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A COMPARISON OF QUANTITATIVE AND QUALITATIVE SET

By

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ABSTRACT

The present study was designed to explore the relationship between the Soviet concepts of quantitative and qualitative set as outlined by D. Uznadze (1966). The illusion phenomena of Soviet quantitative set was also subjected to experimental investigation. Theoretical considerations and experimental techniques were reviewed and discussed.

Two experimental and two control groups were created by random assignment of 79 subjects (Mean age of 15.6 years). Each of the experimental and control groups received a quantitative and a qualitative set task in a counter balanced design. Uznadze's visual set task (quantitative set) was tachistoscopically presented in an individual testing situation. An anagram solving task (qualitative set), based on the work of Rees and Israel (1935), was designed and presented on a IBM 1500 computer system. In each task experimental subjects received a number of trial designed to establish a set followed by a series of critical trials which tested the strength of the set. Control subjects received the same critical trials as the experimental subjects without first being exposed to the setting stimuli.

It was found that experimental and control subjects

did not differ significantly on measures usually indicative of quantitative set. This finding raises serious methological questions concerning the visual set task. As expected, experimental subjects, solved significantly more anagrams in a set inclusive manner than did control subjects, thus replicating the results of Ress and Israel (1935). The present study did not show a significant relationship between quantitative and qualitative set scores. The stimulus aspects of the set tasks and the linguistic abilities of experimental subjects are considered in explaining the experimental outcomes.

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CHAPTER I

INTRODUCTION

The status of set, as an important concept in the determination of behavior, has evolved from the work of many theorists and has been used in many types of investigations in attempts to explain otherwise unexplicable phenomena. As Gibson (1941) points out, thecrists generally use the term set to denote some kind of "tendencies, dispositions, or readiness." The effect of set, Gibson states, is usually described as one of "facilitation, selection, determination or guidance (1941, p. 782)."

Soviet psychologists, under the leadership of Uznadze (1885-1950) and his collegues at the Georgian Institute of Psychology, have developed a comprehensive theory of set. They conceive of set as the "extraconscious state of the mind which has a decisive effect on the nature and course of mental activity (p. 9)." Within this framework they theorize that the effect of set is a "mobilization or readiness of the individual for activity in a certain direction (Hritzuk, 1971, p. 219)."

"Mental sets," created through the sequential solution of related anagram problems, provides the second orientation towards set research relevant to the present study. The term mental set, first examined by Rees and Israel (1935), implies the general concept of direction which may influence

thought processes and modes of behavior. Once aroused "mental sets" may "serve to steer the course of thinking towards a particular channel, to color the character of the thought processes, and to limit the ultimate possibilities of response (p. 1)."

Over View of Soviet and Western Orientation Towards Set

Until recently Soviet and Western investigations of set have proceeded in a cultural vacuum, each ignoring the other. This vacuum is now being broken with the translation of leading Soviet works into the English language. Interest in Soviet psychology and education has risen dramatically in the West since the late sixties. Soviet psychologists have also begun to look abroad in search of new ideas.

The rate with which psychological information is exchanged between East and West is not a rapid one. Most western researchers have trouble separating earlier Soviet research from the Marxist - Leninist philosophy normally used in its interpretation. Conversely, Soviet psychologists, until recently, have been slow to consider the psychology of the "capitalist" nations. However, conferences such as the XVIII International Congress of Psychology held in Moscow in 1966 have promoted greater psychological exchange and understanding between East and West.

It is not suprising, under these conditons, that the Soviet orientation towards set should be quite different

from any approach taken in the West. Soviet psychologists (Uznadze, 1966), view set as a beneficial force, or in fact, a necessary condition for normal behavior. Most Western researchers, (Luchins, 1942) who accept the existence of set, view it as an irritating side effect which confounds the scientific description of behavior. While set, within the Soviet context, is the primary and underlying determinate of behavior, Western psychologists have given set a secondary role a role that may be beneficial but more likely inhibitory. No theory of Western psychology has delineated the role of set at various levels of human functioning as the Georgians have attempted to do.

Statement of the Problem

Because Soviet set theory has only recently been indroduced to Western psychologists, some of its basic concepts have yet to be empirically tested. The aim of this thesis was to examine the relationship between the Soviet concepts of quantitative and qualitative set. Uznadze's (1966) quantitative set task was experimentally compared with a qualitative set task based on the work of Rees and Israel (1935) with related anagrams. The study was so designed that subjects who received setting trials could be compared to subjects who did not receive these exposures.

CHAPTER II

REVIEW OF THE LITERATURE

The literature to be reviewed in this chapter concerns the Soviet concept of quantitative and qualitative set. The concept of "mental sets" as established by the sequential solution of related anagram problems will also be considered.

The Soviet Concept of Set

A major part of the work done by Soviet psychologists on the concept of set is included in the 1966 English translation of Uznadze's book, The Psychology of Set. Uznadze (1966) contends that set is not only a mental phenomenon determining response bias but is itself the "initial, fundamental reaction to a situation where there is a problem to be considered and solved (p. 10)." Normally sets operate at an unconscious level and influence the perceptual process without the subject being aware of them. Soviet psychologists conceive of the unconscious as an intergal state of the mind which preceeds the appearance of consciousness. This stage of mental development consists of the establishment of sets which direct the activity of the subject, leading to the satisfaction of his needs (Uznadze, 1966).

Uznadze (1966) defines the term "need" as any state of the psychophysical organism which, requiring a change in the

environment, moves the individual towards that change. For example, hunger is a substantial need which causes the individual to seek food for its satisfaction. In addition to substantial needs Uznadze views man as having functional needs. This concept refers to man's active curiosity about, and participation in, the environment around him.

Uznadze conceives of man as operating on two levels, the implusive plane of behavior (responding directly to a given stimulus), and the intellectual plane (mediated) reached through a cognitive process termed "objectification." Normally the implusive plane of behavior is charactized by the action of established sets. When a set is not appropriate to the current situation man's cognitive reasoning powers are applied to clarify the interference which is present, and as a result a more appropriate set arises.

Russian experimenters have identifed two types of set which they call quantitative and qualitative. Uznadze (1966) has shown experimentally that quantitative set can be established with any two objects which have the relationship "bigger-smaller." Qualitative sets, in contrast, are established by the sequential presentation of single stimulus items that have one common property. Common properties often-employed in qualitative set research are class inclusion and constant order of stimulus parts, whereas quantitative set research depends on the physical

stimulus dimensions of size, weight and volume. Before a further comparison of qualitative and quantitative set can be made the experimental procedures required to establish each must be specified.

Uznadze's Quantitative Set

Uznadze (1966) reports, in some detail, the experimental procedures for the establishment of quantitative sets. Although sets may be created in a number of sensory modalities by using appropriate stimuli, the haptic and visual modalities have been most frequently used for demonstrating quantitative set. A set can be established in the haptic modality by having the subject grasp two equally weighted spheres that differ in volume. Fixing a set in the visual modality can be accomplished in the following manner.

A set is established in the visual modality by brief, repeated tachistoscopic presentations of two unequal stimuli, usually geometric figures. During the first set of trials, called setting or fixing trials, the two figures (circles) are always presented in the same spatial relationship to one another, for example, the larger on the right and the smaller on the left. Subsequent to each presentation, the subject is required to state whether the two figures appeared to be equal or unequal, and if unequal, which appeared to be larger. This procedure is repeated for a predetermined number of setting trials. When a set is

first established in this manner it is normally weak. However, after a number of setting trials the set becomes "fixed." A set is said to be fixed when the sujects preceives two equal stimulus items as being unequal. One presentation of the equal stimuli constitutes a "critical trial," and the subject's mis-perception is called an illusion. Critical trials are continued until veridical perception is reported on five consecutive trials or until a criterion of 30 presentations is reached. Tabulation of the critical trials is terminated at the first occurrence of veridical perception.

If a set has been established, the subject will display one of the following illusions. Either he will continue to perceive unequal spheres in their previously presented spatial relationship (assimilative illusion) or he will perceive that the two figures have been transposed (contrast illusion). Uznadze (1966) concludes that the number of contrast illusions is more indicative of set strength.

Uznadze (1966) states that the number of setting trials required to fix a set, the number of critical trials required to extinguish a set, and the type of illusions experienced, are different for each individual. Generally, however, the illusions persist for some time, and subjects pass through several stages in the process of extinguishing the set. Subjects who ultimately recognize the equality of

the critical figures are said to posses a "dynamic set." Uznadze reports that some subjects are unable to rid themselves of the influence of the fixed set even after 30 critical trials are presented. These subjects are under the influence of a "static set." A few subjects apparently treat each trial separately and never form a set. These people exhibit adequate perception from the first critical trial and may be classified as possessing "no set." Thus the kinds of illusions which appear and the number of trials required to regain accurate perception can be used as dependent variables in the analysis of the effect of set on perception.

The age of subjects used in quantitative set experiments is deemed by Uznadze (1966) to have a profound effect on the strength of the fixed set. He reports that the "excitability of the set is very high in the preschool period, somewhat lower until the age of 11 years, then (12 to 14) falls sharply, to rise again between 15 and 17 years (1966, p. 39)." Researchers desiring to establish a strong stable set should use subjects who are at least 15 years of age.

Soviet Research Relating to Quantitative Set

Uznadze (1966) contends that sets are a central (intellectual) rather than a peripheral (sensory) phenomena and as such they constitute a modification of the cognitive processes. He further states that "set fixed on

quantitative relationships ... are more highly developed" than sets fixed on qualitative material and consequently are the main vehicle for set research (p. 74).

As has been outlined, the traditional method of establishing quantitative sets depends on the subject actually seeing the unequal circles, or grasping the unequal spheres. Natadze (1970), however, has shown that a similiar set can be established using pictures of objects which have this "bigger-smaller" relationship. Earlier, Natadze (1961) demonstrated that quantitative sets could be developed by having actors "imagine" that they were handling objects having a "bigger-smaller" relationship. Natadze (1970) found that sets of this kind were very hard for the normal individual to establish and hypothesized that the actors were successful only because of their highly developed ability to imagine themselves in different situations. The findings of this research supports Uznadze's contention that set is a central (intellectual) process since sets based on imagination are creations of the mind without actual perceptual input.

Grigolava (1973) used Uznadze's, theory of fixed sets to demonstrate how the stimulus properties of an object may be preceived without being reflected in the subject's awareness. Two balls of different materials were placed in the hands of a blindfolded subject (a large one invariably into the right hand, and a small one into the left). After

each of these setting trials the subject was requested to identify the materials from which the balls was constructed. Thus, in these tests, the type of material constitute the relevant stimulus whereas size, weight, and hardness/softness were irrelevant dimensions. In order to determine if the subjects had been set to the irrelevant stimuli, two equal balls were presented and the subjects were asked if the balls were equal in size, and if not which was largest.

Grigolava (1973) found that all 100 subjects tested showed a contrast illusion on the first critical trial. To ascertain if subjects were aware of the irrelevant stimulus dimensions a second control group was utilized. Subjects in the control group were asked following the setting trials if they had noticed in which hand they had held the larger ball and in which the smaller. The author reports that the subjects could not recall the irrelevant stimulus dimensions even though they were reflected in unconscious sets. Grigolava thus concluded that the traces of perception of irrelevent stimuli are to be found in unconscious sets rather than in conscious recall (memory).

Uznadze's Qualitative Set

To experimentally demonstrate the existence of qualitative set, Uznadze (1966) used a list of 30 five letter Latin words followed by a series of 35 five letter Russian words. Both lists were hand written in Latin

characters. All of the stimuli were tachistoscopically presented to a sample of subjects familiar with both languages. The series of Latin words acted as the set fixing task while the Russian words were employed in the critical trials. Uznadze (1966) found that the set base on reading Latin words was definitely fixed, after presentation of the setting trials. During the critical trials subjects read familiar Russian words with Latin pronounications, indicating that their performance was set influenced. As with quantitative set, subjects seemed to pass through a number of steps on the way to realizing that they were giving familiar Russian words a Latin pronounciation.

Uznadze (1966) claims that the only difference between quantitative and qualitative set is that a contrast illusion, the first stage of quantitative set extinction, can not occur when a set is developed using qualitative materials. This is so, Uznadze contends, because qualitative materials, unlike quantitative materials are not concerned with the "category of intensity."

The second stage of quantitative set extinction, the assimilation illusion, however, does occur in qualitative set experiments. An assimilation illusion, in the context of Uznadze's study, occurred when ever a Russian word was pronounced as if it were a member of the class of Latin words. In the third stage of qualitative set extinction, assimilation illusions were mixed with responses where

Russian words were given Russian pronounciations. These observable stages and their similarity to those observed during quantitative set experiments are the main basis for Uznadze's contention that quantitative and qualitative set are examples of the same general mental process.

Quantitative-Qualitative Set Comparisons

Despite Uznadze's (1966) claim that quantitative and qualitative set are examples of the same mental process, one major methological difference is apparent in the literature related to the two types of set. In developing a quantitative set the subject's task is to compare two stimuli on each of a number of fixing trials. Development of qualitative set, however, clearly depends on the associations built up between stimulus items as they are successively encountered.

A second, methodological difference between the two types of set experiments is the kind of responses that are possible during the critical trials. In a quantitative set task, the subject can meaningfully say that one stimulus object is smaller than, larger than, or equal to the other stimulus object. In a qualitative set task the subject can respond to the critical items in either of two ways. The subject can perceive the critical item as similar to the fixing stimulus and structure his response to reflect this class inclusion, or the subject can perceive the critical stimuli as different from those presented in the fixing

trials and reflect this difference in his response. In the first situation the subject is said to be under the influence of a fixed set, whereas the second situation illustrates the replacement of the formerly fixed set with one more appropriate to the current situation. In either case, a response of "bigger than", or "smaller than" has no meaning in the qualitative set experiment. Psychological equivalence of these two types of set, as proposed by Uznadze (1966), is the main topic of interest in this thesis.

WESTERN SET RESEARCH

Non-Soviet Orientation

Set, within the Soviet context, is a positive and essential concept for the development of consciousness. In contrast, most Western researchers view set as an annoying side effect which confounds the orderly description of behavior. Other psychologists, such as Luchins (1942), expressed concern with the "blinding" effects" that set can have on an individual's approach in a problem solving situation.

Luchins (1942,1946) has conducted extensive research into the blinding effect of "Einstellung," a word he uses interchangably with set. The basic experimental task used to investigate "Einstellung" consists of a series of 11 volume measuring problems, involving different size

containers and a supply of fluid. The subject's task is to figure out how to obtain a stipulated volume of fluid using the three jars. The first six problems, designed to create the set, can all be solved by applying the same formula. In problems 7 and 8, which constitute the critical set, a second easier method of solution is also available. The 9th problem tests for experimental extinction by presenting a problem which is unsolvable using the first formula. The 10th and 11th problems test for recovery from "Einstellung."

An alternate method to the "water jug problems" is the "hidden word test." The subject is given a series of 11 nonsense letter combinations, each of which contains a hidden word. For example, "msavrge" contains the word "mare" while the combination "dzepewr" hides the word "deer." Each second letter is used to form the word and thus the "Einstellung." A sequence of 11 problems are administered using the same experimental sequence that was outlined in the "water jug problems."

Much of Luchin's (1946,1955) research was directed towards investigating the phenomena of set as it operated in the classroom. Other work (1966) was concerned with the maximizing and minumizing of the "Einstellung" effect. This type of research was a natural consequence of Luchin's behavioral definition of set. Hertzog and Unrah (1973) point out that Luchin's viewed set "as an inhibitory mechanism arising from the development of habitual behavior

patterns which interfere with on going activity" (p. 132). Within this framework set is a transfer of previously learned behavior.

Research With Soviet Orientation

A number of North American psychologists have recently conducted research which has attempted to correlate the Georgian concept of set with various achievement and personality factors. Probably the first of these studies was carried out by Hertzog (1968). As a result of his research, Hertzog suggested that there is a significant relationship between complex language performance and set excitation/extinction in both the haptic and visual modalities.

Hritzuk (1968) used Uznadze's visual and haptic set tasks to investigate the relationship between Soviet set and personality variables in introverted and extroverted subjects. His results indicated that these extreme populations could be readily differentiated by set performance, and emphasized the importance of personality factors in set research.

Owens (1970) investigated the relationship between Georgian set measures, socioeconomic background, and sex, in 5 and 6 year olds. He found that set scores were not systematically related to either sex or socioeconomic status. Taylor (1971), using adolescents, also failed to find any significant difference between the set performances

of male and female subjects. However, he was successful in demonstrating that set measures are significant predictors of creativity. Korella (1973), found that subjects who were test anxious required more trials to fixate and extinguish a set.

Only one study by Hritzuk and Janzen (1970) has attempted to experimently compare Georgian set with any Western theory of set. The authors warn of the danger of assuming the equivalence of "ustanovka" and "Einstellung" both of which are translated as "set." They administered Luchin's hidden word test (described earlier in this section) and Uznadze's haptic and visual set tasks to a sample of college students. Since the authors found significant differences between Luchin and Soviet set scores they concluded that they were measuring different cognitive domains.

PURPOSES OF THE PRESENT STUDY

The purpose of the present study was to measure the nature of qualitative and quantitative set for a number of subjects and then to determine if the strength and nature of qualitative set can be predicted by performance on a quantitative set task. In other words, this study was an experimental attempt to assess Uznadze's contention that qualitative and quantitative set are two aspects of the same mental process.

All the Western set investigations, reviewed in the

previous section, were primarily concerned with relating set to other measurable personality or ability variables. None of these studies have attempted to determine how subjects who were exposed to setting trials differed from subjects who did not receive such exposures. Because of this apparent weakness in the reported literature, a secondary purpose of this study was to investigate the illusion phenomena in the visual quantitative set task.

DESIGNING A QUALITATIVE SET TASK

It seemed necessary to arrive at a qualitative set task which preserves the essential features of Uznadze's qualitative set experiment, without requiring that subjects be fluent in two languages. In order to do this it was first necessary to examine the task closely to determine it's essential features. Basically the task follows the pattern of all set tasks. It consists of a number of setting trials during which the subject gains the set, followed by a number of critical trials, during which the nature of the set is measured. During the critical trials, the stimuli which are presented are ambiguous in nature, that is, they can be identified by following the established set or by rejecting it and taking up the second available pattern in the stimuli.

Several Western psychologists have conducted demonstration experiments tc show that qualitative set of this nature can be established. Leeper (1935) showed that

subjects preceived the same woman in Boring's ambiguous "wife, mother-in-law" composite as they had seen in an unambiguous pretest picture. In a more recent experiment of the same nature, Bugelski and Alampay (1961) showed that perception of their ambiguous "rat-man" figure depended upon the nature of the prevailing mental set. Subjects who had been shown a series of animal drawings generally preceived the composite as a "rat" whereas prior presentation of a boy, girl, and woman generally elicited "man" as the subject's response.

While the qualitative experiments outlined above have been successful in demonstrating the phenomenon of set they have been unsuccessful in delimiting the strength and/or quality of set held by individual subjects. In order to successfully compare qualitative and quantitative set it was essential that the qualitative set task used in this study reflect the quality and strength of the established set.

A task which seemed to meet these requirements, was suggested by Rees and Israel (1935) with their work on "mental sets." In this research, "mental sets" were created by the sequential solution of categorically related anagrams. Johnson (1966), speaking about the development of mental sets, states that there are:

> "... abstract similarites and superficial differences between successive problems and that, as practice continues, the similarities are more readily perceived and a common pattern of responses follow (p. 373)."

These attributes of sequentially solved anagram problems appear to compare favorably with those of Uznadze's quantitative set task.

DEVELOPMENT OF MENTAL SETS

The Anagram

The "mixed up word," or anagram, as it is more commonly known, has proven it's usefulness in a wide variety of problem solving situations. This utility is due, in part, to the ease with which they are constructed to fit task specifications, administered and scored. The research reviewed in the following sections demonstrates how anagrams have been employed to study "mental sets."

Factors Influencing Anagram Solution

Over the past 35 years, anagrams and the attributes which effect their solution have been the objects of extensive research. Johnson (1966) reviewed much of this literature and classified it under the following six headings, "problem solving sets, anagram variables, word variables, anagram-word relations, time relations and anagram solving abilities" (p. 371).

Although all these topics are of considerable interest, this review will be, for the most part, restricted to the anagram literature which deals specifically with the establishment of problem solving sets, more commonly called "mental sets." Within this topic a further delimination is

necessary. Research has shown that sets can be established by instructions, if the subjects are co-operative and alternately by the presentation of a series of related anagrams (Rees and Israel, 1935). Although these two methods of establishing mental sets are clearly related this review will center mainly on the latter.

Anagram Studies Dealing With Mental Sets

The effects of set on anagram solving was recognized early in psychological research by Longfeld and Allport (1916). They included an experiment in their lab manual to demonstrate the effect of a determining tendency on speed of problem solving. This experiment and other early work by Foster and Tinker (1929) was conducted to demonstrate the effects of set. However, it was not until 1935 and the emergence of Rees and Israel's monograph that the investigation of set took on genuine research characteristics.

Rees and Israel used five letter "nature anagrams" and five letter "eating anagrams" to establish mental sets in two comparable groups of students. Both groups were then given the same list of ambiguous anagrams to measure the extent of their mental set. It was found that both set tasks were successful in establishing mental sets in the experimental groups. The number of set appropriate solutions was significantly larger for the experimental group than for a control group who recieved a random mixture

of nature and eating anagrams during the setting trials.

Several methodological considerations of this research are of particular interest to the present investigation. In conducting these experiment Rees and Israel gave all subjects five practice trials to minimize warm up effects on the experimental treatments. Further they suggest that the use of pencils and paper during anagram solution not be allowed and that subjects not be informed that ambiguous anagrams have more than one solution. Finally they suggested that anagrams used in establishing category set be closely related to each other. They found that the nature anagrams used in this first study produced a stronger set than the eating anagrams, and hypothesized that this was due to their more homogeneous nature.

Rees and Israel (1935) have extended this research to demonstrate that an unconscious set favoring a certain solution can be formed by employing a definite order in the rearrangement of the letters of an anagram. When this type of "letter order set" leads to the same solution as the "nature" set there is a facilitation of the prescribed solution. When the anagrams are arranged to require different solutions by using the two sets, the "letter order" set prevails over the "nature," or category set. This finding was interpreted in terms of the intrinsic relations of the different sets to the situation and task. Whatever the nature of the set the essence of the anagram

problem is the eventual rearrangement of its letters. Sets related to letter order influence subjects to concentrate on this primary and essential feature of the task. On the other hand, sets defined in terms of the meaning-character of the solution words introduced an additional requirement which is not directly related to the basic operation of anagram-solution (Rees and Israel, 1935).

Maltzman and Morrisett (1952) utilized anagrams similar to those of Rees and Isarel in investigating the Hullian theory of habit strength in problem solving situations. A "strong-habit" group received 30 randomly shuffled "nature" anagrams while the "weak habit" group experienced only four such trials following a series of 26 irrelevant anagrams. Test anagrams, all eating-set for half the subjects, and all nature for the other half, were then administered. Using frequency of set appropriate solution as the criterion measure, the experimenters found that the weak-habit group outperformed the strong-habit group on these critical trials. These results appear to support those of Rees and Israel but were achieved in a reverse manner, that is, instead of setting subjects and enhancing performance the authors induced more interference in one group (strong-habit strength) and consequently decreased its performance.

Several studies by Juola and Hergenhahn (1967, 1968) report findings which the authors feel directly [redacted]tradict

those of Maltzman and Morrisett (1952) concerning habit strength and overtraining. In their 1967 study Juola and Hergenhahn presented three groups of subjects with 60 five letter anagrams. In the set condition the first 45 anagrams were all arranged in a 54123 letter order. In a random set condition several setting trial orders were used where as in a third control group a large number of letter orders were employed. In all three conditions the critical anagrams, which followed the setting trials, were presented in the common letter order 32145.

This study showed that the median solution time for the 15 test trials was significantly faster for the set condition than for the random set condition. The comparison between the random set and control conditions, however was not significant.

Juola and Hergenhahn suggest that the difference bewteen their study and that of Maltzman and Morrisett was due to the more "precise" establishment of training (weak habit) and overtraining (strong habit) in their study. Based on the comparison of the random set condition and the control group, they further concluded that undertraining was as conducive to the establishment of mental set as overtraining. The first finding, that set subjects showed faster solution times than random set subjects, was replicated in a second study (Juola & Hergenhahn, 1968). The second finding, however was not supported with the

increased sample size of the second experiment.

One factor which the authors failed to consider when comparing their work to that of Maltzman and Morrisett was the different nature of the two anagram tasks. The establishment of mental set in Maltzman and Morrisett's studies was accomplished by having subjects solve anagrams taken from the same category of solution words. Mental set in the Juola and Hergenhahn studies were formed by discovering a specific letter order solution in the anagram and using that order to solve subsequent word problems. Although both these methods result in sets which influence performance in a similiar way, it appears that they encourage different approaches to anagram solution. It could be hypothesized that the effect of category set is to encourage the subject to select category inclusive words and then perform a letter to letter match. The effect of order sets it would seem, would be to encourage mental manipulation of the anagram's letters in order to find the solution word.

With regard to the literature just reviewed the ingenious experimental work of Kaplan and Schoenfeld (1966), is of special interest. Subjects in this experiment were shown a series of 40 five letter anagrams. The first 20 anagrams were solved by rearranging their letters in the same order, the next 10 followed a different order while the last ten followed a 3rd rule. Unlike the ordinary set

experiment the study attempted to observe the effects of set on individual anagram solutions by photographing the subjects eye movements during the experimental task. The letters of the anagrams were displayed in a rectangular pattern, with a letter at each corner and one in the center. This wide distribution of letters was necessary to allow the experimenters to determine exactly which letter the subject was fixating. Subjects who reported that they found a pattern in the anagrams solved subsequent anagrams with fewer fixations and in a shorter length of time. Behaviorally these subjects generally adjusted their eye movements to fixate the letter in the correct solution order. The authors concluded that, although eye movements are not normally necessary for anagram solution, they are, in this situation, the "behavioral substance of the hypothetical 'mental set' to perceive the letters of an anagram in the order of the rule" (p. 451).

In a second experiment, Maltzman and Morrisett (1953a) compared the strength of a compound set with the strength of the individual sets used to comprise it. They found, as had Rees and Israel, that compound sets were followed by a greater percentage of set solutions than either single set. In Hullian terms these effects were explained by the summation of the different habit strengths acquired by the two elements of the stimulus compound. It was also determined that a significantly larger part of the set

solutions in the compound class were attributable to the order set than to the categcry set. The authors suggested that the habit strength of order set "overshadows" that for nature anagrams because the words included in the "nature" category tended to subdivide into two groups dealing with bodies of water and plant life respectively. Under these conditions competing responses had been aroused within the category set and thus its effeciency was reduced.

Further support for the foregoing hypothesis was obtained from another experiment by the same authors (Maltzman, & Morrisett, 1953b). By choosing only plant and tree anagrams they made the category of nature more homogeneous and as a result obtained significaltly more critical set solutions from the group trained with the compound set than from the group trained with anagrams having only order solutions.

Hunter (1959) has delineated several factors which influence the speed and nature of anagram solutions. Chief amoung these are the "thinkers set," his linguistic knowledge, and preferences for certain letter position arrangements. Hunter conceives of set as disposing the subject to act in "limited ways even though his disposition is reflected but slightly, cr not at all, in his conscious awareness (p. 192)." This restriction in performing a specific activity, such as anagram solution, allows an efficient trial and checking procedure for testing possible

solutions.

After assessing the obvious importance of linguistic knowledge in anagram solving, the author considers the number and nature of letter moves in anagram solutions. He experimentally compared anagrams requiring one and three letter moves to form the solution work. For example the anagram 'wtera' requires only one letter move to form the solution word 'water'. 'Rawet', however requires three letter moves to form the same solution word.

Hunter (1959) found that the solution time for low scrambled words is significantly shorter than for highly scrambled words. Further more, letter moves in a forward and backward order are equally easy to make. A third finding indicated that words starting with vowels were particularly hard to solve. Apparently subjects reflect their linguistic knowledge and try letter combinations beginning with consonants.

Hunter reports a replication by D. Mackay, of the study just discussed, with school children, aged 12 and 15. This replication was deemed unsatisfactory since 61% and 40% of the anagrams were failed by 12 and 15 years olds respectively, after 60 seconds of solution time. It should be remembered that these were unrelated anagrams and that subjects could not benefit from category or order sets. The author suggests that an inferior level of linguistic knowledge, in the areas of letter sequence, speech sounds

and a generally smaller vocabulary was responsible for the student's poor performance. The literature reviewed here only begins the discussion of anagram variables. Reference to Johnson (1966) and Dominowski (1968) will provide the reader access to most of the revelent research.

Importance of Anagrams to the Present Study

Based on the anagram literature reviewed above, a qualitative set task was constructed for use in this study. It consisted of ten setting anagrams followed by eight critical anagrams. Since each of the critical anagrams had more than one solution, it was possible to measure, in several ways, the strength of sets that were developed. The construction of the anagram tasks is described in detail in Chapter 4. Qualitative set scores from the anagram tasks along with the quantitative set scores were used in testing the experimental hypotheses defined for the study.

CHAPTER III

EXPERIMENTAL HYPOTHESES

The experimental hypotheses for this study are presented in the three categories: Quantitative Set Hypotheses, Qualitative Set Hypotheses and Quantitative-Qualitative Set Comparisons. For ease of reference, hypotheses are numbered sequentially and all are stated in the positive rather than the negative manner.

Quantitative Set Hypotheses

Experimental subjects (those receiving quantitative setting trials) in comparison with control subjects (those not receiving quantitative setting trials) should:

H1a: Require more critical trials to attain veridical perception in the visual modality.

H1b: Show larger illusion scores.

H1c: Give fewer non-illusion responses before veridical perception.

H2: Experimental subjects should exhibit more contrast than assimilation illusions.

Qualitative Set Hypotheses:

Experimental subjects (those receiving "water" set anagrams) in comparison with control subjects (those

receiving unrelated anagrams) should:

H3a: Acquire more set points and give more set inclusive solutions.

H3b: Acquire fewer order points and give fewer order inclusive solutions.

H4: Experimental subjects should amass more set points than order points and give more set inclusive critical solutions than order solutions.

Quantitative-Qualitative Set Comparison Hypotheses

H5a: Knowledge of level of performance on quantitative set tasks permits prediction of corresponding qualitative set performance.

H5b: Subjects who form a strong quantitative set and retain it for a long time (static set) will have the highest scores on qualitative set.

H5c: Subjects who form weaker quantitative sets and lose them within a few critical trials (dynamic set) will have lower qualitative set scores than those showing a static set.

H5d: Subjects who form a very weak or non existant quantitative set will produce the lowest scores on the qualitative set task.

CHAPTER IV

METHOD

Brief Overview

In this study subjects were required to perform a qualitative set task (anagram problem solving) and a quantitative set task (size comparison of two simultaneously presented circles). One half of the sample were administered the experimental tasks while the remaing subjects acted as a control group. Experimental subjects received trials designed to induce a set while control subjects experienced an equivalent number of non-related, non-setting trials. For each task the same critical trials were presented to both experimental and control groups. The effect and strength of setting trials were assessed by comparing the performance of experimental and control subjects on these common critical trials.

Experimental Design

The experimental design used in the study is presented in Figure 1. Two experimental and two independent control groups were utilized. Before completing any experimental tasks, all subjects were given a demonstration-familiarization session on the 1500 computer system demo package.

Experimental		Control	
Group 1	Group 2	Group 1	Group 2
Demo Introductory Period			
Quantitative Setting Trials	Qualitative Setting Trials	Demo Introductory Period	Qualitative Control Trials
Quantitative Critical Trials	Qualitative Critical Trials	Quantitative Critical Trials	Qualitative Critical Trials
Distraction Task			
Qualitative Setting Trials	Quantitative Setting Trials	Qualitative Control Trials	Demo Introductory Period
Qualitative Critical Trials	Quantitative Critical Trials	Qualitative Critical Trials	Quantitative Critical Trials

Figure 1. Experimental Design

Balancing of Tasks

Since the two types of set tasks under investigation may be related, it was considered necessary to control the order in which the experimental tasks were presented. To achieve this balancing effect subjects were assigned to one of the following four treatment groups such that males and females were equally represented in each.

1. Experimental Group 1 - Quantitative set task first.
2. Experimental Group 2 - Qualitative set task first.
3. Control Group 1 - Quantitative set task first.
4. Control Group 2 - Qualitative set task first.

The Distraction Task

The "coin weighing problem" from the standard 1500 computer demo package was administered to subjects in all four groups as a distraction task between the two set tasks. This task was administered in an attempt to limit the amount of transfer between set tasks by requiring subjects to solve an unrelated problem. Due to this distraction task and the scheduling of the two setting tasks, a time interval of at least 10 minutes between setting tasks was maintained. This time interval further assured that the amount of transfer between set tasks was minimized.

THE SAMPLE

The sample initally consisted of 81 grade nine students from Saint Kevin's Junior High School in the city of Edmonton, Alberta. Two subjects reported that they could not see the circles during the quantitative set task and

were subsequently dropped from the sample. This left a total sample of 79 subjects, consisting of 39 males and 40 females with a mean age of 15.6 years. Random assignment of subjects to experimental and control groups before the experiment, resulted in an experimental group of 20 males and 21 females; the control group consisted of 19 males and 19 females.

MATERIALS

Quantitative Set Task

For the administration of the quantitative set task three 4 x 8 white file cards with india ink drawings were utilized. The setting stimulus cards depicted a large circle on the right and a small circle on the left with diameters of 35 mm. and 22 mm. respectively. Equal circles of 28 mm. each were used as critical stimuli. A third card with a single black dot was used as a fixation point. All experimental trials were presented with a Scientific Protype Three Channel Tachistoscope.

Qualitative Set Task

On the basis of Rees and Israel's (1935) work, a task to establish and measure qualitative set was constructed. It consisted of ten anagrams chosen to induce a "water" set, followed by eight anagrams to test the strength of the set. These critical trials were ambigious, that is, they could be solved by retaining the prevailing mental set as "water

words" or as "non-water" words by adopting the constant "letter order" pattern present in the stimulus anagrams. Appendix A gives a complete list of the "water" and critical anagrams used in the study.

Instead of the setting trials, the control group received a separate list of fourteen unrelated anagrams. These anagrams were constructed so that corresponding anagrams in the experimental setting trials had the same solution letter order. For example, the solution for the first experimental anagram "trewa" was "water", with a solution letter order of 45132. Using the same letter ordering scheme on the first control word "learn" results in the anagram form "anrle." These non-setting anagrams are also shown in Appendix A.

The 1500 Computer System

The anagram solution task was especially programmed for presentation on the IBM 1500 computer system located with the Division of Educational Research at the University of Alberta. This computer, mainly used for computer assisted instruction, possesses several features which make it ideally suited to this type of research.

The IBM 1500 computer system consists of a small 1130 computer with a number of individual student stations. Each student station consists of a cathode ray tube (CRT) with a typewriter like keyboard and light pen, an image projector capable of displaying 16 mm. slides and an audio unit

capable of replaying pre-recorded verbal messages. The CRT and its typewriter keyboard were the only components of the student terminal used in this study.

The Coursewriter II (1968) language was used to program the anagram solution task for computer presentation. This language, supplemented by special functions, (1973) allows the author to display text and questions on the CRT, accept keyboard or light pen responses, analyze these responses in terms of expected answers, and keeps track of the number of correct, wrong and unexpected answers.

The system is designed to present the programmed material to each student terminal at an individual rate, measure the student's response time, and record all the data concerning student responses on mangetic tape for subsequent analysis. In short, the use of the 1500 system makes possible group presentation of what is normally an individually administered test.

GENERAL PROCEDURES

The first twenty to thirty minutes of each experimental session were devoted to familarizing the subjects with the IBM computer terminals. This was done by allowing subjects to complete some of the demonstration programs available on the system. This familiarization process was intended to reduce subject variance due to fear and uncertainty. Before being confronted with the

experimental tasks all subjects seemed to feel quite comfortable and competent in operating the student terminal.

Qualitative Set Procedures

Before beginning the sample anagrams the students were told (via the CRT) that their task was to unscramble a number of "mixed up words." They were also told that a total of ninety seconds was available for solving each anagram. Appendix B shows the instructions presented for the anagram solving task.

All subjects were presented five sample anagrams before beginning the experimental task. The first two of these anagrams were presented in a manner which lead the subjects to discover the solution word, if their initial attempts were unsuccessful. The last three sample anagrams were presented in the same format as the experimental anagrams and were designed to acquaint subjects with experimental conditions.

All experimental anagrams were presented, one at a time, on the CRT in dot matrix characters twice the size of normal display letters. This increase in letter size was intended to enhance their readability in a situation where normal language cues are not available.

The maximum "solution time" allowed for any anagram was ninety seconds beginning at presentation time. This limit was imposed to ensure that all subjects would finish the task within the testing interval available, and to

encourage them to report the first solution they found. Since solution time was measured as a dependent variable, it was necessary to seperate "solution time" from "response" or "typing time." This was accomplished by having the subject press the space bar when he solved the anagram. The stimulus anagram was then erased and the subject was given a chance to type his solution. The subject's input was compared to the expected answer and the next anagram was presented if a match was found.

If an unacceptable solution was entered the subject was given an appropriate message (see Appendix C) and asked to try the anagram again. At this point the subject could enter another solution or type "again" to be reshown the anagram. Each trial ended with a solution or 90 seconds of "solution time." If the maximum of 90 seconds was used the subject was told that the solution word would be presented after all the anagrams had been attempted and was then encouraged to try the next one. Anagrams were presented as fast as the subject could solve them with the critical trials immediately following the setting or control anagrams. Solutions and solution times were stored by the computer on magnetic tape, for later analysis as dependent variables.

Quantitative Set Procedures

Subjects were taken individually from the computer terminal room to the Division of Educational Research

Library where the quantitative setting task was administered by a second experimenter. Before administering any experimental trials the experimenter recorded the subject's ID number on a response sheet, noted if the subject was an experimental or control subject, and adjusted the tachistoscopic settings accordingly.

The instructions outlined in Appendix D were read to the subject and the first trial was administered. Subjects in the experimental group received fifteen setting presentations of the slide depicting a large and a small circle. On the 16th presentation the slide showing two equal circles was substituted. The quantitative set task ended when the subject gave five successive correct non-illusion "equal" responses or reached a maximum of 30 critical trials.

Following the presentation of the common instructions the control subjects were presented with the critical trials of the quantitative setting task. That is, they were shown the equal circles (critical stimuli) without being first exposed to the unequal circles (fixing stimuli).

Treatment of the data

The data collected by the 1500 system computer on magnetic tape was transfered to the IBM 360/67 computer located with the Computer Services Division of the University of Alberta. By using CAIS:PLAN06, a performance recording analysis program from the DERS computer program

library, a complete listing of each student's performance was obtained.

Subjects were assigned to the three groups, static set, dynamic set, and no set, on the basis of their quantitative set performances. Subjects were then ranked as to strength and type of qualitative set. Two scoring schemes were used to produce two separate qualitative rankings. The first method simply consisted of counting the number of set inclusive responses that the subjects made and ranking on that basis.

The second scoring system, used in the study, awarded a varying number of points for each critical anagram solution, depending upon the position of the anagram within the critical trials. This scoring system was designed to distinguish between subjects who solved the same number, but different critical anagrams. Since the number of critical anagrams was small (8), ranking of subjects according to the number of anagrams solved resulted in many "tied" ranks. Far fewer "tied" ranks occured when subjects were ranked on the basis of assigned points. The following point scoring system was used to rank subjects on qualitative set performance.

1st and 2nd anagrams	.....1 point each
3rd and 4th anagrams	.....2 points each
5th and 6th anagrams	.....3 points each
7th and 8th anagrams	.....4 points each
Total Possible Points	20

If a critical anagram was solved as a "water" word, the

number of points associated with that anagram, were added to the "set points" total. Conversely, if the anagram was solved by rearranging the letters according to the constant letter order paradigm, the points were added to the "order points" total. For example if the fourth critical anagram "lpsoo" was solved as "pools" 2 points were added to the "set points" total. Finding solution word "spool", following the constant 54132 letter order, resulted in a 2 point addition to the "order points" total. Subjects were ranked on the basis of their total scores, in one continuous sequence from smallest to largest.

In devising this scoring-ranking system it was theorized that subjects possessing a strong set, would not only give more set solutions, but would also solve the final four critical anagrams as set words more often than subjects having a weaker set. Thus a larger set score was indicative of a strong stable set.

Dependent Variables

Fourteen dependent variables were recorded for each subject and punched on data cards in preparation for statistical analysis. A short description of the nine qualitative variables and five quantitative variables is given below:

Qualitative Variables

Set Points: The total number of point given for solving critical anagrams as "water" words.

Order Points: The total number of points given for using the 54132 constant letter order in solving anagrams.

Setting (Control) Anagrams Missed: The number of setting, (control) anagrams not solved after 90 seconds of solution time.

Critical Anagrams Missed: The number of critical anagrams not solved within the 90 second time limit.

Number Of Set Solutions: Number of critical anagrams solved as "water" words.

Number Of Order Solutions: Number of critical anagrams solved using the constant 54132 letter order.

Number Of Other Solution: Number of valid solutions given for critical anagrams excluding set and order solutions.

Average Setting (Control) Time: The average number of seconds taken to solve each setting (control) anagram.

Average Critical Time: The average number of seconds taken to solve each critical anagram.

Quantitative Variables

Trials To Veridical Perception: The total number of critical trials presented before the subjects reached veridical perception.

Contrast Illusions: The number of illusions where the subjects preceives the fixing stimuli as transposed. (This measure not taken for control subjects).

Assimilation Illusions: The number of illusions where

the subjects perceives the stimulus to be larger on the side where the larger fixing stimuli was located. (Not valid for control subjects).

Non-Illusion Responses: The number of times the subject correctly preceives the critical stimuli as equal before veridical perception is reached.

Illusion Scores: Since control subjects received no quantitative setting trials the illusions they preceived could not be categorized as contrast or assimilational. Thus all the illusions preceived by control subjects were combined into one illusion score. For the propose of statistical analysis a similar score was computed for experimental subjects.

CHAPTER V

RESULTS

Overview

The major techniques of analysis, used in the study were the Mann-Whitney U Test and the Kruskal-Wallis One Way Analysis of Variance. Comparisons between experimental and control groups were made using the Mann-Whitney U Test while t-tests for correlated data were employed to test within group hypotheses (Ferguson, 1968 pp. 167-169). To test the hypotheses that qualitative and quantitative sets are related, subjects were first ranked according to qualitative set scores. These ranks were then categorized into three groups on the basis of quantitative set scores. A Kruskal-Wallis One Way Analysis of Variance, as outlined by Seigel (1959, pp. 184-189) was used to analyse these data. However, before the experimental hypothesis could be tested it was necessary to examine the two experimental and two control groups. T-tests for independent samples were used for these comparisons.

Comparison of Experimental Groups

The two experimental groups differed only in the order in which the quantitative and qualitative set tasks were administered. By comparing experimental Group 1, which received the quantitative set task first, with experimental

Group 2, which received the qualitative task first, it was possible to assess the importance of transfer between the two tasks. Table 1 shows the average scores of experimental Groups 1 and 2 and the results of a t-test for the independent measures. The results show that there were no significant differences between any of the experimental measures. These findings justified the combining of the two experimental groups for future analyses.

Comparison of Control Groups

Control Group 1 received the quantitative set task before the qualitative set task. Control Group 2 received the same two set tasks but in the reverse order. Although no setting trials were administered to the control groups, presentation of eight anagram critical trials may be sufficient to induce a weak set. To determine if the control groups could be combined for further analyses a t-test for independent samples was performed. Table 2 presents the means of control Groups 1 and 2 on each of the dependent variables, with the results of the statistical t-test. As with the experimental groups the control groups showed no significant differences at the .05 level on any of the dependent variables. Thus scores from the two control groups were combined, and will be referred to as the control group.

Sex Differences

To determine if sex showed a systematic relationship

TABLE 1

Mean Scores on Dependent Variables and t-Test Results For Experimental Groups 1 And 2

Measure	Experimental Condition Means			
Qualitative Variables	Gr#1	Gr#2	t'	Prob.
Set Points	8.43	9.00	-0.40	.344
Order Points	6.10	6.30	-0.18	.429
Setting Anagrams Missed	2.33	2.50	-0.33	.373
Critical Anagrams Missed	1.29	1.35	-0.17	.433
Number of Set Solutions	3.33	3.70	-0.69	.247
Number of Order Solutions	2.33	2.45	-0.28	.393
Number of Other Solutions	1.00	.60	1.40	.083
Average Setting Time/Anagram	38.46	41.28	-0.98	.281
Average Critical Time/Anagram	31.95	36.92	-1.07	.146
Quantitative Variables				
Trials To Veridical Percept.	18.19	13.12	1.45	.077
Contrast Illusions	11.90	8.80	1.28	.103
Assimilation Illusions	0.43	0.35	0.25	.403
Equal Responses	5.48	4.10	1.02	.311
Illusion Scores	12.33	9.15	1.29	.102
	n=21	n=20		

TABLE 2

Mean Scores on Dependent Variables and t-Test Results For Control Groups 1 and 2

Measure	Control Condition Means			
Qualitative Variables	Gr#1	Gr#2	t'	Prob.
Set Points	6.73	7.37	-0.45	.329
Order Points	6.50	6.56	-0.05	.481
Control Anagrams Missed	2.91	2.75	0.23	.409
Critical Anagrams Missed	1.82	1.31	0.97	.169
Number of Set Solutions	2.50	3.00	-0.92	.184
Number of Order Sclutions	2.77	2.56	0.43	.334
Number of Other Solutions	0.86	1.12	-0.87	.193
Average Setting Time/Anagram	44.13	43.22	0.17	.432
Average Critical Time/Anagram	40.49	35.31	0.95	.173
Quantitative Variables				
Trials To Veridical Percept.	14.36	15.06	-0.15	.441
Equal Responses	6.55	5.94	0.29	.387
Illusion Scores	7.82	9.25	-0.50	.311
	n=22	n=16		

with the application of the experimental treatments, the scores of females were compared with the scores of males in each of the experimental and control groups. The mean scores of male and female experimental subjects are presented in Table 3 along with the results of the t-test, used to statistically compare them. Table 3 indicates that there were no significant differences between male and female subjects on any of the experimental variables. Number of assimilative illusions was the only dependent variable where the difference ($t' = -1.56$, $p=.065$, n.s.) approached the .05 criterion level.

Table 4 presents the mean scores and the results of a t-test for independent samples performed on the males and female subjects making up the control group. No significant difference between male and female control subjects were found. Since male and female subjects showed no significant experimental differences on any of the dependent measures, they were not differentiated in any of the subsequent anaylses.

Testing the Quantitative Set Hypothesis

A Mann-Whitney U Test performed on the number of trials required for the attainment of veridical perception showed no significant difference between experimental and control groups. ($U=709$, $p=.238$, n.s., see Table 5). Thus hypothesis H1a can not be accepted. To further examine this suprising outcome, subjects were categorized according to

TABLE 3

Mean Scores on Dependent Variables and t-Test Results For Male and Female Experimental Subjects

Measure	Experimental Condition Means			
Qualitative Variables	Male	Female	t'	Prob.
Set Points	9.60	7.86	1.23	.113
Order Points	5.70	6.67	-0.85	.200
Setting Anagrams Missed	2.20	2.62	-0.83	.205
Critical Anagrams Missed	1.20	1.43	-0.62	.271
Number of Set Solutions	3.80	3.24	1.05	.150
Number of Order Solutions	2.15	2.62	-1.11	.138
Number of Other Solutions	0.80	0.81	-0.03	.487
Average Setting Time/Anagram	39.60	40.07	-0.10	.461
Average Critical Time/Anagram	33.64	35.08	-0.31	.381
Quantitative Variables				
Trials To Veridical Percept.	15.00	16.52	-0.44	.332
Contrast Illusions	9.10	11.62	-1.04	.152
Assimilation Illusions	0.15	0.62	-1.56	.065
Equal Responses	5.35	4.29	0.78	.219
Illusion Scores	9.25	12.24	-1.22	.155
	n=20	n=21		

TABLE 4

Mean Scores on Dependent Variables and t-Test Results For Male And Female Control Subjects

Measure	Control Condition Means			
Qualitative Variables	Male	Female	t*	Prob.
Set Points	7.74	6.25	1.07	.147
Order Points	7.00	6.05	0.71	.240
Control Anagrams Missed	2.84	2.84	0.00	.500
Critical Anagrams Missed	1.42	1.79	-0.72	.238
Number of Set Solutions	2.95	2.47	-0.92	.183
Number of Order Solutions	2.84	2.53	-0.66	.258
Number of Other Solutions	0.79	1.16	-1.25	.110
Average Setting Time/Anagram	44.78	42.71	0.40	.345
Average Critical Time/Anagram	38.70	37.92	0.14	.443
Quantitative Variables				
Trials To Veridical Percept.	15.68	13.63	0.45	.329
Equal Responses	6.63	5.95	0.32	.374
Illusion Scores	7.68	9.16	-0.53	.300
	n=19	n=19		

TABLE 5

Mean Scores and Mann-Whitney U Test Results

For Combined Experimental and Control Groups

Measure	Means		Mann-Whitney	
Qualitative Variables	Exp.	Cont	U	Prob.
Set Points	8.71	7.00	600.0	.039
Order Points	6.20	6.53	750.0	.390
Set-Control Anagrams Missed	2.41	2.84	688.0	.168
Critical Anagrams Missed	1.32	1.61	716.0	.264
Number of Set Solutions	3.51	2.71	568.0	.018
Number of Order Solutions	2.39	2.68	705.0	.229
Number of Other Solutions	0.80	0.97	685.5	.168
Average Setting Time/Anagram	39.84	43.75	668.0	.140
Average Critical Time/Anagram	34.38	38.31	697.0	.211
Quantitative Variables				
Trials To Veridical Percept.	15.78	14.66	708.0	.238
Equal Responses	4.80	6.29	727.0	.305
Illusion Scores	11.74	10.88	619.5	.058
	n=41	n=38		

their "trial to veridical perception scores," at intervals of 0, 1-2, 3-5, 6-10, 11-15, 16-19, 20-25, and 30 (Hritzuk, 1971). The results of this procedure, as shown in Table 6, indicate that there are some very real differences between the shapes of the two observed distributions.

Again, contrary to expectations, experimental subjects failed to exhibit significantly more illusion scores than control subjects. Thus experimental hypothesis 1B must be rejected at the .05 level of confidence ($U=619.5$, $p=.058$, n.s.).

As expected, control subjects gave more non-illusion responses prior to veridical perception (Control $\bar{x}=6.29$, Experimental $\bar{x}=4.80$). However this difference was not significant ($U=727$, $p=.305$, n.s.), and hypothesis 1c is not accepted.

A t-test for correlated data was utilized to test the difference between the number of contrast illusions and assimilative illusions exhibited by experimental subjects. As predicted, experimental subjects exhibited significantly more contrast illusions than assimilation illusions ($t=8.24$, $p<.01$). This confirms hypothesis 2. Table 6 shows the t distributions of illusion and equality scores used in testing hypothesis 1B, 1C and 2.

Testing Qualitative Set Hypothesis

A Mann-Whitney U Test was used to statistically compare the combined experimental group with the combined

Table 6

Illusion and Equality Scores For Experimental (E) And Control (C) Subjects

Measure	Group	Number of Occurances 0[1]	1-2[2]	3-5	6-10	11-15	16-19	20-25	30[3]	Mean	Prob.
Contrast Illusion	E	3	3	10	6	6	7	5	1	10.39	.000[4]
Assimilation Illusion	E	33	6	2	0	0	0	0	0	0.39	
Illusion Scores	E	36	9	12	6	6	7	5	1	11.74	.058[5]
	C	33	10	8	13	9	2	1	0	8.53	
Non-Illusion Scores	E	9	8	8	13	2	1	0	0	4.80	.301[5]
	C	14	3	4	5	8	3	1	0	6.29	

Notes:
1 Denotes the number of subjects who did not show the specific response.
2 The number of subjects who showed 1 or 2 responses.
3 The number of subjects who responses were all the same.
4 Tested with t-test for correlated data.
5 Tested with Mann-Whitney U test.

control group. Table 5 shows the combined means and the results of the analysis. Experimental subjects obtained significantly more set points ($U=600$, $p<.05$) and gave significantly more set solutions ($U=568$, $p<.05$) than did control subjects, thus supporting hypothesis 3A. However, contrary to expectations, control subjects did not amass more order points ($U=750.$, $p=.39$), or give significantly more order solutions ($u=705.0$, $p=.23$) than experimental subjects during the critical trials. Thus hypothesis 3B is rejected at the .05 level of confidence.

The number of set and order points gained by the experimental group were compared using a t-test for correlated data. Analysis indicated that significantly more set points than order points were obtained by the experimental subjects ($t=2.29$, $df=40$, $p<.05$). Further analyses indicated that experimental subjects gave more set inclusive solutions than constant letter order solutions ($t=2.77$, $df=40$, $p<.01$). These findings suggest that hypothesis 4 should be accepted.

Quantitative-Qualitative Set Comparisons

Before a statistical comparison of qualitative and quantitative set performances could be carried out the experimental subjects were divided into three groups on the basis of their quantitative set scores. Subjects who gave 3 or less illusion responses before reaching veridical perception were placed in the "nil-small set" category.

Subjects who received 30 critical trials and who has still not reached veridical perception were placed in the "static set" category. The remainer of the subjects, i.e. those who possessed a fixed set and extinguished it before 30 critical trials were administered were classified as possessing a "dynamic set." The qualitative set scores (number of set points and number of set solutions) of each subject were then placed in the same category as his quantitative set score. The results of this procedure are shown in summary Table 7, for number of set points and in summary Table 8 for number of set solutions.

The Kruskal-Wallis One-Way Analysis of Variance by ranks was then employed to decide whether the three groups of qualitative set scores were three independent samples from different populations or were merely random samples from the same population (Seigel, 1956, p. 184-193). The Kruskal-Wallis H statistic produced by the number of set points, ($H=1.84$, $p=.410$, n.s.) and number of set solutions ($H=1.46$, $p=.50$, n.s.) are both very small. Neither approaches the critical value of 5.99 for 2 degrees of freedom at the .05 level of confidence. Thus the null hypothesis, that the 3 groups are random samples from the same population, can not be rejected. These results suggest that any futher analysis of the qualitative-quantitatives set comparison data is not warrented.

TABLE 7

Number of Qualitative Set Points Classified

On the Basis of Quantitative Set Scores

Number of Qual. Set Points	Quantitative Set Categories: Nill-Small Qual. Set	Dynamic Quant. Set	Static Quant. Set
0-2	0	3	0
3-5	0	2	3
6-8	4	4	4
9-11	2	9	1
12-14	1	2	0
15-17	0	2	2
18-20	0	2	0
n	7	24	10

TABLE 8

Number of Qualitative Set Solutions Classified

On the Basis Of Quantitative Set Scores

Quantitative Set Categories			
Number of Qual. Set Solut.	Nill-Small Qual. Set	Dynamic Quant. Set	Static Quant. Set
0	0	1	0
1	0	3	1
2	2	2	1
3	3	4	6
4	1	5	0
5	1	6	1
6	0	1	1
7	0	1	0
8	0	1	0
n	7	24	10

CHAPTER VI

DISCUSSION OF RESULTS

Quantitative Set

The most surprising finding in this study was that control subjects who had not participated in setting trials required almost as many trials to attain veridical perception as did experimental subjects. Although there is no significant difference between the mean critical trial scores of the two samples, their distributions appear to be quite distinctive. As would be expected, a greater number of control subjects (14) perceived the equality of the critical stimuli on the first five presentations, compared with this occurrence among experimental subjects (3). However, fifteen control subjects and ten experimental subjects were administered 30 critical trials without perceiving equality for five consecutive trials. These results indicate a dichotomy among control subjects which may be attributable to either perceptual or personality factors unrelated to the setting task presented. Further examination of this phenomena appears essential.

The finding that experimental subjects exhibited significantly more contrast illusions than assimilation illusions supports Uznadze's (1966) predictions, reemphasizing the contention that contrast illusions are the most accurate measure of quantitative set strength.

Assimilation illusions may therefore be indicative of a very weak or perhaps non-existent set.

The observation that experimental and control subjects did not differ significantly regarding the number of illusions experienced during critical trials may be interpreted as a consequence of the first finding, and was equally unexpected.

Results of this quantitative investigation pose a number of methodological questions pertaining to studies of Soviet set. The majority of set studies reported in the literature have focused on the effects of setting trials on various experimental populations and individuals. However, variations between subjects prior to the setting trials have received little consideration. The results of the present study indicate that a re-evaluation of interaction effects between pre- and post-set conditions may be in order.

Further research is required to determine why an apparently large number of presumably normal (control) subjects experience difficulty in perceiving equality. This research might also focus on set in different modalities, in an attempt to clarify how pre-set differences affect the theory of fixed sets.

Qualitative Set

The results of statistical analysis conducted on the qualitative set scores indicated that there were several significant differences between experimental and control

subjects. As predicted, experimental subjects gave significantly more set solutions during the common critical trials. They also amassed significantly more set points than the control subjects who did not receive setting trials. Experimental subjects showed faster average critical anagram solution times and solved more critical anagrams than did control subjects. Although the last two analyses did not reach the required .05 level of significance the overall results illustrate the increased facilitation with which experimental subjects solved the critical anagrams. Generally, these results indicated that the series of setting anagrams were successful in establishing a "water" set in the experimental subjects and thus, duplicate those reported by Rees and Israel (1935).

Contrary to expectations control subjects did not amass significantly more order points or give significantly more order solutions than experimental subjects. Closer examination of individual profiles indicated several factors which may have influenced this outcome.

Firstly, some of the control subjects adapted the experimental set after several critical trials and solved the majority of the remaining critical trials as "water" words. Control subjects who followed this pattern, gave more set solutions than control solutions, consequently lowering both the average number of order solutions and average number of order points for the entire control group.

The second factor which could have influenced the small average number of order solutions by the control group is the 52143 constant letter order employed in the critical anagrams. Hunter (1959) showed that anagrams, requiring three letter moves, are more difficult to solve than anagrams requiring one or two letter moves. There is a possibility that control subjects would have given more "order" solutions if the constant letter order used required only one or two letter moves. However, if the constant letter pattern were made obvious it would quickly displace the category set held by the experimental subjects. More research is required in this area to experimentally determine what letter order sequence should be used to maximize order points in control subjects, without too rapidly destroying the experimental set.

Quantitative-Qualitative Set Comparisons

The results of the Kruskal-Wallis One Way Analysis of Variance performed on the classified qualitative set scores failed to support the hypothesis that qualitative and quantitative set, as they are defined in this study, are different forms of the same mental phenomena. The results of the present study parallel those of Hritzuk and Janzen (1970) in that both studies failed to find a significant relationship between Uznadze's quantitative set task and another form of set.

The failure of this study to find a significant

relationship between quantitative and qualitative set may stem from a number of possible sources. First of all the anagram task used here as a qualitative set task probably involved more complex cognitive processes than Uznadze's quantitative set task. This anagram setting task required the subject to call upon the "objectification" process rather than relaying entirely on the fixed set. As a result the set which is finally established may differ significantly from the type of set which Uznadze described. It would appear that this criticism may also be made of Hritzuk and Janzen's (1970) use of the "hidden word task." In both cases the subjects's perfromance is not a sole function of the fixed set.

The second factor which may have influenced the outcome of this study were the heavy demands placed upon the subject's linguistic knowledge by the anagram solving task. As Hunter (1959) points out, 15 year old subjects may not have all the linguistic abilities to successfully solve anagram problems. Individual student profiles indicated that some students successfully solved anagram problems but misspelled the solution word. Consequently their solutions were not accepted by the computer. The same experimental tasks with older subjects may have produced quite different results.

Any future experimentation designed to investigate the relationship between qualitative and quantitative set should

use a qualitative task which is less cognitive in nature. Consideration should be given to the age of the subjects used and to the linguistic abilities required for the tasks involved. Obviously qualitative-quantitative set comparisons also depend upon the quantitative set task. Some of the questions raised in this study involving quantitative set deserve careful consideration before further attempts to compare quantitative and qualitative set are made.

Implications for Further Research

The findings of the present study have partly replicated and partly refuted the results of previous set research. These inconsistent results have lead to the postulation of more questions than the study succeeded in answering.

The fact that experimental and control subjects did not differ significantly on quantitative set measures suggests that the physical properties of the quantitative setting stimuli should be more closely examined. It is possible that the setting circles of 35 mm. and 22 mm. are not divergent enough to produce the maximum quantitative set. Also the effectiveness of using shaded circles in establishing a set has not been fully explored. Other neglected areas include the roles of eye dominance and eye movements in establishing and testing quantitative set. Further research might focus on basic methological problems

like those outlined above.

Future research should also consider the scoring system used to measure qualitative set. The awarding of "set" and "order" points as carried out in this study, should be revaluated and validated. It may be that reversing this scoring system would more adequately reflect the strength of the established set.

Finally, future research might utilize the oculometer operated by the Division of Educational Research, to preciously record subject's eye movements during the set tasks. This procedure may reveal important behavioral components of setting and critical trials

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APPENDICES

APPENDIX A

ANAGRAMS AND SOLUTIONS FOR EXPERIMENTAL AND CONTROL GROUPS

SETTING TRIALS

Experimental Group			**	Control Group		
Anagram	Set Solution	Other Solution	**	Anagram	Set Solution	Other Solution
trewa	water	--	**	anrle	learn	--
shrma	marsh	harms	**	inatr	train	--
mawps	swamp	--	**	tirew	write	--
llews	wells	swell	**	esrds	dress	--
donsp	ponds	--	**	darsc	cards	--
asknb	banks	--	**	ltnap	plant	--
rokbo	brook	--	**	llisp	pills	spill
ncala	canal	--	**	olsdl	dolls	--
ekcre	creek	--	**	ksdes	desks	--
ierrv	river	--	**	egehd	hedge	--

CRITICAL TRIALS

Anagram	Set Solution	Order Solution	Other Solutions	
selka	lakes	leaks	slake	
socta	coast	coats	--	
eohsr	shore	horse	--	
sdeti	tides	edits	diets	
lpsoo	pocls	spool	loops	sloop
srfee	reefs	frees	--	
srpya	spray	prays	--	
emsli	slime	smile	miles	limes

APPENDIX B

INSTRUCTIONS GIVEN BEFORE BEGINNING QUALITATIVE SET TASK.

" You will receive a series of mixed up words. Your job will be to rearrange the five letters to form a common English word. When you have 'found' the word press the space bar. Type your answer when the box appears on the screen.

You will be given 90 seconds to find a solution to each mixed up word. Press the space bar to try several examples."

APPENDIX C

ERROR MESSAGES FOR QUALITATIVE SET TASK

If the subject touched any key other than the spacebar he received the message:

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**************************************
You must press the spacebar and wait
for the box to appear before typing.
**************************************
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If the subject typed the anagram as it was presented to him he received the message:

"Please do not type the problem as it appears on the screen. Rearrange the letters to form a ccmmon English word.
Press space bar ... "

If the subject typed a letter combination which could not be constructed from the letters given he was shown this message:

"The letters you have typed are different from those given in the problem. Perhaps you made a typing mistake. Try retyping you answer or type 'again' to review the problem
Press space bar ... "

If the subject typed a correct letter sequence but it did not match one of the acceptable answers the following message was given:

"The letters you have typed are correct but they do not form an acceptable word.
Press space bar ... "

If the subject used all ninety seconds and still did not solve the anagram problem he was given the following

message:

"Time's up. That was a hard one. I will tell you what the word was after you have tried the other word problems I have for you. Please give the next one a try.

Press space bar ... "

APPENDIX D

INSTRUCTIONS READ TO STUDENTS BEFORE BEGINNING QUANTITATIVE SET TASK

"This machine is called a tachistoscope and I am going to use it to show you some circles. Look in the eyepiece now and you should see a white field with a black spot in the middle. (Wait for the subject to look into the tachistoscope). When I say ready you should look at the black dot and I will show you two circles for a brief period of time. Each time I do this, please tell me if the circles are equal or unequal in size. If you think that they are unequal in size, tell me if the largest circle is on the right side or on the left side. Do you understand the instructions? OK lets give it a try."