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The Effects of Certain Drugs upon Personal Tempo

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THE EFFECTS OF CERTAIN DRUGS UPON PERSONAL TEMPO

by

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LIFE

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CHAPTER I

INTRODUCTION

The purpose of this study is to investigate certain temporal aspects of behavior. One of the rather unique aspects involved in investigating the time factor in behavior would seem to be the fact that knowledge of some of the temporal components in behavior may contribute to a fuller understanding of at least one of the processes underlying final, resultant behavior. In other words, the emphasis in such a study is not primarily upon what the subject does, but how he goes about doing it. It is possible that results obtained in temporal studies may have wide applicability, since all behavior is elicited within a temporal framework. Therefore, additional insight into this dimension might prove fruitful for a better psychological understanding of many different kinds of behavior.

Temporal aspects of behavior can be investigated within a number of different frameworks. It can probably be stated that psychologists have most often focused upon studies which emphasize the optimum rate at which a subject can respond. Thus, in reaction time studies, speed tests, etc., the experimental situation is so structured as to motivate the subject to respond as quickly as he can. However, psychologists have at times been criticized for making generalizations about behavior from results obtained in rather artificial, unrealistic experimental situations

(Goldstein, 1939). Individuals seldom respond in day to day situations with optimum speed, and usually react in a manner which is comfortable or "natural" for them. Furthermore, the "natural" temporal framework within which individuals respond may be markedly different from person to person. One individual may characteristically respond very quickly while another may prefer to adopt a slower, more deliberate temporal framework. Therefore, it would seem to be of value to investigate similarities and differences among individuals responding at their "natural" rate of speed.

The purpose of this thesis is to study temporal aspects of behavior elicited while the subject is responding in a manner which is assumed to be most comfortable and natural for him. The speed of responding which a subject adopts spontaneously has been called "personal tempo," and has been found by a number of investigators to be a very consistent aspect of personality (see REVIEW OF THE LITERATURE). In other words, the personal tempo which any individual adopts for performing certain tasks tends to remain constant throughout the entire time the individual is performing the task, and for successive performances of that task.

One of the questions which this suggests is that of the limits within which personal tempo remains constant, and under what conditions does it vary. The specific purpose of this thesis is to investigate the effects of drugs upon the consistency of certain measures of personal tempo. The problem is to determine whether or not the physiological and psychological changes produced by certain drugs are reflected in the individual's temporal organization of behavior.

CHAPTER II

REVIEW OF THE LITERATURE

One of the earliest studies pointing to the consistency of motor behavior was Allport and Vernon's Studies in Expressive Movements (1933). They indicated that both gesture and handwriting reflect a basically stable and constant individual style, and that the theories of specificity and identical elements are inadequate to account for the constancy obtained. They favor theories that postulate widespread generalization of motor function and which regard motion as a reflection of well organized dispositions in personality. They conclude that there is no uniform psychic tempo which pervades all activities, but rather postulate three broad speed factors: verbal, manipulative, and rhythmic.

Frischeisen-Kohler (1933) suggested that in order to better understand complex intellectual and psychic processes, one had to "start at the bottom and seize upon elementary functions." She felt that tempo is one such elementary function because it pervades all behavior. Furthermore, since most individuals become immediately aware of the fact that certain tempos are suitable while others are too slow or fast, she considered the possibility of there being a generalized tempo which characterizes different individuals.

In order to test this hypothesis, she had persons of all ages perform certain motor tasks, and counted the number of times they executed these

tasks within a certain period of time. The tasks she employed were tapping with the finger and foot and preferred metronome rate. The tapping tests were repeated four times within an interval of three or four days. The tests of preferred metronome rate were repeated eight times with an interval of two months between the first four and the last four repetitions. The results indicated that the inter-individual variability was far greater than the intra-individual variability. Although no attempt was made to retest the individuals under similar environmental conditions, their performance on the retests remained quite constant. Furthermore, it was found that the inter-relationships among the different tasks were high. In other words, an individual who tapped rapidly could be expected to prefer a faster metronome rate than an individual who tapped slowly. Finally, no reliable differences were found between different sexes and different ages. Therefore, Frischeisen-Kohler concluded that personal tempo was a stable and generalized personality characteristic. She attempted to go one step further and compared the personal tempos of monozygotic twins, bizygotic twins, brothers and sisters, and unrelated individuals. She found that the personal tempo of monozygotic twins were most similar, those of bizygotic twins and brothers and sisters were less similar, and the personal tempos of unrelated individuals were least similar. Therefore, she concluded that an individual's particular personal tempo was to a large extent determined by biological, genetic factors.

Conclusions similar to those of Frischeisen-Kohler were drawn by

Wu (1934) on the basis of both an intensive study of nine unselected persons for a period of ten weeks, and an extensive study of 26 unselected subjects for a single sitting. In both cases, the same six tests were used; they were foot tapping, counting numerals, finger tapping, poetry reading, observing octagons, and word counting. Correlations between the second and ninth, and the third and seventh sittings of the intensive study were computed; all the correlations of the six tempo tasks were positive, with a median value at .875 and .880, respectively. This was interpreted as clear evidence that in each of the six specific simple tests studied, an individual worked at his own characteristic rate or "personal tempo." In other words, an individual's relative standing in the group was fairly constant at all times. Furthermore, with the exception of the word writing test, the intercorrelations among the six tests were all positive, with a coefficient as high as .880 between the finger tapping and counting numerals tests. These results indicated a fairly consistent relationship of the personal tempo in the different tests (except word writing). In the extensive study of a larger group of subjects, the correlations were also positive.

Another aspect of the study involved having the same 26 persons who served in the extensive study respond to the same six tests as quickly as they could rather than in terms of a natural tempo. Once again the intercorrelation among the six tests were all positive. Thus, the author concluded that although no theoretical "g" factor could be demonstrated, there might be considered to be a "general phenomenon" in different tasks,

in the sense that there was always some element of community between any two of the six simple tasks studied. In other words, a person who was comparatively fast in one task might be expected to also be comparatively fast in others.

Finally, it was found that the intercorrelations between the six tasks performed at a natural rate of speed and at a maximum rate of speed were .19 $\pm$ .13. This, the author concluded, was evidence that for certain tasks which have more or less similar content, an individual's natural rate of work or "personal tempo" is somewhat related to his maximum speed.

However, other investigators disputed the probability of there being a generalized factor of speed or personal tempo. Lauer (1933), after comparing typical samplings of voluntary and involuntary rates found there was little relationship between specific response rates. He concluded that any tendency for bodily tempos to vary together, suggestive of a speed factor, would seem to hold only for habitual responses, if at all. Similarly, Foley (1937) indicated that speed of reactions was conditioned primarily by specific environmental factors. Data on the operation of physiological factors, age or motivational factors, sex differences, "constitutional" types, and "racial" types were negative or inconsistent. He concluded that, in general, correlational and factor pattern analysis supported a specificity interpretation rather than one based upon a "general factor" of speed.

One explanation for different authors coming to discrepant conclusions as to whether there is or is not a general speed factor may be the

fact that only a limited number of functions were investigated. In other words, a study of personal tempo which investigates only a few psychological functions may result in high intercorrelation among those functions tested; however, it may be unwarranted to generalize beyond those functions and hypothesize a general speed factor. In order to test this, Rimoldi (1951) included 59 tests representing a comprehensive range of psychological functions in a study of personal tempo. The tests were administered to 91 male subjects, ages 19-25 years. In order to determine test-retest reliability, rank-order correlation coefficients were obtained by retesting 17 of the subjects within a period varying between 15 and 30 days. The correlation coefficients were very high indicating the consistency of personal tempo over a period of time.

In order to investigate the possibility of a general speed factor, a factor analysis was performed. The data was factored to reveal nine factors, including speed of: large motion of trunk and limbs, small motions, drawing with feet, drawing with hands, perception, reaction time, and cognition. Therefore, it was concluded that it is not possible, on the basis of one or two isolated speeds, to predict speeds in other psychological functions with great accuracy. Non-motor speeds could not be predicted with any assurance from motor speeds. The postulation of a general, monistic factor of tempo that could be used for the purpose of prediction did not seem to agree with the experimental findings.

In spite of the discrepancies in the literature regarding the question of a general speed factor, one important point of agreement among almost

all studies is the consistency of the temporal framework within which certain tasks are performed. For instance, subjects performing ergographic work execute almost the same number of contractions per time unit independently of their state of fatigue (Rimoldi, 1946). In another study (Fraisse, Chambron, & Oleron, 1954), the constancy of motor rhythm was investigated on five adults, 23-50 years old. The subjects were tested at six different sessions, by means of two morse keys requiring pressures of 125 and 50 grams, respectively. Intra-individual variability was much less than the inter-individual variability. Speed of tapping was related to individual differences of the subjects more than to the differential exertion required by the two experimental tasks. In still another study (Mishima, 1951), 28 students acted as subjects in a series of conditions designed to measure "mental tempo" in visual and auditory perception, and in motor responses of tapping, figure motion, walking and drawing. The results indicated a lack of sex difference, a high correlation between the tempo on different days, and an apparent lack of distracting conditions. In other studies, temporal constancy has been reported as a casual observation of the experimenter (Buytendijk, 1947).

In view of the above mentioned evidence, it seems reasonable to conclude that the tempo which an individual spontaneously adopts in performing a particular task can be expected to ramin quite consistent over periods of time and in spite of numerous distracting conditions.

The value of allowing an individual to work at his own personal tempo or rhythm has been recognized by a number of studies on work efficiency.

In one study (Sivaden, 1955), the author postulates rhythm of movements as a fundamental factor in causing nervous fatigue. Each worker has his own personal rhythm; and industrial work, such as an assembly line, often violates this, as to both type and timing of motions. Kupke (1933) states that every rhythm in men's activities indicates their psychological adjustment to the work in progress. Definite work rhythm lowers initial inhibiting effects and those of boredom. With proper rhythmic action, work becomes easy and the need for great volitional effort is decreased. Finally, Harding (1932) in studies of the typewriting by trained typists of two test words showed that there was a general tendency to form time patterns or rhythms out of the key strokes. A positive relation existed between the degree to which this rhythm was stressed and the subject's capacity for rapid work. The subjects were divided into two groups, those who quickly established a clear rhythmic pattern in their typing, and those who did not. The former group, who established clear rhythmic patterns, typed approximately 13 per cent faster than did the latter group.

There is also some evidence of constant temporal units in animal behavior as reported by Schaefer (1959). Conrad, Sidman, and Herrnstein (1958) trained five rats and a rhesus monkey to space their responses at least 20 seconds apart. They reported that over a wide range of deprivations, little change in performance was noted.

Finally, there is some evidence that a lack of consistency in individuals' personal tempo may be suggestive of more generalized

personality disorganization. One investigator[1] reported that his personal observation indicated that those subjects whose personal tempo was most variable appeared to have more undesirable personality characteristics than those subjects whose personal tempo was consistent. Another author (Mishima, 1951) concluded that personal tempo showed a high constancy except in some subjects who had other signs of behavior disorder. This author suggested that measurement of mental tempo might be useful in clinical examination. In one formalized study (Gator, 1934), the tapping and counting rates and the choices of "agreeable" metronome rates of 53 normals were compared to 223 psychotic subjects. The psychotic subjects included 11 psychiatric classifications with schizophrenics and epileptics having the largest representation. It was found that large variability was characteristic of pathology. Epileptics were also found to tap at a faster rate than normals. In another study, Shakow and Huston (1949) found that, although schizophrenics' mean rate of tapping was not significantly different from that of normals, their average reaction time was significantly slower than that of normals.

There is one more area of temporal behavior which should be discussed, and that is the area of rhythmic structures, since one aspect of this study shall deal with the temporal structures of certain voluntary mots. The experiencing of rhythmic patterns appears to be a phenomenon often employing several sense modalities and is probably peculiar to

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[1] Rimoldi, H. J. A. Personal communication. 1959.

humans (Ruckmick, 1945). The experience is grounded in time, and in order to be complete requires more than one redition of a unit measure as a stimulating pattern. One of the essential characteristics of rhythm is the tendency to group separate items of experience into unitary wholes, thus enabling the individual to make order out of chaos and monotony. Thus, studies of rhythm would appear to reflect a Gestalt approach to temporal behavior, since by definition "the perception of rhythm arises with the organization in groups of successive discrete stimuli" (Fraisse, 1954, p. 39).

G. de Montpelier (1946) has suggested that there are in behavior natural rhythmic tendencies governed by regular laws. Fraisse (1946; 1956), on the basis of a number of studies, reports that this hypothesis appears to be confirmed. He reports that imposed rhythms corresponding closely to preferred, spontaneous structures are more accurately reproduced, others tending to be assimilated to these structures. This suggests that every individual may have within himself a rather crystalized tendency to respond in terms of a characteristic, particular temporal framework; this temporal framework may be quite resistant to change or alteration. Another interesting conclusion by Fraisse (1946; 1956) is that the interval separating a sequence of rhythmic units is a segregating framework rather than the ground for the rhythmic units. Furthermore, the interval appears to be unaffected by certain changes in the rhythmic units. These results appear to be consistent with certain results obtained by Rimoldi and Cabanski (1961) in a study utilizing the tapping of

patterns of dots as a measure of personal tempo. The subjects were presented with cards on which were printed patterns of either 2, 3, 4, 5, or 6 dots and asked to tap these patterns on a telegraph key in their most natural congenial manner. Their performance was recorded on a tape moving at a constant rate of speed. The subjects were asked to tap each pattern for a short period of time and the average time required to tap each pattern was computed. Measures of variability for each dot pattern were also determined. The results indicated a very high intra-test consistency for all of the patterns. In addition, it was found that the amount of time required to tap the patterns of 2, 3, 4, 5, and 6 dots was related as a "straight line" function. In other words, there was a linear increase in time required to tap a pattern which had one more dot than a previous pattern. However, the amount of time which elapsed between each successive tapping of a particular pattern was not significantly effected by the number of dots in that particular pattern. In other words, the time interval between each successive tapping of two dots was not significantly different than the time interval between each successive tapping of 3, 4, 5, or 6 dots. These time intervals remained constant. It would appear that the consistency of the intervals between the different patterns of dots may reflect the same process which accounts for the similarity in intervals between different rhythmic units reported by Fraisse (1946; 1956).

In summary, it would appear that the evidence cited indicates that personal tempo is a stable characteristic which is quite resistant to

change, and may reflect very basic processes within the total personality.

No attempt shall be made to give a comprehensive review of literature of the drugs utilized in this study. The emphasis shall be upon those studies which cast light upon the mode site of action of the drugs and the side effects; however, some mention shall be made of the therapeutic uses of the drugs.

Dexedrine Sulfate is dextro-amphetamine sulfate (S. K. F.). It is primarily a central nervous system stimulant, and its profound selective action on the central nervous system is its outstanding characteristic. In man, the central nervous system activity of dexedrine is apparent even with small oral doses (Alles, 1939). A comparison with closely related benzedrine showed that, while the peripheral effects of the two agents remain equal, the central nervous system activity of dexedrine is 1½ to 2 times as pronounced (Alles, 1939). The exact mode of action of dexedrine is not yet completely understood. Mann and Quartel (1940) suggest that the basic mechanism of dexedrine is a result of its ability to inhibit the enzyme, amine oxidose. This enzyme ordinarily acts on certain amines in the brain to form aldehydes which depress brain respiration. Therefore, the authors hypothesize that since dexedrine "inhibits amine oxidose, it might theoretically reduce the amount of aldehydes formed and thus allow an increased respiration rate and, thereby, an increased central activity" (Mann & Quartel, 1940, p. 418).

The principal site of action of dexedrine appears to be the higher centers of the brain. Evidence of this is suggested by its effect upon

deceberate rigidity. Deceberate rigidity is thought to be due to loss of inhibitory powers by the cortex, which controls the tone of neck and limb muscles. Dexedrine counteracts this condition (Maling & Acheson, 1938). Studies relating to the anti-appetite effect of dexedrine (Harris, Ivy, & Searle, 1947) also indicate a central site of action, possibly the cerebrum, the hypothalmus, or both.

The side effects and toxicity of dexedrine are minimal. In animal tests the minimal lethal dose of dexedrine was found to be 80 times the dose required to obtain central nervous system effects (Brown, 1947). Other investigators (Ehrich & Krumbhan, 1938) have put the dose as high as 100 to 1,000 times the therapeutic dose.

In high dosage, dexedrine may cause an appreciable rise in blood pressure persisting for several hours. Therefore, it should be used carefully for persons with hypertension, coronary disease, or other cardiac conditions. Furthermore, since dexedrine is a stimulant it is counter-indicated in cases of individuals with great excitability or manic tendencies.

The following is a list of some of the situations in which dexedrine has been utilized therapeutically. Dexedrine helps control appetite and thus has been effective in weight control. Dexedrine has been widely used as an anti-depressant. Although initially used only by psychiatrists, its use has been increasingly adopted by general practitioners who recognize depression as the major, although usually unstated, complaint in patients

with the following symptoms: vague distress without apparent organic cause, constant tiredness, nervousness, and difficulty in sleeping (Brown, 1947). Dexedrine has been effective in treating alcoholism, especially acute alcoholic episodes, by acting as a direct antagonist to the central nervous system depressant effects produced by alcohol. Finally, dexedrine has proven useful in helping to relieve some of the symptoms of drug addition.

Miltown is one of a number of meprobamate compounds which have been synthesized. Miltown is a tranquilizer which acts primarily as a muscle relaxant. It appears to have a marked blocking action on interneurons. This can be demonstrated at the level of the spinal cord by showing that the knee jerk, which is a reflex arc with no interneurons, is practically unaffected by the drug; while the flexor reflex and the crossed extensor reflex, which have one or more interneurons interposed between the afferent and efferent limbs of the arc, are decreased or abolished (Abdulian, Martin, & Unna, 1957; Abdulian et al., 1959). However, the most striking property of Miltown is its selective action on the thalamus. Electrical recordings taken from the thalamus show that Miltown, even in low doses, produces a slowing of activity and an increase in voltage. Simultaneous recordings taken from the cerebral cortex and other subcortical structures are not effected in any way (Hendley, Lynes, & Berger, 1955). In general, the primary site of action of Miltown appears to be the anterior horn cells of the spinal cord and thalamus.

Serious side effects have rarely occurred following the administration

of Miltown. The most common side effect appears to be a feeling of drowsiness.

The only serious side effect reported after administration of Miltown has been the rare occurrence of allergic reactions (Bernstein & Klotz, 1958). This is most often a mild reaction characterized by an itchy rash.

The effects of excessive consumption of alcohol may be increased by Miltown, therefore caution in administration should be exercised with individuals prone to excessive drinking.

Finally, dependence upon the drug has resulted from the continued absorption of large doses, and sudden deprivation has been known to precipitate withdrawal symptoms. Unsuccessful suicide attempts with Miltown have produced coma, shock, vasomotor disturbances, and respiratory collapse, although deaths following suicide attempts are extremely rare (Davis, Shumway, & Bloom, 1959). However, in general, the side effects produced by infrequent absorption of small doses have been rare and minimal.

Miltown has been proven to have therapeutic value primarily in the relief of anxiety and tension states (Borrus, 1955; Dickel, Wood, & Dixon, 1957). However, it has been of value in treating behavior disorders (Baird, 1959) and as adjunctive therapy when anxiety may be a causative or otherwise disturbing factor, such as in heart disease or surgery (Eger & Keasling, 1959). Miltown has also been effective as a muscle relaxant in certain neurological conditions such as cerebral palsy (Carter, 1958). Finally, Miltown has been utilized as an anticonvulsant

agent in treating petit mal epilepsy; however, it has not proven valuable in curbing grand mal seizures.

CHAPTER III

EXPERIMENTAL PROCEDURE

Experimental Setting

Since this study utilized drugs, it was absolutely essential that it be conducted under medical supervision. Therefore, Dean Sheehan of the Loyola Medical School, and Dr. John Madden, Head of the Department of Psychiatry, were contacted; they granted permission to test the subjects at Loretto Hospital. The drugs were administered under the direct supervision of a staff psychiatrist, Dr. John F. Bimmerle.

Subjects

A total of 14 "normal" adults were tested (seven males and seven females). Their ages ranged between 22 and 29 years of age. The criteria for the selection of subjects were simply availability and willingness to cooperate. In view of the fact that the type and extent of the effects produced by different drugs is known to vary, at least to a certain extent, from individual to individual, the question of attempting to control for individual differences was deliberated. Originally, the examiner had considered the possibility of pre-testing the subjects with the drugs and utilizing independent physiological measures, that is, respiration, pulse, and blood pressure changes, as criteria for evaluating the type and extent

of individual differences among the subjects. However, in view of the somewhat limited facilities available to the examiner in the experimental setting, such a procedure was not considered feasible. Therefore, the experimental design does not contain any internal controls for individual differences. The implication of this in terms of the interpretation of the results shall be discussed further in the chapter on CONCLUSIONS.

Independent Variable

Two different drugs (a stimulant and a tranquilizer) and a placebo, all orally administered, comprise the independent variable in this study. The drugs and dosages selected were Dexedrine (5 mg.) and Miltown (400 mg.). The final decision as to the particular drugs and dosages to be utilized rested with the medical consultant, Dr. Bimmerle. The advantages of the drugs selected are the following: considerable information in the literature regarding primary site of action, and a minimum of side effects.

The experimenter tried to procure pill forms of the two drugs which were the same or very similar in size, shape, and color but was unsuccessful. The stimulant was a small, triangular pill (pink) while the tranquilizer was a larger round white pill. This potentially could have been a source of two uncontrolled variables. The first possibility was that of a subject recognizing one or both of the pills as a result of past experience with them. A casual check was made on this possibility by asking the subjects, after all of the testing was completed, if they had been able to identify by means of more than a guess, any of the drugs administered. Only one of the 14 subjects responded in the affirmative, stating

that he had suspected the triangular pink pill was a stimulant because he had taken a number of benzedrine pills in the past, and the two pills were similar in appearance. The other shortcoming which resulted from differences in appearance of the two drugs was related to the fact that the experimenter could easily identify the different drugs. Therefore, it was impossible to establish a "double blind" control in which both experimenter and subject were unaware of the particular drug being administered at any particular time. When the experimenter is aware of the particular experimental condition being tested, there is always the possibility that he will indirectly or unconsciously communicate certain selective cues to the subject; or that he will unknowingly record, or score, the data obtained in a selective manner which may favor getting results which are in accord with certain preconceived ideas on his part. The only way in which the experimenter in this study attempted to guard against such possibilities was to consciously attempt to respond to all of the experimental conditions as objectively as possible.

In view of the differences in appearance of the two drugs, there was one more important point to be considered. It would have been unwise to select a placebo which was similar in appearance to one of the two drugs. If this would have been done, there would have been a possibility of some subject surmising that they were receiving the same drug twice. Thus, it is conceivable that subliminal psychological factors might have become operative, that is, suggestion, which would have increased the similarity of results obtained after administration of the placebo and the drug

which it resembled. Therefore, the placebo selected was different in size and color from the two drugs.

Dependent Variable

The measures of personal tempo, primarily psycho-motor tasks, comprise the dependent variable. The tasks included in this study are the following.

(1) Tapping patterns of dots: White cards on which were printed different patterns of dots were presented to the subjects one at a time. The subjects were asked to tap these patterns on a telegraph key. Each depression of the telegraph key recorded a mark on a tape moving at a constant speed (10 mm./sec.). Therefore, a spatial representation of a temporal pattern was obtained.

After a short "warming up" period to acquaint the subject with the apparatus and procedure, he was told to tap each pattern, and to continue tapping until told to stop. A continuous record was obtained of ten successive "tappings" of each pattern of dots. The patterns of dots utilized were the following:

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The five patterns of dots were presented to all subjects in ascending order, i.e., two dots, three dots, etc.

(2) Reading Science: The subjects were asked to read silently from a General Psychology book (Introduction to Psychology, E. R. Hilgard). At the end of one minute they were told to stop, and indicate to the examiner the last word they had read.

(3) Reading Literature: The same instructions and conditions as above. The book used was The Adventures of Sherlock Holmes by Sir Arthur Conan Doyle.

(4) Making circles with the dominant hand: The subjects were told to make circles with the dominant hand, and to continue making them until told to stop. The examiner did not specify any desired size; this was left to the discretion of the subjects. The time limit for this activity was 30 seconds.

(5) Making squares with the dominant hand: The same instructions and conditions as above (cf. Task #4).

(6) Making circles with the non-dominant hand: The same instructions and conditions as above (cf. Task #4).

(7) Making squares with the non-dominant hand: The same instructions and conditions as above (cf. Task #4).

(8) Swinging the right arm: The subjects were told to swing their right arms back and forth, and to continue doing so until told to stop. The examiner did not specify how far in each direction the subject was to swing his arm; this was left to the discretion of the subjects. The examiner counted the number of swings which the subject completed in 30 seconds.

(9) Swinging the left arm: The same instructions and conditions as above (cf. Task #8).

(10) Swinging both arms simultaneously: The same instructions and conditions as above (cf. Task #8).

(11) Swinging right leg: The same instructions and conditions as above (cf. Task #8).

(12) Swinging left leg: The same instructions and conditions as above (cf. Task #8).

For all the tests, the only instructions were to perform the task "in your most natural, congenial manner." NO mention of speed was made, and the rate of responding was left completely up to the subject.

Instructions to the Subjects

All of the subjects were told that they would be asked to perform certain tasks before and after the administration of a drug. Of course, none of the subjects were told what drug they were receiving at any particular time until all the testing was completed. While waiting to be retested the subjects were asked to sit in a separate room.

Testing Procedure

All subjects were tested under all three conditions: before and after administration of the stimulant, tranquilizer, and placebo. Therefore, they served as their own controls in this respect. Only one condition was tested on any one given day. An attempt was made to complete

all three conditions within as short a period as possible . However, the limited availability of the subjects introduced a certain amount of variability. The shortest interval was four days, and the longest, 22 days with a mean of approximately 11 days.

All subjects were required to execute the tests of personal tempo three times for each of the three conditions (i.e., stimulant, tranquilizer, and placebo). The subjects were tested prior to the administration of the drug or placebo, and were retested at intervals of one and two hours[2] after the drug or placebo was taken. Therefore, all the tests of personal tempo (except the reading tests) were administered nine times for all subjects, three times for each condition. The tests of reading were an exception. It was felt that since the subject was asked to re-read the same passage there might be too much transfer if the reading tests were repeated twice after the administration of the independent variable. Therefore, the two tests of reading were conducted only twice, before the administration of the independent variable, and two hours afterward.

At this point it seems advisable to establish a system of abbreviations and subscripts in order to simplify further discussion of the three experimental conditions (i.e., stimulant, tranquilizer, placebo) and the three separate testings for each condition (one before administration of the independent variable, and two afterward). The following abbreviations

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[2]Intervals of one and two hours after administration of the drug were chosen because consultation with Dr. Rimmerle indicated that, generally, the effects of both drugs can be expected to be optimal during this period.

shall be utilized:

St = stimulant

T = tranquilizer

P = placebo

The following subscripts shall also be employed:

I = first testing, prior to administration of the independent variable

II = second testing, after an interval of one hour

III = third testing, after an interval of two hours

Table 1 summarizes the system of abbreviations and subscripts for all conditions and testings.

Table 1

Key to Abbreviations and Subscripts

Conditions	Testings		
	I: Prior to Administration of Independent Variable	II: One Hour After Administration of Independent Variable	III: Two Hours After Administration of Independent Variable
Stimulant--St	St I	St II	St III
Tranquilizer--T	T I	T II	T III
Placebo--P	P I	P II	P III

Since the same subjects were tested under all three conditions, it was considered necessary to control for possible positional effects. In

other words, if all subjects were tested under condition St first, condition T second, and condition P third, the result would have been that each subject would have already executed the tempo tasks three times prior to being tested under condition T, and six times prior to being tested under condition P. In order to control for this, the order in which each condition was tested was rotated. Table 2 summarizes the order in which each of the three conditions was tested for the 14 subjects.

Table 2

Sequence of Test Conditions

Condition	Sequence		
	1st Session	2nd Session	3rd Session
St	5 subjects	5 subjects	4 subjects
T	5 subjects	4 subjects	5 subjects
P	4 subjects	5 subjects	5 subjects

Recording of the Measures of Personal Tempo

For all of the tests of personal tempo (except the tapping of dot patterns) the measure of personal tempo which was utilized for comparison and statistical analysis was the number of times a certain action was performed in a given period of time. The following listing exemplifies the specific measures employed:

(1) Reading science--number of words read in 1 minute

(2) Reading novel--number of words read in 1 minute

(3) Making circles with right hand--number of circles drawn in 30 seconds

(4) Making circles with left hand--number of circles drawn in 30 seconds

(5) Making squares with right hand--number of squares drawn in 30 seconds

(6) Making squares with left hand--number of squares drawn in 30 seconds

(7) Swinging right arm--number of swings in 30 seconds

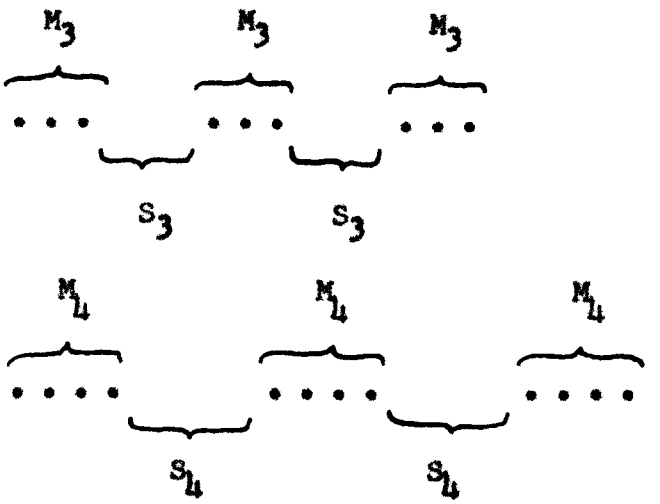
(8) Swinging left arm--number of swings in 30 seconds

(9) Swinging both arms simultaneously--number of swings in 30 seconds

(10) Swinging right leg--number of swings in 30 seconds

(11) Swinging left leg--number of swings in 30 seconds

The measures of tapping were treated in a more complex manner. As stated previously, the record obtained is a spatial transformation of a temporal sequence. A ruler calibrated in millimeters was used to measure the distance between the first and last dot of each of the ten successive "tappings" of each pattern. Furthermore, the intervals between each of the ten successive "tappings" for every pattern were also measured. The distance between the first and last dot of any particular group of dots was called the Musical (M) period and the distance of the interval between any two groups of dots was called the Silence (S) period. The following are some examples of the manner in which the records were measured:



Since the subjects tapped each pattern ten times, the mean scores for every M and S period of all the dot patterns was determined for every subject. Therefore, it was the mean scores for every subject which were utilized for comparison and statistical purposes as the measures of personal tempo for the tapping test.

CHAPTER IV

RESULTS

The first step in the treatment of the results was the computation of the Mean values of all the Musical and Silence periods for the tapping test. This was necessary since the subjects tapped each pattern ten times during each testing session. Therefore, it was the mean scores for every subject which were utilized for comparison and statistical purposes as measures of personal tempo for the tapping test. The next step was to determine the Mean of the Means for the M and S periods for all the subjects (see Tables 3 and 4). These values were derived for the three testings under each of the three conditions. This operation was performed in order to obtain an average value of the M and S periods which could be plotted, and thus, represented graphically (see Figures 1, 2, 3, 4, 5, 6). Examination of these graphical representations indicates that the amount of time required to tap patterns of 2, 3, 4, 5, and 6 dots increases as a linear increase in time required to tap a dot pattern which has one more dot than a previous pattern. However, the intervals (the Silence periods) between the successive "tappings" of the dot patterns remain relatively constant under all experimental conditions irrespective of the particular patterns (2, 3, 4, 5, or 6 dots) tapped. These results are consistent with those reported in a previous study (Rimoldi & Cabanski, 1961).

Table 3

The Mean of the Means $\left(\frac{\Sigma M}{N}\right)$ for the Values of Patterns M_2 through M_6 for Each of the Three Testings under Each of the Three Conditions

Condition	Testing	M_2	M_3	M_4	M_5	M_6
Stimulant	1st	3.69	6.99	10.36	14.48	17.95
	2nd	3.57	6.97	10.56	14.64	18.18
	3rd	3.46	6.95	10.52	14.57	18.64
Tranquilizer	1st	3.42	6.36	9.51	13.27	16.94
	2nd	3.76	7.29	11.54	15.41	19.44
	3rd	4.13	8.05	12.75	17.56	21.55
Placebo	1st	3.41	7.08	10.40	14.39	18.34
	2nd	3.78	7.62	11.25	15.09	18.86
	3rd	3.90	7.59	11.32	15.04	19.60

Table 4

The Mean of the Means $\left(\frac{\Sigma M}{N}\right)$ for the Values of Intervals S_2 through S_6 for Each of the Three Testings under Each of the Three Conditions

Condition	Testing	S_2	S_3	S_4	S_5	S_6
	1st	7.46	7.51	7.69	8.12	8.30
Stimulant	2nd	7.30	7.16	7.67	7.94	8.02
	3rd	7.43	7.47	7.91	8.18	8.45
	1st	7.19	7.21	7.69	7.97	8.19
Tranquilizer	2nd	8.56	8.47	9.05	9.11	9.26
	3rd	9.19	9.10	9.42	9.62	9.55
	1st	7.22	7.31	7.37	7.84	8.28
Placebo	2nd	8.11	8.08	8.51	8.60	8.98
	3rd	7.88	7.82	8.29	8.38	8.66

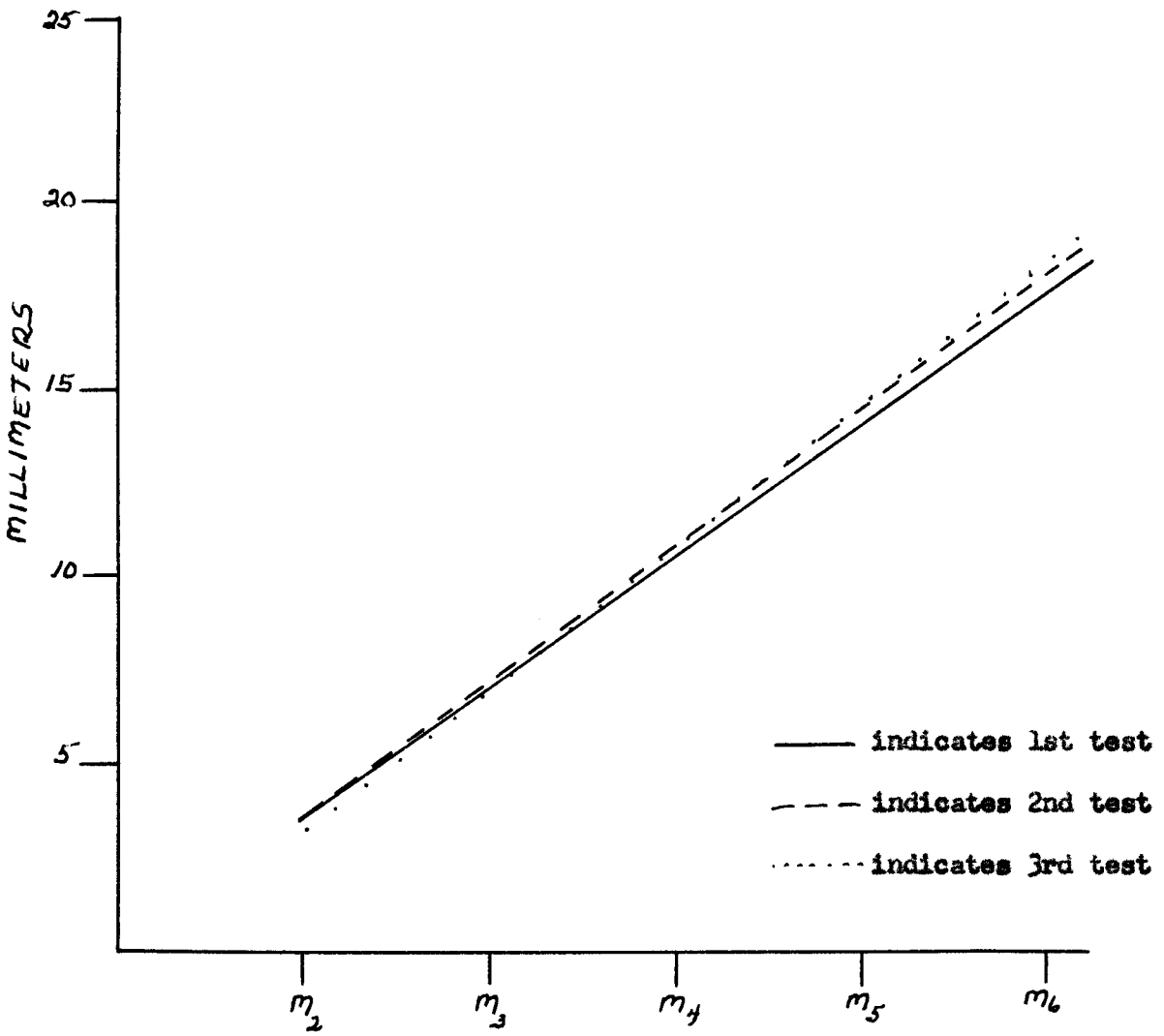


Fig. 1. Graphical representation of the mean of the means for the values of patterns M_2 through M_6 for the three testings of the stimulant condition.

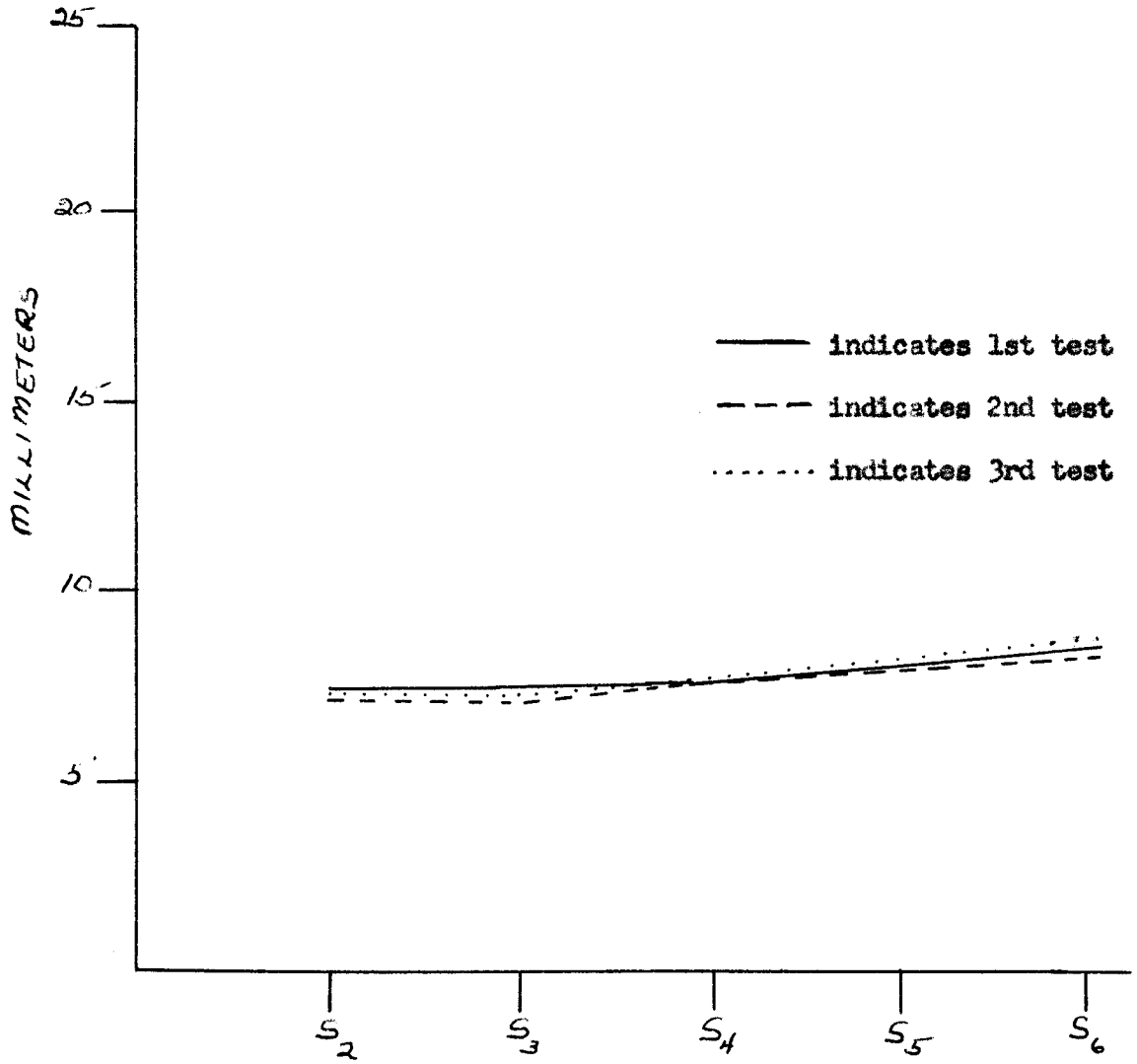


Fig. 2. Graphical representation of the Mean of Means for the values of Intervals S_2 through S_6 for the three testings of the stimulant condition.

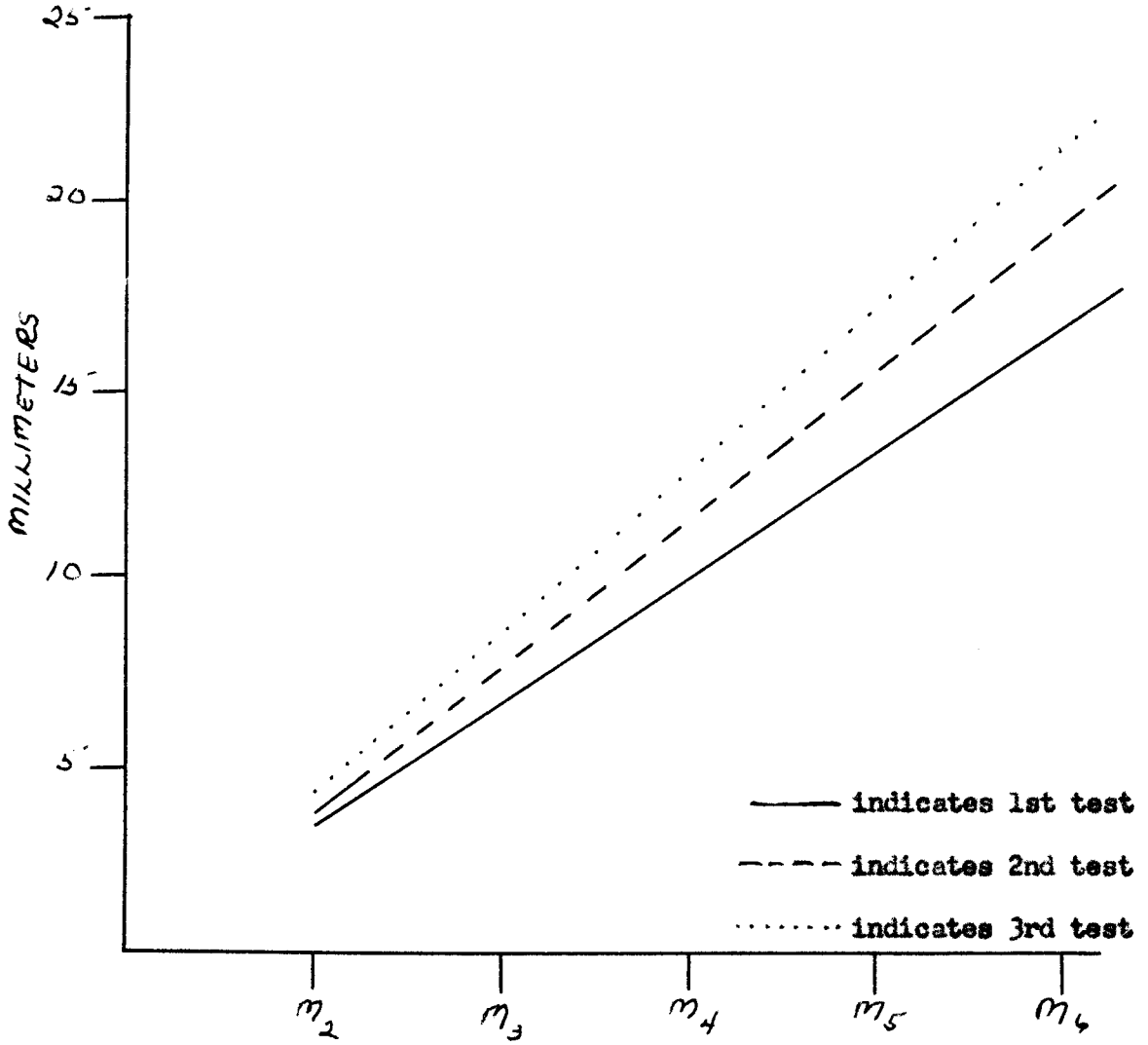


Fig. 3. Graphical representation of the Mean of the Means for the values of Patterns M_2 through M_6 for the three testings of the tranquilizer condition.

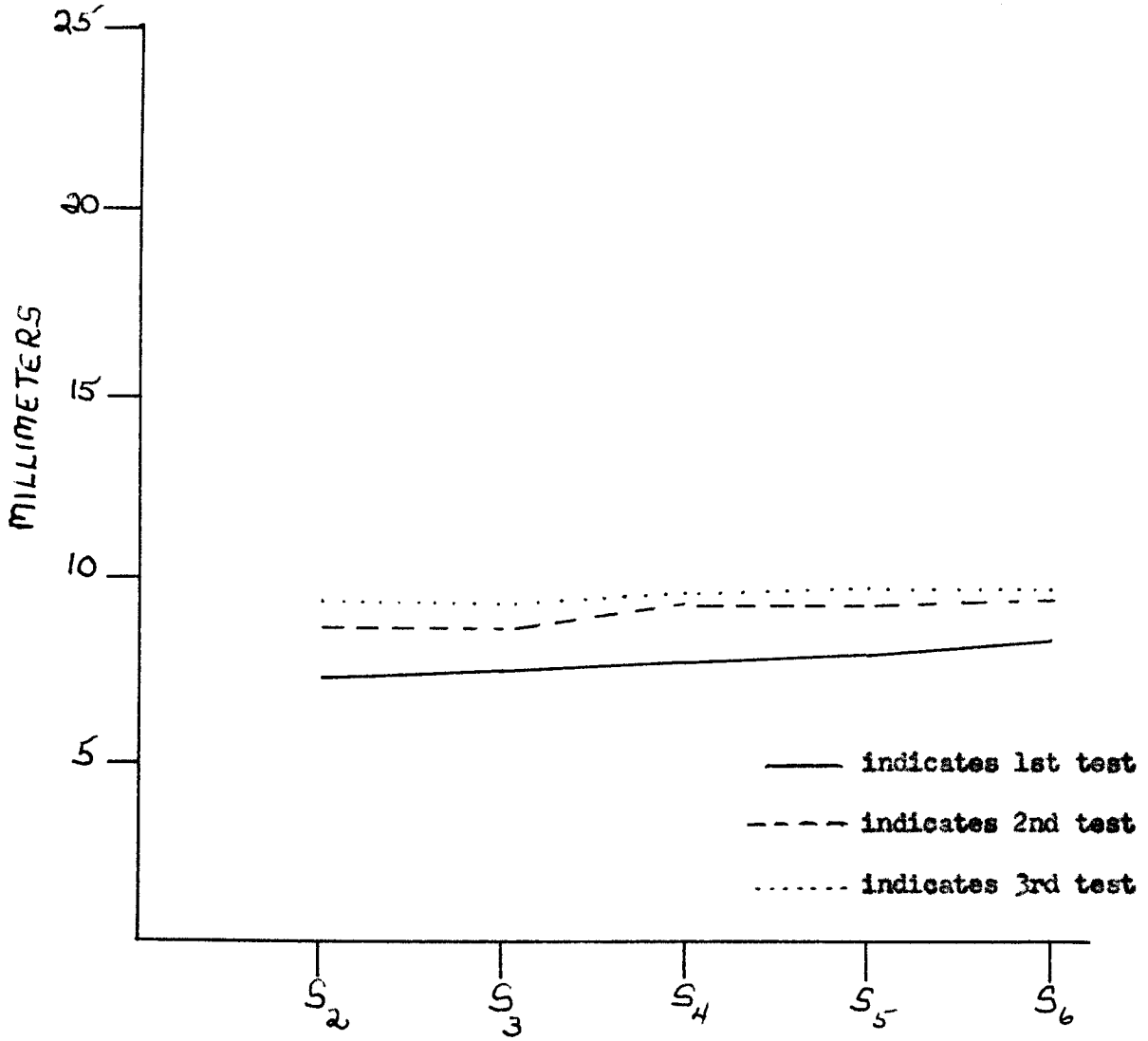


Fig. 4. Graphical representation of the Mean of the Means for the values of Intervals S_2 through S_6 for the three testings of the tranquilizer condition.

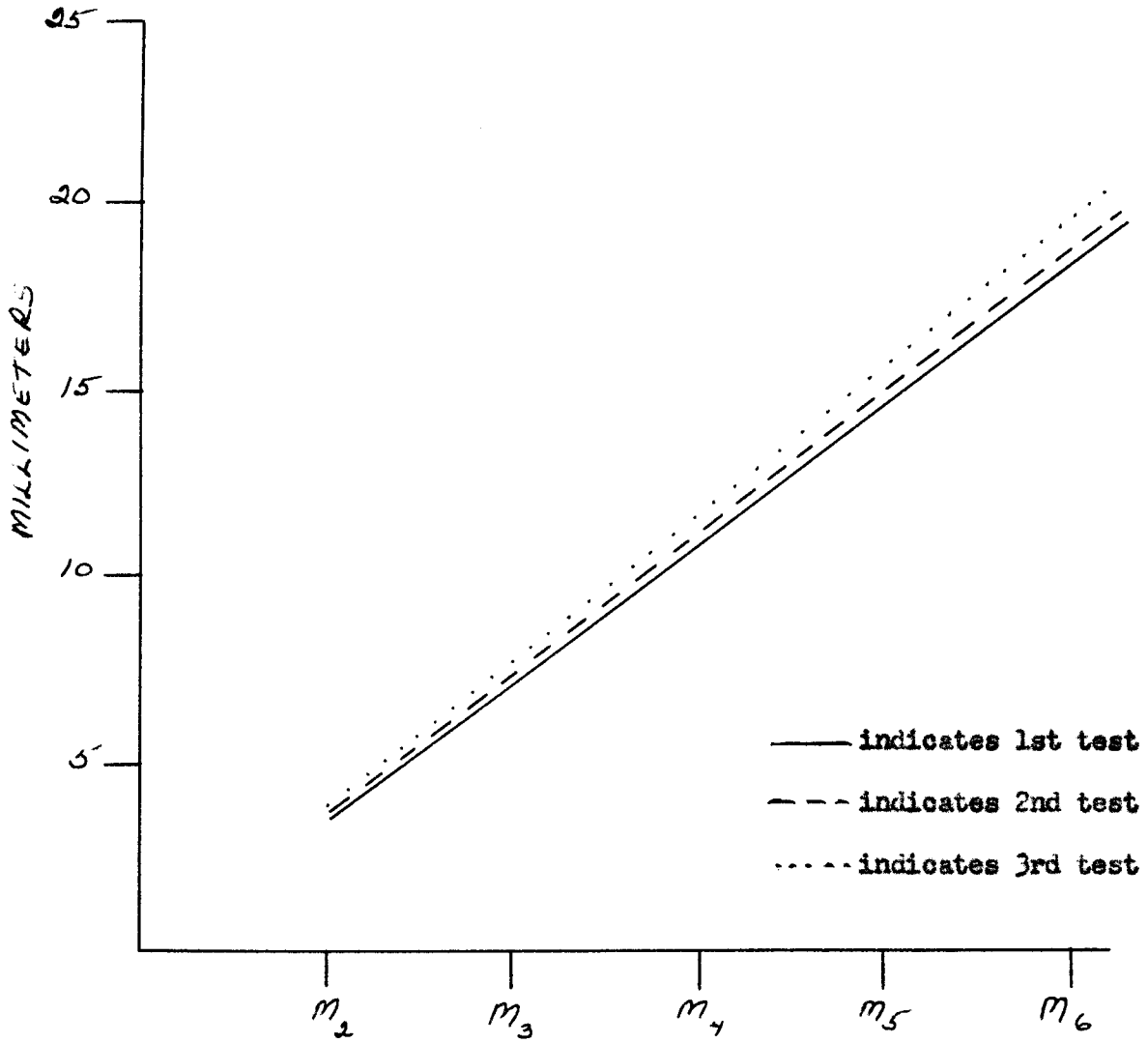


Fig. 5. Graphical representation of the Mean of the Means for the values of Patterns M_2 through M_6 for the three testing of the placebo condition.

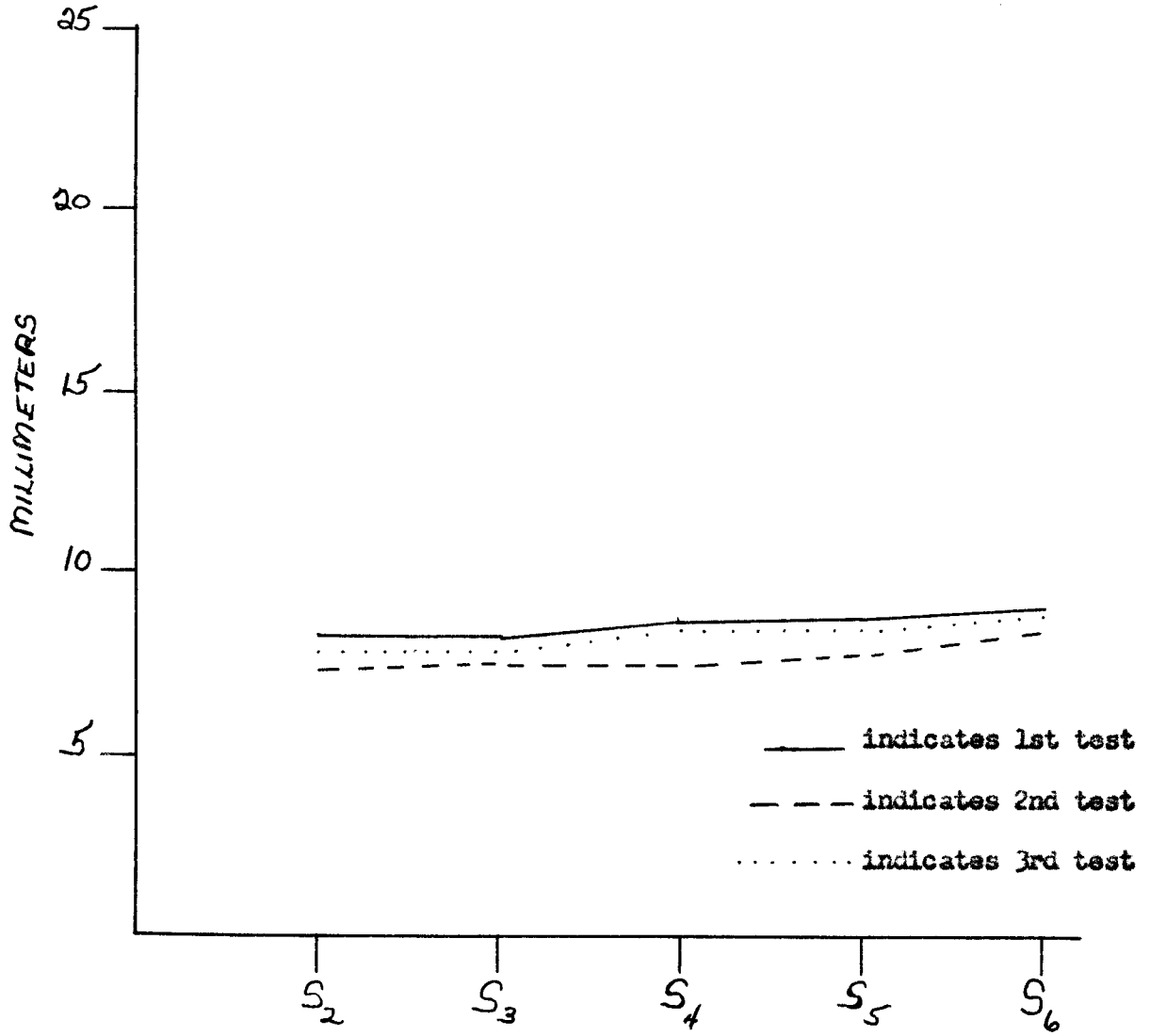


Fig. 6. Graphical representation of the Mean of the Means for the values of Intervals S_2 through S_6 for the three testings of the placebo condition.

In order to test the major hypothesis, that the drugs would not have a significant effect upon the consistency of personal tempo, a comparison was made of the differences between the first testing (pre-drug) and the second and third testings (one and two hours after administration of the drug or placebo) under each of the three conditions. The method of analysis utilized was a Two-Way Classification Analysis of Variance.

The data were divided into five major groups. The first group included the five Musical periods; the second group, the five Silence periods; the third group, the two tests of reading; the fourth group, the writing of circles and squares with the right and left hands; and the fifth group, the swinging of arms and legs.

Tables 5, 6, and 7 list the results of the analysis of variance of the Musical periods for the three tests under the three conditions. The variance estimates for the columns indicate differences among the different dot patterns. The variance estimates for the rows indicate differences among the three testings for each condition. Examination of these tables reveals that the F ratios of the columns are significant beyond the .01 level of confidence for all three conditions. This simply reflects the differences in time required to tap patterns of 2, 3, 4, 5, and 6 dots. Examination of the variance estimates of the rows reveals no significant differences for the stimulant and placebo conditions (see Tables 5 and 7); however, there is a significant F ratio (.05 level of confidence) for the rows of the tranquilizer condition (Table 6). This indicates a significant slowing down in the Musical patterns, after the

Table 5

Analysis of Variance of Patterns M_2 through M_6 for the Stimulant Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	.64	2	.32	.02
Columns (P. T. Tasks)	5741.90	4	1435.48	99.89*
Interaction	3.67	8	.46	.03
Within Sets Variance	2802.77	195	14.37	

* Significant at .01 level.

Table 6

Analysis of Variance of Patterns M_2 through M_6 for the Tranquilizer Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	296.92	2	148.46	4.11*
Columns (P. T. Tasks)	6479.29	4	1619.82	44.87**
Interaction	79.84	8	9.98	.03
Within Sets Variance	7040.46	195	36.10	

* Significant at .05 level.

** Significant at .01 level.

Table 7

Analysis of Variance of Patterns M_2 through M_6 for the Placebo Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	22.82	2	11.41	.31
Columns (P. T. Tasks)	6030.77	4	1507.69	41.32*
Interaction	4.59	8	.57	.01
Within Sets Variance	7114.78	195	36.49	

* Significant at .01 level.

administration of the tranquilizer. This slowing down of the two testings after the administration of the tranquilizer can be verified by inspection of the three curves depicted in Figure 3.

Tables 8, 9, and 10 list the results of the analyses of variance of the Silence periods. The variance estimates for the columns indicate differences among the Silence periods for the different dot patterns. The variance estimates for the rows indicate the differences among the three testings for each condition. Tables 8, 9, and 10 reveal that the F ratios for the columns were not significant in any of the three conditions. Therefore, this corroborates the conclusions drawn from inspection of Figures 2, 4, and 6; namely that the intervals between any two successive "tappings" of dot patterns remain relatively constant under all experimental conditions irrespective of the particular patterns tapped.

Just as was observed in the analyses of the Musical patterns, the only significant F ratio among the rows was under the tranquilizer condition (Table 9). Therefore, there was also a significant slowing down (.01 level of confidence) in the intervals between the tapping of dot patterns after the tranquilizer was administered. This "slowing down" of the Silence periods is depicted graphically by the three curves in Figure 4.

Tables 11, 12, and 13 summarize the results of the analyses of variance of the two reading tests. Examination of these tables reveals no significant F ratios for either the columns or the rows under any of the conditions. This indicates, somewhat surprisingly, that there were

Table 8

Analysis of Variance of Intervals S_2 through S_6

for the Stimulant Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	2.98	2	1.49	.24
Columns (P. T. Tasks)	24.18	4	6.05	.99
Interaction	1.15	8	.14	.02
Within Sets Variance	1196.93	195	6.14	

Table 9

Analysis of Variance of Intervals S_2 through S_6 for the Tranquilizer Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	113.95	2	56.98	5.25*
Columns (P. T. Tasks)	19.37	4	4.84	.45
Interaction	.18	8	.02	
Within Sets Variance	2117.40	195	10.86	

* Significant at .01 level.

Table 10

Analysis of Variance of Intervals S_2 through S_6 for the Placebo Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	26.93	2	13.47	1.59
Columns (P. T. Tasks)	24.69	4	6.17	.73
Interaction	1.38	8	.17	.02
Within Sets Variance	1654.21	195	8.48	

Table 11

Analysis of Variance of the Reading Tests

for the Stimulant Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st & 2nd Testing)	5168.64	1	5168.64	.44
Columns (P. T. Tasks)	42130.28	1	42130.28	3.59
Interaction	114.29	1	114.29	.01
Within Sets Variance	610524.72	52	11740.86	

Table 12

Analysis of Variance of the Reading Tests

for the Tranquilizer Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st & 2nd Testing)	1607.14	1	1607.14	.13
Columns (P. T. Tasks)	36925.78	1	36925.78	3.02
Interaction	686.01	1	686.01	.01
Within Sets Variance	636777.57	52	12245.72	

Table 13

Analysis of Variance of the Reading Tests

for the Placebo Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st & 2nd Testing)	1575.16	1	1575.16	.13
Columns (P. T. Tasks)	6710.16	1	6710.16	.54
Interaction	4.02	1	4.02	.001
Within Sets Variance	641342.22	52	12333.50	

no significant differences between speed of reading science and literature (Tables 11, 12, and 13; Columns). Furthermore, there were no significant differences between speed of reading before and after administration of any of the drugs or placebo (Tables 11, 12, and 13; Rows). This is even more surprising in view of the fact that the subjects re-read the same passages after administration of the drugs, and one might have expected the learning factor to contribute to an increased reading speed.

Tables 14, 15, and 16 list the variance estimates for the following tasks: circles, right hand; squares, right hand; circles, left hand; squares, left hand. These four tasks were combined under a single analysis of variance because they all have been reported to have high intercorrelations as evidenced by high loadings in the same primary factor (Rimoldi, 1951). The F ratios for the columns under all three conditions are significant beyond the .01 level of confidence. This simply indicates the fact that, within a given period of time, there are marked differences among the number of circles and squares made with the right and left hands. The F ratios for the rows of the tranquilizer and placebo conditions are not significant (Tables 15 and 16); however, the F ratios for the rows of the stimulant condition (Table 14) is significant beyond the .05 level of confidence. This reflects a significant speeding up in the number of circles and squares that the subjects executed after the administration of the stimulant.

Tables 17, 18, and 19 summarize the results of the analyses of variance of the tasks involving the swinging of the arms and legs. These

Table 14

Analysis of Variance of the "Circles and Squares" Tasks for the Stimulant Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	286.59	2	143.30	4.23*
Columns (P. T. Tasks)	23320.60	3	7773.53	229.49**
Interaction	31.50	6	5.25	.02
Within Sets Variance	5321.29	157	33.89	

* Significant at .05 level.

** Significant at .01 level.

Table 15

Analysis of Variance of the "Circles and Squares" Tasks for the Tranquilizer Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	24.34	2	12.17	.43
Columns (P. T. Tasks)	19144.08	3	6381.36	226.21*
Interaction	8.70	6	1.45	.05
Within Sets Variance	4428.86	157	28.21	

* Significant at .01 level.

Table 16

Analysis of Variance of the "Circles and Squares" Tasks for the Placebo Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	260.04	2	130.02	2.99
Columns (P. T. Tasks)	23031.00	3	7677.00	176.32*
Interaction	27.0	6	4.5	.1
Within Sets Variance	6835.86	157	43.54	

*Significant at .01 level.

Table 17

Analysis of Variance of the Swinging of Arms and Legs Tasks for the Stimulant Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	13.27	2	6.64	1.61
Columns (P. T. Tasks)	16.19	4	4.05	.98
Interaction	5.78	8	.72	.17
Within Sets Variance	805.36	195	4.13	

Table 18

Analysis of Variance of the Swinging of Arms and Legs Tasks for the Tranquilizer Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	.88	2	.44	1.92
Columns (P. T. Tasks)	5.55	4	1.39	.61
Interaction	4.59	8	.57	.25
Within Sets Variance	445.79	195	2.29	

Table 19

Analysis of Variance of the Swinging of Arms and Legs Tasks for the Placebo Condition

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (1st, 2nd, 3rd Testing)	7.80	2	3.90	1.07
Columns (P. T. Tasks)	4.89	4	1.22	.33
Interaction	3.20	8	.40	.11
Within Sets Variance	714.57	195	3.66	

five tasks were combined under a single analysis of variance because they also have been reported to have high inter-correlations as evidenced by high loadings in the same primary factor (Rimoldi, 1951). Inspection of these tables reveals that there are no significant F ratios for any of the Rows or Columns. The lack of significant differences among the Columns seems to indicate that individuals adopt the same tempo for a number of different large muscle movements. Furthermore, the absence of significant F ratios for the Rows indicates that the administration of the drugs and placebo did not significantly effect the speeds of these large muscle movements.

At this point it is important to examine in more detail the significant slowing down of the Musical and Silence periods which occurred after the administration of the tranquilizer, and the significant speeding up of the "circles and squares" after the administration of the stimulant. It is interesting to note that, in both cases, a similar (although not significant) change occurred after the administration of the placebo. In other words, the Musical and Silence periods "slowed up" after the administration of the placebo as well as (after the administration of) the tranquilizer. This can be verified by a comparison of the plots obtained for the tranquiliser condition (Figures 3 and 4) and the plots obtained for the placebo condition (Figures 5 and 6). Similarly, there was a "speeding up" of the "circles and squares" tasks under the placebo condition as well as under the stimulant condition. Hence, this raises a

question as to whether the changes observed after the administration of the two drugs can be clearly attributed to the effects of these drugs. In order to test for this, analyses of variance of the tapping tests were performed comparing the first testing (pre-drug) of the tranquilizer condition with the first testing of the placebo condition (Tables 20 and 21). An analysis of variance of the "circles and squares" data was also performed comparing the first testing of the stimulant condition with the first testing of the placebo condition (Table 22). None of the F ratios for any of the rows were significant. This indicates that the subjects tapped at approximately the same rate of speed for the 1st testing of the tranquilizer and placebo conditions, and made "circles and squares" at approximately the same speed for the 1st testing of the stimulant and placebo conditions. Therefore, it was hypothesized that, since the experimental situation was the same under all three conditions except for the introduction of different independent variables, if either of the drugs produced significant changes in the rates of personal tempo, there should be significant differences between the second and third testings of the stimulant and placebo conditions, and the tranquilizer and placebo conditions. In other words, in order to establish the fact that the significant speeding up and slowing down observed in certain tasks after the administration of the stimulant or tranquilizer was due specifically to the effects of the drugs there would also have to be significant differences between the rates of personal tempo under the drug conditions and similar speeding up and slowing down of the rates of personal tempo

Table 20

Comparison of the First Testing of the Tranquilizer and Placebo Condition for Patterns M_2 through M_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Tranquilizer and Placebo Conditions)	23.78	1	23.78	.69
Columns (P. T. Tasks)	3547.13	4	886.78	25.64*
Interaction	7.86	4	1.97	.06
Within Sets Variance	4494.96	130	34.58	

* Significant at .01 level.

Table 21

Comparison of the First Testing of the Tranquilizer and Placebo Condition for Intervals S_2 through S_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Tranquilizer and Placebo Conditions)	.04	1	.04	.001
Columns (P. T. Tasks)	20.91	4	5.23	.76
Interaction	.92	4	.23	.03
Within Sets Variance	899.51	130	6.92	

Table 22

Comparison of the First Testing of the Stimulant and Placebo Conditions for the "Circles and Squares" Tasks

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Stimulant and Placebo Conditions)	15.72	1	15.72	.44
Columns (P. T. Tasks)	14184.47	1	4728.16	132.22*
Interaction	25.49	8.50	.24	
Within Sets Variance	3719.43	104	35.76	

* Significant at .01 level.

observed under the placebo condition.

Since the subjects' rates of personal tempo were approximately the same for the first testing under the stimulant, tranquilizer, and placebo conditions (Tables 20, 21, and 22), it was considered justifiable to compare also the raw scores of the second and third testings of the different conditions in order to determine whether or not there were significant differences among the amounts of change which took place. Therefore, analyses of variance were performed comparing the Musical and Silence periods of the second and third testings of the tranquilizer condition with the Musical and Silence periods in the second and third testings of the placebo condition (Tables 23, 24, 25, and 26). An analysis of variance was also performed comparing the "circles and squares" in the second and third testings of the stimulant condition with the second and third testings of the placebo condition (Tables 27 and 28).

Examination of Tables 23, 24, 25, 26, 27, and 28 reveals that none of the differences between rows resulted in a significant F ratio. This indicates that there were no significant differences between the speeding up and slowing down observed under the placebo condition and the speeding up of the "circles and squares" rates observed under the stimulant condition and the "slowing down" of the tapping rates observed under the tranquilizer condition. Therefore, it would seem reasonable to conclude that the changes in the rates of personal tempo observed after the administration of the drugs cannot be clearly attributed to the direct effects of these drugs. These results shall be discussed further in the chapter

Table 23

Comparison of the Second Testing of the Tranquilizer and Placebo Condition for Patterns M_2 through M_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Tranquilizer and Placebo Condition)	.98	1	.98	.003
Columns (P. T. Tasks)	4161.55	4	1040.39	30.53*
Interaction	3.42	4	.86	.003
Within Sets Variance	4427.22	130	34.06	

* Significant at .01 level.

Table 24

Comparison of the Third Testing of the Tranquilizer and Placebo Condition for Patterns M_2 through M_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Tranquilizer and Placebo Conditions)	60.46	1	60.46	1.53
Columns (P. T. Tasks)	4847.93	4	1211.98	30.74*
Interaction	119.60	4	29.90	.76
Within Sets Variance	5140.05	130	39.54	

* Significant at .01 level.

Table 25

Comparison of the Second Testing of the Stimulant and Placebo Condition for Intervals S_2 through S_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Stimulant and Placebo Condition)	6.60	1	6.60	.63
Columns (P. T. Tasks)	14.42	4	3.61	.34
Interaction	.29	4	.07	.01
Within Sets Variance	1364.42	130	10.50	

Table 26

Comparison of the Third Testing of the Stimulant and Placebo Condition for Intervals S_2 through S_6

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Stimulant and Placebo Conditions)	48.96	1	48.96	3.20
Columns (P. T. Tasks)	9.72	4	2.34	.16
Interaction	.59	4	.15	.01
Within Sets Variance	1987.69	130	15.29	

Table 27

Comparison of the Second Testing of the Stimulant and Placebo Conditions for the "Circles and Squares" Tasks

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Stimulant and Placebo Conditions)	.32	1	.32	.01
Columns (P. T. Tasks)	13395.61	3	4465.20	113.82*
Interaction	33.61	3	11.20	.29
Within Sets Variance	4080.14	104	39.23	

* Significant at .01 level.

Table 28

Comparison of the Third Testing of the Stimulant and Placebo Conditions for the "Circles and Squares" Tasks

	Mean Sum of Squares	Degrees of Freedom	Variance Estimates	F Ratio
Rows (Stimulant and Placebo Conditions)	48.89	1	48.89	1.47
Columns (P. T. Tasks)	14530.39	3	4843.46	14.54*
Interaction	41.26	3	13.75	.41
Within Sets Variance	346.34	104	33.30	

* Significant at .01 level.

on CONCLUSIONS.

Finally, it should be noted that none of the Interaction Variances were significant for any of the tasks under any of the conditions.

CHAPTER V

CONCLUSIONS

It would seem best to begin with a restatement of the major hypothesis. The physiological and psychological changes produced by certain drugs (stimulants, tranquilizers) shall have no effect upon any of the operational measures of personal tempo utilized in this study. In view of the overall results obtained in this study it is concluded that the null hypothesis must be accepted. It is true that there were significant changes in the "circles and squares" tasks after the administration of the stimulant, and in the tapping tasks after the administration of the tranquilizer. However, further investigation revealed that, in both cases, these changes were not significantly greater than similar changes which occurred after the administration of the placebo. Therefore, it is reasoned that one would not be justified in concluding that those changes in personal tempo which did occur were the specific result of the effects of the drugs.

Nevertheless, it is important to attempt to determine the source or sources of those changes in personal tempo which did occur. The most reasonable explanation would seem to be that the particular changes which proved significant may have resulted from the method of analysis employed. By the very nature of Analysis of Variance all sources of variation

contributing to a particular estimate of variance are additive. In other words, it may very well be that those changes observed in the tapping and "circles and squares" tasks were produced not by a single source of variation, e.g. the drugs, but by a combination of a number of sources of variation, e.g. drugs, learning, boredom, etc. Furthermore, it may very well be that any one of these sources taken independently would not have a significant effect upon the measures of personal tempo; however, when all of them are combined in an analysis of variance a significant change is more likely.

The explanation of the changes described above seems most reasonable for a number of reasons. The most important reason for concluding that there was no single source of variation which produced these results is lack of any consistent changes in the different tasks. For example, both tasks which were markedly changed, the tapping and "circle and squares" involve psycho-motor reactions which are very similar (small muscle movements of the hands). Furthermore, there is some empirical evidence which indicates that "the speeds of all motor activities are related by means of a fundamental motor function basic to all of them" (Rimoldi, 1951, p. 297). This suggests that the same, or similar, psychobiological functions underlie different specific kinds of psycho-motor reactions. Therefore, it would seem reasonable that if either of the drugs had a consistent effect upon personal tempo, the tapping and "circles and squares" tasks should have been effected in approximately the same manner. However, this was not the case. The tapping tasks were significantly slower after the

administration of the tranquilizer, with no significant changes observed after administration of the stimulant; while the "circles and squares" tasks were speeded after the stimulant was administered, but no changes occurred after the administration of the tranquilizer.

A consideration of the results on the basis of the primary site of effect of the two drugs seems to indicate the same conclusions. The primary site of effect of the stimulant is the higher cortical centers. Therefore, if one were to conclude that the speeding up of the "circles and squares" was primarily due to the effect of increased cortical activity, it would seem to follow that the tests of reading, which most likely involve more cortical activity than the "circles and squares" tasks, should also have shown a significant speeding up after the administration of the stimulant. However, this was not the case in spite of the fact that the subjects re-read the passage after the drug was administered.

The primary site of effect of the tranquilizer is the anterior horn cells of the spinal cord, specifically the interneurons. This blocking of the interneurons enables it to act as a muscle relaxant. Therefore, if one were to conclude that the slowing down of the tapping tasks were primarily due to increased muscle relaxation, then it would also seem to follow that the tasks involving swinging of arms and legs should also have slowed down. However, this was not the case either. There were no significant changes in the rates of swinging arms and legs after the tranquilizer was administered.

Finally, the fact that those significant changes which were observed

occurred in tasks which were quite similar (tapping, "circles and squares") seems to preclude the possibility that these changes were produced by a single uncontrolled source of variation, e.g. learning, boredom, other than the drugs. If there were a single source of uncontrolled variation producing the significant changes, then one would expect similar tasks like tapping, "circles and squares" to be effected in the same or similar manner. However, this was not the case. Therefore, once again, it seems that the most reasonable explanation of the two significant changes in personal tempo which were observed is that they were the result of an accumulation of a number of sources of variance, none of which may have been significant by itself.

It is important to note here that any generalization drawn from these results about the effects of drugs upon personal tempo are applicable only to the minimal dosages utilized in this study. It is quite conceivable that larger dosages of the same drugs might very well produce striking changes in all measures of personal tempo. Whether or not this is the case, is a question to be answered by further research.

Furthermore, the lack of internal controls for individual differences among the subjects should be kept in mind in interpreting these results. It is possible that if another sample were tested, the results might indicate a significant effect by both drugs in all the tempo tasks. However, the applicability of these results to the other samples depends, not upon whether there are or are not individual differences within the sample, but upon the similarity between this sample and other samples, or

the population. Therefore, the only way to be more certain as to what extent these results can be generalized is to repeat this experiment with other groups and compare the results. However, the major caution to be exercized, even if these results do apply to other groups, is to keep in mind that one may not be able to accurately predict the effects of the drugs upon the consistency of a particular individual's personal tempo.

In general, it would appear that the overall consistency of personal tempo observed in this study is consistent with the results reported by other investigators. This consistency and resistance to alteration by extraneous sources suggests the possibility that personal tempo may very well be a very basic, fundamental aspect of personality. The fact that inter-individual variability usually is much greater than intra-individual variability indicates that it may be possible to characterize different individuals in terms of the personal tempo, or tempos which they adopt in performing one or more different types of behavior. Furthermore, the results reported by Fraisse (1946) indicating that the intervals separating different rhythmic patterns (combined with the results of this study related to the fact that the intervals--Silence--separating different dot patterns also remained the same) suggests the possibility that at least certain aspects of behavior may revolve around a very basic, consistent unit of time.

It seems obvious that the concept of a consistent personal tempo has implications for numerous areas of psychological study. The fact that the particular tempo which individuals spontaneously adopt may reflect the

speed at which they work most effectively may be pertinent to industrial studies. It is possible that a considerable amount of the difficulty experienced in establishing assembly line procedures may have been produced by attempts to force many different individuals with different optimal rates of responding to work at the same speed.

The possibility of an individualized, consistent personal tempo also provides reason to seriously question the assumptions underlying the interpretation of speed tests as measures of intelligence or specific abilities. A consistent relationship between intelligence and personal tempo has never been demonstrated. Therefore, it is possible that some of the variation among individuals on certain speed tests is due, not to differences in intellectual ability, but to differences in personal tempo. In view of this hypothesis, it is interesting to note that the Digit Symbol Subtest of the Wechsler Adult Intelligence Scale is one of the subtests which correlates lowest with general intelligence. It certainly seems that further research is indicated in the area of the relationship between personal tempo and performance on speed tests.

Another area in which certain aspects of personal tempo seem to have some applicability is that of personality tests. It would seem that the concept of a consistent personal tempo lends some support to the practice of many clinicians of attributing special significance to unusually short or long reaction times to specific aspects of some personality tests, e.g. Word Association Test, Rorschach Psychodiagnostic. If individuals adopt a rather consistent manner of responding to such complex

perceptual stimuli as Rorschach cards or T A T pictures, than it may very well be that a sudden change in this rate of responding reflects the presence of rather intense, emotionally disrupting factors. However, this inference would be applicable only to intra-individual variation. One would not be warranted in concluding that differences among individuals in overall reaction time to certain test stimuli reflect differences in emotionality of response, since these differences may be due primarily to initial differences in personal tempo. Certainly the above mentioned implications of the concept of personal tempo for clinical evaluation warrant further investigation. A good starting point would be a thorough study focusing upon a comparison of the personal tempos of, so called, normal individuals with those of individuals evidencing different symptoms of organic and functional pathology.

In conclusion, it is felt that the results of this study have contributed additional information to the concept of a consistent "personal tempo" which may have an important effect upon many different forms of behavior.

CHAPTER VI

SUMMARY

The purpose of this study was to determine the effects of certain drugs (stimulant and tranquilizer) upon the consistency of personal tempo. Fourteen subjects (7 males and 7 females) were asked to perform a number of tasks before the particular drug was administered and twice afterward (at intervals of one and two hours after administration of the drug). A placebo was also administered in order to control for the possibility of factors other than the direct effects of the drugs producing significant changes. The tasks performed (which served as operational measures of personal tempo) were the following: tapping patterns of dots on a telegraph key; reading science and literature; making circles and squares with the right and left hands; and swinging the right and left arms, both arms simultaneously, and the right and left legs.

In all, every subject was tested under three different experimental conditions: before and after the administration of a stimulant, tranquilizer, and placebo. The order in which the three conditions were tested was rotated, and the different conditions were tested on separate days.

The results were analyzed by the method of analysis of variance. Although the tapping rates changed significantly after the administration

of the tranquilizer, and the "circles and squares" rates changed significantly after the administration of the tranquilizer, it was concluded that one would not be justified in stating that these changes were due primarily to the direct effects of the drugs. In general, it was concluded that the overall consistency of personal tempo was not significantly and consistently effected by the drugs. Some speculations were made regarding the implications and applications of the concept of personal tempo to industrial problems, intelligence and personality tests, and a more comprehensive theory of temporal organization of behavior. A number of suggestions for further research were indicated.

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Approval Sheet

The dissertation submitted by Stanley J. Cabanski has been read and approved by a board of five members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the dissertation is now given final approval with reference to content, form, and mechanical accuracy.

The dissertation is therefore accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

Date

Signature of Adviser