.	M	Stutterer	High School
24	RL	15 yrs. 9 mos.	M	Non-stutterer	High School
25	GG	25 yrs. 0 mos.	M	Stutterer	College
26	BH	26 yrs. 4 mos.	M	Non-stutterer	College
27	TH	15 yrs. 8 mos.	M	Stutterer	High School
28	RC	15 yrs. 3 mos.	M	Non-stutterer	High School
29	LH	22 yrs. 6 mos.	M	Stutterer	College
30	FA	22 yrs. 11 mos.	M	Non-stutterer	College
31	EH	24 yrs. 9 mos.	M	Stutterer	College
32	DS	25 yrs. 3 mos.	M	Non-stutterer	College
33	HJ	21 yrs. 1 mo.	M	Stutterer	College
34	MS	21 yrs. 4 mos.	M	Non-stutterer	College
35	KL	21 yrs. 1 mo.	M	Stutterer	College

APPENDIX A--Continued

Subj. No.	Name	Age	Sex	Group	Education
36	DK	21 yrs. 1 mo.	M	Non-stutterer	College
37	LM	23 yrs. 8 mos.	M	Stutterer	College
38	ES	23 yrs. 6 mos.	M	Non-stutterer	College
39	RM	28 yrs. 1 mo.	M	Stutterer	College
40	KZ	28 yrs. 4 mos.	M	Non-stutterer	College
41	JM	20 yrs. 3 mos.	F	Stutterer	College
42	AW	20 yrs. 9 mos.	F	Non-stutterer	College
43	MM	35 yrs. 9 mos.	M	Stutterer	College
44	LW	26 yrs. 3 mos.	M	Non-stutterer	College
45	KR	26 yrs. 2 mos.	M	Stutterer	College
46	MG	27 yrs. 6 mos.	M	Non-stutterer	College
47	CS	15 yrs. 6 mos.	F	Stutterer	High School
48	MP	16 yrs. 2 mos.	F	Non-stutterer	High School
49	GT	19 yrs. 8 mos.	M	Stutterer	College
50	JC	20 yrs. 2 mos.	M	Non-stutterer	College
51	FT	16 yrs. 8 mos.	M	Stutterer	High School
52	JG	16 yrs. 11 mos.	M	Non-stutterer	High School
53	RU	17 yrs. 9 mos.	M	Stutterer	High School
54	SW	17 yrs. 3 mos.	M	Non-stutterer	High School
55	RW	21 yrs. 10 mos.	F	Stutterer	College
56	PB	21 yrs. 5 mos.	F	Non-stutterer	College
57	MW	17 yrs. 1 mo.	M	Stutterer	High School
58	RM	17 yrs. 2 mos.	M	Non-stutterer	High School

APPENDIX B

RAW SCORES IN SECONDS FOR 29 STUTTERERS AND 29 NON-STUTTERERS OVER SIX TOUCH SENSATION TRIALS

Name	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial Time	Delay Time
				Stutterers				
DB	13.09	8.11	4.73	5.88	9.40	5.19	41.11	20.55
JB	3.93	3.86	2.70	1.97	1.96	3.30	15.42	7.71
GC	5.10	8.98	12.03	14.59	22.02	24.45	62.72	31.36
BC	13.67	4.04	2.07	1.30	5.59	5.06	26.67	13.33
RC	45.79	31.22	50.42	43.65	52.88	56.02	223.96	111.98
WD	20.82	19.38	11.01	14.11	4.34	20.30	69.66	34.88
PF	10.20	5.08	4.37	3.81	4.24	9.72	27.70	13.85
JF	13.74	23.12	6.22	2.40	1.30	1.32	46.78	23.39
BF	10.75	7.72	4.11	3.51	6.43	4.81	32.42	16.21
AG	24.50	13.92	20.15	14.73	12.13	19.50	84.43	42.21
LG	6.70	5.85	4.60	3.70	2.59	2.10	22.44	11.22
AG	15.03	7.87	10.11	10.42	11.06	10.30	54.49	27.23
GG	7.08	3.21	6.88	3.28	5.71	9.44	26.16	13.08
TH	31.58	13.86	16.59	12.73	36.01	13.58	110.47	55.23
LH	25.53	9.42	8.09	6.90	9.32	10.98	59.26	28.03
EH	17.56	33.90	19.84	40.13	27.95	28.20	139.38	68.19
HJ	5.35	13.44	3.86	2.60	2.57	9.83	27.82	13.91
KL	27.00	55.01	49.47	73.43	27.22	58.32	232.13	116.06
LM	17.16	82.86	29.50	19.71	15.84	79.59	165.07	82.54
DM	7.84	34.91	8.70	7.60	19.10	12.84	78.15	39.07
JM	77.87	166.59	81.65	52.38	53.19	97.19	431.68	215.84
MM	41.75	26.31	10.41	40.09	22.88	64.57	141.44	70.72
KR	22.93	78.69	81.00	130.86	98.91	67.72	412.39	206.19
CS	12.28	26.88	13.92	13.61	11.90	65.15	77.59	38.79
GT	28.00	79.31	26.35	30.42	11.79	48.97	175.87	87.93
FT	17.29	15.50	10.63	18.83	19.81	6.62	82.06	41.03
RU	49.23	11.75	15.30	38.96	19.80	34.04	135.04	67.52
RW	25.79	15.11	16.66	7.76	18.45	18.38	83.77	41.88
MW	3.51	4.89	1.52	3.61	1.53	.74	15.06	7.53

APPENDIX B--Continued

Name	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial Time	Delay Time
				Non-stutterers				
PC	14.37	8.96	33.92	44.97	37.93	44.77	140.15	70.07
PD	7.34	4.43	5.72	4.64	3.26	4.81	25.39	12.69
DY	19.18	5.29	6.44	4.48	3.62	28.19	39.01	19.50
DM	10.68	16.10	6.23	8.89	3.10	4.98	45.00	21.50
DP	30.12	15.70	24.49	23.89	17.22	46.59	111.42	55.71
BD	13.63	17.97	9.99	17.38	9.91	75.48	68.88	34.44
RM	6.87	9.64	7.99	9.77	4.03	5.49	38.30	19.15
MM	133.47	59.57	75.15	31.60	63.66	86.10	243.55	121.77
PL	28.70	67.93	26.57	59.38	55.58	35.00	238.16	119.08
JL	85.43	31.55	34.59	35.49	33.95	26.38	221.01	110.50
CA	12.93	6.90	4.81	4.37	4.43	4.16	33.44	16.72
RL	29.43	17.50	16.27	12.04	24.76	16.15	100.00	50.00
BH	46.15	27.40	27.08	13.37	12.12	34.58	126.12	63.06
RC	9.29	5.46	3.03	1.30	1.15	9.17	20.23	10.11
FA	15.10	13.15	7.98	11.15	12.79	12.12	60.17	30.08
DS	7.59	11.61	11.08	15.49	6.43	10.98	52.20	26.10
MS	41.11	58.38	61.36	23.01	62.39	26.90	246.33	123.31
DK	73.98	71.02	57.35	28.78	22.86	44.06	253.99	126.99
ES	5.24	9.58	3.09	3.94	1.43	3.34	23.28	11.64
KZ	4.33	9.41	7.29	6.92	9.00	10.41	46.95	23.47
AW	40.72	14.70	15.22	14.43	18.81	12.15	103.88	51.44
LW	15.20	19.98	28.14	5.90	51.49	22.10	120.71	60.35
MG	15.44	11.45	5.45	4.25	2.43	1.40	39.07	19.53
MP	49.20	100.85	29.81	53.50	23.43	53.89	256.79	128.38
JC	90.30	80.17	7.98	16.28	26.22	18.32	220.95	110.47
JG	16.02	11.41	13.37	12.50	12.38	16.22	65.68	32.84
SW	33.13	17.51	17.83	18.34	20.86	33.49	107.67	53.83
PB	15.14	12.96	7.76	13.64	8.93	3.90	58.43	29.21
RM	23.90	26.70	10.46	8.88	9.14	5.28	79.08	39.54

APPENDIX C

RAW SCORES OF NON-FLUENCIES AND TRIAL TIME IN MINUTES FOR 29 STUTTERERS AND 29 NON-STUTTERERS OVER SIX ORAL READING TRIALS

Name	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial Time	Delay Time
				Stutterers				
DB	22	15	14	13	9	17	11:30	5:45
JB	57	40	18	12	8	11	10:55	5:28
GC	92	70	61	57	53	71	12:50	6:25
BC	8	4	2	2	1	4	9:00	4:30
RC	16	15	11	11	13	10	11:50	5:55
WD	126	101	99	86	87	96	26:40	13:20
PF	25	19	17	14	14	20	11:10	5:35
JF	72	57	23	19	18	12	12:40	6:20
BF	30	7	2	1	1	3	11:10	5:35
AG	112	77	32	25	8	26	20:05	10:03
LG	5	2	1	1	2	2	8:50	4:25
AG	55	42	36	27	20	35	11:10	5:35
GG	10	5	1	2	2	4	10:30	5:15
TH	84	60	64	66	75	84	23:10	11:35
LH	11	11	9	3	3	13	10:50	5:25
EH	15	11	8	7	6	9	11:30	5:45
HJ	17	9	10	8	9	8	9:30	4:45
KL	10	4	4	5	3	4	9:10	4:35
LM	2	3	3	1	0	0	12:20	6:10
RM	65	51	52	52	45	54	17:40	8:50
JM	18	19	10	6	6	5	10:30	5:15
MM	10	6	2	2	1	1	11:20	5:40
KR	11	4	1	2	1	1	8:50	4:25
CS	33	30	22	27	16	28	8:30	4:15
GT	64	42	43	41	47	50	13:00	6:30
FT	8	5	5	1	2	5	11:00	5:30
RY	10	4	0	0	0	0	10:40	5:20
RW	14	6	4	3	4	4	10:40	5:20
MW	19	11	8	3	1	2	9:50	4:55

APPENDIX C--Continued

Name	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial Time	Delay Time
				Non-stutterers				
PC	2	1	0	1	1	0	6:30	3:15
PD	10	5	4	4	4	6	9:20	4:40
DY	4	1	0	0	1	1	9:35	4:48
DM	6	2	0	3	0	2	10:02	5:01
DP	2	1	2	1	1	1	7:33	3:46
BD	3	0	2	1	0	1	11:45	6:13
RM	1	0	0	2	0	2	10:42	5:21
MM	1	2	1	1	0	1	9:16	4:38
PL	1	0	0	1	0	0	9:30	4:45
JL	1	1	0	0	1	0	10:00	5:00
CA	4	4	3	2	1	3	13:56	6:58
RL	19	8	7	10	9	7	10:02	5:01
BH	5	2	1	4	2	3	8:15	4:08
RC	3	2	1	1	1	3	7:35	3:48
FA	4	1	1	1	2	1	7:30	3:45
DS	2	5	2	1	1	2	9:15	4:38
MS	4	2	3	1	2	2	8:07	4:03
DK	8	6	3	5	3	3	9:11	4:35
ES	10	6	2	4	1	3	10:15	5:08
KZ	6	2	3	3	3	3	8:26	4:13
AW	4	4	2	1	1	2	8:00	4:00
LW	4	4	1	1	2	1	9:00	4:30
MG	3	8	1	2	1	0	8:58	4:29
MP	1	1	4	0	2	1	7:56	3:58
JC	8	3	1	3	1	3	9:48	4:54
JG	5	2	2	3	3	1	10:12	5:06
SW	6	5	4	2	2	4	9:30	4:45
PB	5	4	0	0	0	2	10:17	5:08
RM	4	1	1	1	0	0	8:16	4:08

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