A STUDY OF MOTOR PERSEVERATION

A Thesis Presented for the Degree of Master of Arts

by

Nuria Cortada
Profesora de Filosofía y Letras
Universidad Nacional de Cuyo. Mendoza (Argentina)

THE OHIO STATE UNIVERSITY
1947

Approved by

[Signature]
Acknowledgements.

I would like to express here my deep appreciation to Dr. Victor O. Raimy who "non-directively" and directly helped and encouraged me during the preparation of this thesis. His suggestions and advice contributed more than can be estimated, and without them this work could not have been accomplished.

I want to acknowledge also my indebtedness to Mr. W. W. Barlow, Director of the Dana Avenue Elementary School (Columbus, O.), for welcoming me so graciously to his school and providing me with the best possible circumstances for testing. I am also very grateful for the kindness of the teachers, Mrs. H. Greely, Miss Z. Rasner, and Miss I. Leonhardt, who undertook the task of rating their pupils with much interest and solicitude.
CONTENTS

CHAPTER I

WHAT IS PERSEVERATION. THE FACTS. 1
Definitions and Classification 2
Statement of the Problem 4
Need for a Study of Perseveration 5
Purposes and Aims of the Present Study 6

CHAPTER II

HISTORICAL REVIEW OF THE PROBLEM 9
Tests for Perseveration 15
Perseveration and Intelligence 19
Perseveration and Personality 22
Perseveration and Psychoses 29
Perseveration and Physiological Findings 31
Perseveration Related with Age and Sex 32
Perseveration, Inheritance and Racial Differences 33
Perseveration and Scoring Problems 35

CHAPTER III

METHOD FOLLOWED IN THE PRESENT STUDY 40
Description of the Tests 40
Description of the Population 44
Procedure for the Administration of the Tests 45

CHAPTER IV

STATISTICAL ANALYSIS OF THE RESULTS 48
Intelligence Test 48
Motor Perseveration Test 54
CHAPTER

IV

Rating Scale for Personality Traits 73

V

INTERPRETATION AND CONCLUSIONS OF THE STUDY 78

Explanatory Theories of Perseveration 78

Conclusions and Suggestions of the Present Study 86

BIBLIOGRAPHY 90

(APPENDICES A, B, and C in the folder at the end)
...Therefore the pursuit of knowledge, instead of making us proud and boastful, should make us modest and humble...

— Koffka

CHAPTER I.

1. WHAT IS PERSEVERATION. THE FACTS.

What is perseveration? Some exemplifying facts will show more clearly than any definition the concept that psychologists have found worthy to be symbolized by the word "perseveration".

For some people it is very annoying to change to another task after doing a particular task for a while. Sometimes when we are concentrated or "warmed up" in some activity — mental or physical — it is very difficult to start a new one. It seems as if our thoughts or movements once started in one specific direction find some mysterious resistance to change from it. Persons differ in this readiness to stop one activity and start immediately another one, as well as they differ in the capacity of adjustment to darkness after having been in the sun light. If a disc with white and black radial bars is rotated, the speed at which the bars fuse into a uniform gray varies with different people. All of us remember some instance when we could not get rid of a tune heard a while ago that "runs in the head". Also many of us had the experience of some word appearing involuntarily to our mind that we have seen before in some luminous advertisement. It can be recalled as really annoying when at night while trying to sleep we have the illusion of the appearance of playing cards, returning successively to our
visual field. That happens commonly if we play cards in the evening. Those who have been for some days in a ship have had the experience of the sensation of movement after they have disembarked.

Psychologists consider the facts mentioned above and many other experiences as having a common quality of perseverating. Perseveration is said to be what makes the white bars of the disc persist on the retina a fraction of a second and fuse with the superimposed black. Perseveration is said to take place when an idea or tune has the tendency to return again and again in spite of our wish to stop it. Perseveration then occurs when we find ourselves unable to shift from one type of response to another.

2. Definition and Classification.

Perseveration is not limited to some specific kind of behavior but seems to arise in many diverse fields. It is obvious in sensory processes but also occurs frequently in motor action, measurable because of the low output in a motor task when the effect of a previous task of some sort interferes with it. This is more exaggerated in some psychotic patients who repeat a recent movement in spite of the voluntary effort to produce a new one. In some paraphasic disorders, the persistent repetition of one word or group of words makes a challenge to the patient's attempt to change the topic and the observer's attempt to introduce other stimuli (21). Perseveration is involved also in more complex behavior as when some thought or idea shows the tendency to return repeatedly. Briefly, by perseverance we mean a phenomenon — the nature of which is still ob-
scure — that appears as the reoccurrence of certain sensations, images, movements, ideas, or purposive tendencies in spite of any conscious effort on the part of the subject to banish them. It is also related to the difficulty of "getting started" in some activity and conversely after having started with the effort required to change this.

Most definitions of perseveration are simply repetitions using different words. Spearman's definition seems to us as good at least as any other and has the advantage of being short and comparatively broad. To Spearman, perseveration is the tendency of mental events to begin and end more slowly than their apparent causes. This statement includes all the different effects that we stated at the beginning appearing in several fields of experience.

What is the difference between perseveration and so called "Persistence"? These two phenomena are actually separated, although they were not thought to be so, from the beginning (see Chap. II). Perseveration seems to be a deeper function independent of our will and occurring in many instances against our will. Instead, persistence, has become associated always with voluntary actions and measures, let us say, the ability of a person to stick voluntarily to a problem until solved; one who can be depended on to finish some task once started.

Perseveration has been attributed to many different types of behavior. It seems somewhat justified to classify it into different categories according to the behavior to which it appears


linked. Indeed, with the problems of classification, the question is raised immediately about the existence of perseveration as a single function or of "many" perseverating functions. Classifications are many times artificial, so we believe it is better to name more precisely the specific behaviors in which perseveration is manifest without making any assumption about the reality of such differentiations.

The characteristic fields where perseveration has been cited are: sensory, motor, emotional or conative (i.e. spasms of anger), cognition, and borderline conscious activity in line with inclination. The effects of perseveration in those fields are mainly of continuance, recurrence, and fixation (27). It is not clear if this appearance in several fields of perseveration is due to a real functional differentiation in perseveration or only a differentiation due to the tools and instruments used for its measurement.

3. Statement of the Problem.

From the previous considerations it follows that the problem of perseveration is a very complex one. The existence of the facts stated at the beginning cannot be denied, but a revision seems necessary in order to see if their grouping under a unitary perseveration is functionally justified. Perseveration will receive a very different consideration if it exists as a central function independent of training or a peripheral function liable to the effects of practice and learning. Besides, is perseveration dif-
ferentiated individually enough to attract the attention of psychologists in order to have some practical value as an individual index? What are the relationships between perseveration and intelligence and other better known abilities? What kind of relationship can be established between perseveration and other variables of behavior such as age and sex?

Those and many other questions are fundamental in the problem of perseveration. Some of them have been answered more or less satisfactorily by some investigators, but sometimes their results have aroused so many criticisms that a revision of them and a checking of the methods used seems to be worthwhile.


A survey of the existing literature (see Chap. II) shows much disagreement regarding the nature of perseveration. A question will summarize two general contrasting points of view. Is perseveration a central function occurring similarly in the same individual for different activities, or is it a peripheral function with a specific index for every kind of activity that the same individual performs? A third alternative, more eclectic is suggested by Shevach (45), who views perseveration as a functional unity only for certain subjects, notably children, but in all other individuals the phenomenon is largely specific to the test used.

Methods of study -- usually tests -- make the study of perseveration difficult. In the study of perseveration it seems as if every one of the investigators has disregarded the work of preceding
authors. Every one who attempts research on perseveration apparently constructs his own tests and his own methods paying little attention to the problem of validation of former researches. Furthermore, the tests used are rarely standardized. Very few studies refer to reliability and other statistical characteristics of the tests used.

Recently one more fact has been added to this already chaotic state. Some careful studies made in Australia (5, 55), showed that the way in which many of the motor perseveration tests were scored by former investigators was inadequate to the nature of the function. They were better measures of the "tempo" of the subject than of the difficulties in changing activities or perseveration.

All this seems to show an urgent need for organizing and clarifying the status of perseveration. The task of checking and validation of certain conclusions, and of the standardization of some reliable tool — not necessarily a new one — could be useful by giving some sort of clues to future studies on this matter.

Psychology is full of problems like this one which seems to justify the bitter attacks of Cattell who says (9,p.5);

"...Measures and statistical observations come in rightly from many kinds of research interest and from all angles of approach, except unfortunately, that kind of research directed to the methodological heart of the problem. Extremely little research has been directed, in fact, to obtaining meaningful, defined measurements of personality variables or toward systematizing the task of describing personality..."

5. **Purpose and Aims of the Present Study.**

Contrary to most researches the present study started with
the purpose not of demonstrating a new hypothesis or sustaining a personal theory on the problem of perseveration, but rather with the aim of validating previous studies. The purpose of the work is thus simply to make a revision of old conclusions and sporadic researches which used the most diverse tests in several fields of behavior. It seemed worthwhile to repeat the administration of some of the tests that appeared most useful for the study of the function, to score them in the light of a sound system and to try to control the experiment in some way to validate or invalidate former studies. It was felt that a revision of this sort without a preconceived theory to prove, letting the facts tell the story would be best carried on in the motor field. The motor tests selected, most of which were widely used by Lankes, Pinard, Stephenson, Walker, and many other investigators, were never systematically standardized.

The study is not, however, a mere repetition of former experiments. With the main problem of perseveration in mind I wanted to check the hypothesis of perseveration as a central factor in personality, against the possibility of its being a specific function liable to be influenced by learning processes likely to differences in several activities. The real value of one of these points of view could be stated for motor perseveration if I were able to demonstrate a positive correlation between the results of similar tests of motor perseveration and given to two different sets of muscles in the same person. In a few words, I gave tests to both right and left hands of the same individuals. A second purpose of this study was to make a standardization for a given
population of a battery of motor tests, so that later studies could have some specific clues about using this tool.

Those are in a broad sense the purposes of this paper. The studies of perseveration have been, quoting Allport (1, p. 417), "more numerous than fruitful". The aim of this thesis is not to be one study more on perseveration, to be recalled as the introduction of a new hypothesis or the use of some mysteriously powerful new test -- for this still more mysterious function --. The aim is a revision in a very specific field -- motor perseveration -- of old settings, the recognition of shortcomings of former hypotheses and evaluation of previous findings in the light of obtained data.
CHAPTER II.

1. HISTORICAL REVIEW OF THE PROBLEM.

The testimony of Aristotle can be reported in almost any field that we intend to study. Therefore, it is not a surprise to find some remarks in his books on the involuntary recurrence of ideas. In one chapter on memory in his Psychology he wrote:

...this affection resembles names, melodies, words when they are given violent utterance. For, after one has ceased the singing or speaking recurs involuntarily. Further those whose upper body is large and also dwarfish persons have less power of recollection than those of the opposite physical structure because the former are too heavy about the organs of sensation and because the initial movements cannot persist but are destroyed....

(quoted from 23)

This paragraph is also important because it introduces the comparison between body structure and mental functioning, anticipating in this way the dichotomous typology stressed by investigators in psychology much later. In spite of Aristotle's observations, perseveration was not usually taken into consideration by philosophers.

However, Johan K. Herbart (well known because of his influence on educational problems) gave an important role to this function in the building of his metaphysical psychology. He considered that ideas had a certain force by which they tended to thrust themselves into consciousness. Herbart did not use the word perseveration though the concept is found implicitly in many of his passages. For example, at the very beginning of his Text-
book in Psychology he states:

...Concepts become forces when they resist one another. This resistance occurs when two or more opposed concepts encounter one another...Here it is in effect stated that, as soon as the hindrance yields, the concept by its own effort will again make its appearance in consciousness... (22, p.9)

The name "perseveration" is credited to a psychiatrist, C. Neisser, who in 1894 used it to distinguish this phenomenon as a clinical symptom of some psychotic patients showing an abnormally persistent repetition of an activity long after the stimulus had been removed.

The beginning of the interest in this function started when G.E. Müller in a study in collaboration with Pilzecker (Gedächtnis) in 1900 defined for the first time perseveration as the tendency which every idea has, after having occurred once "to remount consciousness spontaneously". For, to Müller every idea had a certain "force" and:

...when the other functions which are besieging consciousness are not of special strength and persistence the given idea will come to consciousness solely in consequence of its perseverative tendency....

(quoted from 27)

Such an explanation does not explain the nature of the function at all, but blindly accepts the existence of mysterious forces without further validation of the theory. Müller called attention to perseveration mainly because he was deeply impressed by the results of his experiments upon the memorization of syllables. Some syllables were found to recur again and again as substitutes for the forgotten original. He saw in the perseverative tendency
an important point for further practical applications:

...It is easy to see that individuals with strong perseveration will not be rightly placed in a location which needs a quick and frequent change of attention or a rapid disposal of numerous and quite different businesses...

(quoted from 47)

Müller considered the perseverative tendency related to the dependability of individuals when it came to the matter of carrying out resolutions and decisions, so he assimilated the perseverative tendency appearing in processe independent of will of the person and what is more commonly called today persistence or willingness of an individual, ability to stick to some decision once made, etc.

Later on, Otto Gross the German psychiatrist observing different kinds of psychoses arrived at the conception of a division between two types of persons; the "deep-narrow" and the "shallow-broad" which arose from a physiological differentiation. Those in which the "secondary function" of the nervous system dominates pertain to the first type; those in which the "primary function" dominates fall into the second category. By "secondary function" Gross meant the after-effect observed in the persistence of the impression after the stimulus had disappeared. "Secondary function" can be correlated with what Müller called perseverative tendency, while the opposite trait, oscillation, variation or fluency, is represented in Gross' system by the "primary function".

Influenced by the ideas of Gross a Dutch investigator, E.Wiersma in 1906 devised the first experiment to measure perseveration. His procedure involved only sensory processes, especially in the field of vision. A series of trials were made, and their results clearly
stated, regarding the threshold of color fusion (red and green into a uniform gray) on a rotating disc. Individuals were tested also in their adaptability to the light and in their adaptation to electrical stimulations of the skin. Out of these experiments some conclusions were drawn in regard to the temperamental traits of the subjects studied.

In 1913 Heymans and Brugman extended the number of tests and included some of the motor type. They characterized Gross' secondary function as a

..relatively constant complex of factors which bring unity and coherence into life and in the case of inevitable changes is able, through its restraining power to effect a gradual weering about in the place of sudden shifts...

(quoted from 1, p. 417)

These investigators together with Wiersma are usually spoken of by the general name of the Dutch school. Their conclusions were not very important in regard to individual differences but it may be that this was due to the fact that statistical procedures and scoring were not adjusted to the size of the sample. We will come later to these studies and their conclusions in relation to psychoses.

From this time on many other investigators became interested in the problem of perseveration, especially in England. Several other tests were devised. The analysis of those studies was carried on under the guidance of the so-called School of London and made use of factorial techniques which were beginning to be used at that time. We will review in detail most of those studies. From the theoretical point of view it is important to report the
systematic approach to which they were subject and the theory under which they became linked.

C. Spearman drew up a theory on perseverance which only recently has come to be seriously criticized. In his book Abilities of Man published in 1927 Spearman states that perseverance constitutes a factor and gives to the process the character of a mental law, "law of lag or inertia", formulated as follows; "cognitive processes always both begin and cease more gradually than their (apparent) causes". He identifies individual differences in perseverance with the antithesis of introversion-extroversion and other similar typologies, in fashion at that time. He was aware of the small amount of work on which he was basing his conclusions. It cannot be denied after reading this paragraph:

...In respect to "intelligence" they have measured individuals by millions collating the results with all the information available elsewhere and enthusiastically deducing fundamental applications to education, industry, and society. But in respect to perseverance have they thus measured and treated a single person? Far from it they seem no even to have cared to inquire whether such character admits of being measured at all or what comes to nearly the same thing, whether he who perseveres in one kind of operation may be expected to do so correspondingly in others...

(47 p.232)

Spearman, inspired with the results of the work of Lankes, Wynn Jones, Stephenson and others, build up a theory in which he had the highest confidence as possible source of many practical accomplishments;

...Turning to the practical standpoint, the prospect here is extraordinarily hopeful. When once the pack of modern investigators can be
called off the many false scents of illusory faculties to this genuine trail; when the perseveration even measurable by groups, has been evaluated for different persons of diverse age, sex, character, and social status; when the connection has been traced out which it bears to success in different branches of education and varieties of vocation — then perhaps psychological science will make a second advance not much less in magnitude than that which is being achieved with respect to "intelligence"...

(47, p.307)

From the point of view of the London School, $G$ (general intelligence) and "$p" (perseveration) are two independent factors which can be dealt with essentially as two different aspects of the same thing: mental energy. "$G" will measure its quantity and "$p" expressing its degree of inertia. In the last chapter we will discuss the validity of Spearman's hypothesis in the light of more recent researches. For the moment let us say only, that it has been this school that pays more attention to this function.

German psychologists have been interested also in the phenomenon considering it as related to memory and classifying it as a clinical symptom for some psychoses. From these theories a new typology arose.

In America perseveration has not aroused much interest. Studies have not been limited to any one particular school. Some psychologists like Warden, McGeoch and Bentley accepted perseveration in the sense of Müller. Morgan uses the term as a clinical symptom and only Jaspers carried out research following the methods and pathways of the English school.
2. Tests for Perseveration.

A. Sensory Measurement.

Individuals differ in the degree to which they are influenced by the effects of a sensory stimulus after the stimulus has ceased.

1. Flicker Fusion Speed of Rotation: the threshold for flicker is useful for this measure. A disc half green, half red with the same intensity is rotated. A certain degree of speed is necessary for the individual to see the disc as gray. (Wiersma)

2. Light Adaptation: a sensory test for perseveration is useful also to measure the time that different persons need to perceive fainter lights in the darkness after having been in the bright light. The measurement should be carried on under standard conditions. (Wiersma)

3. Adaptation to Successive Electrical Stimuli in the Skin. (Wiersma)

4. Adaptation to Sound Stimulation. (Heymans and Brugman)

5. Color Dots Test: This test involves more complex processes. The subject has to name the color of some dots printed on a large card (fig.1) at which he points with the finger or a pencil, as rapidly as he can, and then, the next trial he has to repeat the experience naming the dots exactly in the reverse way. For instance, if the dots to which he has to pay attention, are red and blue, in the first trial he will call the red dots "red" and the blue ones "blue". Instead, in the second trial the subject has to name as "red" the blue dots, and as "blue" the red ones. The measure is indicated by the ratio of the number of dots correctly named the first and second trial, during the same time. This device has some advantages in a situation when no laboratory setting is available. (Staphenson, Cattell)

Fig. 1

B. Motor Measurement.

These tests measure essentially the ability of the individual to shift from one activity to another. They can be divided in two types. They are of the "creative effort" type, when the
subject has to break down simply a familiar pattern; for instance, to make S's backwards:

Direct activity..... S S S S S...
Reverse activity..... S S S S S ...

The score is indicated by the difference or the ratio in the number of elements written in the first and the second part of the test, the time allowed being the same. The tests are of the "alternative effort" type when the measure is the comparison of the difficulty of performing two tasks first independently and then in alternation. They are based on the hypothesis that individuals vary in the readiness with which they can shift from one activity to another. The tests used are usually "paper/pencil" tests. The distribution of the tasks is for example:

Simple activities.... (Direct).... S S S S S... (Reverse) S S S S S ...
Alternate activity..... S S S S S S S S S ...

We will discuss the way in which these tests are scored with further detail, later in this paper.

Jasper (23), classifies the motor tests of perseveration in several classes according to the performances required on the part of individual. These are:

1.- Reverse Order Letters: Five letters written forty times in one order, twenty times in the reverse order (abode, edcba). The difficulty of shifting to the second arrangement was to indicate perseveration. (Heymans, Lankes, Bernstein)

2.- Letter Cancellation; in a page where are written mixed all the letters of the alphabet, to cancel one, always the same. (Lankes) Perseveration is here measured from the number of errors made by the subjects when they are asked to change the letter they cancel.

3.- Inverted S's Test: (Used for exemplification previously). (Jones, Bernstein, Heargraves, Stephenson, Pinard, Walker, etc.)
4. - Tapping Test: (Similar to the Tapping Test for reaction time). (Heymans, Langos)

5. - Mirror Drawing: the subject must draw a pattern first directly and then as it appears in a mirror image. (Jones)

6. - The "it" Test: a passage of prose written first as fast as possible being careful to dot all the "i"s and to cross all the "t"s, and next writing with the express instruction of not dotting the "i"s nor crossing the "t"s. (Jones, Jaspers)

7. - Reverse Stroke Test: a certain number of digits written repeatedly in a certain way and then reversing the way of doing the strokes. For instance, $\overline{123}$ and then $\overline{231}$ (Stephenson, Bernstein)

8. - Triangle Test: for example to draw $\triangle \triangle$ and then $\bigtriangleup \bigtriangleup$ (Stephenson, Pinard)

9. - Capitals Test: a passage of several sentences was written first normally and later had to be written making all the small letters as capitals and the capitals as small letters. (Jones, Bernstein)

10. - Vertical-Horizontal Test: four rows of simple geometrical forms were given to be copied for one minute. The same figures were then to be written substituting all vertical lines for the horizontal ones and vice versa. (Jaspers)

11. - The "ea" Test: write a passage first normally and then placing an "a" after every "a" in the passage.

12. - Perseverameter: Cattell (6), has devised this instrument to measure motor perseveration. He observed that ability to draw mirror images, for example, has frequently been used as a test of intelligence. In a test like that of writing S's normally and then backwards, the new activity $\mathcal{S} \mathcal{S} \mathcal{S} \mathcal{S}$ may be differently treated by people of different intelligence. It may be regarded as an alternation of old and new shapes or it may be perceived as an entirely new "gestalt". The more intelligent of the subjects are decidedly prone to the latter perception; they would not write the alternative activity in this way, $\mathcal{S} \mathcal{S} \mathcal{S} \mathcal{S}$ but as a series of groups like these, $\mathcal{S} \mathcal{S} \mathcal{S} \mathcal{S}$. So, Cattell devised an apparatus, type-writer like, as it appears in fig. 2. The first activity might be to press the keys in a certain order, for instance, 2 - 5 - 4 - 5 while the second activity could be to depress the keys in another order like, 2 - 5 - 6 - 1. The score is given for the transference
the first activity puts in the second one.

C.- Measurement of Perseveration in the Ideational Field.

1.- Recall Test: (Müller and Foster with syllables, Lankes with narratives).

2.- Towns Test: the instructions are to write as many towns as possible beginning with the same letter. (Hargreaves)

3.- Word Building: as many words as possible have to be made out of the letters contained in four given words. Time limit 1 minute, one point each word written, low score indicating strong perseveration.

4.- Nouns Test: the subject has to tell as many nouns as possible beginning with a certain letter. (W. Jones, Kendig)

5.- Animals Test: give the names of as many animals as possible in a certain time. Each name a mark.

6.- Whipple's Ink Blots: one mark given for each different meaning. (Wynn Jones)

7.- Essay Test: the ease of writing essays in a given time on a given topic. (Lankes)

8.- Associative Reaction: repetition of identical associations to a series of stimulus words in which some words are repeated.

The school of Lewin (32), mainly his pupils Ovsianikina and Zeigarnick while working on problems of memory have shown that completion or incompletion of the task has great importance in the process of learning the task. They maintain that this is due to the fact that conative processes tend to perseverate. Incomplete tasks somehow arouse emotional tensions which make the incompleted tasks stick more firmly in the subjects' mind and learn them more surely. This return to the incomplete tasks is always involuntary (26).


This method has been used by Lankes, Kendig, Jaspers, etc., etc.
It is used mainly for the validation of other measures and also (Lankes) for the purpose of establishing relations between perseveration and the voluntary qualities of character such as persistence.

Typical questions of those questionnaires are such as the following:

When writing a paper or working out a problem can you drop it easily, pick up some other task and put your mind easily upon a new task? ........ Yes - No

Do frequent changes in the routine of life annoy you? ......................... Yes - No

When you have started to do something do you feel uneasy if it left incomplete? .................... Yes - No

Do you often notice that a tune, a line of poetry or a phrase frequently return to your mind without any effort or intention on your part? ............ Yes - No

3. Perseveration and Intelligence.

In 1913 Heymans and Brugman in a study published in the "Zeitung für Psychologie" Vol. VII, established the results of an experiment made with fifteen students to which they gave five tests of the sensory type and one of motor perseveration. They gave to the same group other tests, intelligence, memory, imagination, etc. The correlation between the tests of perseveration and the tests of intelligence was very small and later Spearman proved it to be negligible, by using the tetrad difference method.

The next year Wynn Jones gave seventy-seven 12 year old children four tests of the motor type (creative effort). The results showed a high intercorrelation (average +.49) and using the tetrad difference method they appeared to the English investigators as showing some group factor pervading the tests of perseveration.
As the intercorrelation could appear as being due to the fact that the tests used were all motor type, Jones extended the research to some tests of motor dexterity other than perseverative, like speed of making dots, speed of copying foreign letters of the alphabet, etc. The intercorrelation proved then to be very small (47).

Lankes' work was published posthumously in 1915. His investigation was twofold. First, he wanted to determine if perseveration was a general factor influencing the entire range of mental abilities, and second, he wanted to study how perseveration was related to persistency of will; a quality of character. The study started in London under the direction of Spearman. Lankes worked out the statistical results of nine tests of sensory and motor perseveration plus a large questionnaire. His subjects were forty-seven adults. He found small intercorrelations between the tests used which were not explicable by the presence of "g", as the tests were carefully selected to avoid it. He concludes (31 p. 397):

...Therefore, in spite of the lowness of nearly all single correlations they must be the results of a general factor influencing all various performances tested by the experiments and by the interrogatory. And this general common factor cannot be general ability, which will scarcely be supposed to influence e.g. Tapping or Colour Disse,...

The results of most of the authors are quite similar in this respect whenever the range of intelligence scores is small. Borsenstein in 1924, Rangachar in 1952 (40), and Cattell in 1935 (6), did not find any significant correlation between intelligence and perseveration. However, Jersild (24), in his experiments found that the more intelligent person as measured by intelligence
tests (Stanford-Binet and Merrill-Palmer) not only obtained a better score in tests of performance involving shift but also suffered the least relative loss in passing from the separate tasks performance to the performance calling for alternation between elements of the separate tasks. In this way he criticized the work of Lankes and others because none of these investigators took full account of the relation between the particular factor studied and the type of ability which made for skill which served to give control data in the experiments.

Different investigators have made a point of the occurrence of perseveration in feeble-mindedness. For instance, E.A. Doll referring to the characteristics of mentally deficient people in a fairly recent article says; "... they excel in monotonous perseveration..." (13 p. 408)

Ketzer (23), in 1936 studied a case of low mental ability (IQ around 69) and concluded that there exists a parallelism between retardation in school work and perseveration in the reproduction of a similar pattern of drawing. A recent work of Kenna and others (53), shows that children retarded in school work have higher motor perseveration than those who stand at the corresponding grade for their age.

Strauss and Werner in 1942 (50), studied sensory perseveration in mentally deficient children and apparently found some differences according to whether the children were classified exogenous or endogenous mental deficiency. Repetitive and delayed perseveration seems truly specific to the brain injured children. Strauss and
Werner applied some devices for overcoming blocking due to perseveration and thus helped the method of training these children. In a more recent paper, Werner (56), reports an experiment in which eighteen pairs of mentally retarded and brain injured children matched for MA and IQ were studied. When they took four perseveration tests; reproduction of a tone, rhythms, pictures, dot patterns, and words, the brain injured children showed more delayed perseveration than the endogenously retarded children. Werner concludes that endogeneous rigidity involves failure to differentiate within coarse grouping whereas brain injured perseveration is desintegrative or abnormal with elements remaining isolated or ungrouped.

4. Perseveration and Personality.

From the very beginning perseveration has been associated with some traits of personality, especially introversion. Lankes correlated the results of perseveration tests with Webb’s will tests. There appeared a negative correlation (-.26) between the perseveration tests and the estimates of persistency. He considered that perseveration was an innate quality different from that of persistence. Many other investigators have been interested in the same problem of finding the relationship between perseveration and personality because from the former studies some statements were made in regard to this relationship.

Pinard (39), working on 196 children in a Residential Children's Home found that the more mischievous, troublesome, and quarrelsome
children were either very high or very low perseverators. He used four tests of the motor type and gave the children several periods of practice until they were reasonably confident of the method in which they had to work. In this way he eliminated the possibility of measuring ability to understand orders, intelligence, etc. He found that the tests had low reliabilities if he gave the tests only once, so he gave them on five different occasions and averaged the score. The time for every test was six minutes. Finard's conclusions are that individuals with extreme "p" scores are likely to be defective in character as measured with the Webb test.

"P" correlates negatively with "w" to the extreme of -.40 or -.50. The results can be represented graphically in a curve such as the one of fig. 3*. Pinard contradicted in his study the association previously claimed between perseveration and several qualities of character (see later in this chap. Psychoses and perseveration), which have from time to time been claimed to indicate introversion. Not only the extreme perseverator but also the extreme non-perseverator tends to lack perseverance and self-control and to be obstinate, unreliable, "touchy", and difficult. Whereas the perseverator tends to be nervous, sensitive, affondate, and sentimental, the non-perseverator tends to be unconsiderate, tactless, and critical. The moderate perseve-

* The non-curvilinear relation between the two traits "w" and "p", was stated later by Cattell.
rator is generally considerate, harmonious, reflexive, courageous, and a "good mixer".

The investigators have recently -- especially in England -- been interested in perseveration mainly because of its supposed connection with character. Character is referred to in the sense of a volitional function in relation to one's motives.

Stephenson (49) for instance, emphasizes that the so-called motor perseveration tests are so far the best tests for character. He states, however, that he prefers to call them just "p-tests" until knowing more clearly what they really measure. He generalizes the conclusions of many other authors saying that a high p-score is associated with all the poorer qualities of personality; poor intelligence, poor self-control, poor power of concentration, poor physical energy, and weak character in general. In the same paper Stephenson discusses the validity of the p-tests as measures of perseveration and ends with such a hopeful statement regarding the use of p-tests for indirect measure of character, that we thought worthwhile to quote him (49, p. 50)

... the truth is that p-tests first and foremost present miniature life-situations to the individuals who attempt them. They offer a slight difficulty to be overcome, and allow for the interplay of conation and motivation, of effort, will, purpose, in a word character. P-tests are thus, direct tests of character and it is not necessary to consider that perseverance plays any essential part in them...

He suggests at the end of the article that perhaps these motor tests are related to some important phase of personality -- the "determining tendency"
Cattell (6), undertook a quantitative study of the ten highest and the ten lowest perseverators out of a group of fifty subjects measured by eight tests. In general character qualities both groups were inferior, a very high score or a very low score being indicative and typical of a low "w" score. He suggests that a high score may be due to conflict, discouragement, and inhibition dating from early age.

From the studies of Pinard and Cattell this last author makes up a list of what he considers the more reliable distinguishing personality characteristics of extreme high or low p-score cases.

The list is as follows (9 p. 441):

**CHARACTERISTICS OF**

**Low Perseverators.**

- Prone to action in dissatisfaction. Assertive; active.
- Insistently assertive. High tension. Hence nagging, restless, fussy.
- Enterprising, self-reliant.
- Openly individualistic.
- Tend to be natural leaders.
- Not affected by emotional scenes.
- Inconsiderate, tough.
- Irritable, selfish, silent, anxious, tense.
- Tends to be interested in mechanical, scientific, and mathematical matters.
- Decisive and impetuous. Ability

**High Perseverators.**

- Resigned, but often seeking expression in tortuous ways—hence sometimes deceitful cruel, spiteful, unpredictable.
- Quiet, slow, more emotional and "deep" in general.
- More skeptical and pessimistic.
- Conservative in habits.
- Sensitive emotionally.
- Rebellious in theoretical outlook, serious, shy, and solitary.
- Tends to be interested in history, languages, and humanities.
- Absent-minded. Impressed by one thing at a time.
to grasp situations whole.
Good taste and definite style
in dress, voice, music, etc.

Dreams very little.

Liable to short periods of
acute restlessness and crises
of intense emotional dissatisfac-
tion.

More interested in scientific
business and practical matters.

Makes good use of relatively
low IQ. (In social status,
responsibility of occupation)

Systematic, precise, planful.

In general character is defec-
tive because of "immaturity",
naiveté, superficiality of
emotions, and self-will.

Drifting to decisions. Dreamy.
Sentimental. Careless of detail.
Slovenly in dress.

Greater tendency to dreaming
(in sleep).

Liable to long periods of
depression or gentle melanc-
choly.

More interested in religious,
historical, and language sub-
jects.

Neurotic symptoms of a gen-
eral nature more prevalent.

Fails to make use of intel-
ligence in any ordinary sense.
Negligent of external demands.

In general character is defec-
tive because of excessive
depth inhibitions, emotionality
with general discouragement
and lack of integrated driving
power.

Clarke (5) studying delinquents showed that extremes of perse-
veration were associated commonly with opposition to authority.
The difficult child is frequently an extreme perseverator or non-
perseverator; Clarke is in perfect agreement with the earlier
statements of Pinard.

Langlie (30) made a study of the relationship between per-
sistence in errors and perseveration. He gave his subjects a
learning problem and the Bernreuter Personality Inventory. Those
who made repetitive errors possess in general the same charac-
teristics as the perseverators. This author suggests a new inter-
pretation of the nature of perseveration in terms of "cortico-
thalamic balance".
We could find only one study of perseveration in animals. Everall (16), using rats says that a very intimate connection exists between perseveration and emotional disturbance.

I. Kendig (26) in 1937, made a series of studies on perseveration that are very interesting. She tried to find out if what she calls "compulsory perseveration" is correlated with obsessive attitudes measured by an adaptation of the Bernreuter Personality Inventory. The measure of perseveration was the compulsive effect that the production of thirty words beginning with the same letter left in the subjects. Kendig's procedure was a long and complicated one, but the main feature is that she divided the subjects into groups according to the instructions under which the tests were given. The author concludes that when the task was accepted as a "casual" one, there was a minimum of later compulsive activity. When there was a desire to "help" the experimenter it increased. When the subjects accepted the task as an intelligence test and were allowed to succeed there was more perseveration, and under these conditions if they failed a maximum of "compulsive perseveration" developed. These findings agree with the results of Zeigarnick and Ovsiankina and also with the ideas of Jung that emotionally-toned activities have a greater tendency to perseverate than otherwise. From this study of Kendig it follows that the maximum conditions for development of compulsive activity are those in which the subjects experience failure and are not immediately involved in a new activity, but the failure is followed by an "empty" interval.
Kendig, on the other hand found some correspondence between compulsive activity and obsessive attitudes as measured by the Bernreuter but did not find correlation between the "neurotic tendency" measured by the Bernreuter Personality Inventory and perseveration.

If it is true that "neurotic tendency" in the Bernreuter and introversion correlate .95, these findings contradict the former opinions of psychiatrists who linked perseveration and introversion. In another experiment in which no time limit or minimum number of words were set, Kendig studied the possibility of the existence of limens for perseverative tendency. For this experiment ten subjects were instructed to compete in a contest in writing as many words as possible beginning with the same letter. On the basis of this experiment giving the same task to the individuals under two variables, failure or success, she definitely established that perseveration is a function of failure.

Often disorders in speech have been reported as associated with behavior problems and personality disturbances. It seems important to state the findings of Eisenson and Wislow (15) who discovered that perseveration is present in a comparatively greater degree among stutterers than among non-stutterers.

The relation between physical type and perseveration was the object of the study made by Mislak and Pickford in 1944 (35). They classified ninety-two boys according to Kretaner's types of physique. Results of the chi-square test showed that asthenic boys tended to be low and pithic boys to be high perseverators while athletics and boys of indefinite type are as often high or
low perseverators.

In the studies on personality made under the direction of Murray (37), perseveration is considered as forming part of a general trait or attribute of personality called endurance. This is defined as the protensity of a behavioral trend, and includes, "power of endurance", persistence, and conative perseveration. Opposites to these are transience, impersistence, and imperseveration.

5. Perseveration and Psychoses.

It is well-known the fact that in some schizophrenic reaction types, like catatonia, perseveration may reach an extreme degree; for example a patient who takes meals in a singular mechanical way will continue to go through the same motions long after he had finished the food that was before him. Although, perseveration is somewhat different from stereotypies. The latter consist of an action or words monotonously repeated long after fatigue would ordinarily caused relaxation. Perseverations are odd but stereotypies are bizarre, fantastic, and ridiculous. Besides the patient displaying a stereotypie has lost the sense of reality completely in most of the cases while the psychotic who presents perseveration is still in many ways in touch with reality. However, perseveration thus defined, is rarely observed as Stephenson (49) notices.

Jung (25), gives the example of a man's perseveration of the word "short" to all kinds of stimulus words in an association
test. He uses it as one instance more where his analytical theo-
ries are fulfilled, and considers that words that perseverate
always contain something of importance for the individual.

From the experimental field Wiersma and Heymans using flicker
tests and other sensory measurement of perseveration claimed to
find that melancholics were stronger and maniacs weaker perseve-
rators than normal people. Heymans said that the secondary
function when highly exaggerated, lead to melancholia and paranoia.
It is — to him — often the cause of sterile brooding, a reduced
sense of reality and lack of presence of mind as well as low adap-
tability. The primary function on the other hand is to be associated
with superficiality and incoherence. Later Stephenson and Pinard
found that maniacs and hysterics were low perseverators while
melancholics and schizophrenics were high. They said that in
schizophrenics showing recovery the return of the "p" score to
normal limits was the best index of returning to health.

However, some studies show results that are contradictory to
the above stated. Wynn Jones (57), using memory tests found no
distinction between melancholic and maniac subjects.

Other investigators have been interested in perseveration of
psychotics. Shipley (46), compared the results in a series of
tests with normals and ranked the groups in descending order
regarding perseveration scores as follows; schizophrenics, maniac-
depressives, psychoneurotics, and normals. Eysenck (17), made
a study of thirty hysteric patients and thirty normals matching
them in regard to age and sex. He gave to them a battery of four
different tests: intelligence, suggestibility, temperament, and perseveration. He found that the differences were not statistically significant between the two groups for tests of suggestibility, temperament and perseveration.

6. Perseveration and Physiological Findings.

The comparison has been made between the hindrance effect of a very strong perseveration (impossibility to reverse an activity in some schizophrenia type) with the lack of inhibition due to the lack of function of the upper parts of the nervous system (48). A dog with extirpated cerebellum will continue to react to a conditioned or unconditioned stimulus for an indefinitely long time, always in the same monotonous way, in conditions in which a normal dog has stopped reacting long before. It is the cerebellum according to Pavlov which adds the inhibitory forces and subjects this unnecessary repetition—physiological perseveration?— to control. Modern studies locate generally all the most delicate functions of the nervous system at the synapse. But very little is known and the concept of synapse itself is a construct where seem to be dropped all the unexplained phenomenon occurring in the nervous system. The advancement of electrical techniques to measure different levels of potentials in the nervous tissues made possible some studies which eventually might give some light on the physiological background of the problem of perseveration.

In 1937 a study was made with electroencephalograph tech-
nique for seeking the perseveration time of words visually presented and the presentation of simple light. It was demonstrated thus (52), that words were associated with longer perseveration time than mere presentation of light. This the authors interpret as giving a physiological basis for the "meaning" of words.

In another recent study Brickner (3), during electrical exploration of the cortex of a convulsive patient, discovered an area which when stimulated produced perseveration in speech. This area (called area X) was on the mesial side of the left hemisphere in area 6 probably near the posterior part of area 32 and 8.5 cm. away from Broca's area. While under anesthesia the patient said the alphabet, the letter being said at the moment of the stimulation was repeated throughout the duration of the stimulus. Perseveration ceased instantly with cessation of the stimulus. Although aware of her behavior the patient was unable to check herself.

7. Perseveration Related with Age and Sex.

Finard's study (39) shows that adults are higher perseverators than children and men somewhat higher than women.

The work of Gattell (7) mostly on motor tests, showed that perseveration can be measured with adults quite satisfactorily by tests of the alternative effort type and making use of the perseverament; but, that children are better measured with the creative effort type. This author assumes that tests of 1.5 or 2 minutes are the best for adults but longer time is
needed for children. F-score declines with age to adolescence and then raises to a stable level with a further rise in old age. Cattell did not find marked sex differences for adults, but the boys between ten and fourteen years appeared higher perseverators than the girls. However, Stephenson reports that there were not difficulties in testing children above eight-years-old. Maybe the difficulties that Cattell found were due to working most of the time with abnormal children.

Dybowsky (14), published the results of a very extensive study of perseveration. Some tests were given to 824 girls from six to twenty years-old. He found that perseveration increases during puberty and falls off after the process is complete.

Yule (53), in his study of twins did not find sex differences.

Shevach (44) agrees with most of the authors stating that children tend to be less perseverative than adults.


Lankes did not find the relationship that he was expecting between the estimates of character qualities and perseveration and in his attempts for an explanation accepted the possibility that perseveration was an innate quality, a determining quality of character, which could be changed or altered by the circumstances imposed through education and training. So, the old controversy between the nature and nurture theories for explaining
human behavior found its place also in the field of perseveration. Some authors accepting a more realistic point of view of interdependence of environmental influences and inherited traits, tried to find out through experimentation and testing the part that inheritance might play in perseveration.

Yule (58) gave 115 pairs of twins a battery of p-tests designed by Stephenson. The same battery was given to a control group roughly uniform in socio-economic status. Monozygotic twins showed more resemblance in "p", than dizygotic of the same sex, and those more than those of the unlike sex.

Cattell and Molteno (10) studied the problem of perseveration in twins and concluded that p-tests results give no strong evidence of hereditary influences. However, Tomson's results are slightly contradictory (51) He made a comparative study of two twin sisters. The experiment was planned thus: a twin girl was trined in a play-room situation to play always with the same toy, while the other sister in exactly similar play-room was allowed complete freedom of action. After some time the first of the girls when left alone showed a greater perseveration in play than her untrained sister, changing less frequently of toy. After a few months, the effects of training disappeared and the twins showed a very similar degree in perseveration.

Cattell states in his books that some differences have been found in perseveration between Northern and Southern Europeans, the latter having higher scores in perseveration. He does not seem to validate his findings sufficiently. In general the
the results of studies on racial differences in perseveration are very scarce and negative. The most complete study was made by Sangachar (40). He compared English and Jewish boys having a similar socio-economic status and did not find any statistically significant differences between the two groups.

Shevach (44) made a similar study with adults and concluded that the tests of perseveration had no racial determinants.


Very early in the study of perseveration several authors noticed the difficulties in obtaining reliable scores for perseveration tests. Pinard used a score which was the mean of several trials. Stephenson made a comparison in the scoring of motor perseveration tests with two methods; one using the difference in output in one activity and the other as a second one using the ratio of the outputs. To clarify the exposition of this problem, we will consider one test, for example "S"s test. The whole test can be divided into two activities, X and Y, according to the performance demanded. For instance:

<table>
<thead>
<tr>
<th>Activity X</th>
<th>Activity Y</th>
</tr>
</thead>
</table>

A score can be obtained averaging the number of element per time in activity X and the number of elements per time in activity Y. In the first method the formula will be $X - Y$.

But the comparison can be made in a second way, $\frac{X}{Y}$, this manner
being somewhat more exact. Stephenson suggested that scoring alone could be responsible for many anomalies in perseveration. In 1937, Shevach (45), criticized the suitability of the scoring motor tests because if during the initial phase of the performance activity X, the score is higher than in the activity Y in this difference there is an amount due to the "initial spurt" that occurs in any activity.

However, it has been only very recently that attention has been directed to the validity of perseveration studies in regard to scoring methods.

Darroch (12) made a study of the different methods of scoring. She invalidates completely Pinard's results because he scored the tests by the subtractive method \((X - Y)\) which is almost certainly in part a measure of speed of hand-writing. Darroch studied the reliability of those tests and found them generally low with the exception of Rangachar's of which the lowest was .759. He correlated the average score of ten trials with the average score of the other ten. Rangachar's study is the only one that gave the tests under balanced conditions. The investigation of Darroch intended to find whether the scores in a motor test of perseveration became constant when it was repeated a larger number of times or whether it continued to vary. The subjects used were sixteen adult students and the tests used was the "W Test" od Stephenson; fifty trials were obtained for every subject. The methods used for the scoring were:

1) \(\frac{X_1 + X_2}{Y}\), 2) \(\frac{X_1}{X_2}\), and 3) \(\frac{X_1 + 2X_1}{X_2 + Y}\). Darroch's graphs
showed that the scores varied considerably from one trial to another, but the more constant scores were obtained with the \( \frac{X_1 \times X_2}{Y} \) method.

Notcutt (36), in a study made in 1943, introduce a important modification in the method of scoring because he took the ratio between the score made by the subject in the difficult activity and the theoretically expected score that the subject would have if there was no perseveration. The tests used by Notcutt were taken from Cattell in a form of eight trials (similar to the example of the 3's tests given above).

Rows 1 and 3, first and normal activity, rows 2 and 4, second and conflicting activity, and rows 5 to 8, first and second activities in alternation. The scoring used for this tests was usually, \( P = \frac{1+2+3+4}{5+6+7+8} \)

but, as pointed out by Darroch, this score is influenced by individual differences in the ratio of forward and backwards activities, altogether apart from differences in the difficulty of alternation. Notcutt's formula is as follows: he calls \( N_x \) the number in responses in the first activity, \( N_x = (1+3) \). \( N_y \) the number in responses in the second activity, \( N_y = (2+4) \), and considers \( N_{xy} \) equal to the activity-output of the rows \( 5+6+7+8 \). The reasoning is as follows: if no interference occurred and the rate was constant then \( N_{xy} = \frac{4N_x \cdot N_y}{N_x + N_y} \).

Thus perseveration can be measured by the difference or the ratio between the predicted and the actual value of \( N_{xy} \).

\[ P = \frac{4 \cdot N_x \cdot N_y}{N_x + N_y} - N_{xy} \quad \text{or else} \quad P = \frac{4 \cdot N_x \cdot N_y}{N_{xy}} \]. Notcutt noticed
that sometimes he found negative scores which he attributed to the practice effects.

This new method of scoring is used also by Walker and others (55) who call it Method E. These authors reviewed the methods applied for scoring motor perseveration tests and they said that three methods can be used for the "creative effort" type of tests of which only one developed by Clarke (5) is advisable. Method A consists in the difference of the score in the first and second activity, \( X - Y \); Method B is the ratio between both activities \( \frac{X}{Y} \); Method C (Clarke's method) has the following formula \( \frac{X - Y}{X} \). This is much superior to the others because it avoids the influence of speed; for example, we have two subjects, I and II:

Subject I.....Act. X 100, act. Y 90 Method A, X-Y, 10

Perseveration index through this method is the same ten units, for both subjects while in Clarke's Method C the results are different, as illustrated below:

Subject I.....Method C \( \frac{X - Y}{X} \), \( \frac{100 - 90}{100} \) perseverates 10%

Subject II.....Method C \( \frac{X - Y}{X} \), \( \frac{30 - 20}{30} \) perseverates 33%

For "alternation type" these authors (55) recommend the two method D and E. The tests used by Walker have 6 parts, for instance:

1. 88 for 30 sec.
2. 22
3. 88
4. 22
5. 88
6. 88
For method D the formula is: \( \frac{X + Y}{2XY} \). This method showed them that in some instance it gives a false interference score.

So, to obtain a sure measure of the difficulty in alternation they used Method E*. The formula for this interference score (Method E) is \( \frac{E}{A} \), where \( E \) equals expected score in \( XY \) activity and \( A \) actual score obtained in \( XY \).

\[
E = \frac{\text{Output score in } X \text{ plus } Y}{T_1 + T_2}, \quad T_1 = \frac{\text{Score in } 1 + \text{Score in } 3}{60 \text{ sec.}},
\]

\[
T_2 = \frac{\text{Score in } 2 + \text{score in } 4}{60 \text{ sec.}}, \quad \text{and } A = \text{Score in } 5 \text{ plus score in } 6.
\]

These authors gave 6 different motor perseveration tests and scored them in all the different methods later correlating later the results. After a long discussion, they concluded that there was no point in using alternation type tests unless they were scored by method E. Because in this way the ease or difficulty in alternating bears no relationship to the initial difficulty and the "creative effort".

In the last chapter, we will discuss the theoretical consequences to which the development of the scoring methods lead in the perseveration problem.

* This is the method used in the present study.
CHAPTER III.

1. METHOD FOLLOWED IN THE PRESENT STUDY.

In the present study perseveration was tested in children with a motor activity similar to writing. To check former studies a test of intelligence and a rating scale for personality traits were administered to the same group.

2. Description of the Tests.

**Motor Perseveration Test.** The test of perseveration was constructed especially for this study since no test of this type could be found which was standardized and could be applied to the children studied. In most of the former studies very few motor perseveration tests were found and these were always mixed with batteries of sensory or ideational perseveration tests. In other investigations perseveration was studied only in populations of adults or abnormal children. The writers give an inadequate presentation of their instructions, procedure, and the reliability of their tests.

The tests used in this study were really a battery of six different but highly similar subtests. For the convenience of the statistical treatment and analysis of the results we consider them as one test. Every part or subtest is considered as an item.

In devising the actual form of the test, preliminary trials were made with adults. Although the results with adults cannot
be compared directly with those of children, this preliminary treatment of the tests with adults had some advantages. The adults had more insight than the children and were able to describe their introspections and give some clues about the shortcomings (suggestions for the improvement in the form), amount of fatigue, need of practice, optimal time of the activity, etc., etc. The tests were given with blank sheets to eighteen adults of both sexes. The subtests used in this first experiment were nine motor perseveration tests of the type used more commonly by Stephenson, Pinard, and lately by Walker; most of them were mirror drawing letters such as $S$, $
abla$, $H$, $a$, $b$, $c$, $d$, $e$, etc. We presented the first sheet to the subjects with oral instructions and let them practice for a short time the symbols at the corner of the sheet. The activity was measured by the alternative effort type (see Chap. II under the heading Motor Measurement) and the tests given individually. These preliminary administrations were carefully examined and the more evident error corrected. The internal consistency of the tests showed that some tests scarcely correlate with the final average score of the nine tests and so they were omitted from the final form. The series was thus reduced to six tests. The "S"'s test was eliminated because Cattell's suggestion of the introduction of a gestalt factor. (The two S's, one reversed, may be perceived as a whole which would reduce "perseveration".)

To test the reliability of the preliminary performance, the
rank coefficient of correlation was obtained comparing the results of two successive administrations with the eighteen adults. It proved to be +.38.

After other improvements such as the use of lines on which the symbols were to be written, written instructions, etc., the test was constructed in the form of a booklet of thirteen pages, the first one being reserved for identifying information of the subjects; it also included instructions to be read by the children and a practice subtest. The six subtests used were as follows:

<table>
<thead>
<tr>
<th>Subtest order.</th>
<th>Direct activity</th>
<th>Inverted activity</th>
<th>Alternate activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>△ △ △</td>
<td>▽▽▽</td>
<td>▽▽▽△△△</td>
</tr>
<tr>
<td>2.</td>
<td>abcabc...</td>
<td>АВСАВС...</td>
<td>ааБВсаА...</td>
</tr>
<tr>
<td>3.</td>
<td>55555555...</td>
<td>22222...</td>
<td>555555552222222...</td>
</tr>
<tr>
<td>4.</td>
<td>HHHHHH...</td>
<td>= = = = = =</td>
<td>H=H=H=H = = = =</td>
</tr>
<tr>
<td>5.</td>
<td>WWWWWW...</td>
<td>МММММММ...</td>
<td>МММММММWWW...</td>
</tr>
<tr>
<td>6.</td>
<td>ZZZZZZZ...</td>
<td>≤ ≤ ≤ ≤ ≤ ≤</td>
<td>Z≤ Z≤ Z≤ Z≤ Z≤ Z≤</td>
</tr>
</tbody>
</table>

Each activity in each subtest was performed twice (six forms in all) in order to balance the results. (For more details see copy of test in folder. Appendix A.)

The time in which the children had to work and the intervals of rest were studied for adults. We found that more than twenty seconds for every period of every subtest caused fatigue in some of the subjects. (Every subtest has six periods in the following order, for example: 1) 888 2) 222388 4) 22 5) 828282 6) 828282). Five second rest intervals
were found sufficient. In the actual testing of the children we reduced the performance to fifteen seconds, with a total duration of every subtest of one minute and fifty-five seconds. Between the different subtests there was always a period of rest introduced by the instructions for the next subtest. The same form of the test was administered for both right and left hands*.

Test of Intelligence.— Conditions permitted only a rough measurement of the intelligence of the subjects. The test selected, therefore, was the "Intermediate Classification Test" by S.L. and L.C. Pressey for Grades 3 - 6. This is a group test which takes only fourteen minutes and gives a fairly accurate index of the verbal intelligence. It had also been standardized on children of the city of Columbus. (See Appendix B in the folder.) The exact instructions given by the authors were followed in administration of the test and we scored them according to the published norms.

Rating Scale for Personality Traits.— The object of the inclusion of this rating scale in the present study was mainly to determine the validity of many assumptions made by former writers in regard to the association between perseveration and several personality characteristics. After a review of the litera-

* For the purposes of comparative analysis of performance right hand means preferred hand and left hand unpreferred. The scores of left handed subjects are considered under the general heading of right hand.
ture we found a large and extensive list given in Cattell's book *Description and Measurement of Personality* (9). We selected the traits which seemed to be most emphasized in his list (see page 25 of this study), and arranged them in pairs of opposites located at the extremes of a straight line. The traits were distributed at random in such a way that sometimes the traits supposed to be characteristic of low perseverators were at the right of the line and other times at the left. Some of the trait names at one extreme given in the "Rating Scale" do not appear in Cattell's list because Cattell does not always present opposite extremes of the traits he lists. At the beginning of the rating scale there is a short paragraph of instructions for the rater and also a blank space at the end in which the judge could add any observation which had some relation to the traits mentioned in the scale. (See Appendix C, Rating Scale, in the folder.)

3. Description of the Population.

The present study used as subjects children of Dana Avenue Elementary School (Columbus, O.) There were 103 children in all, fifty-three girls and fifty-five boys. The ages varied from nine years four months to eleven years eight months. The mean was ten years seven months. The subjects were pupils in three different Grades; 4 A, 5 A, and 5 B. All of the students appeared to be physically normal with the exception of one girl whose left arm was crippled. Her right hand scores were included in all analyses of the right hand data.
4. **Procedure for the Administration of the Tests.**

The test of motor perseveration was the first to be given. It was administered to groups of children usually eight to ten at a time. The test always was given during the morning, generally within the period of the first two hours of class from nine to eleven, to avoid any possible accumulated fatigue from the usual school work. The children of each group were conducted to an empty class-room which was familiar to them. They worked at independent desks with specially provided pencils. They were told that they had an easy task to perform but that they should work as well and as quickly as possible. The instructions at the top of the first page were read aloud while they followed in silent reading. A demonstration of stop-watch timing was given. Then the experimenter asked them to pay attention and to look at the board. The experimenter did the first example of the test herself at the board and then if everyone gave signs of understanding and there were no questions, the sample in page was filled in. Generally the first page the time used was shorter than that in the rest of the subtests, because there was no need to fatigue the children.

At the beginning of every subtest the children were warned to work attentively and as rapidly as possible; in order to avoid misunderstandings, the experimenter showed the children at the blackboard how to write the symbols. The experiment was followed smoothly until the subjects arrived at the 7th
page of the booklet whereupon they were told to do the same as before but this time with the left hand. Usually they objected saying they could not write with the left hand. The experimenter assured them that everybody can write with more or less difficulty with the left hand and showed them how she could do it at the board. Once sure that everybody was holding the pencil with the left hand the experiment continued with the same steps.

The resistance to write with the left hand was overcome and the difficulty of the performance seemed to arouse interest in the procedure. The sessions lasted approximately three weeks in order to tests all 108 subjects once.

When the children left the room, they were asked not to tell their companions what the experiment consisted in order to avoid practice and secure spontaneous results. The teachers informed the experimenter later that this request was followed and in one instance a curious teacher could not obtain information about the testing.

The intelligence test was given to total class rooms. It was given in three sessions one for every different grade. The situation was simplified in this case because the teacher left the room and the pupils were tested in their usual environment. The instructions (see for more details, sample of the test in the folder, Appendix B) were followed strictly. The administration lasted fourteen minutes. There appeared to be no difficulty or resistance, and the pupils seemed to feel completely confident and at ease. Precautions were taken against cheating.
Each child was rated on the rating scale by his own teacher since only this person was familiar with him in the school. The teachers met together in a session with the experimenter where they were given instructions on the rating procedure. Several examples were given as how to rate the pupils and their questions and observations were discussed together to achieve as much uniformity of judgement as possible. We are aware of the limitations imposed by such judges and the intrinsic limitations of any scale of personality traits. Nonetheless, as will be seen later in the discussion of the results, the teachers rated the children in this study with similar means and ranges for each group.

Finally twenty-four children evenly distributed over the three grades were selected at random using Lindquist's table of random numbers (33). These twenty-four children were retested approximately six weeks after original testing in order to measure test-retest reliability in the motor perseveration test. The results will be discussed in the next chapter.

The whole experiment was performed by the same experimenter. The total time spent for the administration of the test was somewhere around one and a half month.
CHAPTER IV.

STATISTICAL ANALYSIS OF THE RESULTS.

The results of the different tests will be studied in the following order: Intelligence Test, Motor Perseveration Test, and Rating Scale for Personality Traits. Later, we will study the possible relationships between the results of these tests and the statistical conclusions to which they lead.

1. Intelligence Test.

Some reservation must be kept in mind concerning the Pressey I. C. T. as a measure of intelligence because the test is completely verbal and probably is a measure of both verbal and reading ability. For this reason, children who are very much handicapped in reading ability will appear with somewhat distorted results. For the purpose of the present study this was not very important because we were dealing with supposedly normal children -- with all the reservations in regard to the word "normal" -- and we did not attempt to have an exact estimate of their intelligence but only a relative measure among the population in regard to general intellectual ability.

The score in the test is the number of items correctly answered. The highest score possible is ninety-six. Raw scores were used in all calculations in this study.

In our population the scores ranged from 5 to 86 points.

The frequency distribution of the scores by 5 point intervals
is given in Table 1, which shows the distribution for each grade. The last column represents the total distribution.

In Graph I the distribution appears slightly skewed. This skewness can be attributed to the fact that this composite distribution includes children from three different grades — the test is devised to classify pupils among school grades — and within a rather large age range (9 years 4 months to 11 years 8 months).

The mean of the total distribution (103 subjects) is 56.29 and the standard deviation is 13.37.
### TABLE 1.

**FREQUENCY DISTRIBUTION FOR INTELLIGENCE TEST RAW SCORES.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>6 - 10</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>11 - 15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16 - 20</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>21 - 25</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>26 - 30</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>31 - 35</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>36 - 40</td>
<td>-</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>41 - 45</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>46 - 50</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>51 - 55</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>56 - 60</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>61 - 65</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>66 - 70</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>71 - 75</td>
<td>8</td>
<td>-</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>76 - 80</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>81 - 85</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

**Number of Subjects.**

|                      | 38       | 34       | 35       | 107      |

**Mean.**

|             | 68.7     | 54.2     | 46.8     | 56.29    |

**SD.**

|     | -        | -        | -        | 13.33    |
GRAPH I.

FREQUENCY POLYGON FOR INTELLIGENCE TEST RAW SCORES

TOTAL POPULATION

N = 108
Range 5 to 86 points.
Mean 56.29
SD. 13.83

— Actual curve
For the partial distributions, we shall refer to Graph II based on Table 1, where the curves for the separate populations of Grades 5 A, 5 B, and 4 A are represented. The medians for each grade are as follows:

- Grade 5 A...... 69 (62)
- Grade 5 B...... 48 (55)
- Grade 4 A...... 58 (49)

Grade 5 B proved to be somewhat retarded according to the norms of the test. The medians given by Pressey for the respective grades appear in parenthesis besides those actually obtained. Grades 5 A and 4 A appear slightly superior to the norms. These results were predicted by the teachers who considered Grade 5 B as a difficult group of students to deal with.
GRAPH II

FREQUENCY POLYGONS FOR INTELLIGENCE TEST RAW SCORES.

SEPARATE GRADES.

Grade 5 A

N = 39
Mean 68.7
Median 69

Grade 5 B

N = 34
Mean 46.8
Median 48

Grade 4 A

N = 35
Mean 54.2
Median 58
2. **Motor Perseveration Test.**

The first problem we had to solve regarding this test was the procedure to be used for scoring. According to the work of Walker and others (55), the measure of motor perseveration obtained with the creative effort methods or with the alternative effort showed different results. These authors maintain that the creative and the alternative type of testing measure two different processes. Therefore, we decided to compare children on the basis of their ability to shift quickly from one response set to another. This seems better measured by the alternative effort type methods. From the work of Notcutt (33) and Walker (55) it followed that the only adequate method for alternation type tests was the so-called method E, in which the actual score obtained in the alternative activities (e.g. 32528) is compared with the score that could be expected in those activities if no difficulty in shift (i.e. perseveration) existed. (See Chap. II p. 38).

Each of the six subtests was scored by method E and the mean obtained. The same procedure was followed for scoring the test results for each hand.

In some few cases, for the sake of comparison with Walker's results, we scored the test as a creative effort type (disregarding the two last rows) with method B (X/Y, see chapter II p. 37). The results were completely unlike those obtained for the same subjects with method E. Although no further study was made, the inconsistency of the scores obtained with method B
as compared with those of method E can be seen in Table 2. As we were interested mainly in alternation perseverative effort, method B was omitted from further consideration. From now on, any reference made to the scores should be understood as those obtained with method E devised by Notcutt and stressed by Walker.
TABLE 2.

MOTOR PERSEVERATION TEST SCORES: COMPARISON OF SEVENTEEN SUBJECTS FOR METHOD B AND METHOD E.

<table>
<thead>
<tr>
<th>Method B Creative type</th>
<th>Method E Alternative type</th>
<th>Method B Creative Type</th>
<th>Method E Alternative type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.57</td>
<td>1.38</td>
<td>1.30</td>
<td>1.50</td>
</tr>
<tr>
<td>1.41</td>
<td>1.13</td>
<td>1.39</td>
<td>1.41</td>
</tr>
<tr>
<td>1.62</td>
<td>1.12</td>
<td>1.11</td>
<td>1.17</td>
</tr>
<tr>
<td>1.39</td>
<td>1.16</td>
<td>1.25</td>
<td>1.19</td>
</tr>
<tr>
<td>1.64</td>
<td>1.03</td>
<td>.84</td>
<td>.90</td>
</tr>
<tr>
<td>1.25</td>
<td>.95</td>
<td>1.21</td>
<td>1.18</td>
</tr>
<tr>
<td>1.02</td>
<td>1.02</td>
<td>1.13</td>
<td>1.22</td>
</tr>
<tr>
<td>1.24</td>
<td>1.48</td>
<td>.93</td>
<td>1.03</td>
</tr>
<tr>
<td>1.47</td>
<td>1.32</td>
<td>1.08</td>
<td>.94</td>
</tr>
<tr>
<td>1.45</td>
<td>1.31</td>
<td>1.16</td>
<td>1.06</td>
</tr>
<tr>
<td>1.75</td>
<td>1.68</td>
<td>1.18</td>
<td>1.09</td>
</tr>
<tr>
<td>1.69</td>
<td>1.49</td>
<td>1.65</td>
<td>1.22</td>
</tr>
<tr>
<td>1.13</td>
<td>1.27</td>
<td>1.00</td>
<td>1.01</td>
</tr>
<tr>
<td>1.54</td>
<td>1.17</td>
<td>1.57</td>
<td>1.40</td>
</tr>
<tr>
<td>1.32</td>
<td>1.29</td>
<td>1.09</td>
<td>1.17</td>
</tr>
<tr>
<td>1.42</td>
<td>1.54</td>
<td>1.93</td>
<td>1.07</td>
</tr>
<tr>
<td>1.12</td>
<td>1.25</td>
<td>1.28</td>
<td>1.12</td>
</tr>
</tbody>
</table>
The frequency distribution for scores for both right and left hands with their means and standard deviations can be seen in Table 3. Graphs III and IV are based on Table 3. The black line indicates the plotted scores; the red line is a smoothed curve which should appear with a theoretically larger number of similar children.

The total range of scores considering both hands varies from .86 to 1.80.

It can be observed in Table 3, that the mean for right and left hands is quite different (\( M_R = 1.249 \), \( M_L = 1.095 \)). We compared these values using the formula:

\[
\sigma_{\text{diff.}} = \sqrt{\sigma^2 M_R + \sigma^2 M_L - 2 \cdot r \cdot \sigma^2 M_R \cdot \sigma^2 M_L}
\]

Knowing that the value of \( r = .32 \), we obtained a sig. diff. = .014

The Critical Ratio (\( CR = \frac{\text{diff. mean}}{\sigma_{\text{diff.}}} \)) obtained was 11.

The value of this CR can be compared with the values of Fisher's "t" for the same number of cases. These are:

\[
t 1\% = 2.632 \\
t 5\% = 1.987
\]

Thus, the difference between the means of the right and the left hands is highly significant statistically.
<table>
<thead>
<tr>
<th>Class intervals</th>
<th>Right hand N=108</th>
<th>Left hand N=107</th>
</tr>
</thead>
<tbody>
<tr>
<td>.86 - .90</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>.91 - .95</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>.96 - 1.00</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1.01 - 1.05</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>1.06 - 1.10</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>1.11 - 1.15</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>1.16 - 1.20</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>1.21 - 1.25</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>1.26 - 1.30</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>1.31 - 1.35</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>1.36 - 1.40</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1.41 - 1.45</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>1.46 - 1.50</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>1.51 - 1.55</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.56 - 1.60</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.61 - 1.65</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.66 - 1.70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.71 - 1.75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.76 - 1.80</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

Mean 1.24 1.09
SD .11 .13
GRAPH III

FREQUENCY POLYGON FOR PERSEVERATION TEST SCORES.

RIGHT HAND

---

- Actual frequencies.
- Smoothed Theoretical curve.
GRAPH IV.

FREQUENCY POLYGON FOR PERSEVERATION TEST SCORES

LEFT HAND

--- Actual frequencies.
--- Smoothed theoretical curve.
Sex Differences.- The results for boys and girls are presented in Table 4 and the curves are represented in Graphs V and VI. The differences were not statistically significant between the means for boys and girls for neither right nor left hands. The CRsig. between the means for boys and girls right hand was 1.60 and for the left hand was 1.67. Comparing the values with Fisher's "t" Table we find that:

\[
\begin{align*}
t_{1\%} \text{ for 50 cases} & \quad 2.673 \\
t_{5\%} & \quad 2.008
\end{align*}
\]

The present perseveration test as scored by method E does not discriminate between the two sexes.
<table>
<thead>
<tr>
<th>Scores Class intervals</th>
<th>BOYS</th>
<th></th>
<th>GIRLS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right hand</td>
<td>Left hand</td>
<td>Right hand</td>
<td>Left hand</td>
</tr>
<tr>
<td>.36-.90</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>.91-.95</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>.96-1.00</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1.01-1.05</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>1.06-1.10</td>
<td>3</td>
<td>9</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>1.11-1.15</td>
<td>7</td>
<td>14</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>1.16-1.20</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>1.21-1.25</td>
<td>7</td>
<td>7</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>1.26-1.30</td>
<td>9</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>1.31-1.35</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>1.36-1.40</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.41-1.45</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>1.46-1.50</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.51-1.55</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1.56-1.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.61-1.65</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.66-1.70</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.71-1.75</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N.</th>
<th>55</th>
<th>55</th>
<th>53</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.263</td>
<td>1.137</td>
<td>1.199</td>
<td>1.056</td>
</tr>
<tr>
<td>SD</td>
<td>.14</td>
<td>.16</td>
<td>.29</td>
<td>.13</td>
</tr>
</tbody>
</table>
GRAPH V.

FREQUENCY POLYGON FOR PERSEVERATION SCORES

RIGHT HAND, SEXES SEPARATELY.

--- Boys.

----- Girls.
GRAPH VI

FREQUENCY POLYGON FOR PERSEVERATION SCORES.

LEFT HAND. SEXES SEPARATELY

--- Boys.
--- Girls.
Age Differences.— The test does not discriminate between the different ages within the range used in this study. The values obtained for our population according to separate ages are stated in Table 5. None of the differences between the means proved to be statistically significant.
<table>
<thead>
<tr>
<th>Age</th>
<th>9 years</th>
<th>10 years</th>
<th>11 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects.</td>
<td>22</td>
<td>44</td>
<td>42</td>
</tr>
<tr>
<td>Mean right hand.</td>
<td>1.20</td>
<td>1.21</td>
<td>1.27</td>
</tr>
<tr>
<td>Mean left hand.</td>
<td>1.07</td>
<td>1.07</td>
<td>1.03</td>
</tr>
</tbody>
</table>
Reliability.- The reliability of the perseveration test was considered by use of two different methods.

Twenty-four subjects who had already taken the test were selected at random, eight for each grade, in order to balance the possible influence of teaching. The time between the two trials was roughly six weeks. The children were asked to work as they did before and the procedure for the administration of the test was similar to that of the first trial. The pupils were tested in small groups, eight each. The Pearson r between the score in the first and the second trial for this group of 24 gave the following results:

right hand $r = +.758$
left hand $r = +.944$

Both r's are significant even considering the small number of cases used for this method.* (Lindquist considers for 24 cases 1% sig. = $t.515$)

The second measure of reliability was secured by the "split-half" method. The correlation was taken among the average score of the following subtests: 1) ΔΔΔΔΔ 3) 55555 5) ahaah versus the average of the scores of the subtests 2) abcabc 4) HHHHH and 6) ZZZZZ. The reliability coefficients for this method are:

right hand $r = +.820$
left hand $r = +.674$

For this method the total population, 108 subjects, was used.

Comparing the results of the two methods a discrepancy ap-

* All coefficients given in this study are raw (non-corrected).
pears in the values. In the test-retest method (which always implies interference factors such as: memorization, practice, learning, etc.,) the reliability of the test is higher for the left hand than for the right hand. For the split half method, the test appears more reliable for the right than for the left hand. It seems reasonable to conclude that the test is more reliable when some practice has been secured than for the measure of the completely spontaneous function (like the testing of the left hand for the first time). The test makes the subject perform one activity in which he has had a great deal of practice with the right hand even before the experiment begins while the left hand is completely untrained. Thus the reliability of the right hand in the split-half method is a different measure than the reliability with the same split-half method for the left hand. However, even with this reservation and the understanding that the reliability coefficient does not have the same meaning in this test for both hands we obtained coefficients higher than most of the authors who report the coefficients obtained in their experiments (12, 23, 24).

Comparison of the Performance of the Separate Hands.—The range of the scores for right hand and left hand is different. While for the right hand the scores extend from .96 to 1.80 the range for the left hand is shifted downwards extending from .36 to 1.50. The mean is significantly lower for the left hand as shown on page 57.
The more consistent a function within the individual, the more useful it is as an index of differentiation from other individuals. A function which lacks consistency within the individual when measured by different instruments or under slightly different conditions or in different members of the organism is of little interest for the psychologist who hopes to predict. Authors generally agree that the different parts of the organism have some formal relation to each other because they exist in the same organism and are exposed to similar inner stimuli. Many times habits which could be expected to be independent, like the speed and style of movements made with the right hand and the left foot tend to correlate (36).

In some instances e.g. curves of fatigue obtained with the ergograph, the shape of movements and the general pattern of the curve is highly similar for different members of the same individual.

We decided to test motor perseveration in regard to consistency of the activity within the individual; so we correlated the scores obtained on the test for right and left hands. The correlation obtained for the perseveration scores is +.319. The $F_{PE}$ for the number of cases studies is .058. The correlation is thus positive and significant statistically, but in view of the facts stated above relative to the high similarity of other better studied functions within the individual, we believe that this relationship is psychologically of little significance.

We will review this fact in the last chapter where we shall dis-
cuss the consequences of the present study.

Fig. 4 gives the scatter diagram and regression lines for the relationship between the scores of the right and left hands.
SCATTER DIAGRAM AND REGRESSION LINES SHOWING THE RELATIONSHIP BETWEEN PERSEVERATION SCORES OF RIGHT AND LEFT HANDS.

**Right hand X**

**Fig. 4**

Pearson's \( r = +.32 \)

Regression lines formulae: \( Y = .37X + .64 \)  
\( X = .27Y + .96 \)
Comparison Between Perseveration and Intelligence Scores.— The raw coefficient of correlation between right hand perseveration and raw scores on the Intermediate Classification Test is \(-.22\) and for the left hand it is \(-.23\). Thus both are negative. According to Lindquist (33, p. 212, Table 13), such correlations are not statistically significant. We did not go further in analysis of these coefficients because they are so low. Yet they are negative—high perseveration scores tending to be linked with low ability—and this seems to corroborate in general terms the study and observations made by Jersild (24).

Perseveration and Fatigue.— The question was raised regarding the possibility that high scores in perseveration could be the result of perseveration itself plus the interference of fatigue in those supposedly high perseverators. By brief periods of testing we attempted to control fatigue. We saw that for some adults more than twenty seconds performance in the subtests was tiring. The test was administered to children only with fifteen seconds for each period. Under such conditions the range of fatigue should be very small. Under these conditions we should expect the results to be different than some of the results obtained by other authors. Cattell(7), giving the tests in different periods of the day, morning and evening, and also Burri (4), found radical changes in the scores. In examining the possible influence of fatigue on the results of our present study, we divided the subjects in two groups. Let us call them A and B. Group A had scores on perseveration higher than 1.35 and group B had scores lower than 1.15.
(Only right hand -- which mean was 1.24 -- was considered for this purpose.) We scored the tests for both groups afterwards in regard to fatigue. The score for every test was the average of the differences for the six subtests for the right hand, between the output of the first and the third periods. When the difference was negative, we considered the subject as showing fatigue. When the score was positive or zero, we considered the result free from fatigue. Maybe this reasoning could be considered arbitrary because only the first and third rows were considered; but we could not find another better procedure to score fatigue in the same task and we were consistent in the scoring. We organized the data for obtaining a chi-square test of independence. The null hypothesis to be proved was the lack of dependence (no relationship) between high perseveration scores and fatigue. The result was $X^2 = 1.4$ which for 1 degree of freedom gives a $P = 0.79$. This upholds our hypothesis indicating that the high scores in motor perseveration as measured by our test are not dependent on the degree of fatigue observed in the same measurement.

3. Rating Scale for Personality Traits.

The ratings made by the teachers (see appendix C in the folder), were scored as follows; each line (ten centimeters) that separated one trait from its opposite was divided arbitrarily into ten equal parts numbered from 1 to 10. 1 represented the minimum score obtainable when the teacher rated the trait at the extreme of the line indicating what was supposed to be a low perseveration characteristic and 10 the maximum obtainable.
when the teacher rated the opposite characteristic. A key was constructed on a piece of semi-transparent paper and every test was scored according to the key. The average score for each child indicated his possible position on a theoretical scale from a very high perseverator to a very low one.

As the subjects were rated by three different persons (three teachers; each subject being rated only once), we transformed the score obtained into z scores subtracting the actual scores from the mean for the respective group and dividing for the corresponding standard deviation. Thus all scores became comparable. It seems worthy to note that the three teachers rated the pupils with a fairly similar criterion. The means and SD for the three subgroups of the raw scores show this uniformity:

<table>
<thead>
<tr>
<th>Grade 5 A.</th>
<th>Grade 5 B.</th>
<th>Grade 4 A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.30</td>
<td>5.58</td>
</tr>
<tr>
<td>SD</td>
<td>.98</td>
<td>.80</td>
</tr>
</tbody>
</table>

In z scores the range varies from -2.30 sigma to +3.10 sigma.

Table 6 and Graph VII represent the frequency distribution of the z scores for this test.
TABLE 6.

FREQUENCY DISTRIBUTION FOR Z SCORES OBTAINED FROM RATING SCALE FOR PERSONALITY TRAITS.

<table>
<thead>
<tr>
<th>Class intervals z scores</th>
<th>Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.29 - -1.70</td>
<td>3</td>
</tr>
<tr>
<td>-1.69 - -1.10</td>
<td>13</td>
</tr>
<tr>
<td>-1.09 - - .50</td>
<td>20</td>
</tr>
<tr>
<td>- .49 - + .10</td>
<td>24</td>
</tr>
<tr>
<td>+ .11 - + .70</td>
<td>18</td>
</tr>
<tr>
<td>+ .71 - +1.30</td>
<td>15</td>
</tr>
<tr>
<td>+1.31 - +1.90</td>
<td>9</td>
</tr>
<tr>
<td>+1.91 - +2.50</td>
<td>4</td>
</tr>
<tr>
<td>+2.51 - +3.10</td>
<td>1</td>
</tr>
</tbody>
</table>

N. 107
GRAPH VII

FREQUENCY POLYGON FOR Z SCORES ON THE RATING SCALE
We did not analyse the scores for each of the thirty-one traits on the Rating Scale since we believed that a rough estimate of the possible relationship between the average of the traits and the test of perseveration should be sufficient. The correlation proved to be extremely low. (Pearson's $r$ between perseveration scores in the right hand and scores on the Rating Scale +.07)

Finally for some subjects we compared perseveration scores with some individual trait score such as active-inactive, superficial-deep, etc., but none of them correlated highly enough to justify the time and work necessary for further analysis.

We may conclude that with this instrument we were not able to detect any of the relationships stated by Cattell and others between perseveration and personality traits.
CHAPTER V.

INTERPRETATION AND CONCLUSIONS OF THE PRESENT STUDY.

1. Explanatory Theories of Perseveration.

Each school of thought sees the problem of perseveration in a different light. It is helpful to be consistent within a system and within its implications. However, a great deal can be learned about behavior if different points of view are weighed and reorganized according to the demands of the function under consideration.

Stephenson (43), in an earlier work, states that a great shift was made in the concept of perseveration from Gross to Spearman. Gross considered perseveration (called by him "secondary function") as a helping process which could likely explain the joining of one conscious process to the succeeding one by virtue of its after-effects. William James offers a similar type of explanation. On the contrary, Lankes and Wynn Jones (from the Spearman school) considered perseveration as a disturbing influence.

Possibly in a broad sense the most systematic theory of perseveration has been Spearman's theory of mental inertia, wherein perseveration is considered as a unitary factor comparable to the concept of inertia in physics. The idea of p as a factor which could be considered as the degree of inertia of a somewhat vague "mental energy" was highly attractive to the London school
which for years was trying to find, by the artificial means of factorial analysis, a way to fit the facts to the theory. They were however, not very successful with perseveration and the correlations were generally very low among those tests which were supposed to measure different kinds of perseveration.

These results aroused doubt in some investigators such as Jaspers, Jersild, Walker, Darroch, Notcutt, etc., who began to question the reality of perseveration as a unitary factor. From the very beginning some authors rejected the concept of perseveration as a factor, but at times, as in the case of Foster (19), without success. He thought that the concept of perseveration violated the law of parsimony and interpreted the results of certain verbal experiments in terms of unnoticed motives of association, possibly kinaesthetic or organic in nature.

The problem of perseveration in alternating activities has been studied from two different angles (4); a) the study of the effect of alternation and b) the individual differences in the ability to alternate. In actual work situations in groups, superior performance was obtained under alternating conditions. These results have been generally explained in terms of fatigue, monotony and boredom, work motivation, attitude, etc. Weigandt showed clearly that alternation at times increases, but other times decreases, efficiency and this is apparently related to the difficulty of the work.

The different methodologies used in studying the problem have resulted in different notions about the nature of perseveration.
For the sake of convenience and to clarify the different types of explanations given to the problem of perseveration, we shall group these explanations under separate headings.

Theory of Continuance - Hindrance Effect. - The basis for this theory is sensory persistence. Stephenson (43) compares the situation created by p-tests (e.g. the S's test) with inhibitory conditioning. Pavlov found that when a conditioned reflex has been established and a new stimulus is presented, which closely resembles the older one, a new response is required. The explanation, according to the theory of inhibition of Pavlov, is then that when the symbol "2", is written with the idea in mind of writing a reverse "S", the operation is difficult; but if it is thought of as a shape in itself, the writing is done with ease.*

Theory of Extraneous Mediation of W-characteristics. - This theory depends on the finding that p-scores seem to correlate with estimates of character (39). Perseveration thus would be the explanation of anything that could be called the innate determination of character. The theory stems from the observation that the alternative activity (82) is more difficult than the simple activity (83). But the difficulty is not insuperable, so a p-score must be regarded as a measurement of the way in which the individual reacts to the alternative activity. His will to

* It might be interesting to validate this hypothesis measuring the individuals in comparison with their ability to perceive new "gestalten".
succeed will cause him to do as much as his so-called innate ability to perseverate, (31).

The Theory of Intrinsic "Will" Function.— It supposes that the disability and individual differences measured by the p-factor should not be regarded as due to the continuance-hindrance effect. On the contrary, it proposes that it is nearer to the facts to explain the disability or high p-scores as due to conscious and subconscious control, or lack of it, which may be called fundamental "will" like processes (43). In this theory, then, more emphasis is put on the possibility of a conscious or unconscious controlling and coordinating function of the p-scores, rather than on the physiological process. Because we are alike in the fundamental rate of our nerve "action currents", the possibility is very great that we are also alike in our fundamental nervous after-effects.

Theory of Mental Set.— The theory proposes that p-scores may be in part a measurement of the individual differences in the ability to establish and maintain a "mental set". Those cases sometimes found in which there is no perseveration in motor tests of alternating activity are explained by this theory. P-scores thus have a significance the very opposite of that hitherto given to them. Jersild (24) is one of the stronger proponents of this point of view. When two or more activities, each of which by itself operated under the influence of a characteristic mental set, are combined into one performance calling for shift from one activity to another, the effects of shift vary with the
nature of the activity involved. Within separated and apparently uniform activities, there is an element of shifting in the form of readjustments required in passing from one stimulus to the next. Within a performance combining two or more activities there is an element of shift passing from an item of one activity to an item of another; the shift of the latter situation differs from the former not so much in kind as in degree, for both situations involve a preliminary mental set. Therefore, the problem of perseveration in alternating activities is no more than a special case of the adjustment necessary for the change from one mental set to another.

Theory of Disposition - Rigidity. Some authors criticized the unity of function implied in the theory of Spearman and, drawing on their own experiments, divide the perseverative tendency into two opposed factors; fluency and rigidity. In Notcutt's study (38), fluency had manifested itself strongly. Later, Walker and others (54) arrived at similar conclusions. So Cattell (9), summarizing these experiments together with his own, takes the view that the only measured manifestation of perseveration is disposition-rigidity; i.e., the difficulty found in performances of new tasks in relation to old ones when the new task is not difficult in itself. Cattell holds that perseveration is the balance between an inherent disposition-rigidity and a marshaled force of the ego -- the will -- trying to overcome this rigidity. This factor is more clearly manifested in motor performances, particularly of the creative type, but
is also found in alternation tests. He also mentions a clinical symptom of "ego-rigidity" as comparable to conative perseveration which he does not elaborate.

**Dynamic Theory.** Instead of looking for a mechanical explanation of perseveration, many authors have looked at the problem from a dynamic viewpoint. From observing perseveration in emotionally unbalanced persons these writers consider perseveration as arising from an emotional tension or stress that could not be expressed otherwise. The main concept is expressed clearly by Murray:

...A need which is aroused in a subject and not completely objectified may perseverate for some time afterwards....(37, p.86)

Psychology here, as in many other instances, has completely changed its point of view. In the history of memory, psychologists who believed in "traces" thought that they were conserved by some sort of mysterious power in the nervous system. In learning processes the law of repetition explained everything in terms of "circular reflexes". Murphy (36) still tries to integrate this point of view for the understanding of perseveration when he states that perseveration is a term for the type of circular response in which the activity is continuous rather than phasic; but he goes further than the earlier psychologists in saying that these perseverational trends are always the expression of a tension which is motivated and dynamic. Surely, the simple notion of circular reflexes may partially explain rigidity, but fails to explain fluency or those cases in which perseveration
does not occur. Furthermore, it fails to show why perseverative activity once begun should not continue indefinitely.

Some recent writers on conative perseveration (Kendig, Shevach, Murray, etc.,) found that it was necessary to introduce their dynamic conception of behavior. A tension represents disequilibrium and can be resolved by a perseverative process. This theory of course, was derived mostly from conative and sensory perseveration research using in part concepts put forth by Lewin and his students. However, it probably can be extended to motor perseveration as well if we understand the difficulty of alternating activities as a difficulty in getting rid of an inner tension. In this case we believe it can be compared to some cases of stuttering, where the patient perseverates in the repetition of one syllable and cannot formulate the following properly, as though some tension were blocking the normal pathway. Stutterers have been found to be higher perseverators than non-stutterers (15).

In Kendig's experiments (26), perseveration is more intense when unfilled time follows the task. She explains this by saying that if another task follows immediately, the accumulated tension can be discharged into a new activity and perseveration does not occur; but, if there is no activity to follow, it appears as a compulsive tendency to repeat the activity just performed. This is entirely in accord with the fact that interrupted tasks are better remembered than completed tasks, and that even trivial tasks become almost haunting in character until they are completed, as shown in the experiments of Zeigarnick and Ovsiankina. O.E. Smith
(quoted from Allport (1)) demonstrated that there is more success in removing a conditioned reflex to fear if the deconditioning process is begun immediately, because in this way there is no place for a strengthening of the reflex through perseverative repetition.

Kendig and others have shown that tension expressed as a perseverative tendency is aroused more easily when the activities more closely affect the system of needs and drives of the person. Perseveration is more pronounced when the task is more important for the individual. When an emotional need is abruptly restrained -- the energy not being discharged -- residual tension will perseverate and lead perhaps to a number of after-effects. These after-effects do not seem to occur in everyday life when some unemotional, consciously intended action is inhibited.

This theory seems to us important because it is consistent with most of the new dynamical conceptions which more acceptably explain behavior in terms of the facts and are less artificial than the simple stimulus response mechanical conceptions. Besides it is quite possible that much of the behavior described at present -- mainly in child psychology -- as disobedience, defiance, stubbornness, and lack of cooperativeness might better be explained on the grounds of the presence of a high degree of perseverative tendency if perseveration is understood as a function of needs.

The problem of the internal inconsistency of perseveration over which so many authors have struggled -- is perseveration a unit or a specific function? -- can also be discarded under this hypothesis. It provides the ground for its elucidation without giving way to
to some typological dichotomy -- perseverators and non-perseverators. Perseveration exists as a fact but individuals should not necessarily be divided into high and low perseverators; but rather some individuals, in certain circumstances, are perseverators when for some reason a tension is aroused in them which does not find another path for discharge. Shevach's hypothesis (45) in this respect seems to be nearer than any other to the truth. Perseveration is a unit for some persons, while for others it is a highly specific function.

The fact that perseveration is denied here as a functional unity for all individuals does not diminish the intrinsic interest of the problem. But certainly this dynamic conception of perseveration can guide the study of the facts into a more fruitful channel based on idiographic rather than nomothetic point of view. Why does a particular individual discharge his tension under given conditions with a perseverative trend?

2. Conclusions and Suggestions of the Present Study.

The conclusions reached as a result of the present study can be only tentative. The two conceptions which seem to agree most with our findings are the dynamic theory which regards perseveration as a general trend involving sensory, somatic and motor processes and the theory of perseveration as mental set which encompasses motor activities such as were used in our tests. Observation of the children showed real difficulty in shifting from one item to another in the alternative activity. The nega-
tive correlation between perseveration and intelligence scores also seems to validate this theory. It would seem possible to study this sort of perseveration with block building test. The fact that organic mental patients tend to cling desperately to one principle when confronted by problems such as those presented by the Vigotsky test, plus the statement made by Werner (57) that perseveration is stronger with those mentally retarded children who are brain injured cases seems to justify such a study.

Our results do not demonstrate functional unity in perseveration (low correlation between perseveration scores between right and left hands). It was rather difficult to determine whether practice had any influence on perseveration. The split-half method of determining reliability was higher for right than for left hand, and this seems to prove the effect of practice. In addition, is the fact of a significantly higher mean for the right than for the left hand. Evidently with the right hand the child has a great amount of practice accumulated from everyday life in normal writing, and this practice may well interfere with the appropriate performance of the unusual alternating activity. On the contrary in using the left hand the child has had practically no previous practice, and under such conditions it is presumably easier for the left hand to perform the alternating activity. Thus our results can be interpreted as showing that practice may interfere.

Fatigue did not seem to be an interfering factor in our results.
No sex differences were found in the age range (9 to 11 years) of our group.

We found no evidence that perseveration can be linked to specific personality traits as stated by Cattell and others. In this experiment of motor perseveration we found no relationship with the personality of the subjects. One group of pupils forming grade 5B presented a large number of behavior problems. The teacher mentioned them at the end of the rating scale and we could verify it in some children while administering the tests. However, the results of the perseveration test do not discriminate in regard to this group. It seems to us that perseveration studied through these motor tests is of little value for predicting behavior problems.

This study has suggested to us the fact that in many instances phenomena often interpreted as perseveration could be better understood as the result of some gestalt effect. For example, Wiersma's experiments in sensory perseveration based on flicker threshold were not controlled in regard to some possible distortion of the resulting perception because of changes in the organization of figure and ground. Recent experiments made by Hartmann and cited by Koffka in his *Principles of Gestalt Psychology* demonstrate clearly that different shapes have different functional values for fusion time. Evidently these factors were neglected in the earlier experiments of perseveration.

We believe that the study of perseveration, like many other psychological functions, must be approached from now on with a
different orientation than mere interest in psychometric results.

Probably Shevach is right in saying that:

... the problem of perseveration was considered
and settled prematurely...

(44, p. 427)

We feel now that the problem needs reorganization and will
give more fruitful results if it is considered as dynamic behavior
which influences mental sets. In this way Cattell's idea of ego-
rigidity can also be reconciled.
BIBLIOGRAPHY


10. ——— and MOLTENO. Contributions concerning mental inheritance. J. gen. Psychol. 1940, 57.


29. KING, J.L. Span of apprehension and perseveration. *Arch.*
30. LANGLIE, T.A.  
Perseveration and non-adjustive reactions.  
_Gest. Psych._ 1934, 22 (From _Psychol. Abstr._)

31. LANKES, W.  
Perseveration.  

32. LEWIN, K.  
_Dynamische Theory of Personality._ New York:  
McGraw-Hill, 1940.

33. LINDQUIST, E.F.  
_Statistical Analysis in Educational Research._  

34. MAYE, L.L.  
Studies in catatonia. Perseverational  
tendencies in catatonic patients.  
_Psychiat._ Quart. 1934, 8.

35. MISIAK, H. AND  
PIERCE, R.W.  
Physique and perseveration.  
_Nature_, 1934.

36. MURPHY, G.  
_Personality._ New York: Harper and  
Brothers, 1947.

37. MURRAY, H.A.  
_Exploration in Personality._  
Oxford Univ. Press, 1938.

38. NOTCUTT, B.  
Perseveration and fluency.  
_Brit. J. Psychol._ 1945, 22.

39. PINARD, J.W.  
Tests of perseveration.  
_Brit. J. Psychol._  

40. RANGACHAR, C.  
Differences in perseveration among English  
and Jewish boys.  

41. ROGERS, K.  
Perseveration and personality.  

42. ————  
Perseveration.  

43. SCHADE, K.H.  
Motor perseveration with reference to a  
study of personality.  
_Untersuch._ Psychol. Phin. 1937, 72 (From _Psychol. Abstr._)

44. SHEVACH, B.J.  
A note on racial differences in persevera- 
tion.  
_J. Psychol._ 1938, 5.

45. ————  
Studies in perseveration. Methods for  
the study of sensory perseveration.  


52. TRAVIS, L.E. AND KNOTT, L.R. Brain potential studies of perseveration. J. exp. Psychol. 1937, 21.


54. __________ Is there a general factor of perseveration? Aust. J. Psychol. Phil. 1941, 12. (From Psychol. Abstr.)

55. __________ The influence of scoring methods upon score in motor perseveration. Brit. J. Psychol. 1945, 25, 3


Appendix A

Directions.

Underneath this paragraph are some letters, numbers, and figures. Look at the first row and you will see three letter 3's. When I say "start", you are to start writing the letter 3 just as it appears at the beginning of the row. Try to write carefully but as fast as you can. When I say "stop", put your pencil down at once.

3333333333
2222222222
3333333333
2222222222
3333333333
5555555555

\[
\frac{30}{2.4} = 1.25 \quad \frac{30}{2.5} = 1.20 \quad \frac{30}{2.45} \\
\frac{12.2}{10.1} = 1.16
\]
\[
\frac{30}{30} = 1 \quad \frac{30}{34} = 0.88 \quad \frac{30}{1.85} = \\
\frac{15.7}{11.5} = 1.36
\]
abcabca bcp bca bca bca bca bca

abcabcdefabcabca bca abca bca bca bca bca

abcabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabcdefabc
\[
\frac{30}{21} = 1.42 \quad \frac{30}{18} = 1.67 \quad \frac{30}{809}
\]

\[
\frac{3.70}{7.5} = 0.50
\]
555555/555555/555555

222222222222227

55555555555555

2222222222222222

552525252525252525
\[
\frac{30}{32} = 0.93 \quad \frac{30}{26} = 1.15 \quad \frac{30}{208}
\]

\[
\frac{14.42}{8.5} = 1.69
\]
\[
\frac{30}{16} = 1.875 \quad \frac{30}{12} = 2.5 \quad \frac{30}{4.32} = 0.694
\]
\[
\frac{30}{32} = 0.93 \quad \frac{30}{36} = 0.83 \quad \frac{30}{17.04} = 1.76
\]

\[
\frac{17.04}{12.5} = 1.36
\]
\frac{30}{24} = 1.25 \quad \frac{30}{10} = 3 \quad \frac{50}{40} = 1.25

6.78 \div 3 = 2.26
\[ \frac{30}{12} = 2.5 \quad \frac{30}{12} = 2.5 \quad \frac{30}{4.9} \]

\[ \frac{6.10}{5} = 1.22 \]
\[
\begin{align*}
\frac{80}{18} &= 4.44\overline{4} \\
\frac{30}{16} &= 1.875 \\
\frac{30}{354} &= 0.085
\end{align*}
\]
\[ \frac{30}{6} = 5 \quad \frac{30}{9} = 3.33 \quad \frac{30}{9.33} \]

\[ 3.60 \]

\[ 4.5 \quad 0.90 \]
\[
\frac{30}{9.1} = 1.42 \quad \frac{30}{14} = 2.14 \quad \frac{30}{8.56} = 1.19
\]
\[ \frac{3 \times R}{6} \quad \text{for R hand} \quad \frac{773}{6} = 1.28 \]

\[ \frac{3 \times L}{6} \quad \text{for L hand} \quad \frac{82 \times L}{6} = 1.37 \]
INTERMEDIATE CLASSIFICATION TEST
Devised by R. L. and L. G. Pressley
For Grades 3-6

Name: [Blank]
Age: [Blank] Grade: [Blank] Date: [Blank]
School: [Blank] City: [Blank]

QUESTIONS

1. Which is smallest? an elephant a dog a horse a mouse

2. Which is the most important part of a dog? body tail ears bark

3. Which word means the same as large? little flat big round

4. Which is the smallest number? 9 1 3 7

On the other three pages there are some more questions like those you have just read. Each question is followed by four answers. Only ONE of these answers is right. You are to read each question and then draw a line under the right answer, as you did for the answers you have just marked. Work as quickly as you can, but be sure to get the answers right. Do not stop working until you are told to do so. When you finish one page go on to the next. Now turn over to the next page, and start!
1. Which is lightest? **key** feather pencil book
2. Which is the most important part of a base-ball game? tickets fence money players
3. Which word means the same as joy? **happiness** sorrow sadness truth
4. Which number must you add to 6 to get 11? 4 7 5 12
5. Which would you rather have? 2 dimes 3 nickels 1 quarter 10 pennies
6. Which is the most important part of a school? teacher blackboard desks games
7. Which word means the same as sleepy? bored stupid still drowsy
8. Which number is half of 261? 19 13 3 62
9. Which contains most books? home church theatre library
10. Which is the most important part of a porch? railing steps floor posts
11. Which word means the same as baby? **infant** boy girl mother
12. Which number is just above 24? 23 22 19 34
13. Which is most valuable? agate diamond emerald moonstone
14. Which is the most important part of a book? size color shape print
15. Which word means the same as swift? fast moderate beautiful slow
16. What is half of 24? 8 26 12 6
17. Which holds most? bushel gallon barrel quart
18. Which is the most important part of a dinner? napkins food table dishes
19. Which word means the same as pure? polluted lovely real clean
20. Which number is largest? 999 8,246 220 11,200
21. Which runs fastest? a dog a pig a hen a cow
22. Which is the most important part of a bookcase? doors glass shelves keys
23. Which word means the same as separate? unite demolish remove divide
24. Which number is out of place? 1 2 9 3 4 5 6 7 8
25. Which is most harmful? coffee poison tobacco dust
26. Which is the most important part of a movie? pictures music stage ushers
27. Which word means the same as empty? full vacant light whole
28. What number added to 8 makes $3 \times 31$? $\frac{1}{5}$ 10 2
29. Which is sweetest? cake pie ice-cream candy
30. Which is the most important part of a man? eyes brain arms ears
31. Which word means the same as fall? autumn spring winter summer
32. Which number is out of place? 9 8 3 7 6 5 4

Do not stop; GO ON TO THE NEXT PAGE!
33. Which is the most fatal part to injure? **finger** head foot arm
34. Which is the most important part of a swing? **seat** squeak ground rope
35. Which word means the same as jump? **leap** run trot jerk
36. Which number is most uncommon? 25 5 27 30
37. Which goes fastest? **train** horse aeroplane bicycle
38. Which is the most important part of a garden? **flowers** paths weeds fence
39. Which word means the same as begin? **stop** leave find commence
40. Which is not a piece of money? 10¢ 17¢ 25¢ 50¢
41. Which is loudest? **violin** banjo flute cornet
42. Which is the most important part of a circus? **band** trapeze animals money
43. Which word means the same as brave? courageous religious boasting cruel
44. Which is the even number? 41 12 33 9
45. Which is most useful? chicken **cow** chipmunk cat
46. Which is the most important part of glasses? **price** shape rims lenses
47. Which word means the same as shrill? piercing funny loud gentle
48. Which number is different from all the others? 15 20 23 25 30 35
49. Which floats most easily? **glass** lead cork paper
50. Which is the most important part of a locomotive? **bell** boiler whistle smokestack
51. Which word means the same as awkward? agile thin crude clumsy
52. Which number is different from the others? 23 33 43 47 53
53. Which is most common? piano viola flute harp
54. Which is the most important part of a watch? **stem** crystal mainspring case
55. Which word means the same as dangerous? bad careless part unsafe
56. Which number must you subtract from 12 to get 5 × 2? 6 3 2 10
57. Which can jump highest? **mouse** dog sheep cow
58. Which is the most important part of a test? questions paper ink pen
59. Which word means the same as industrious? pretty diligent lazy tall
60. Which is the three-place number? 46% 33 2238 3
61. Which amount is a piece of money? 13¢ 30¢ 15¢ 25¢
62. Which is the most important part of a store? **counter** goods clock money
63. Which word means the same as enemy? foe stranger neighbor friend
64. Which number is nearest 100? 34 119 86 242

Do not stop; GO ON TO THE NEXT PAGE!
Appendix B

DEPARTMENT OF PSYCHOLOGY

INTERMEDIATE CLASS

Devised by S. L. A. Bloomington, Ill.

For Grade

Name: Alton Hill

Age: 10 Grade 5th

School:

QUESTIONS

1. Which is smallest? an elephant, an ant, a mouse

2. Which is the most important part of a watch? movement, hands, face

3. Which word means the same as large? large, big, huge

4. Which is the smallest number? 9, 10, 11

On the other three pages there are a number of questions and answers. Each question is followed by three answers. You are to choose the one that fits the meaning. Place the number directly under the right answer, as you did in the previous pages. Work as quickly as you can, but be sure to stop working until you are told to do so. Then go on to the next. Now turn over to the next page.

Copyright 1923
Public School Publishing Co.
Bloomington, Ill.
Each of the following lines represents the progressive degrees from one personality trait to its opposite. After your own observations made while dealing with, put a cross (X), in each line at the point that you believe the child stands in each item.

<table>
<thead>
<tr>
<th>Active</th>
<th>Inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Assertive</td>
<td>Does not assert himself</td>
</tr>
<tr>
<td>Solitary, keeps to self</td>
<td>Gregarious, wants to be with others</td>
</tr>
<tr>
<td>Deceives others</td>
<td>Does not deceive others</td>
</tr>
<tr>
<td>Restless, fussy</td>
<td>Calm, relaxed</td>
</tr>
<tr>
<td>Is a leader</td>
<td>Is a follower</td>
</tr>
<tr>
<td>Quiet</td>
<td>Talkative</td>
</tr>
<tr>
<td>Superficial</td>
<td>Deep</td>
</tr>
<tr>
<td>Conservative in habits, does things in the same way</td>
<td>Changeable in habits</td>
</tr>
<tr>
<td>Shows enterprise and self reliance</td>
<td>Lacks enterprise and self reliance</td>
</tr>
<tr>
<td>Irritable, anxious, tense</td>
<td>Hard to irritate, not anxious or tense</td>
</tr>
<tr>
<td>Pessimistic</td>
<td>Optimistic</td>
</tr>
<tr>
<td>Very rebellious</td>
<td>Not rebellious</td>
</tr>
<tr>
<td>Shy, bashful</td>
<td>Forward, bold</td>
</tr>
<tr>
<td>Absent-minded, day dreamer</td>
<td>Alert, attentive</td>
</tr>
<tr>
<td>Inconsiderate of others' feelings</td>
<td>Considerate of others' feelings</td>
</tr>
<tr>
<td>Interested in arithmetic</td>
<td>Not interested in arithmetic</td>
</tr>
<tr>
<td>Interested in history</td>
<td>Not interested in history</td>
</tr>
<tr>
<td>Interested in language, spelling</td>
<td>Not interested in language, spelling</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Antonym</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Interested in science</td>
<td>Not interested in science</td>
</tr>
<tr>
<td>Selfish</td>
<td>Generous</td>
</tr>
<tr>
<td>Careless of details</td>
<td>Very attentive to details</td>
</tr>
<tr>
<td>Easily depressed</td>
<td>Hard to depress</td>
</tr>
<tr>
<td>Sentimental</td>
<td>Not sentimental</td>
</tr>
<tr>
<td>Impetuous</td>
<td>Not impetuous</td>
</tr>
<tr>
<td>Systematic, precise, planful</td>
<td>Not systematic, careless, not planful</td>
</tr>
<tr>
<td>Takes things seriously</td>
<td>Frivolous</td>
</tr>
<tr>
<td>Sensitive</td>
<td>Impervious</td>
</tr>
<tr>
<td>Predictable</td>
<td>Unpredictable</td>
</tr>
<tr>
<td>Popular among other children</td>
<td>Unpopular among other children</td>
</tr>
<tr>
<td>Sticks to problems until finished</td>
<td>Does not stick when difficulties arise</td>
</tr>
</tbody>
</table>

Notes and observations: