EFFECTS OF ARITHMETIC ABILITY, VISUALIZATION ABILITY, AND PRESENTATION MODE, ON THE TOTAL SCORES IN A VERBAL LEARNING TASK.

by

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ABSTRACT OF THE THESIS

Effects of Arithmetic Ability, Visualization Ability, and Presentation Mode, on the total scores in a Verbal Learning Task

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The general purpose of this thesis is to add to the knowledge of the parallels existing, in both the verbal and arithmetic learning processes, between symbolism and concreteness.

The first specific purpose was to determine the relationship between the visualization ability and arithmetic ability in sixth grade children. All the sixth grade children (109 students) from two schools in Saanich School District were included in this correlation study.

The second specific purpose was to investigate the interaction between visualization level and presentation mode, and their variable relationship in cases of above and below average arithmetic achievement. From the group of 109 students who were present for all

criteria testing on the Stanford Achievement Test, and the Guilford Zimmerman Perceptual Tests, subjects were randomly discarded until five students were selected, for each of nine cells for a three by three analysis of variance on the scores.

The task, which was the learning of paired stimulus foreign words with English words--was presented in two modes; iconic mode which used actual pictures or sounds, and symbolic mode which used only the words themselves. Three sensory modalities of auditory, visual, and auditory-visual were equally varied in the stimulus content. (Tactual modality was used in a pilot study, the results of which are reported in an appendix). Although each student was a participant in all the presentations, the order of presentation was varied for all the groups, with one control group receiving a completely scrambled task.

Statistical treatment included 109 subjects for the correlation study, 109 subjects for the multiple group discriminant function analysis, and 45 subjects for the three way analysis of variance with repeated measures on two levels.

Within the limitations described in the paper, the following conclusions are made.

1. Arithmetic tests of computation, concepts and applications correlate positively with the perceptual tests of perceptual speed, spatial orientation and spatial visualization. Although each had a different individual relationship, the significant relationship was

between spatial visualization and arithmetic concepts.

3. The students in the high arithmetic grouping did learn significantly more words than the children in the low ability grouping for the symbolic mode only. When the pictures of the words were presented, there was no significant difference in the scores. Presumably then, high arithmetic ability is related to the ability to form an internal image for the symbol, and to remember this internal image.

4. High visualizers did not learn significantly more words presented in either mode.

5. For the iconic mode, the measuring of the arithmetic abilities was more valid than the measuring of the visualization ability. The comparisons changed more with the highness or lowness of the arithmetic ability than with the highness or lowness of the visualization ability. Some comments on the reliability and diffuseness of the perceptual tests were made.

6. Symbolization level of words was found to be more important than presentation mode for the high and medium ability groups, and this was related to the need for concreteness. The low arithmetic low visualization group preferred the symbolic presentation over the iconic presentation, and for this group only, the presentation mode was found to be more important than the symbolization level of the words. Giving a picture did not necessarily help the mediation process nor the memory process.

The thesis also contains an extensive review of the literature including (1) an outline of research studies describing characteristics of sensory modalities; (2) research dealing with presentation modes and information processing; (3) research describing complexity levels and content types of messages, together with symbolization levels of messages and visualization levels of messages ; (4) a review of research articles describing learner characteristics in arithmetic learning; (5) a selected review of research describing learner characteristics in language adoption; and (6) a section relating this research to the specific problem.

The thesis also contains an extensive array of suggestions for both a more intensive study of the current data, and an extension of the method of the study to include other areas.

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Chapter I

INTRODUCTION

A comparison of the effectiveness of the material available for remediation in reading with the materials available for remediation in arithmetic lead to the unhappy conclusion that, while the needs of the students with a reading disability may be appropriately matched with the available materials, there is some considerable doubt whether many of the students with specific arithmetic disabilities can be significantly helped to understand arithmetic better because of their use of any of the available materials.

Attitudes toward reading disability have changed from equating reading disability with lack of intelligence to understanding the part various physiological,[1] psychological,[2] and environmental factors [3] play in the reading process. Although research articles, periodicals, and books attributing reading disability to one cause have been gradually displaced by research articles attributing multiple causes for reading disability,-- no such

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1. perceptual deficits, such as inadequate auditory discrimination, unequal depth perception, or extremely low or high thresholds for reaction to tactual stimulation.
2. emotional disturbance either caused by or as a cause.
3. extremely low Socio-Economic Status, or home environment which derogates learning and provides little related stimulus material or related experiences

progression or alteration of views was evident in the analysis of articles dealing with arithmetic disability. The idea that level of arithmetic ability is related to the general level of reasoning ability was the main view that was presented in the educational research and educational methods literature.

Barakat (1950) used tests of cognitive ability and mathematical attainments, and found that a "basic or general ability roughly identifiable with innate intelligence appears to play by far the largest kind in mathematical attainments of every kind". Blackwell (1949), Vernon (1939), Sutherland (1941), and Coombs (1944) stress the very large part played by the general intellectual factor as compared with specific factors in arithmetic.

Although the causes of acalculia, or very severe arithmetic disability were discussed intensively in literature dealing with the neurology and neuropsychology of the learning processes, these findings and theories do not appear to have been related to or transferred into the literature of the general methods and remediation literature of the teacher.

The National Foundation for Educational Research in England and Wales published a report of an extensive survey of arithmetic research studies made by Biggs (1962): which states,

> there has been a diversion of interest from the more obvious cognitive, to non-cognitive or affective, determinants; an increasingly large number of papers deal with interactions between anxiety, rigidity, frustration, introversion, etc.;--and attempts have been made to relate this theoretical work; but such attempts have not been marked with a great deal of success,--at least in the case of Arithmetical performance.

Measurement of the reading and language processes was described in terms of many-faceted abilities and disabilities, while measurement of the arithmetic process was still described in conceptual, reasoning, symbolic, or memory-linked terms.

What made the learning situation for arithmetic different from that of reading or language? Children with reading or language disability, children with arithmetic disability, and children with both reading and arithmetic disability can be found in any classroom. The communalities of environments have not overcome the individual differences within each child. In the past, these individual differences, where arithmetic was concerned, were assumed to be individual differences in intellectual ability. The knowledge gained through research and analysis has hardly changed this view. Mathematical research has followed two major directions:--one which looks very closely at mathematical learning itself to see what consistent principles arise through "response analysis" studies such as those by Brownell (1944), Thyne (1954), and Saad (1957); and the other involves the application of the principles derived from general psychology to the learning of mathematics. (Biggs, 1952). Notwithstanding the quality of the knowledge thus made available, the extent of the circulation of such knowledge is such that, these same individual differences (previously referred to where arithmetic is concerned) are still assumed (at least in the minds of the fellow students) to be individual differences in intellectual ability.

A belief in intelligence as the only cause of any disability interfered with attempts to remediate. When remediation was seen as requiring an increase in conceptual skills; individuals and theorists found their explanatory and descriptive task difficult to achieve in practical terms. Furthermore, the assumption that there was "one cause" discouraged conjecture. Postulating a multiplicity of unknown causes and searching for these causes was the process that brought reading from the conceptual to the variable human cause.

Creative studies of the learning process could help explore the multiple causes of arithmetic disability. Experiences, concepts, words and skills all inter-relate in the conceptual framework from which memories flow, yet each remains distinct in certain aspects, and a man listening to a speaker may follow the man's words, ignoring the concepts; or he may attend only to the concepts of which the words are symbols, ignoring the words. The ideational flow of arithmetic can change emphasis from verbal description to clarify the ideas represented by the concrete quantities, measures, or numbers;--to mental imagery of these same concrete quantities to clarify the verbal description or components. The strength of the reliance upon varying degrees of symbolic concreteness or verbal reinforcement is a personal idiosyncrasy, in that the tendency to attend to words might be accompanied by a tendency to prefer verbal reinforcements of arithmetical ideas; while a tendency to attend to the verbal concepts might be accompanied by a tendency to create the mental images of the arithmetical ideas.

Although there are other important variables relevant to the learning process, such as memory levels, concept levels of varying abstractness, and activation patterns for memory skills and conceptual skills, the purpose of this paper is to explore the reasons for the parallels between symbolism and concreteness in both the verbal and arithmetic learning process. Research studies investigating the factors of iconic learning or concreteness, symbolic learning or integrated concreteness, and their effects in verbal and arithmetic learning are also included.

Chapter II

STATEMENT OF THE PROBLEM

The tendency toward symbolic concreteness varies from perfect ability to visualize to a complete inability to visualize. Arithmetic ability also varies from the perfect ability to learn arithmetic to a complete inability to recognize number. The parallel does exist, and the amount of visualization ability really determines the amount of arithmetical ability. The problem becomes the description of the facets of visualization ability and of adequately measuring the amount of this visualization ability which each person has. The problem also involves the experimental manipulation of a learning task, which demonstrates in a supporting way, this same variability as it related to arithmetical and verbal learning. These abilities, with some of their components, and the reasons for including them as variables, are described in the ensuing chapters.

The Importance of Presentation Mode.

Studies of relationships between the method of presenting material to be learned, and methods which the learner was required to use in the responding, have been reported from various content areas. Visual and Audio Presentation in Machine Programmed Instruction (Allen, 1965), reported an evaluation of interaction

of presentation modes, program types, and content as they affect the learner characteristics. Each experiment used 18 treatments in a factorial design with randomly selected groups of about 400 eighth grade students. Audio presentation modes were: silent, redundant[1], and directive. Visual modes were printed verbal, still graphic, and motion picture. Programs were either linear or branching. Program content involved nonconcrete referents, concrete referents, and action-process. Content was held constant in each experiment. Equipment and student selection factors were carefully controlled. Immediate post-test scores on four different measures were statistically analyzed and several significant relationships for specific conditions emerged. Although no consistent patterns of superiority for any relationship between visual, audio or programming variables were demonstrated and few consistent relationships between presentation modes and learner characteristics were found, one major conclusion was that even under selected conditions, a relationship could be demonstrated between content and presentation mode.

The assumption made at the beginning of Allen's experiment seemed to be that in whatever varying amounts the abilities to util-

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1. the same information presented in more ways than is needed to understand the concept. For other studies dealing with learning at different levels, and programmed learning, see Eustace, 1969; Earhard, 1968; and Feldman, 1965.

ize sensory stimulation from the various sensory stimuli (auditory, visual, tactual, olfactory, gustatory, proprioceptive, haptic, or kinesthetic) are present in humans, that these abilities exist in equal relative amounts; but these abilities were never tested for, or otherwise considered to be a variable.

Assuming instead that there is a difference in the facility with which each individual utilizes each of his sensory modalities, these differences, if taken over a large group of thirty or more individuals would tend to approach the average, or have their diversified effects cancelled; and in the effective learning resultant from the presentations, the individual differences would be hidden. Probably my way of stating this statistical principle, emphasizes that there is no satisfactory method which easily and reliably assessed the relative strengths of preference and the effects of the various sensory modes of stimulation and response in any one individual.

The Importance of Sensory Mode

Allen's study which described presentation modes and their interactions with sensory modality prompted a more discriminating search of the literature describing characteristics of sensory modalities and differential effects which sensory modalities had on learning. The difficulty of finding studies which described similar conditions of factors and modalities made generalizations difficult to make, but the following significant studies were described in the literature.

McLaughlin (1967) reported the results of a study in which he presented trigrams in auditory, visual, tactual, audiovisual, audio-tactual, and visuo-tactile modes to retarded children, and found differential preference for mode on this task. The order of preference from most to least was (a) visual and audio visual (b) visuo tactile and auditory-visual-tactile (c) audio tactile (d) auditory and (e) tactile.

But again, similar to the Allen experiment, the individual orders of preference are hidden within the average orders which have been reported. For each subject the order was not necessarily the same as the general order reported for the group.

Conway (1968) using 4 sec., 2 sec., 1 sec., and .6 sec. presentation times for simultaneous presentation of spoken word and printed word, found that recall following 10 learning trials was audio-visual equals audio equals visual, for all of the presentation rates. Particularly significant were the times for the presentation speed of .6 sec. with no evidence of overloading.

Conway then suggested a learner strategy which implemented the simple efficiency of processing only one of the inputs.

Again, although the averages reported could be hiding the individual differences, a multi-sensory presentation is based on the assumption that although each of us is different we can choose the modality which suits us, provided that particular sensory stimulation is there for us to choose. The results of the Conway study, emphasize the fact that for most individuals redundancy is not interfering.

The Importance of Visualization Ability

Studies which had mentioned relationships most significantly related to the arithmetic process as it had been seen in the disabled learner, were those relating to symbolization level[1] and visualization level[2], independent of intelligence. Christiansen and Stone (1968) compared visualizers and non-visualizers on learning tasks which used concrete and abstract nouns as mediators[3], and found that mediation was related to both the type of mediator used in the learning task and the subject's ability to visualize. Statistical significance beyond the .01 level of significance, as indicated by an analysis of variance[4], showed concrete nouns to be more effective mediators than abstract nouns.

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1. Symbolization level is generally assumed to extend from concrete or actual article to abstract or name of article. Equivalently, names of articles themselves which are concrete (car) to names of ideas which are hard to materialize internally (goodness).

2. Visualization level refers to the ability to see something internally, the proof of which is accepted to be a drawing, a word, or an explanation, or a reference through some other symbol.

3. Mediation is learning through an intervening or go-between variable; connected but not directly connected with the original. The mediator used in this reported experiment was word-noun.

4. Subjects were 240 seventh-grade students, divided into equal groups of 30, with approximately equal numbers of boys and girls. Lorge-Thorndike IQ scores were available for all. Two training lists were used to determine that there was no significant difference in learning rate. Groups in which the IQ's differed by more than one point, were submitted to an analysis of co-variance, using the Lorge-Thorndike scores.

The Christiansen and Stone experiment clearly indicated the differential effects of visualization ability. Limitations of this study were that only the visual sensory channel or modality was used, and although the symbolic and abstract levels were used in the content of the learning task, the tactual presentation was only symbolic. The significance of the scores for the low and high visualizers could be increased if the presentation modes included both iconic and symbolic presentation, and if the sensory modalities contained auditory as well as visual.

The Importance of Symbolization Level

Paivio and Foth (1970) compared the effects of verbal mediation and imagery inducement in lists of abstract content and concrete content. Imagery mediation was produced by drawing images, and verbal mediation was induced by writing phrases or writing sentences. Recall tests revealed that verbal mediation produced higher recall for abstract pairs while imagery mediation produced better recall for concrete pairs.

Bruner (1964, 1965, 1968) has suggested that the young child adjusts to his environment on the basis of concrete perceptual cues while the older child is able to represent and to deal with his world on an abstract symbolic level, this transformation being achieved through the verbal-symbolic training provided in school. Butters (1969) has found that verbal practice significantly improves verbal mediation while perceptual practice makes perceptual categorization more efficient and possibly interferes with the development

of verbal mediation. Pettifor (1968) studied the role of language in the development of abstract thinking in both deaf and hard-of-hearing children, and found that lack of language interfered with the development of conceptual thinking.

The difference between verbal and imagery mediation is even more critical in the learning of arithmetic, where the material so often includes both the 'iconic' and the symbolic.

A Necessary Synthesis in Arithmetic Disability

The importance of presentation mode, sensory modality and visualization level has been discussed. Their relationships to arithmetic disability have been most clearly described by Kaliski (1962). Her list of characteristics common to children with both language and reading disability or arithmetic disability contained some common elements.

(1) Fluctuating attention

(2) Perceptual disturbances--visual and/or auditory or kinesthetic, related to

(3) Figure-background confusion, i.e. difficulty or inability in differentiating the foreground from the background, as in

  (a) Picture identification and discrimination

  (b) Identification and discrimination of patterns of sounds

  (c) Identification and reproduction of patterns by touch

(4) Distortion of body image

(5) Visual and motor incoordination

(6) Disturbed spatial, size, sequence, and temporal relationships

(7) Motor disinhibition

(8) Left-right confusion

(9) Perseveration

(10) Language disabilities

(11) Deficient conceptualization

(12) Need for concreteness

Kaliski emphasized that items from (6) to (12) appeared to be the most predictive of the development of arithmetic ability. While some learning was accomplished in the language arts by children who showed varying degrees of these disabilities, little or no learning was accomplished in arithmetic.

Although the elements are grouped differently, and are described in more mathematical style, we find a similar listing in Breuckner & Grossnickle (1953). 'Disturbed sequence' as described by Kaliski, is considered by Breuckner & Grossnickle to be 'visual memory span of forms, numbers, ideas and concepts, and ability to keep related events or ideas in mind'; while 'perceptual disturbances' are detailed as 'accurate visual discrimination and perception, auditory discrimination of sounds, visual maturity, and freedom from reversals.'

Schonell & Schonell (1956) consider that achievement in mechanical arithmetic, problem arithmetic, and mental arithmetic require slightly different elements. Their pattern of factors influencing arithmetical attainment is as follows: general intelligence, general and school experiential background, and comput-

ational accuracy being common elements to all three types of arithmetic. Spatial ability is needed specifically for mechanical arithmetic and problem arithmetic; visual imagery is needed for problem arithmetic and mental arithmetic; memory of number combinations is needed for mechanical arithmetic and mental arithmetic; verbal ability is needed for problem arithmetic; and auditory memory is needed for mental arithmetic.

Theoretical Matrix of Contributing Variables

The manipulable and control variables were chosen from the following list. Each one of the items was considered as a separate dimension and as a possible manipulable variable.

(a) Sensory modalities--visual, auditory, tactual, and combinations

(b) Presentation Modes--iconic coding and symbolic coding

(c) Symbolization levels--abstract word or concrete word meaning

(d) Visualization levels--low visualizers and high visualizers

(e) Achievement levels--low arithmetic and high arithmetic
--low language and high language

(f) Intelligence levels--low intelligence and high intelligence

(g) Socio-Economic Status--low and high Socio-Economic Status

(h) Response mode--visual, auditory, tactual, vocal
--iconic coding and symbolic coding

(i) Sex

(j) Grade in school

(k) Years in school

(l) Age

Limitations in Theoretical Assumptions and Delineation of this Study

Presentation mode was considered a means by which it might be possible to distinguish between conceptualization as a cause, and conceptualization as a concomitant item but not a cause, necessarily, of arithmetic disability. Kaliski has referred to a deficiency in this area as being critical.

The inclusion of symbolization level was considered a means of distinguishing language disability from arithmetic disability and a means of assuring significant results which could be measurable.

The inclusion of visualization ability was also considered as a means by which it might be possible to distinguish betwen language and arithmetic disabilities. Imagery related to other modalities had been generally found to be included in the term visualization, but these were not necessarily of equal strengths. The ability of the subject to evoke imagery related to all the senses should have been considered and measured or controlled, before visualization levels and their relations to arithmetic and language were accepted.

Some measurable correlations between language disability and arithmetic disability were referenced through visualization levels, and might be of value in explaining the discrepancies between language and arithmetic in children who have multiple disabilities.

SUMMARY

The problem of describing visualization ability, measuring the amount of this visualization ability, and demonstrating an interrelationship between visualization ability and arithmetical ability

was introduced. The importance of presentation mode, sensory modalities, symbolization levels, and their possible relationships to arithmetic and language disability were also introduced. Some limitations of application and further considerations regarding measurement need to be made.

Chapter III

DEFINITION OF TERMS AND BASIC ASSUMPTIONS

Sensory Modalities

Most of the literature emphasized the perceptive qualities of the different sense modalities, and articles tended to be unrelated to the act of learning material as we know it in the school setting. From these articles and books dealing with pure perceptive processes, those which seemed to be related to both perception and the learning process were selected.

Unimodal. Unimodal refers to learning through one sensory mode at a time, such as visual, auditory, or haptic. Usually these relationships between learning and any one of the sensory modes is measured separately.

Interneurosensory Learning

Intraneurosensory refers to learning involving predominantly one system in the brain, interneurosensory learning refers to more than one system, while integrative learning refers to learning which utilizes all of the systems functioning simultaneously. Reports of studies in which one or combinations of two of the modalities have been used, form the majority of the reported studies.

Bimodal. Combinations of modalities are listed under the following:

(a) haptic visual--which refers to touch and vision or to the transfer from touch to vision and vice-versa.

(b) auditory visual--which refers to the transfer from auditory to visual or the reverse. This is usually tested by a task, half of which is visual and half of which is auditory.

(c) auditory tactile--which refers to the transfer from the auditory to the tactile and the reverse.

Few experiments report any significance of results when using combinations of sensory modalities other than those listed above.

Multi-modal. Combinations of space and time with the modalities of vision, touch, and hearing are generally described as temporal and spatial. These combinations implicitly include the proprioceptive and kinesthetic senses. Their influence on test conditions was acknowledged but so far has not been measured independently. The most common combinations are:

(a) haptic spatial visual--which refers to the effects of touch and vision considered together and separately to estimate distances.

(b) spatial visual--studies used space and vision. (Spatial visual combinations were related to creative imagery in the stimulation of uses from common objects.)

(c) temporal spatial visual--which refers to the effects of time and distances as measures of visual recognition.

(d) temporal visual--dynamic as opposed to static.

Reported superiorities of auditory presentation mode over visual presentation mode in some of the experiments may be complicated by uncontrolled spatial and temporal effects.

Imagery.

Imagery is here considered to refer to the ability of individuals to recall the sight, sound, feel or movement associated with the stimulus in whatever form it is given. Visual imagery refers to the ability to recall the image, and to revisualize or draw or point to a representation of the original image. Auditory image is considered to refer to the ability to associate ideas with various sounds, to recall these and to be able to reproduce them. A description of imagery related to other modalities is somewhat elusive, and will not be attempted, but will be considered to be implicitly included in any learning experience.

Mode of Presentation

Mode of presentation can refer to timing and other physical conditions of an experiment or learning situation. Variations in timing have been reported as having direct effects on results. A progression in the physical equipment such as, the use of an actual article, to the more abstract line drawing of an article, to the most abstract use of the printed word or sounded word for the article, have been reported as having a direct effect on results. The presence or lack of certain background noises or material which add to, detract from, or interfere with the stimulus material have also been reported

as having a direct effect on the results.

Information Processing

Ambiguities exist regarding modalities and channels. The use of the term information processing in the comparison of methods of coding distinguish modality from channel. Coding systems refer to a progression of stimulus material from actual article, to a picture of the article, to printed word of the name of the article, when presented in the visual modality. When presented in the auditory modality, coding system refers to the progression made from the sound made by an object, the imitation of the sound made by the object, to the spoken name of the sound made by the object, to the spoken name of the object.

Crossing the iconic visual coding (picture facsimile) with the iconic auditory coding (sound made by the object), has been reported in the literature as synonymous with crossing the symbolic visual coding (printed word) and symbolic auditory coding (sound of the name of the object). These presentations are of unequal complexity, although the results have often been erroneously reported as interchangeable.

Chapter IV

REVIEW OF THE LITERATURE

The present study deals with the interaction between visualization level and presentation mode, and their variable relationship in cases of above and below average arithmetic achievement. Comparisons are made between criterion scores achieved by four different experimental groups, in both high and low achievement and visualization categories. Since the basic purpose is to discover a measurable characteristic of either high or low arithmetic achievement, or to eliminate the possibility of visualization level or presentation mode as a measurable variable, research that investigates the effects of sensory modalities, presentation modes, visualization levels together with visual imagery and symbolization levels is surveyed.

This chapter will be divided into five parts: (1) an outline of research studies describing characteristics of sensory modalities. This section is included, even though the final procedure adopted was partly a multi-sensory presentation, as it was felt that the necessity of appreciating fully the reasons for the choice could only be made through a survey of the important findings in the entire field. (2) research dealing with pres-

entation mode and information processing is presented; (3) the research describing complexity levels and content types of messages, together with symbolization levels of messages and visualization levels of messages; (4) a review of research articles describing learner characteristics in arithmetic learning; (5) a selected review of research describing some learner characteristics in language adoption and foreign language learning; and, finally, (6) a section which relates this research to the specific problem.

SENSORY MODES

Unimodal

Lingual Tactile. The sensory awareness and perceptual relationships needed in learning the movements for speaking were assessed by McCall (1969) through the application of wisps of cotton to one, or simultaneously to two parts of the tongue. Irregularities were considered to interfere with normal speech development, although temporary loss of sensitivity through anaesthesia did not interfere with speech, as subjects were able to compensate. This was hypothesized as proprioceptive and kinaesthetic memory in the muscles used in speaking. However, in any prolonged lack of sensitivity of lingual musculature, these patterns were presumed to be either not learned or soon forgotten.

Kinaesthetic. Kinaesthetic memory has been measured through kinesthetically monitored performances, and implications for learning were found to be interacting with a number of reinforcements: --memory trace (Norrie, 1969), spatial relationships (Churchill, 1969),

immediate or delayed recall (Wilberg, 1969), and uneven or unequal memory images in short-term visual and kinesthetic storage (Posner, 1966). Arithmetical concepts require that the learner have a minimum of these abilities in order to succeed.

Auditory. Auditory perception has been defined by Blair (1969), as "aural deficiency", and is related to a group of diverse problems in which the auditory system can be incapable of providing the child with acoustic information in a normal manner, thus interfering with the development of speech, language, and possibly, cognitive development. The auditory system is composed of the neuroanatomical pathways extending from the end organ of the ear to the auditory cortex of the brain. Disruptions in this system may result in a variety of auditory disorders, including reduced sensitivity to the sound spectrum, phonemic discrimination difficulties, and imperfect comprehension of spoken messages. Related and somewhat similar information about the importance of auditory perception is made by Sabatino (1960); Clements & Peters (1962); McCarthy & KIrk (1961), Johnson & Myklebust (1967); and Frierson & Barbe (1967). Research in learning obviously should not rely on auditory stimulation alone.

Visual. Vision affects the performance and achievement of every child. (Cohen, 1968). The memory for visual events occurring at and near the rate of eye fixations has been studied (Poter & Levy, 1969). By varying the presentation rates, and indiscriminately mixing the presentation time, Potter & Levy showed that rapidly presented pictures are processed one by one for precisely the time

each is in view and are not held with other items in a short-term store.

Piaget (1970) considers that the concepts of movement and speed especially touch upon the fields of mathematics and science. Movement and speed give rise to long elaborations of responses at first sensori-motor, then intuitive and finally operational. He also believes that movement really marks the transition from one perception to another; and that one must recognize the reciprocity between a transformation as such--namely, movement; and successive states arising from the transformation--namely, perception. In this sense, every movement may be regarded as a transformation of the perceptual field and every perceptual field as a group of relationships determined by movements. (Piaget, 1967).

A comparison between the effects of using either pictures or words in a recognition task was made, (Jenkins & Neale, 1967). Varying the presentation to interfere with expectancy or prevent the formation of a learning set, resulted in the following order of maximal learning. (See picture-recognize picture; PP; See word-recognize picture; WP; See picture-recognize word; PW; See word-recognize word; WW). PP was much greater than WP. Matheson (1968), compared the strength of after-images from visual forms, which had been presented with varying amounts of auditory stimulation, and found that after-image was significantly greater with auditory stimulation than without auditory stimulation.

Bimodal

Haptic Visual. Information about the size of a stimulus is used to estimate distance. When the stimulus article is handled but not seen, and then is used as the basis for distance estimation, the true distance of the object is underestimated. (Coltheart, 1969). Although not stated in this article, it seems to prove explicitly that vision is either better than (or is complementary to) haptic exploration, and that both vision and touch are necessary in the forming of an accurate space estimate.

Rasaf (1968) investigated the relationship between haptic exploration and sight in the discrimination of forms of different shapes and sizes. The ability to attend to both modes followed a developmental course and was modified to some extent by the nature of the stimulus and by the experimental testing condition. When the order of presentation was varied, the rank order from the highest to lowest was found to be visual-to-visual, visual-to-haptic, haptic-to-visual, haptic-to-haptic. When the conflict involved the size of the objects, the visual-to-haptic appeared to be somewhat more difficult.

Milne (1968) attempted to measure cross-modal transfer in both directions, from touch to vision. The learning task which involved transferring symbols of symmetrical and non-symmetrical forms was investigated in children of ages 9, 11, and 14 years of age. Intramodal visual learning and relearning speeds were constant with age; ability to learn or relearn by touch showed a strong developmental trend;

cross-modal ability was constant with age, within an age where intramodal tactual facility was still developing: and evidence of directionality of transfer was constant with age.

These findings may demonstrate that tactual learning can be more accurate than visual learning, even when tactual learning is slower. The inclusion of some tactual presentation was based on the results of this research.

Auditory-Visual. Relative strengths of auditory over visual mode depend upon the other variables in the experiment. When rhythm and timing are involved in the ability to judge the length of the stimulus, Goldstone (1964 & 1968) found that auditory durations were judged as longer than visual ones, when using both verbal category scaling procedures and nonverbal methods of production.

Although most studies report positive relationships between the degree of language disorder and degree of auditory-visual integration, Belmont, Birch & Belmont (1968) using a rhythm sequence matching task, did not find any dependency upon verbal mediation. Beery (1967) used an augmented procedure and found that the performance of reading disability children was definitely inferior in auditory-visual integration, and that the effect did not seem to depend on age, nationality, form or length of test, or the manner in which the stimuli were presented.

This research emphasized the importance of redundancy when testing for mediated relationships, and cautions against pairing a

stimulus from one sensory modality (vision) with learning in another modality (auditory)--unless this transfer or cross-over is the specific unknown variable being tested. In this study, the relationship of both the stimulus and the paired stimulus to a basic unknown is what is being tested, and not primarily the cross-over of learning.

Schulz and Hopkins (1969) in presenting paired associates found that the learning of highly meaningful material is largely unaffected by mode (auditory or visual) but gave evidence to suggest that subjects process visually received material differently than they do auditorially received material. Again caution was suggested in interpreting single modality testing.

Cross Modal

Visual Tactual Spatial. Attneave and Benson (1969) discussed spatial coding of tactile stimulation. Using a visual condition and a blindfolded condition-, and alternating procedures randomly to permit both free association and patterned responses, researchers found that spatial coding is represented primarily in visual terms, even when based on input from another modality than vision.

This idea that input to one modality may be mapped or coded into the representational system of another modality was reported also by Conrad, who indicated that visually presented sequences of words or letters are temporarily held in auditory memory, (Conrad, 1963; Sperling, 1963).

Different modalities appeared to have qualitatively different

facilities for data handling and sensory information seemed to be transferred to the modality best able to process and store it.

Implications for learning or testing relationships, as well as for teaching, are noted, (Bill and Teft, 1969).

Tactual Motor. Knights et al (1967) investigated the performance of retardates on five discrimination tasks, and found that although tactual perception in mongoloids (as measured on an exploratory task) was poorer than in normal children, their visual perception appeared to be equivalent to normals. A relationship between touch and mental imagery was considered in that inner criteria for touch would be the image, while the inner criteria for the image would be the touch discrimination. Some connection with arithmetic and visualization might lie here, (Gibson, 1962; Cann, 1967).

Piaget (1967) describes perception as the knowledge of objects resulting from direct contact with them. To learn to recognize geometrical shapes the child has to explore the whole contour before he can make the transition from the tactile-kinaesthetic to the visual-image. "After the co-ordination of vision with grasping there occurs a complete transformation of perceptual space. An object passed from one hand to the other, turned over in all directions, touched at the same time as it is looked at, is from a spatial point of view an entirely different thing from the same object seen. From being purely perceptual, space has become partly representational. Both perceptional and representational construction are to some extent repetitive and possess a factor in common: this common factor is motor activity".

Temporal Spatial Visual. Studies of many authors have presented a resumee of superiority for auditory presentation of verbal information when compared to visual presentation (Frey, 1970; Fisher, 1968; and Colgate, 1968). Murdock (1969) attempted to determine whether this superiority of auditory over visual might be based on temporal spatial components, and found that even when associations were defined spatially, auditory presentation resulted in more accurate performance than visual presentation. Recall in this experiment was not a function of time, but was a function of space. Abravanel (1968) investigated the development of haptic and visual sense modalities in children between the ages of three and six years. Cross modal sameness-difference judgments and recognition matches were made in which accuracy required differentiating spatial position. Subjects aged three and four years showed little accuracy, whereas significant increases in accuracy were found by ages five and six. The implications were discussed in terms of perceptual activity and integrative mechanisms which rely heavily on reproductive imagery.

Goodnow (1968) compared imaginative uses for objects using the conditions of looking only and of handling and looking. His findings indicated that the latter produced more "non-standard" uses. It was hypothesized that these "non-standard" uses which depended primarily on changes in the composition of the spatial position of the subject, came more readily to mind when an object was both seen and handled. These results emphasized the role of manipulative

activity in the development of knowledge, and supported the inclusion of touch as one presentation modality, (Cappon, Banks & Craig, 1968).

Long (1967) in working with educable mentally retarded children, found a relationship between intelligence and sensory mode preference, and suggested that modality preference had an important bearing on learning.

To fully understand the complexity of this problem area (mode of learning), the results of the following studies may be considered, In an experiment on concept formation (Haygood, 1965), concept instances were presented to college students in an auditory and in a visual mode simultaneously. Four different kinds of concepts giving two dimensional solutions were used. The two relevant dimensions were auditory and visual:--information in the two modes was completely redundant or divided in such a way that one dimension was visual and the other auditory. Performance across the first three conditions did not differ significantly but the cross-modal concept was the more difficult of the three. Cooper and Gaeth (1967) have reported a study of paired-associate learning in which the interaction of mode (auditory versus visual) with meaningfulness revealed no mode difference for highly meaningful material (words), whereas the visual mode was superior for less-meaningful material (trigrams). The study was reported with results from fourth,-fifth,-sixth,-tenth,-and twelfth,-grade subjects, and a developmental interaction was significant such that the auditory was better for the younger and the visual mode was better for the older subjects.

This research emphasized the necessity for both redundancy and multi-modal presentation of stimuli and for a consideration of age and intelligence level.

VISUAL IMAGERY AND ABSTRACTNESS

Sensory Modality and Imagery

Leibovitz (1968) reviewed sensory modality and imagery, tracing beliefs from earlier researchers who thought that the individual who was good in one form of imagery was also good in other forms of imagery as well. Leibovitz selected forty words such that each of the six sensory modalities (seeing, hearing, touching, tasting, smelling, and movement) were represented. He showed eight stimulus items to provoke the dominant imagery, then used the Q-sort technique to elicit imagery for the above mentioned forty words. The results clearly supported the hypothesis that imagery ability was not a general trait, that people who easily produce imagery in one modality could be deficient in others, and clearly contradicted the notion that imagery ability was the same across different sensory modalities.

Robertson and Youniss (1969) used Piaget's analysis of mental imagery as part of the child's operational intelligence, and investigated levels of imagery found in deaf and hearing subjects. Their results provided positive evidence for a developmentally advanced symbolization in a deaf population. (Piaget posits that the availability of symbols per se lead only to behaviour which is as "mature"

as the thinking structure themselves). This study supported symbolic functioning as separate from linguistic skills, and led to the investigation of its relation to arithmetic.

Piaget (1967) considers the image to be a product of imitation. "It is in fact, an internalized imitation, one that can be made without resort to external gestures, though it is at first associated with such gestures. Imitation is basically a continuation of the adaptive movements characteristic of actions. The whole trend of events appears to suggest that the power to imagine shapes visually when they are perceived through the sense of touch alone, is an expression of the sensori-motor schema involved in their perception. A visual image is really an image of potential action".

Symbolization Level

The effects of noun imagery, noun frequency, and noun meaningfulness have been studied in verbal discrimination and in paired-associate learning trials. Paivio and Rowe (1970) found high imagery words easier to discriminate with meaningfulness insignificantly related to discrimination. Bower (1970) found that types of imagery differed in effectiveness. The most effective was interactive imagery which required the subject to link two stimulus pairs with a sentence, to separation imagery which required that the subjects form two distinct and unrelated images for each stimulus pair, to rote repetition which gave no auxiliary directions. Paivio and Foth (1970) found that there was a difference in recall for imagery type and mediator type. In the

case of concrete pairs of words interactive imagery produced better recall, while for abstract pairs verbal mediation produced better recall.

Paivio, Yuille, and Rogers (1969) compared the effects of noun imagery and meaningfulness in free and serial recall. Interaction effects in both the Free recall and Serial recall experiments yielded significantly greater positive effects for imagery than for meaningfulness.

Paivio and Yuille (1969) found that in successive trials subjects abandon the use of ineffective associative strategies and adopt mediation strategies appropriate to the meaning of the item-to-be-learned. Imagery appeared to be a preferred type of mediator when at least one member of the pair was concrete and high in its capacity to evoke images.

Mediational Learning

Craig and Silverman (1969) found that verbal mediation was within the capabilities of kindergarten and first grade children, but that they did not mediate unless required to do so, and when they did, there was no appreciable effect noticed on their scores. Meichenbaum and Goodman (1969) found that freedom to mediate, organize, and interpret stimuli and regulate their own temp led subjects to achieve better results. Superficially, this finding would appear to be significant for those who control their own behaviour by means other than verbalizations.

Probably the most detailed work in this field is that reported by Bruner et al (1956). He investigated the attainment of two main kinds of concepts, conjunction and disjunction. He gave to a large number of subjects, cards which could vary in four possible ways: colour, type of figure, number of figures, and border. By varying these attributes consistently he was able to show how different groups of people make widely differing uses of the available cues, or adopt different strategies, in attaining specific kinds of concepts. Even when conditions were highly controlled in the laboratory, with a limited number of concepts and a limited number of cues for the subject, the process was an extremely complicated and to a degree an idiosyncratic one.

Bruner draws attention to the "focussers" and the "scanners" in his cognition experiments. In order to test the generality of focussing versus scanning strategies he and Tajfell (1959) asked some of their subjects to estimate the number of dots in various groups of dots presented too quickly for accurate counting. The subjects distinctly fell into two groups--those who guessed within narrow, and those who guessed within wide limites. Narrow categorizers seemed to count samples of dots and estimate the total size in this way; while the broad categorizers arrived at the result by means of some form of global intuitive guess.

Piaget has drawn attention to the fact that there are variations in kinds of thinking according to chronological or mental age; Bruner has shown that people of the same age, and even of the similar

level of "intelligence", attain specific concepts according to quite different strategies, some of which are more efficient than others.

Information Processing

Information processing is a function of sensory modality, interneurosensory modality, methods of presentation, levels and divisions of materials, and response mode. Conway (1967) clarified some of the ambiguity regarding modalities and channels. The presentation of a picture of a cow and the printed word "cow" is a combination of coding systems (concrete and abstract) employing a single sensory modality, (visual); while the simultaneous presentation of a picture of a cow and the spoken word "cow" is both a combination of coding systems (abstract and concrete) and of sensory modalities (visual and auditory).

Conway (1968) added an investigation of redundant materials in auditory, visual, and auditory-visual learning and found auditory learning equals visual learning equals auditory-visual learning at all rates and channels.

Review of Research Studies in Arithmetic

Broadly speaking, there are two major kinds of research into mathematical ability. One involves the application of the principles derived from general psychology to the learning of mathematics; and the other involves looking very closely at mathematical learning itself to see what consistent principles arise therefrom. Studies in the last category, by virtue of their methodology, are called

"response analysis" studies of which there are two kinds.

The first kind of these 'response analysis' studies consist of the analyses of children's errors in mathematics (Judd, 1927; Buswell, 1927; Brownell, 1944; Thyne, 1954; Saad, 1957). The general procedure is to take a mathematical example and break it down into its logical constituents and classify children's errors in terms of the logical context in which they occur. However descriptive these studies are, they tend to resemble labelling of errors in such terms as "over-estimation" or in Saad's more "psychological" terms, "verbal fixation"-- we are not told a thing of the nature of the processes causing the child to over-estimate or to repeat verbal formula.

A more significant kind of response analytic study is the factorial design--this time, the emphasis is not upon instances where the thinking process has gone wrong. These studies have been guided by an attempt to discover if mathematical ability is a group factor quite apart from general intelligence, or g, on the other hand, and various numerical, spatial and other specific factors, on the other. The studies fall neatly into two roughly equal groups, those which indicate that there is <u>not</u> a specific mathematical factor (Cameron, 1925; Oldham, 1937; Mitchell, 1938; Blackwell, 1940) and those which indicate equally clearly that there is (Vernon, 1950; Barakat, 1951; Hamza, 1952; Lee, 1955; Werdelin, 1958; Wrigley, 1958).

The most recent studies state that there is, a specific mathematical factor, although it is necessary to note that these studies are performed on older or secondary school pupils.

Research which involves the application of the principles derived from general psychology to the learning of mathematics probably began with Thorndike (1922) who viewed the main psychological basis of arithmetic teaching as a behaviouristic one:-- viewing skills and habits as fabrics of connections.

This view of arithmetic as a series of bonds and rule-governed operations which are rote learned according to the usual S-R principles of repetition and drive reduction clearly ignored the structured or logical side of arithmetic. As a reaction against this view the principles of gestalt psychology were invoked.

The stress here is on whole relationships and parts making a whole: and a problem is said to produce vectors in the child, pressing towards "closure" and this closure takes place when he hits upon the right solution by a "flash of insight". (Wertheimer, 1959).

This psychological narrative did not take into account the developmental aspects of learning, and we have seen that the factor analytic work indicates that this could be an important feature as far as mathematical learning is concerned.

The most versatile approach to mathematical learning has been that of Piaget (1952) who contends that the child's concept of space, topological notions, such as proximity, separation, order, enclosure, and continuity arise first, and that projective and

euclidian notions arise later. In the development of the child's concept of number his grasp of order relations and cardinal number grow hand in hand. A child progresses through the four major stages of mental growth as follows: sensori-motor intelligence (birth to two years); period of preparation for and organization of concrete operations (2 to 11 years); which is subdivided into (a) pre-operational thought (2 to 7 years) and (b) concrete operations; and the period of formal operations (11 and onwards).

Noting that Piaget also says "--there are three factors that play a part in preparing the child to advance from one stage of mental growth to the next; and these are "maturation of the nervous system, experience acquired in interaction with the physical environment, and the influence of the social milieu", we see that passive education might be lacking, in its 'wait and see' attitude.

"Physical action is one of the bases of learning. To learn effectively, the child must be a participant in events, not merely a spectator. The physical action is merely the foundation for the mental operation that we want to develop. We should create opportunities for the child to be less and less dependent on the physical action until the action is entirely internalized as a mental operation".

For Piaget, the so-called 'concrete' operations of a person are mental operations with propositions about some real system of objects and relations that the person perceives. What is concrete, in this sense, or not concrete, is relative to the person's past

experience and his mental maturity. "For the kindergarten child adding a set of two beads with a set of three beads is concrete, but adding numbers 2 and 3 is not concrete. For the sixth grade student adding the numbers 2 and 3 is probably concrete, but adding X and Y is probably not concrete. Moreover, in the development of new concepts in all stages of learning, it is necessary to proceed from the concrete to the abstract".

Thought becomes "operational" in the sense that real concepts are formed, however, until the age of eleven it must remain 'concretely' operational, and be directly related to the world he knows, and sees and touches.

At early adolescence he reaches the formal operational stage, which differs from the preceding in that cognitive processes are not limited to concrete situations i.e. the cognitive processes use concepts relating to other concepts, where formerly the cognitive processes had to relate to experiences.

In Piaget's and in some studies other than Piaget's own, it is evident that the conceptual level may depend as much upon environmental experiences as genetic endowment. Churchill (1955) found that with appropriate play experiences the development of certain number concepts appeared to be accelerated by as much as a year over the ages Piaget quotes. Similarly Beard (1960) found that the children were a year in advance in conceptions of quantity and some spatial concepts. Similarly Carpenter (1955), Williams (1958), Mannix (1960), and Beard (1960), show the stage sequence to be

more closely related to mental rather than chronological or experiential age.

Piaget's work gives us an insight into (a) the logical constitution of different kinds of thinking and how they differ, and (b) the relationship between these and the different stages in, the child's development. Specifically, he shows that for thinking of all kinds, and number and spatial thinking in particular, the underlying principles of reversibility and conservation need to be made operational.

RELATING THE PROBLEM TO PREVIOUS RESEARCH

Although we have limited knowledge of the processes mediating the final consummation of the experience which is learning, it is obvious that there are definite physiological prerequisites for this phenomenon.

Penfield and Roberts (1966) have described many relationships between imperfections in the brain and processes such as speech, memory, and motor movement.

Gerard (1953) vividly described activity in the brain in terms of swelling of nerve fibres, sprouting of new branches when the fibres are in an activated state; breaking of twig-like branches off during electric shock, and reverberating inter-related redundancy of stimulus networks.

Penfield and Roberts (1969) have delineated speech areas, visual areas, and motor areas. Anderson (1968) has described a

physiological-chemical-biological type of learning and memory.

Davis (1966) suggested that the neurons in the brain which correspond to the tested modality were increased in excitability because of their anatomical proximity to the neurons of the accessory modality that were firing at the same time. In such a theory, a neuron is capable of responding to the excitement of at least two modalities and can choose to contribute its effect to first one and then to the other sense modality. Its selectivity would depend upon the relative rate at which the two modalities bombard it with excitement. The modality that bombarded it with the greater frequency would have the better chance of finding such a mutually recruitable neuron in a nonrefractory state and firing it.

The general similarity to be found in each of the fragments of the above theories is some sort of physical basis for learning, However, Penfield (1966) also described the formation of concepts, as follows:

> "These concepts have been formed gradually over the years. Each time a thing is seen or heard or experienced, the individual has a perception of it. Each successive perception forms and probably alters the permanent concept. The more concrete the experience the less conflicting the concept. Within the brain ganglion equivalents of concepts are formed. Experience over the years continues to re-inforce the back-and-forth inter-neuronal-relationship between the two."

That seems to be saying that concept formation, including arithmetic concept formation is as much a function of the number of integrational ways that the concept manages to penetrate the skull

and reverberate around, as it is a function of those mechanisms and abilities which convey that concept into the ganglionic network for assimilation.

Kaliski, in Frierson & Barbe (1967) comments on the lack of diagnostic tools to explain and predict failure in arithmetic, and suggests that a study to determine the correlation between language and arithmetic disability would be helpful. Kaliski compares the language of arithmetic to a special or foreign language, (Frierson & Barbe, 1967, pp. 461)

> "Language disability may occur in the brain-injured child in the receptive or expressive area or in both. But even if we consider the child who has no particular language disturbance, we must admit that his mental apparatus must become geared and adapted to the special language of arithmetic, which is a symbolic coded language with its own peculiar stenograph-like shortcuts, abbreviations, and telegraph-like style. In the teaching of arithmetic to the non-handicapped child, it is recognized that success or failure will depend to a large extent upon the wording used in teaching the numerical concepts and process."

And if the wording is so critical for the non-handicapped consider the difficulty for the language handicapped.

Not necessarily being accompanied by a language disability arithmetic disability is characterized by fuzzy spatial relationship, size relationship, and temporal relationship. To the degree that arithmetical terms are not normally discussed in every day conversations, arithmetic processes might not be in the imagery repertoire of the individual child.[1]

Another thing we might notice is that attitudes have a

stronger relationship to performance in the case of arithmetic than in that of other school subjects. Davidson (1950) and Biggs (1962) have demonstrated this general point. Davidson found that (a) the correlations between attitude and attainment were higher in the case of arithmetic than in that of English, and (b) that there was no relationship between attitude and intelligence in the case of arithmetic while there was in that of English; i.e. bright children were just as likely to do badly in arithmetic when they disliked it as dull children were. Attitude alone, in other words, has normally only a slight relationship with actual performance in the case of most school subjects, but when it comes to arithmetic and mathematics, there is a very clear and striking relationship.

The reason for this may well be that dislike for arithmetic is accompanied by some other, and perhaps more deep-seated emotional factor than dislike alone. Dreger and Aiken (1957) have suggested that "number anxiety" is a term which usefully describes this "thing" which people sometimes have about mathematics.

> "The kind of anxiety that affects arithmetical performance may initially have sprung from a general disposition towards anxiety, but due to other specific factors (such as a series of failures in school mathematics), now works independently of any such predisposition."

Insufficient concrete experiences to make arithmetical concepts operational, Piaget (1970), especially in relation to space, movement speed, and time might also contribute.

Sex Differences. The picture that emerges from the studies of Watts, Pidgeon & Yates (1952), Yates & Pidgeon (1957), and Anastasi's review of American literature on sex differences (1958), is the following:--

> -- at 7+ girls are better than boys at mechanical arithmetic and very much better by 10+, and also at 10+ they are better, but not strikingly so, in problem arithmetic. However, at 14+, the difference between the boys' and girls' performance in mechanical arithmetic has virtually disappeared and in problem arithmetic, boys are very much superior to the girls. The superiority of the girls in primary school, in other words, has become reversed towards the end of the normal secondary schooling. That this difference cannot be put down entirely to the earlier maturation of the girls, can be seen in one of the studies where it was found that at 11 years of age, girls with symptoms of early puberty performed significantly better on all the tests administered than girls with no pubertal symptoms.

SUMMARY

Summary of Sensory Studies.

First, a progression of studies dealing with sensory awareness in perceptual relationships, and the way in which movement marks the transformation from one perceptual field to another. Second, a progression of visual studies including the connection between spatial relationships and visual recall; the relationship between vision, movement and speed; and the relation between accurate vision and touch with the relatively greater accuracy of tactual learning over visual learning. Third, a progression of auditory studies relating the effects of interference in auditory perception, and the interaction between the duration of after-images and type of auditory stimulation.

Fourth, a progression of visual, auditory, and tactual studies relating the differential effects of static versus dynamic comparisons of visual versus auditory recall; the superiority of auditory over visual recall, when recall was a function of space; the superiority of visual over auditory for low meaningful material; the equality of recall for visual and auditory with highly meaningful material; the interaction between modes such that vision was used to remember space, even when based on auditory cues; and the effects of redundancy with a multimodal presentation. Fifth, a progression of tactual studies describing the relationship between touch and mental imagery, the relation between touch and reproductive imagery, and the relationship between intelligence and sensory mode preference. Sixth, the correlating descriptions of Piaget relating perception as the knowledge of objects resulting from direct contact with them; representational and perceptional construction as reciprocated through motor activity in the development of knowledge; (caution in pairing a stimulus from one sensory modality --visual-- with learning in another modality --auditory-- unless this transfer or cross-over was the specific unknown variable being tested for.

Summary of Studies Relating Visual Imagery and Abstractness.

First, a general description of imagery ability; that it is not a general trait, and not the same across different sensory modalities; and that it has a symbolic function separate from linguistic skills, to Piaget who thinks of a visual image as an

image of potential action. Second, came a progression to the stronger influences for imagery than for meaningfulness; imagery and mediation types or verbal imagery with abstract nouns and interactive imagery with concrete nouns; and greater when at least part of the interactive concepts are concrete. Third, came variations in kinds of thinking according to chronological or mental age; variations and strategies in concept formation irrespective of intelligence level; and a clarifying description of information processing as a function of sensory modality, interneurosensory modality, methods of presentation, levels and divisions of materials, and response modes.

Summary of Arithmetic Studies.

Research includes response analysis studies or descriptive breakdowns into logical thinking patterns; a break-down or factorial composition of the thinking process, such as numerical, or spatial; the application of psychological principles to the learning of arithmetic; the Gestalt approach; and Piaget's developmental stages, with his emphasis on physical activity as one of the bases of learning. Piaget gives his insights into the logical progressions for thinking of all kinds and number and spatial thinking in particular:--by his description of how thought becomes operational through the stages of concrete, concretely operational, and formally operational, with his stage sequence being more closely related to mental than to experiential ages.

Summary of Material Related to Research in other areas.

First, random samples from theories such as Penfield & Roberts, Gerard, Anderson, and Davis stress the physical basis for learning, as a function of the number of times and number of integrational ways that a concept is encountered. Second, a failure in arithmetic was considered difficult to assess because of a lack of diagnostic tools. Third, a description of the language of arithmetic related its criticalness for both the non-handicapped and the handicapped language ability student. Fourth, a general description of arithmetic disability with its relation to attitude, and anxiety, followed by some comments on sex differences in relation to arithmetic disability.

Chapter V

HYPOTHESES AND DESIGN

THE HYPOTHESES OF THIS STUDY

Levels of achievement of cognitive material have been found to vary with response mode, presentation mode, sensory modality, visualization level, general achievement level, and symbolization level of the content.

The following hypotheses refer to Grade Six children in Cordova Bay Elementary School and Royal Oak Elementary School of Saanich School District, twelve years of age, participating in paired-associate learning trials of foreign words.

1. Arithmetic abilities[1] will correlate positively[2] with perceptual abilities.[3]
2. Achievement in language[1] arts will correlate positively[2] with perceptual abilities.[3]

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1. Arithmetic abilities were measured by the Stanford Achievement Test.
2. The significance level of the correlations were expected to be greater than the 5 percent level.
3. Perceptual abilities were measured by the Guilford-Zimmerman Aptitude Survey.

3. High Arithmetic achievers[1] will learn significantly more paired-associate, foreign-word with English noun combinations, in all the experimental conditions[2] than low Arithmetic achievers.[1]

4. High visualizers[3] will learn significantly more paired-associate, foreign-word with English noun combinations, in all the experimental conditions[2] than low visualizers.

5. All children will learn significantly more paired-associate, foreign-word with English noun combinations presented in the iconic mode than in the symbolic mode.

6. All children will learn significantly more words of the concrete[4] word list than of the abstract[4] word list.

7. When the word lists are treated as separate variables (concrete versus abstract), the rank order of means for the learning of foreign words for the four presentation modes will be Iconic concrete, Iconic abstract, Symbolic concrete, and Symbolic abstract.

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1. High arithmetic achievers were those with scores more than-one-half a standard deviation above the mean for this group, while Low Arithmetic achievers were those with scores more than one-half a standard deviation below the mean for this group.

2. Experimental conditions are iconic versus symbolic and are described in complete detail on page 55.

3. High visualizers were those who scored more than one-half a standard deviation above the mean for this group, while Low Visualizers were those who scored more than one-half a standard deviation below the mean for this group.

4. Concrete and abstract word lists, refers to the grading of the imagery potential of the word, as listed in the Appendices.

THE DESIGN OF THE STUDY

This study was designed to test for interactions between presentation modes and vocabulary retention, in sixth grade children of low and high arithmetic levels and low and high visualization levels.

The Population and Selection of the Sample.

The sample of 49 girls and 59 boys was drawn from the sixth grade population enrolled in the public schools[1] of Saanich, a municipality of Greater Victoria. This group was stratified on the basis of arithmetic achievement, by assigning subjects whose scores were one-half a standard deviation above the mean for this sample on the Stanford Achievement Arithmetic tests, to a sub-group called High Arithmetic Achievers; and assigning subjects whose scores were one-half a standard deviation or more below the mean for this sample to a sub-group called Low Arithmetic Achievers.

The group was also stratified on the basis of visualization ability, by assigning subjects whose scores were one-half a standard deviation above the mean for this sample on the Guilford-Zimmerman Visualization Test, to a sub-group called High Visualizers, and assigning subjects whose scores were one-half a standard deviation below the mean for this sample to a sub-group called Low Visualizers. Table I lists the means and standard deviations for the Stanford Achievement Test.

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1. Two classes from each of two schools in the north and south parts of the district were assigned to me.

TABLE I

MEANS AND STANDARD DEVIATIONS FOR STANFORD ACHIEVEMENT

	Mean	Standard Deviation		Mean	Standard Deviation
Word Meaning	36.65	11.06	Arithmetic Concepts	17.46	7.62
Paragraph Meaning	79.01	14.19	Arithmetic Computation	16.85	5.63
Spelling	29.92	6.36	Arithmetic Applications	20.95	7.64
Language	38.43	10.92			

TABLE II

MEANS AND STANDARD DEVIATIONS FOR GUILFORD ZIMMERMAN APTITUDE

	Mean	Standard Deviation
Perceptual Speed	41.78	12.31
Spatial Orientation	13.67	6.61
Spatial Visualization	9.25	6.37

The above scores were used to determine the cut-off scores for plus and minus one-half a standard deviation for both the arithmetic achievement groups and the visualizer groups of low, medium, and high ability grouping levels.

TABLE III

ARITHMETIC GROUPINGS BY SEX

Sex	High Arithmetic	Medium Arithmetic	Low Arithmetic	Totals
Boys	19	17	16	50
Girls	11	23	16	52
Totals	30	40	32	102

TABLE IV

VISUALIZER GROUPINGS BY SEX

Sex	High Visualizer	Medium Visualizer	Low Visualizer	Totals
Boys	23	11	22	56
Girls	13	10	19	42
Totals	36	21	41	98

The groups of Arithmetic achievers and Visualizers are merged to form groups called High Arithmetic High Visualizer, Low Arithmetic Low Visualizer, Medium Arithmetic Medium Visualizer, and the other possible combinations of ability levels. The central cells of the 3 by 3 table had many more scores. These extra scores were randomly discarded to make equal n's of 5 per cell.

TABLE V

ARITHMETIC AND VISUALIZATION LEVELS

	High Arithmetic	Medium Arithmetic	Low Arithmetic	Totals
High Visualizers	5	5	5	15
Medium Visualizers	5	5	5	15
Low Visualizers	5	5	5	15
Totals	15	15	15	45

The subjects were then randomly assigned to either experimental condition one, which was presented with the abstract content list before the concrete content list; or experimental condition two which was presented with the concrete content list before the abstract content list. Each experimental condition received the iconic and symbolic presentation modes.

PROCEDURE

The first step in developing the procedure used in this study was to compose two lists of 40 words each, half of which were definitely concrete words, and half of which were definitely abstract words. Reference was made to published lists of words rated according to concreteness, imagery level, and emotionality, by Paivio, Smythe, and Yuille (1968), and a monograph by DiVesta and Walls (1970). Appendix I lists the words with their composite ratings, and the average ratings for the list of words chosen for this study.

Once the word list had been formed, a foreign language which had a stable phoneme grapheme relationship was chosen. The word lists were then translated into this language. Spreen, Borkowski, & Benton (1967) found that phoneme recognizability, independently of other word characteristics can be a crucial variable in studies of auditory recognition; and that the strength of the initial phoneme of a word is independent of its ease of pronunciation and meaningfulness. The final selection of the list was then made on a perceptual basis. The length of the words was kept to within five to eight letters in length; the similarities to any English word was checked. The similarity to English sounds was also checked, as Hall (1968) had found this to be an important consideration with paired-associate learning.

One half of the original concrete words and one half of the original abstract words were selected for the learning trials.

Since the words were to be taught in three sensory

modalities, and in two experimental conditions, materials for these presentations were constructed and assembled.

The visual sensory modality required a picture of the object for the iconic presentation and a printed word for the symbolic presentation modes. Coloured slides of these were shown with a Kodak Carousel Projector. Appendix II illustrates the stimulus in photographs.

Auditory sensory modality required a sound associated with the object for the iconic presentation mode, and the sound of the word itself for the symbolic presentation mode. These sounds were recorded on tape.

The tactual sensory modality required that the actual object be available for manipulation in the iconic presentation mode. The tactual sensory modality was not presented in the symbolic mode to the entire group, and conclusions concerned with this mode have been footnoted, and placed in the appendices.

The timing for the presentations of the stimulus for all of the conditions was carefully synchronized with a tape recorder which had the times metered by a stop watch, and was operated by a remote control switch on the Kodak Carousel projector. The timing for trials was not considered a variable as Jahnke (1967) had found that except for sufficient time being needed to process the information, the timing was insignificantly related to the results of the experiment. The timing in this study was adaptable, and slightly shorter for each trial than it was for the previous trial. The times used were eight seconds, seven

seconds, six seconds, and five seconds.

A paired-associate method of presentation was used for the learning of the list of foreign words. The instructions were designed to encourage the subjects to visualize the stimuli for both the iconic and symbolic presentations. Bower (1970) states that mental imagery has been repeatedly shown to be facilitating for learning, and Paivio (1969) considers this to be most notably true when freedom to integrate the stimulus is left to the design of the subject. During the symbolic presentations, the subjects were asked to think of why the examiner had chosen these particular stimuli, and thus an attempt was made to link the stimuli with the foreign word.

At the end of trial one, the subjects were given a sheet of paper which had five rows with fifteen squares each, numbered successively from one to fifteen. A list of words was shown with the projector, five new words, plus ten of the words from the training trial, to make fifteen words per test list. The subjects were asked to mark a "Y" in the appropriate square if they thought they had seen the word in the previous learning trial, and to mark an "N" if they either were sure they had not seen the word in the learning trial, or if they didn't think they had seen the word in the learning trial.

Trial two of the paired-associate list was chosen, followed by a test of fifteen words. Each of the testing trials had the original words in a different order, and the extra or 'completely new' words, were different words for each retest list.

Experimental Conditions

Iconic. The iconic list was divided into three parts, the first seven words were presented with an auditory stimulus (e.g. the sound of a lion roaring presented simultaneously with the flashing of the word "lavi" which means lion); the second seven words were presented with a visual stimuli (e.g. the picture of a zebra presented simultaneously with the flashing of the word "konje" which means horse); the third seven words were presented with both an auditory stimulus and a visual stimulus. (e.g. the sound of the baby gurgling and cooing, presented with the picture of the little darling, plus the sound of the foreign word "beba" and the picture of the word "beba".

Symbolic. The symbolic list was also divided into three parts, the first seven words were presented with an auditory stimulus (e.g. the sound of the word "point"--"siljak" was played); the second seven words were presented with a visual stimulus only (e.g. the combination "angle-trouga" was flashed on the screen); the third seven words of the list were presented in both visual and auditory stimulation conditions (the combination "krst--cross" was played on the tape recorder, while the combination "krst--cross" was flashed on the screen).

The complete list of words and their associated visual, auditory and combined stimuli are presented in Appendix III.

In order to control for possible Hawthorne effects of this rather specialized treatment the subjects in the control group were administered the identical procedure during the learning trials.

During the testing trials the test lists were switched, so that after the concrete learning list, they received the abstract testing list. This meant that actually, these subjects had seen none of the words before being asked to rate them as a "Y" or yes, and an "N" or no.

Chapter VI

ANALYSIS OF DATA

Purpose

The data derived from the study will be analyzed in light of the questions posed in the hypotheses, namely:

1. What are the correlations between language arts, arithmetic scores, and perceptual scores?
2. Are the mean differences significant for arithmetic ability levels?
3. Are the mean differences significant for visualization levels?
4. Are the mean differences significant for presentation method (iconic versus symbolic)?
5. What are the interaction effects for presentation mode, trials, arithmetic ability and visualization ability?
6. Do the children learn significantly more words from the concrete list than from the abstract list?
7. Is the presentation mode more significant than the symbolization level, i.e. is the order Iconic concrete, Iconic abstract, Symbolic concrete, Symbolic Abstract?

The statistical procedures and tests of significance used were the analysis of variance, the 3 Way Anova, and the 3 Way Anova With Repeated Measures on 2 Levels, Multiple Group Discriminant Function Analysis, Factor Analysis, Duncan's Multiple Range Test, and F-tests of significance.

Interpretations of the Correlations. The correlations which are presented in Table VI, were tested for significance using the formula for variables roughly considered to be normally distributed in the sample:

$$t = r\sqrt{\frac{N-2}{1-r^2}} \quad \text{with } N-2 \text{ degrees of freedom,} \qquad N = 98$$

The correlations between .200 and .275 were significant at the .05 level of significance, while those greater than .275 were significant at the .01 or greater level of significance, for two-tailed tests. A brief overview of the correlations follows: for a more detailed description of all the correlations see the Appendix.

Sex. The correlations between sex and all other variables were low; with only one significant correlation between Spatial Orientation and Sex.

Language Arts. All the correlations between the language arts and the arithmetic variables were significant at the .01 level of significance. Word meaning did not correlate with any perceptual variable. Paragraph Meaning correlated at the .05 level of significance with Perceptual Speed and Spatial Visualization. Spelling correlated at the .05 level of significance with Spatial Visualization. Language correlated at the .05 level of significance with Perceptual Speed.

Arithmetic Variables. All the correlations between the arithmetic variables and the language arts variables were significant

at the .01 level of significance. Arithmetic Concepts correlated at the .01 level of significance with Spatial Visualization; Arithmetic Application and Arithmetic Computation correlated at the .05 level of significance with Spatial Visualization.

Perceptual Variables. Spatial Orientation and Spatial Visualization correlated with each other at the .01 level of significance. Perceptual Speed did not correlate significantly with either of the two perceptual variables, although there was a correlation at the .05 level of significance with two of the language variables, Paragraph Meaning and Language. Spatial Orientation correlated with Sex at the .05 level of significance. Spatial Visualization was a more evident variable, correlating, at the .05 level of significance with Paragraph Meaning, Spelling, Arithmetic Computation, Arithmetic Concepts, Arithmetic Applications and Spatial Orientation.

Hypothesis one which states that there will be a positive correlation between the language arts variables, arithmetic variables and the perceptual variables, is accepted for the language arts and arithmetic variables. However the correlations for the perceptual variables are significant only with the arithmetic variables, and only the one perceptual variable, that of spatial visualization, is significantly correlated with all three of the arithmetic variables.

TABLE VI

CORRELATIONS BETWEEN FOUR LANGUAGE ARTS TESTS, THREE ARITHMETIC TESTS, THREE PERCEPTUAL VISUALIZATION TESTS, AND SEX

		1	2	3	4	5	6	7	8	9	10	11
1.	SEX	X	ns	ns	ns	ns	ns	ns	ns	ns	232	ns
2.	WORD MEANING		X	587*	535*	477*	375*	473*	432*	ns	ns	ns
3.	PARAGRAPH MEANING			X	541*	635*	503*	579*	596*	274	ns	219
4.	SPELLING				X	707*	430*	566*	563*	ns	ns	204
5.	LANGUAGE					X	534*	576*	688*	262	ns	ns
6.	ARITHMETIC COMPUTATION						X	596*	533*	ns	ns	222
7.	ARITHMETIC CONCEPTS							X	808*	ns	ns	311*
8.	ARITHMETIC APPLICATIONS								X	ns	ns	241
9.	PERCEPTUAL SPEED									X	ns	ns
10.	SPATIAL ORIENTATION										X	280*
11.	SPATIAL VISUALIZATION											X

* indicates significance at the .01 level of significance.

Arithmetic Ability Levels. The "2 Way Anova" and the "3 Way Anova With Repeated Measures on Two Levels" were used in the analysis of scores. The Two Way Anova was used to test for interaction and effects of Arithmetic Ability Levels with Visualization Ability Levels. Separate analyses were considered for the presentation modes of (a) iconic and (b) symbolic. Tables VII and VIII present the tabulated results. The Three Way Anova was used to test for the combined effects of Arithmetic ability levels, Visualization ability levels, presentation modes of iconic and symbolic, and the progression through the three trials, together with any possible interaction effects of the listed variables. The tabulated results of the Three Way Anova are presented in Table IX. A discussion of the significance and meanings of these tables follows.

The F-Ratio for the three levels of arithmetic ability, at 5.32 is significant at the .00795 level of significance, for the symbolic presentation mode. The three groups were then compared using Duncan's Multiple-Range Test for nearly equal n's. The low group of arithmetic ability was found to be significantly different from the high group of arithmetic ability. The medium arithmetic group was not found to be significantly different from either the low arithmetic ability level or the high arithmetic ability level.'

The F-Ratio for the three lev els of arithmetic ability, at 1.31 is not significant at the 0.2792 level, for the iconic presentation mode (Table VII and VIII). Hypothesis three is accepted for the particular mode of symbolic presentation.

TABLE VII

ANALYSIS OF VARIANCE FOR ARITHMETIC LEVELS AND VISUALIZATION LEVELS FOR THE SYMBOLIC MODE

SOURCE	SUM SQUARES	DF	MEAN SQUARES	F	PROBABILITY
SS ARITHMETIC	204.304	2	102.152	5.32	0.0079 **
SS VISUALIZATION	14.085	2	7.042	0.37	0.6948 ns
SS ARITH X VISUAL	132.722	4	33.180	1.73	0.1579 ns
ERROR	998.796	52	19.207		

TABLE VIII

ANALYSIS OF VARIANCE FOR ARITHMETIC LEVELS AND VISUALIZATION LEVELS FOR THE ICONIC MODE

SOURCE	SUM SQUARES	DF	MEAN SQUARES	F	PROBABILITY
SS ARITHMETIC	48.607	2	24.303	1.31	0.2792 ns
SS VISUALIZATION	78.126	2	39.063	2.10	0.1325 ns
SS ARITH X VISUAL	240.818	4	60.204	3.24	0.0190 **
ERROR	966.582	52	18.588		

TABLE IX

ANALYSIS OF VARIANCE FOR VISUALIZATION LEVELS, ARITHMETIC LEVELS, AND PRESENTATION MODES OF ICONIC AND SYMBOLIC, FOR THREE TRIALS

SOURCE	SUM SQUARES	DF	MEAN SQUARES	F	PROBAB	
BETWEEN SUBJECTS	267.941	44				
ARITHMETIC BY VISUALIZATION	86.94	8	10.86	2.16	0.0547	???
SUBJECTS WITHIN GROUPS	181.000	36	5.027			
WITHIN SUBJECTS	1096.66	225				
ICONIC BY SYMBOLIC	.72	1	.726	0.15	0.7034	ns
ARITH BY VISUAL BY ICONIC BY SYMBOLIC	106.27	8	13.28	2.69	0.0197	**
ICONIC BY SYMBOLIC BY SUBJ WITHIN GROUPS	177.66	36	4.93			
TRIALS	139.339	2	69.66	23.40	0.000	**
ARITH BY VISUAL BY TRIALS	41.92	16	2.62	0.88	0.5936	ns
TRIALS BY SUBJECTS WITHIN GROUPS	214.40	72	2.97			
ICONIC BY SYMBOLIC BY TRIALS	83.11	2	41.55	10.27	0.0001	**
ARITH BY VISUAL BY ICONIC BY SYMBOLIC BY TRIALS	41.882	16	2.61	0.65	0.8344	ns
ICONIC BY SYMBOLIC BY SUBJECT WITHIN GROUPS	291.33	72	4.04			

Visualization Level. The F-Ratio for the three levels of visualization ability, for the symbolic mode, of 2.01 and for the iconic presentation mode of 0.307, were both non-significant at levels of .6948 and .1325 respectively. Hypothesis four is not accepted.

Presentation Mode. The F-Ratio of .15 is non-significant at the .70345 level(Table IX). Hypothesis five is not accepted. There was no difference that could be accounted to presentation mode alone.

Interaction Effects for Arithmetic Ability and Visualization Ability. The F-Ratio for the interaction effects of arithmetical ability levels and visualization ability levels, for the symbolic presentation mode of 1.73 is non-significant at the 0.1579 level. The F-Ratio for the interaction effects of arithmetic ability levels, and visualization levels, for the iconic presentation mode, of 3.24 is significant at the 0.0190 level of significance. The Nine groups were then compared using Dundan's Multiple-Range Test for nearly equal n's. High Visualization-Medium Arithmetic, High Visualization-Low Arithmetic were significantly higher than all other groups; while low Visualization-Low Arithmetic, Low Visualization-Medium Arithmetic, and Medium Visualization-Low Arithmetic were found to be significantly lower than all other groups. The other groups were significantly different from one or more groups, but not consistently lower or higher than a set of three or more.

The F-Ratio for the interaction effects of arithmetic ability and visualization ability for the symbolic mode was non-significant, while the F-Ratio for the iconic mode was significant. (Table VII and VIII for Two Way).

The F-Ratio of 2.16 is non-significant at the .0547 level of significance (Table IX for Three Way Analysis). As this was irrespective of mode, or total effect, these means will be further analyzed when dealing with interactions with mode.

Simple Effects for Trials. Each subject had three trials for two different presentation modes, or six trials in all. The F-Ratios for trials (from Table IX) for the Three Way Analysis, of 23.40 is significant at the 0.0000 level. The twenty-seven groups were then compared in groups of three across trials, using Duncan's Multiple-Range Test for nearly equal n's. High Arithmetic-High Visualization, High Arithmetic-Medium Visualization, High Arithmetic-Low Visualization, Medium Arithmetic-High Visualization, Medium Arithmetic-Medium Visualization, and Medium Arithmetic-Low Visualization were all significant and consistent in their changes across trials. However, Low Arithmetic-High Visualization, Low Arithmetic-Medium Visualization, and Low Arithmetic-Low Visualization were all significant for only trials one and three, and did not show a significant change for trial two.

Interaction Effects for Presentation Mode and Ability Levels. The F-Ratio for the symbolic presentation mode (Table VII) was significant for Arithmetic only; while the F-Ratio for the iconic mode (Table VIII) was significant for arithmetic-visualization interaction only. The F-Ratio for the interaction between ability levels and presentation mode (from Table IX, Three Way Analysis) of 2.69 is significant at the 0.0197 level of significance. The eighteen groups were then compared

using Duncan's Multiple-Range Test for nearly equal n's. Low Arithmetic-Low Visualization, Low Arithmetic-Medium Visualization, and Medium-Arithmetic-Low Visualization were significantly lower, while Medium Arithmetic-Medium Visualization, and Low Arithmetic-High Visualization were significantly higher, for the iconic presentation mode. For the symbolic presentation mode, Low Arithmetic-High Visualization were significantly lower than all other groups, Medium Arithmetic-Low Visualization and Low Arithmetic-Low Visualization were significantly lower than all the medium groups, and the High Arithmetic-High Visualization, and High Arithmetic-Low Visualization were significantly higher than all other groups. All of the Medium combinations with Medium and High were not significantly different from the other groups.

Interaction Effects for Trials and Presentation Mode. The F-Ratio for trials and presentation mode (from Table IX) of 10.27 is significant at the 0.00011 level of significance. Duncan's Multiple-Range Test for nearly equal n's was used. For trial one the symbolic mode is significantly greater; for trial two the iconic mode is significantly greater, while for trial three there is no significant difference in performance for the iconic or the symbolic presentation modes. Across trials, there is a significant difference for each of the three trials, for the iconic presentation mode; but for the symbolic presentation mode there is a significant difference between trials one and three, but not between trial two and either trial one or three.

Interaction Effects for Trials and Ability Levels. The F-Ratio for trials and ability levels (from Table IX) of 0.88 is non-significant at the 0.593 level.

Interaction Effects for Trials, Presentation Mode, and Ability Levels. The F-Ratio for trials, presentation mode and ability levels (from Table IX) of 0.65 is non-significant at the 0.8344 level.

Symbolization Levels of Abstract Versus Concrete. A delayed recall test which included all of the words from both the training lists and the recall lists, had a mean of 11.72 for the abstract list, and a mean of 20.22 for the concrete list. Both recall tests were for a possible total of 25. The standard deviation for the abstract list was 5.46 and for the concrete list was 7.12. The confidence limits for each of the lists was found using the formula:

Mean $\pm$ (significance level) times (Standard Error of the Mean)
with N = 98 (Weinberg & Schumaker, p 184)

The confidence limits for the abstract list at the .05 level of significance are 10.6888 and 12.752 and at the .01 level of significance are 10.361 and 13.079. The confidence limits for the concrete list at the .05 level of significance are 18.872 and 21.568 and at the .01 level of significance are 18.450 and 21.990. Clearly there is a significant difference between the number of abstract words remembered and the number of concrete words remembered. Hypothesis six is accepted.

Interaction Effects for Presentation Modes of Iconic and Symbolic and Symbolization Levels of Abstract and Concrete. The

Multiple Group Discriminant Function Analysis was used to determine the rank order of the means for the four groups iconic abstract, iconic concrete, symbolic abstract, and symbolic concrete. The rank orders differ for arithmetic level, visualization levels and combined arithmetic visualization levels. Table X presents these means. The symbolic presentation was preferred for arithmetic and visualization levels; and the concrete word lists were preferred for arithmetic and visualization levels. However when the arithmetic ability levels were combined with the visualization ability levels the iconic presentation was preferred, and the concrete word list was also preferred,

From Table XI,--with the exception of the Low Arithmetic Ability Level, the rank order seems to be symbolic concrete, iconic concrete, symbolic abstract, iconic abstract for the levels that have mixed levels. The rank order for separated levels of high with high, and low with low, is iconic concrete, symbolic concrete, iconic abstract, and symbolic abstract. Hypothesis seven stated that the iconic presentation mode would be preferred over the symbolic presentation mode, that the concrete symbolization level would be preferred over the abstract symbolization level, and that the presentation mode would take precedence over, or be more important, than the symbolization level.

This was not found to be the case. For the arithmetic groups which had their groupings contaminated by mixed visualization levels, and for visualization groups which had their groupings con-

TABLE X

MEANS FOR PRESENTATION MODE AND SYMBOLIZATION LEVEL BY ARITHMETIC, VISUALIZATION AND COMBINED ARITHMETIC-VISUALIZATION ABILITY LEVELS

ICONIC CONCRETE	ARITHMETIC	VISUALIZATION	ARITHMETIC-VISUALIZATION
HIGH	7.88	7.66	9.28
MEDIUM	7.00	7.67	
LOW	6.95	7.42	7.99
ICONIC ABSTRACT			
HIGH	6.16	5.54	7.42
MEDIUM	5.13	5.35	
LOW	4.25	5.41	6.30
SYMBOLIC CONCRETE			
HIGH	9.58	8.66	7.78
MEDIUM	7.87	8.30	
LOW	8.05	9.08	7.30
SYMBOLIC ABSTRACT			
HIGH	7.19	6.90	6.14
MEDIUM	6.85	7.06	
LOW	7.27	6.71	4.83

TABLE XI

RANK ORDER OF MEANS FOR ABILITY LEVELS

BY PRESENTATION MODE

ARITHMETIC	
HIGH	Sym. Conc./ Ic. Conc./ Sym. Abs./ Ic. Abs.
MEDIUM	Sym. Conc./ Ic. Conc./ Sym. Abs./ Ic. Abs.
LOW	Sym. Conc./ Sym. Abs./ Ic. Conc./ Ic. Abs.
VISUALIZATION	
HIGH	Sym. Conc./ Ic. Conc./ Sym. Abs./ Ic. Abs.
MEDIUM	Sym. Conc./ Ic. Conc./ Sym. Abs./ Ic. Abs.
LOW	Sym. Conc./ Ic. Conc./ Sym. Abs./ Ic. Abs.
ARITHMETIC-VISUALIZATION	
HIGH	Ic. Conc./ Sym. Conc./ Ic. Abs./ Sym. Abs.
MEDIUM	
LOW	Ic. Conc./ Sym. Conc./ Ic. Abs./ Sym. Abs.

contaminated by mixed arithmetic groupings, the symbolization level was found to take precedence (except for the low arithmetic group), and the presentation mode that was apparently preferred was in the reverse of the hypothesized order, and was symbolic greater than iconic.

For the more refined grouping of high arithmetic with high visualization, and low arithmetic with low visualization the presentation mode was in the order hypothesized, or iconic preferred over the symbolic.

The symbolization level was still preferred over the presentation mode, although it was in the hypothesized order of concrete greater than abstract. Hypothesis seven is not accepted.

Summary. The hypotheses, together with their acceptance or rejection, and the qualifying explanations are the following:

1. Arithmetic abilities do correlate positively with Perceptual Abilities, but not with the significance of correlations expected.
2. Achievement in Language Arts correlates positively with Perceptual Abilities, although not with the significance of correlations expected.
3. High Arithmetic Achievers did learn significantly more words than the Low Arithmetic Achievers, for the symbolic presentation mode only.
4. High Visualizers did not learn significantly more words for either presentation mode.
5. All children did not learn significantly more words presented in the iconic mode than in the symbolic mode. There was in fact an interaction with trials and presentation mode.

5a. There were significant interaction effects for arithmetic ability levels and visualization ability levels for the iconic presentation mode.

5b. There were significant interaction effects for presentation mode (symbolic) for Arithmetic ability; and significant interaction

effects for the presentation mode (iconic) for combined arithmetic-visualization ability levels.

5c. There were significant interaction effects for trials and presentation mode for both the iconic and symbolic modes.

5d. There were no significant interaction effects for trials and ability levels; trials, presentation mode and ability levels.

6. All children did learn significantly more words from the concrete word list than from the abstract word list.

7. Symbolization level of words was found to be more important than the presentation mode. The low arithmetic achiever preferred the symbolic presentation over the iconic presentation, so that for this age group the presentation mode was found to be more important than the symbolization level of the words.

Chapter VII

DISCUSSION

This chapter briefly summarizes the results, discusses the hypotheses, and makes some suggestions for future study.

Hypothesis One and Hypothesis Two will be considered together.

Hypothesis One. Arithmetic Abilities will correlate positively with Perceptual Abilities.

Hypothesis Two. Achievement in Language Arts will correlate positively with Perceptual Abilities.

The correlations between the reading variables of word meaning and paragraph meaning, language variables of spelling and language, and the arithmetic variables of arithmetic computation, arithmetic concepts, and arithmetic applications were all significant and positive. Perceptual Speed correlated only with Paragraph Meaning and Language, Spatial Orientation correlated with no other variables; but Spatial Visualization correlated significantly with Paragraph Meaning, Spelling, Spatial Orientation, and with all three Arithmetic variables.

Kaliski (1962) included language disabilities in her list of factors accompanying arithmetic disability. The correlations in this study of .534 with arithmetic computation; .576 with arithmetic

concepts; and .688 with arithmetic applications yield coefficients of determination of only .285 for arithmetic computation, of only .332 for arithmetic concepts, and of .473 for arithmetic applications. That is to say, that for these grade six children, 28% of the variability in arithmetic computation is related to the variability in language; 33% of the variability in arithmetic concepts is related to the variability in language; and 47% of the variability in arithmetic applications is related to the variability in language. Between one-quarter and one-half of the time poor language ability could accompany or cause arithmetic disability.

The correlations for reading or paragraph meaning of .503 with arithmetic computation; of .579 with arithmetic concepts; and of .596 with arithmetic applications yield coefficients of determination of .253 for arithmetic computation; of .335 for arithmetic concepts; and of .355 for arithmetic applications; which is roughly 25%, 34% and 36%, respectively. It would seem that reading ability is a good predictor for arithmetic disability between one-quarter and one-third of the time. It is the other half of the time with which the remainder of this discussion is concerned.

Biggs (1962) provides similar evidence for great variability when he found a stronger relationship between attitude towards and competency in arithmetic than between attitude and competency for any other school subject.

These findings are also similar to those of Schonell & Schonell (1956) who referred to a verbal ability requirement for problem arith-

metic but not specifically for mechanical arithmetic. When only part of arithmetic competence depends on verbal ability, then, as in this study, the size of the correlations and coefficients of determination must reflect this partition.

The Spatial Visualization subtest was the only perceptual variable which correlated with all three of the arithmetic variables, and with Arithmetic Concepts at the .01 level of significance. Since the numeric abilities peculiar to and distinct from verbal abilities and peculiar to visualization ability may be expressed by these two tests, and since the descriptions of the present use of the Guilford Zimmerman Test is limited to the article by Christiansen and Stone (1968), a factor analysis was run on the scores. These calculations seemed to be a necessary defense for my choice of this latter test as a predictor.

The unrotated factor did not distinguish factors other than a general Learning Factor One; Sex, Language and Spatial (Orientation and Visualization) Factor Two; and a Sex and Perceptual Speed Factor Three; Visualization and Perceptual Speed Factor Four; and an indeterminate Factor Five. In order to eliminate the negative elements in several factors, the matrix was rotated through the equamax, quartimax, and varimax rotations. Specifically these rotations were performed in order to find an arithmetic-perceptual factor. Tables listing the unrotated factor matrix, and the rotations are in the Appendix.

The varimax and quartimax rotations extracted separate factors for Spatial Visualization, Sex, Perceptual Speed,-a factor for spatial orientation and language, and a general learning or arithmetic and

language arts factor. The equamax had an arithmetic plus reading, a language arts, a perceptual speed, a sex and a spatial orientation, and a spatial visualization factor.

As early as 1941, Thurstone & Thurstone were using factor analysis on multiple batteris of tests, and extracting what they called primary mental abilities. They found a Verbal Factor V, a Word Fluency Factor W, a Space Factor S, a Number Factor N, a Memorizing Factor M, an Inductive Factor I, a Deductive Factor D, and a Perceptual Speed Factor P, with correlations between the number factor and the two verbal factors, plus some associations between the space factor and the verbal comprehension factor.

Thurstone & Thurstone describe their space factor as being quite distinct from the usual perceptual processes which require only the perception of detail in a flat surface and which do not require the imaginal movement of the object in two or in three dimensions. This space factor is found in tests which require that the subject manipulate an object imaginally in two or three dimensions.

Thurstone & Thurstone sought to answer the relationship between the numbers and space by relating the numeric ability to kinaesthetic imagery. Piaget (1970) considers that knowledge of space and number is learned through manipulations, movement, timing and dynamic operations on the environment. The combination of spatial relations with kinaesthetic imagery, movement, and timing resemble a numeric-space factor. The creation of 'operational' number sense requires these

abilities according to Piaget, and this study did find a relationship between these variables.

Similarly, Kaliski (1962) included spatial size, sequence and temporal relationships as critical for arithmetic; Breuckner and Grossnickle (1953) mention perceptual disturbances as related to arithmetic disability and Schonell & Schonell (1956) signify spatial ability as necessary for mechanical arithmetic.

Schonell & Schonell (1956) consider that the common factor in all three types of arithmetic ability are general intelligence, general and school experiential background, and computational accuracy. From an inspection of the correlation table for this study, on page 62, arithmetic computation correlates .533 with arithmetic applications and .808 with arithmetic concepts. Schonell & Schonell consider that mechanical arithmetic requires spatial ability, and the significant correlations for arithmetic computation of .222, arithmetic concepts of .311, and arithmetic applications of .241, all with spatial visualization, as found in the present study, are all saying the same thing.

Schonell & Schonell include spatial ability as a requirement for problem arithmetic and for this study the significant correlations with arithmetic applications is .241.

Schonell & Schonell list verbal abilities needed for problem arithmetic, and this study found significant correlations with the reading variables of Word Meaning .432, Paragraph Meaning .596; with the language variables of Language .688, and Spelling .563. Schonell & Schonell have not quantified the relationships, so that the amount

by which the correlations within this study disagree cannot be determined. The correlations are positive, they are significant, and they are between the variables specified in the Schonell & Schonell book.

The original random assignment to groups, for this study, was made on the basis of all three perceptual scores. Perhaps more significant results would be obtained by using the separate arithmetic subtests with the spatial visualization test.

One interesting relationship between the reading variables and the perceptual variables, is the separation of the spelling and the language from the word meaning and paragraph meaning. Words are seen and heard in terms of someone else's mediation more often than one is required to use them as mediators in a new integrational way oneself. For the children, the T. V. exhibits such rapid exposures and such repetition of under-extended word and picture relationships that it tends to weaken the individual's ability to extend integrational thinking.

A reason for the separation of the reading and the language variables, at least in the magnitude of their significant correlations with the arithmetic variables and the perceptual variables can be reasoned in Penfield's (1966) concept integrational terms. Since concept formation involves the number of repetitions and integrational ways in which the concept is encountered, might not the difference between the two types of reading variables be in terms of the total daily encounters with words; and might not a parallel explanation

apply to the acquisition of arithmetic concepts.

Hypothesis Three. High Arithmetic achievers will learn significantly more words in all the experimental conditions than low arithmetic achievers. This hypothesis was significantly proved, for the symbolic presentation only. The correlations between word scores and arithmetic pretest scores could be further tangible evidence of the correlations between reading and arithmetic. Were the low word scorers also the low arithmetic pre-test scorers? The correlations between the word scores and low arithmetic ability of .231 and the correlation between the word scores and high arithmetic ability of .411 indicate that high arithmetic ability individuals are more likely to have high word scores than the low arithmetic ability individuals are likely to have low word scores. This statistic seems to be more closely related to Biggs Anxiety (1962), than it is to intellectually related arithmetic disability.

Hypothesis Four. High Visualizers will learn significantly more words in all the experimental conditions than Low Visualizers. This hypothesis was not significantly proved for either the iconic or symbolic presentation mode.

Hypothesis Five. All children will learn significantly more words in the iconic presentation mode than in the symbolic presentation mode. Presentation mode alone, was not found to be a consistently significant variable in this study. Allen (1965) did not find significant relationships between presentation mode and learner characteristics. Schulz & Hopkins (1970) likewise found that the

learning of highly meaningful material was largely unaffected by mode. And for Piaget (1970) the so-called concrete 'operations' of a person are mental operations with propositions about some system real to the person, and Piaget considers the 'concrete or iconic' to be relative to the reference world of the learner.

Piaget described an image as a product of imitation or one that can be made without resort to external gestures. A word, though abstract in meaning, might well be concretely operational through having been used, heard, read, and integrated with all the sounds, movements, smells, and motions. The words used in this study, although classified as abstract by Paivio (1968) and DiVesta (1970), were simple, uncomplicated, common, and probably highly meaningful to most of the children of this age level.

Interactions. When the arithmetic level is controlled, presentation mode is significant and the iconic or picture representation is greater than the symbolic or word representation for the high and the medium arithmetic achievers.

When visualization level is controlled, the presentation mode is significant for the high visualizer for the symbolic mode. If a high visualizer is one who is able to internalize images of all kinds, but especially visual images, he would have myriads of internalized images for all the words of the lists, whether concrete or abstract. The fact that the correlations between low visualizers and words is only .100 probably parallels Leibovitz findings that imagery ability is not a general trait, and that people who easily produce imagery

in one modality can be deficient in another modality--and people who have an ability to internalize sounds might not have an equal ability at internalizing pictures. Those who are good in forming all sensory images might be the so-called 'high' visualizers of this experiment.

The Low Arithmetic Low Visualizer was significantly lower for both modes, being unable to supply their own images or to use the image stimuli supplied.

Butters (1969) found that perceptual practice interferes with the development of verbal mediation, while verbal practice significantly improves verbal mediation. As this learning task involved words--practice with words alone, at least for those who are low in arithmetic ability and low in visualization ability, is recommended. The generalized 'anxiety' caused arithmetic disability might respond to a different method.

Trials. All groups increased significantly over trials. The difference in their rates of learning had to do with ability levels, and is explained by Penfield (1966) in his description of concept formation as (1) the number of times and number of ways in which, and (2) the mechanisms and abilities with which these concepts are received and expressed.

From the slowest to the fastest, grouped according to significance levels, they were: Low Arithmetic-Low Visualization; Low Arithmetic with Medium or High Visualizer; Medium Visualizer joined with High, Medium or Low Arithmetic; and High Arithmetic or Medium Arith-

metic coupled with High, Medium or Low Visualizer.

When presentation mode was considered with trials, the learning rate was faster for iconic, although by trial three the symbolic mode was not significantly different. This was simple material and the task was quickly learned. For more difficult material which is not so readily internalized the (a) iconic presentation mode could remain superior for very difficult learning tasks. The symbolic is superior when the subject has an adequate internalization image to which he can attach the meaning of the task.

For the Visualizers alone the High Visualizers learned significantly faster but by the third trial, the Low Visualizers and the Medium Visualizers had also learned the task, and there was no longer any significant measurable difference in their performance. More repetitions are required for this group to master the learning task.

When trials, modes, and ability are considered simultaneously all groups learned equally in both the iconic and the symbolic presentation modes, although the High Arithmetic High Visualizer was much faster while the Low Arithmetic Low Visualizer was much slower.

Bruner (1964) describes the diversities of people, particularly their diverse approaches to new materials, in using available cues, and in adapting different learning strategies. A comparison of the learning methods of the Low Arithmetic Low Visualizer group with the High Arithmetic High Visualizer group, for as many kinds of learning situations as can be devised, might isolate some helpful characteristics through which their disability can be remediated.

Hypothesis Six. All children will learn significantly more words from the concrete word list than from the abstract word list. Symbolization level was found to have a significant effect. The concrete word list was remembered almost exactly twice as well, with significant means of 11.72 for the abstract word list and 20.22 for the concrete word list. The rating lists for imagery and concreteness do separate the words into significantly different lists.

Hypothesis Seven. When the word lists are treated as separate variable (concrete versus abstract), the rank order of means for the learning of foreign words for the four presentation modes will be Iconic concrete, Iconic abstract, Symbolic concrete, Symbolic abstract. This hypothesis was not completely acceptable. With the exception of the low Arithmetic group, the arithmetic groups and the visualization groups preferred the concrete symbolization level over the abstract symbolization level, and the symbolic presentation mode over the iconic presentation mode. The concrete symbolization level of preference is expected, but unless thoughtful reference is made to the possibility of symbolic as being 'mentally operational' or 'internally concrete', the preference for symbolic mode, even at this age level is completely unexpected.

For the more refined groupings of high arithmetic with high visualization, and low arithmetic with low visualization the presentation mode was in the order hypothesized, or iconic presentation mode preferred above the symbolic; and the concrete symbolization level preferred above the abstract symbolization level. The symbolization

level was still preferred above the presentation mode, although it was in the hypothesized order of concrete greater than abstract.

Allen (1965) had found that a relationship could be demonstrated between content or symnbolization level and presentation mode. In this study, when the arithmetic ability levels and visualizer levels are considered together content takes preference over presentation mode; while when the arithmetic and visualizer levels are separated, the reverse relationship is true. That is to say, that both the symbolic presentations scored higher, and at the same time, the concrete list scored higher than the abstract list.

Paivio & Foth (1970) found that verbal mediation produced higher recall for abstract pairs (i.e. better without pictures) while the imagery helped for concrete pairs. This agrees with the results of the present study for visualizer level alone, or for arithmetic level alone. This does not agree with the results of the present study when the levels are considered simultaneously for both ability levels of visualizers and arithmetic. Perhaps the divisions of experimental groups in this present study are more discriminating, at least for the procedure used. Paivio & Yuille (1969) also found that imagery appeared to be a preferred type of mediator when at least one member of the pair was concrete and high in its capacity to evoke images. For this present study alone, then, either concrete list for both presentation modes fill these requirements and both the Iconic concrete and the Symbolic concrete lists would be preferred. The Iconic abstract (picture or sound with abstract word) is also a mixed pair, and should

be preferred over the symbolic abstract. This order is precisely the order found for the combined arithmetic visualizer levels.

Another way of describing this relationship is to say that for the High Arithmetic High Visualizer group pictures helped as the iconic is greater in each case, and did not help for the low Arithmetic Visualizer. This is perhaps not surprising, as a low visualizers inability to visualize is surely related to an inability to remember a concrete image. The implications for teaching are probably that the usual assumption that the concrete image builder will always form a concept is perhaps unwarranted. The number of exposures is perhaps dependent upon some other tie to the image, in order to equalize the learning rate of the low and the high visualizer.

The profile method of comparing strengths and weaknesses within an individual for various types of performance tests, should include some indication of his ability to form images, some indication of his ability to recall or revisualize these images, in order to learn.

Suggestions for Future Study

Sensory MOdality. The present study has investigated relationships between arithmetic ability levels and visualization ability levels, presentation mode and symbolization levels. Further information could be related to an analysis of sensory modalities, as the words were presented equally in the auditory, visual and auditory-visual sensory modalities. The stimulus preferences for these modalities could be compared.

Which of the words were more frequently remembered, the words which were presented in the auditory modality, the words which were presented in the visual modality, or the words which were presented in the auditory-visual modality? The tactual[1] sensory modality could also be compared with the auditory, visual or auditory-visual.

Interaction of Sensory Modality and Presentation Mode. Were the auditory words remembered more frequently when they were presented in the iconic mode, or when they were presented in the symbolic mode? Were the visual words remembered more frequently when they were presented in the iconic mode, or when they were presented in the symbolic mode? Does the active touching of the article lead to a stronger memory for the mediated relationships as reflected in the total word scores?

Interaction of Sensory Modality, Presentation Mode and Trials. When the speed of learning is measured, is there a significant preference for any of the three sensory modalities? Was the same sensory modality preferred for all of the three trials, or was there a preference? Long (1968) found an interaction between intelligence and sensory modality. For this age group of grade six children was there a preferential difference for the three ability levels? Was this preference maintained across the trials, or was any difference equalized with the trials?

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1. A pilot study using the visual, auditory, and auditory-visual and tactual sensory modalities indicated a significant separation into groups. The table of means and an analysis of variance produced by a multiple group discriminant function analysis is presented in the Appendix.

To what extent did the repetitions increase or decrease the preferences for any of the sensory modalities?

When the presentation mode was also considered, was there any significant preference? Were the iconic auditory totals the same as the symbolic auditory totals? Were these constant over the three trials, or, if there was a difference for trial one, was this difference maintained, decreased, increased, or changed with further trials?

Interaction of Sensory Modality and Symbolization Level. The total number of concrete words remembered has been compared with the total number of abstract words remembered. Was there an interaction between the sensory modalities and symbolization level? For the concrete word list, was there a preference for any of the sensory modalities? Was there a preference for any of the sensory modalities in either/or both the iconic and symbolic presentation modes? Was there an interaction between symbolization level, presentation mode and sensory modality? Did trials or timing play a significant part?

Memory. The total number of words chosen by each of the ability groups for the visualizers and the arithmetic achievers and the combined visualizer arithmetic achievers could be compared. Presumably the high arithmetic ability group will also remember more of the words, illustrating memory as an important variable. But, could this ratio be such as to be significantly proved for the medium arithmetic level, the low arithmetic level, the three visualizer levels, or for the combined arithmetic visualizer levels?

The total number of times each word was chosen could also be cal-

culated, and an order of preference for the words could also be compared with the listings by Paivio & Yuille or DiVesta & Walls.

Individual Ability. To what extent is there a relationshp between poor auditory discrimination and a learning rate for auditory sensory modality as a presentation mode? Is there a relationship between visual discrimination problems and the rate of learning visually presented words? Is there a relationship between the tactual sensitivity ability and the learning rate for tactually presented words? For the various arithmetic and visualizer ability levels, is there a relationship between sensory preference, sensory competence, and presentation mode?

With reference to the discussion about Bruner's methods of comparing individual learning styles, the high arithmetic high visualizer and the low arithmetic low visualizer could be compared in as many kinds of learning situations and testing situations as possible, in order to isolate some helpful characteristics about their respective learning styles. It is, of course, possible, that there is no consistency of difference between the two groups, but that, too, will add to the knowledge about remediation procedures.

Language Ability Groupings. The relationships between the above variables could all be considered in their respective relationships to language ability. As all the individuals were in both the experimental conditions, the scores could be re-grouped using a random method of selecting and discarding, to create equal cells for a Three Way Anova Comparison, using language ability as the criterion.

A comparison of the arithmetic, visualizer, combined arithmetic-visualizer groupings and the language groupings could be made. Is there any effective difference in the learning rates, and the interactions with presentation mode and symbolization level, between the Anova Comparison with arithmetic or visualization ability as the criterion, and with the language ability as the criterion? The correlations and coefficients of determination account for only about one-third to one-half of the variability. Is there even that much of a similarity between the learning rates for this type of task.

Piaget has placed great importance on the use of the spoken word which raises the issue of the place of language in the experiential learning of the child. Touch (1963) investigated the contributions made by relevant experience and language to the formation of the number concepts in five-year old children. Of the four groups considered, the group with whom the appropriate language was introduced at the same time as the experience made significant progress.

The learning task of this study did not involve the learning of mathematical concepts, but was designed to test for the effectiveness of sensory stimulation and the effects of the presentation mode. The comparison between five-year olds learning a numerical concept accompanied by language and concrete experience is rather tenuous. Would the same orders of preference for presentation mode and symbolization level be found in younger children? Would the differences in learning rate between the high ability levels and the low ability

levels for the first trial and the third trial be even greater for the younger children than it was for the grade six students?

SUMMARY

One purpose of this study was to determine the relationship between visualization ability and arithmetic ability, in sixth grade children. All the sixth grade children (109 students) from two schools in Saanich School District were included in the correlation study.

The second purpose of this study was to measure the differential rates of learning two mediation tasks. From the group of 109 students who were present for all the criteria testing, subjects were randomly discarded until five students were selected, for each of nine cells for a three by three analysis of variance.

The task, which was the learning of paired stimulus foreign words with English words--was presented in two modes; iconic mode which used actual pictures or sounds, and symbolic mode which used only the words themselves. Three sensory modalities of auditory, visual, and auditory-visual were equally varied in the stimulus content. (Tactual modality was used in a pilot study, the results of which are reported in an appendix). Although each student was a participant in all the presentations, the order of presentations was varied for all groups, with one control group receiving a completely scrambled task.

Statistical treatment included 109 subjects for the correlation study, 109 subjects for the multiple group discriminant function analysis, and 45 subjects for the three way analysis of variance with repeated measures on two levels.

Within the limitations imposed by this study and in light of the validity of the measuring instruments used, and the design of the learning tasks, the data derived from the study would appear to make valid the following conclusions.

1. Language tests of language, spelling, word meaning and paragraph meaning correlate positively with the perceptual variables of perceptual speed, spatial visualization, and spatial orientation.
2. Arithmetic tests of computation, concepts, and applications correlate positively with the perceptual variables of perceptual speed, spatial visualization and spatial orientation. Although each had a different individual relationship, the significant relationship was between spatial visualization and arithmetic in general, and between spatial visualization and arithmetic concepts in particular.
3. The students in the high arithmetic grouping did learn significantly more words than the children in the low ability grouping for the symbolic presentation mode only. Those with the developmental ability to invoke the image and remember the images used as stimuli, or who had an inner 'anchor' for the words, were the same children who were good at arithmetic. When the pictures of the words were presented, there was no significant difference in the scores. Pre-

sumably then, high arithmetic ability is related to the ability to form an internal image for a symbol, or become internally as well as externally 'concrete'.

4. High visualizers did not learn significantly more words presented in either mode. Perhaps the test used for the comparisons was too diffuse, and better results could be achieved using the spatial visualization test, only.

5. For the iconic mode, the high visualization-medium arithmetic, and high visualization-low arithmetic were significantly higher than all groups, while the low visualization-low arithmetic, low visualization-medium arithmetic, and medium visualization-low arithmetic were lower than all groups.

The measuring of the arithmetic abilities was more valid than the measuring of the visualization ability, as all the comparisons changed more with the highness or lowness of the arihtmetic ability than with the highness or lowness of the visualization ability.

6. All children did learn significantly more words from the concrete word list than from the abstract word list.

7. Symbolization level of words was found to be more important than presentation mode for the high and medium ability groups. This is related to the lack of need for concreteness. The internal anchor is there for all the concrete words, and a mediator in the form of a 'picture' or 'sound' is not required.

The low arithmetic-low visualization group preferred the symbolic presentation over the iconic presentation so that for this group only

the presentation mode was found to be more important than the symbolization level of words. Giving a picture did not help the mediation process nor the memory process. Although the concrete word was still remembered more than the abstract word.

Finally, some suggestions for further research were given and related to the review of the literature.

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APPENDIX I

RATINGS FOR CONCRETENESS, MEANINGFULNESS, AND IMAGERY

ACCORDING TO

PAIVIO, YUILLE, AND MADIGAN

CONCRETE LIST

Word Trans	Imagery	Concrete	Meaningfulness
AUDITORY			
plane	6.33	6.80	6.48
dog	6,27	6.83	6.00
piano	6.70	6.85	6.40
elephant	6.83	7.00	6.88
engines	6.33	6.76	6.08
cow	6.23	6.94	6.96
pig			
VISUAL			
zebra	6.80	6.94	8.67
fly	6.53	6.96	7.84
cat	6.80	7.00	6.76
car	6.87	7.00	6.38
bear			
monkey			
goat			
AUDIO VISUAL			
baby	6.70	7.04	7.04
sea birds	6.87	6.96	7.88
clock	6.50	6.94	7.08
tiger	6.10	6.94	7.00
baby chick	5.87	6.75	7.36
duck		6.58	
tractor			

ABSTRACT LIST

Word Trans	Imagery	Concrete	Meaningfulness
AUDITORY			
medium			
hard			
courage			
useful			
lie			
simple			
smooth			
VISUAL			
many	5.50	5.19	6.24
angle			
point			
sticky			
cross			
arc			
circle			
AUDIO VISUAL			
fool	2.93	2.63	4.40
dull			
enjoy			
losing			
races			
rough			
liquids			

APPENDIX II

RATINGS FOR CONCRETENESS, IMAGERY, AND EMOTIONALITY ACCORDING TO DIVESTA AND WALLS

Word Trans	Imagery	Concrete	Emotionality
AUDITORY			
plane	70		
dog	70	70	20
piano			
elephant			
engines			
cow			
pig			
VISUAL			
zebra	70	70	20
fly	70	70	30
cat	68	70	24
bear			
car	64	70	20
monkey			
goat			
AUDIO VISUAL			
baby			
sea birds			
clock			
tiger			
baby chick			
duck			
tractor			

ABSTRACT LIST

Word Trans	Imagery	Concrete	Emotionality
AUDITORY			
medium	28	24	28
hard	42	22	36
courage	28	12	24
useful	26	26	18
lie	28	20	30
simple	28	24	16
smooth	40	58	22
VISUAL			
many			
angle			
point			
sticky			
cross			
arc			
circle			
AUDIO VISUAL			
fool	24	22	32
dull	14	28	26
enjoy	26	26	20
losing	28	20	30
races	30	14	22
rough	38	48	32
liquids			

APPENDIX III

PRESENTATION MODE STIMULI FOR THE ICONIC MODE

CONCRETE LIST

AUDITORY

The sounds for the auditory iconic presentation mode were transcribed from a 'Sound Effects' record.

VISUAL.

The slides for the visual iconic presentation mode were made from pictures found in various books and magazines. These pictures had been enlarged using a Close-up Lens attachment for the Voigtlander Vitomatic Camera. The lettering in the pictures was 'Press Letters' size 3/4 inch.

AUDITORY VISUAL

These stimuli were a combination of the auditory and the visual.

TACTUAL.

The stimuli for the tactual iconic mode were actual objects. The concept 'square' was a group of square objects, not all the same size, nor all of the same texture.

ARC SVODA

MANY MNOGO

COURAGE SKUPI

SUROV

LEPJIV

RACES GRANAT

APPENDIX IV

TRIAL ONE

ABSTRACT	AUDITORY	VISUAL	AUDITORY-VISUAL	MEANING
1. krug		******		circle
2. trouga		******		angle
3. sredina	*******			medium
4. surov	******			hard
5. skupi	******			courage
6. izgled	******			useful
7. razume	******			lie
8. lepjiv		******		sticky
9. obilje				------
10. gustif				------
11. kupa				------
12. krst			******	cross
13. jagnje				------
14. naivan	******			simple
15. sladak	******			smooth

TRIAL TWO

1.	svoda	******		arc
2.	glasan		******	fool
3.	budala		******	------
4.	otmen			------
5.	krst	******		cross
6.	budala		******	fool
7.	granat		******	races
8.	procena			------
9/	slona			------
10.	lepota	******		ball
11.	karuce			------
12.	trenut			------
13.	mnogo	******		many
14.	veran			------
15.	izbor			------

TRIAL THREE

ABSTRACT	AUDITORY	VISUAL	AUDITORY VISUAL	MEANING
1. redovan				------
2. koristan				------
3. opor			******	rough
4. veselo			******	happy
5. branik			******	liquids
6. gubiti			******	losing
7. granat			******	races
8. branik			******	liquids
9. pavko			******	dull
10. opor			******	rough
11. disanje				------
12. mekan				------
13. ergela				------
14. lepota				ball
15. optaci				------

CONCRETE

TRIAL ONE

1. muva				------
2. gomila			******	chick
3. bubat		******		fly
4. konje		******		zebra
5. redovan				------
6. cipele			******	birds
7. macka		******		cat
8. majmun		******		monkey
9. imela	******			engines
10. labav				------
11. gomila			******	CHick
12. versak			******	tractor
13. kola		******		car
14. uzvik			******	tiger
15. kozar		******		goat

TRIAL TWO

CONCRETE	AUDITORY	VISUAL	AUDITORY VISUAL	MEANING
				clock
1. sato			******	------
2. tvuba				engines
3. imela	******			plane
4. ravan	******			------
5. koristan				baby
6. beba			******	cow
7. krava	******			cow
8. krava	******			duck
9. plovka			******	monkey
10. majmun		******		------
11. jagnje				cat
12. macka		******		------
13. zavodic				------
14. svoda				cow
15. krava	******			

TRIAL THREE

1. trenut	******			pig
2. slona	******			elephant
3. pasim	******			dog
4. aginal				------
5. cipele			******	birds
6. javan				------
7. bojati				------
8. beba			******	baby
9. zivost				------
10. dratan				------
11. pasim	******			dog
12. otpaci				------
13. klavir	******			piano
14. konje			******	zebra
15. barjak				------

APPENDIX V

FACTOR ANALYSIS AND ROTATIONS

UNROTATED FACTOR MATRIX

	COMMUNALITIES	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
1.	0.839	0.005	0.682	-0.512	-0.144	-0.301
2.	0.768	0.664	-0.403	-0.111	0.240	-0.310
3.	0.719	0.799	-0.226	0.139	-0.008	-0.103
4.	0.782	0.788	0.017	-0.218	-0.153	-0.325
5.	0.789	0.839	-0.007	0.007	-0.282	-0.076
6.	0.688	0.711	-0.063	0.071	0.023	0.415
7.	0.801	0.839	0.073	-0.157	0.091	0.242
8.	0.795	0.840	0.069	-0.178	-0.057	0.222
9.	0.889	0.273	0.128	0.806	-0.300	-0.244
10.	0.699	0.208	0.748	0.190	-0.131	0.207
11.	0.957	0.374	0.459	0.268	0.716	-0.148
	8.725	4.561	1.479	1.159	0.813	0.713
PERCENT OF COMMON VARIANCE						
	100.00	52.274	16.949	13.284	9.316	8.177
PERCENT OF TOTAL VARIANCE						
	79.318	41.462	13.444	10.537	7.389	6.486

EQUAMAX ROTATION

	COMMUNALITIES	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5
1.	0.839	-0.100	0.063	-0.147	0.895	0.053
2.	0.768	0.205	0.790	-0.034	-0.226	0.224
3.	0.719	0.444	0.607	0.311	-0.164	0.173
4.	0.782	0.347	0.736	0.178	0.288	0.073
5.	-.789	0.548	0.566	0.382	0.149	0.009
6.	0.688	0.762	0.183	0.151	-0.142	0.173
7.	0.800	0.755	0.377	0.033	0.100	0.278
8.	0.795	0.762	0.399	0.088	0.156	0.150
9.	0.889	-0.061	0.054	0.928	-0.096	0.110
10.	0.699	0.300	-0.347	0.377	0.518	0.280
11.	0.957	0.038	0.066	0.107	0.094	0.965
PERCENT OF COMMON VARIANCE						
	100.00	28.629	26.599	15.397	15.172	14.203
PERCENT OF TOTAL VARIANCE						
	79.316	22.707	21.098	12.213	12.034	11.265

APPENDIX VI

PILOT STUDY

TACTUAL, VISUAL AND AUDITORY MODES

MEANS AND STANDARD DEVIATIONS

SENSORY MODALITY	TRIAL ONE	TRIAL TWO	TRIAL THREE
TACTUAL			
Mean	6.6250	7.6250	8.1250
Standard Deviation	1.4087	1.0061	1.6910
VISUAL			
Mean	5.3333	6.8889	8.4444
Standard Deviation	1.2472	1.6630	1.7069
AUDITORY			
Mean	5.2222	4.7778	4.3333
Standard Deviation	1.1331	1.1331	2.0548
SYMBOLIC			
Mean	7.5556	4.8889	5.7778
Standard Deviation	1.3426	0.9749	1.7498
CONTROL			
Mean	3.0000	2.0000	3.0000
Standard Deviation	3.9370	2.4495	3.8742
GRAND MEANS	5.8462	5.5897	6.2564
Standard Deviation	2.2018	2.1374	2.8539

The control group was presented with test lists of words which did not match the presented lists. This group was tested on words that they had never seen, although they had been taught twenty words similar in appearance. (i.e. the words were from the same language).

The Multiple Group Discriminant Function Analysis was used to test for the significance of the separation into groups. The F-Ratios were all significant, and are presented in the following table.

TRIALS BY GROUPS

ANALYSIS OF VARIANCE FOR TRIALS 1, 2, and 3.

TRIALS	SOURCE	SUMSQUARES	MEAN SQUARES	D.F.	F.	P.
1	Treatment	69.42	17.35	4	4.932	0.003
	Within	119.65	3.5	34		
2	Treatment	110.22	27.55	4	9.444	0.00003
	Within	99.20	2.91	34		
3	Treatment	148.78	37.19	4	7.4499	0.0001
	Within	168.6	4.96	34		

Stanford Achievement Test

INTERMEDIATE II

PARTIAL BATTERY

TRUMAN L. KELLEY • RICHARD MADDEN • ERIC F. GARDNER • HERBERT C. RUDMAN

If a separate answer sheet is being used, do not make any marks on this test booklet.

NAME _____
last *first* *initial*

BOY ☐ GIRL ☐ GRADE _____ TEACHER _____

SCHOOL _____ DATE OF TESTING _____
year *month* *day*

CITY OR TOWN _____ DATE OF BIRTH _____
year *month* *day*

STATE _____ AGE _____
years *months*

	GRADE SCORE	PERCENTILE RANK*	STANINE*								
Word Meaning			1	2	3	4	5	6	7	8	9
Paragraph Meaning			1	2	3	4	5	6	7	8	9
Spelling			1	2	3	4	5	6	7	8	9
Language			1	2	3	4	5	6	7	8	9
Arithmetic Computation			1	2	3	4	5	6	7	8	9
Arithmetic Concepts			1	2	3	4	5	6	7	8	9
Arithmetic Applications			1	2	3	4	5	6	7	8	9

*Percentile Ranks and Stanines based on tables for Beginning ☐ Middle ☐ End ☐ of grade (check one)

HARCOURT, BRACE & WORLD, INC. NEW YORK

DIRECTIONS: Read the beginning part of each sentence and the words under it. Decide which of the answers given is *best*. Look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same number as the word you have chosen.

SAMPLES

A The name of a color is —

			1	2	3	4
1 farm	3 red	A	○	○	●	○
2 milk	4 pet					

B The day that comes after Monday is —

			5	6	7	8
5 Sunday	7 Wednesday	B	○	○	○	○
6 Tuesday	8 Saturday					

1 To clutch a person's hand is to —

			1	2	3	4
1 release it	3 tickle it	1	○	○	○	○
2 grasp it	4 burn it					

2 If your jacket is crumpled, it is —

			5	6	7	8
5 smooth	7 wrinkled	2	○	○	○	○
6 raveled	8 torn					

3 Something which you can see is —

			1	2	3	4
1 invisible	3 edible	3	○	○	○	○
2 hidden	4 visible					

4 When you reduce something, you —

			5	6	7	8
5 forget it	7 make it smaller	4	○	○	○	○
6 remove it	8 throw it away					

5 A stream which contributes water to another stream is called a —

			1	2	3	4
1 pond	3 beach	5	○	○	○	○
2 tributary	4 sea					

6 A long, slippery fish shaped like a snake is called —

			5	6	7	8
5 a copperhead	7 a lizard	6	○	○	○	○
6 a chameleon	8 an eel					

7 A person guilty of a crime is a —

			1	2	3	4
1 judge	3 culprit	7	○	○	○	○
2 leader	4 witness					

8 A long, narrow, mountain gorge with steep sides is called a —

			5	6	7	8
5 plateau	7 plain	8	○	○	○	○
6 canyon	8 rut					

9 Flint is a kind of —

			1	2	3	4
1 rock	3 cloth	9	○	○	○	○
2 wood	4 animal					

10 An incredible story is —

			5	6	7	8
5 long	7 true	10	○	○	○	○
6 endless	8 unbelievable					

11 The giving up of something which is wanted needed is —

			1	2	3
1 a sacrifice	3 a benefit	11	○	○	○
2 a relief	4 an assistance				

12 A business transaction in which one gains by sell is said to be —

			5	6	7
5 miserable	7 bankruptcy	12	○	○	○
6 penurious	8 profitable				

13 A group of people gathered for religious worshi called a —

			1	2	3
1 colony	3 congregation	13	○	○	○
2 convention	4 committee				

14 To seek is to —

			5	6	7
5 find	7 settle	14	○	○	○
6 see	8 search				

15 A line passing through the center of a circle a with its ends on the circle is called a —

			1	2	3
1 radius	3 diameter	15	○	○	○
2 diamond	4 diagonal				

16 If you are daring but unwise, you are consider to be —

			5	6	7
5 foolhardy	7 shameful	16	○	○	○
6 awkward	8 noisy				

17 That which is extremely cold is —

			1	2	3
1 cool	3 frigid	17	○	○	○
2 temperate	4 torrid				

18 To be humiliated is to be —

			5	6	7
5 hated	7 lost	18	○	○	○
6 hungry	8 mortified				

19 An audience held spellbound is —

			1	2	3
1 fascinated	3 reassured	19	○	○	○
2 convinced	4 indifferent				

20 An official count of people is called a —

			5	6	7
5 grouping	7 census	20	○	○	○
6 document	8 conference				

21 If you can see through something, it is —

			1	2	3
1 translucent	3 solid	21	○	○	○
2 opaque	4 transparent				

22 The maintenance and preservation of our natu resources is called —

			5	6	7
5 conservation	7 reservation	22	○	○	○
6 elimination	8 concentration				

A wandering singer and storyteller is —

1 a writer　3 a minstrel
2 a lumberjack　4 an acrobat

23 ○ ○ ○ ○ (1 2 3 4)

A timid person is —

5 lonely　7 hungry
6 fearful　8 tired

24 ○ ○ ○ ○ (5 6 7 8)

When you inscribe something, you —

1 write on it　3 find it
2 search for it　4 inspect it

25 ○ ○ ○ ○ (1 2 3 4)

To discontinue for a time is to —

5 resume　7 progress
6 suspend　8 disturb

26 ○ ○ ○ ○ (5 6 7 8)

Strain on a wire caused by action of a pulling force is called —

1 remission　3 slack
2 weakness　4 tension

27 ○ ○ ○ ○ (1 2 3 4)

An anonymous author is —

5 old　7 poor
6 unknown　8 well-known

28 ○ ○ ○ ○ (5 6 7 8)

If you liberate a pet rabbit, you —

1 free it　3 love it
2 kill it　4 feed it

29 ○ ○ ○ ○ (1 2 3 4)

A concise reply to a question is —

5 incorrect　7 lengthy
6 brief　8 complicated

30 ○ ○ ○ ○ (5 6 7 8)

A chronic worrier is a person who worries —

1 continuously　3 frequently
2 seldom　4 intermittently

31 ○ ○ ○ ○ (1 2 3 4)

When you are a spectator, you —

5 practice　7 watch
6 sail　8 inspect

32 ○ ○ ○ ○ (5 6 7 8)

To wither is to —

1 run　3 wander
2 wish　4 dry

33 ○ ○ ○ ○ (1 2 3 4)

A person who speaks with a slow, lengthened tone —

5 stutters　7 chatters
6 drawls　8 shrieks

34 ○ ○ ○ ○ (5 6 7 8)

Beds on a train are sometimes called —

1 sleepers　3 berths
2 gliders　4 cots

35 ○ ○ ○ ○ (1 2 3 4)

36 A person who is perplexed is —

5 confused　7 lazy
6 misinformed　8 friendless

36 ○ ○ ○ ○ (5 6 7 8)

37 The destruction of an entire race of people would make that race —

1 extinct　3 bountiful
2 rejuvenated　4 abundant

37 ○ ○ ○ ○ (1 2 3 4)

38 The locality in which an animal usually lives is called its —

5 habitat　7 hacienda
6 habit　8 cage

38 ○ ○ ○ ○ (5 6 7 8)

39 When you descend a mountain, you —

1 climb up　3 explore it
2 come down　4 avoid it

39 ○ ○ ○ ○ (1 2 3 4)

40 An impromptu speech is —

5 premeditated　7 practiced
6 prepared　8 unplanned

40 ○ ○ ○ ○ (5 6 7 8)

41 A deceitful person is —

1 upright　3 fraudulent
2 dependable　4 trustworthy

41 ○ ○ ○ ○ (1 2 3 4)

42 A look of derision is —

5 admiring　7 respectful
6 scornful　8 reverent

42 ○ ○ ○ ○ (5 6 7 8)

43 A candid answer to a question is —

1 untrue　3 short
2 frank　4 complicated

43 ○ ○ ○ ○ (1 2 3 4)

44 When people disperse, they —

5 accumulate　7 scatter
6 congregate　8 die

44 ○ ○ ○ ○ (5 6 7 8)

45 People conquered by their enemy are —

1 liberated　3 destroyed
2 educated　4 subjugated

45 ○ ○ ○ ○ (1 2 3 4)

46 When your duties are neglected, they are —

5 increased　7 slighted
6 boring　8 removed

46 ○ ○ ○ ○ (5 6 7 8)

47 A bitter and irritated person is —

1 galled　3 pacified
2 reconciled　4 appeased

47 ○ ○ ○ ○ (1 2 3 4)

48 A hard coal that burns with very little smoke or flame is called —

5 coke　7 bituminous
6 charcoal　8 anthracite

48 ○ ○ ○ ○ (5 6 7 8)

STOP

No. Right	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41	42	44	46	47	49	51	52	54	55	56	57

No. Right	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	59	60	62	64	66	67	68	69	71	73	75	76	78	80	83	85	88	90	95	100	105	110	118	129

DIRECTIONS: Read each paragraph below. Decide which of the numbered words or phrases below the paragraph is *best* for each blank. Look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same number as the word(s) you have chosen.

SAMPLES

We went up in an airplane. At first we flew near the __A__ where we could see people and animals. Later we could not see them. Our plane was too __B__.

				1	2	3	4
A	1 house	3 town	A	○	●	○	○
	2 ground	4 hills					

				5	6	7	8
B	5 high	7 far	B	○	○	○	○
	6 low	8 fast					

Bread used to be quite expensive, but rolls were even __1__.

				1	2	3	4
1	1 less expensive	3 the same price	1	○	○	○	○
	2 more expensive	4 as expensive					

Although the girls were not related, their resemblance was striking. Even their voices sounded __2__.

				5	6	7	8
2	5 alike	7 high	2	○	○	○	○
	6 different	8 sharp					

If you look at your hands closely, you will see that the skin has little ridges. The pattern of the ridges on the tip of one of your fingers never changes while you live, and this __3__ is different from that on any other finger in the world. This is why the police can use __4__ as a means of identification.

				1	2	3	4
3	1 color	3 texture	3	○	○	○	○
	2 design	4 feeling					

				5	6	7	8
4	5 photographs	7 handshakes	4	○	○	○	○
	6 handwriting	8 fingerprints					

The Olympic Games, named after Olympia, the town in Greece where they were first held, were started to entertain the dwellers on Olympus. These most important of all the ancient __5__ were held every four years and lasted five days. An enclosed plain was dedicated to them, and they were eagerly attended not only by the __6__, but also by men from other lands far and near.

				1	2	3	4
5	1 wars	3 towns	5	○	○	○	○
	2 games	4 sacrifices					

				5	6	7	8
6	5 contestants	7 Greeks	6	○	○	○	○
	6 spectators	8 Romans					

A fresh egg is heavier than water. It will __7__ wh placed in water. In a rotten egg, the yolk and white have split up into other things and by chemi reaction have produced gases. The __8__ will ca the rotten egg to float in water.

				1	2	3
7	1 break	3 float	7	○	○	○
	2 shrink	4 sink				

				5	6	7
8	5 gases	7 yolk	8	○	○	○
	6 shell	8 heat				

If there is a steady wind which usually blows from c direction, that wind may bend a tree; or if a tr grows in a place, such as near a wall, where the lig strikes its sides unequally, it may grow crooked. E a tree usually grows __9__ because that is the best w for it to grow, and because everything generally hel it to do so. Also, a tree throws out branches abo equally on all sides so that their weight all around hel to __10__ it and keep it straight.

				1	2	3
9	1 fast	3 straight	9	○	○	○
	2 at an angle	4 full				

				5	6	7
10	5 tilt	7 retard	10	○	○	○
	6 loosen	8 balance				

Archeologists can tell the age of the various old bon and ashes they find in ruins. Anything which is ali absorbs carbon 14 from the atmosphere. When living thing dies, the carbon 14 begins to decay ar vanish. By measuring the amount of __11__ remainir in a bone, a piece of wood, or anything else which __12__ we can tell how __13__ it is.

				1	2	3
11	1 archeology	3 bone	11	○	○	○
	2 carbon 14	4 flesh				

				5	6	7
12	5 we dig up		12	○	○	○
	6 belongs to the archeologist					
	7 was once alive					
	8 we might find					

				1	2	3
13	1 old	3 long	13	○	○	○
	2 heavy	4 good				

Planetary means wandering or moving about. Whe ancient astronomers watched the skies, they notice that most stars remained in the same relative positio night after night. A few very bright stars, howeve moved about in position from night to night. Th __14__ called these bodies planets because they __15__.

				5	6	7
14	5 astronomers	7 planets	14	○	○	○
	6 bright stars	8 wanderers				

				1	2	3
15	1 wandered or moved about		15	○	○	○
	2 were few in number					
	3 were very bright					
	4 were very ancient					

GO ON TO THE NEXT PAGE

en Jane went shopping for a dress, she bought the
st expensive one __16__ her limited budget.

5 in spite of
6 notwithstanding
7 regardless of
8 on account of
16 (5) (6) (7) (8)

e edges of the leaves of books used to be gilt not only
appearance, but also to present a smooth surface
ich would not readily collect __17__.

1 readers
2 print
3 dust
4 borrowers
17 (1) (2) (3) (4)

an and Ned are entirely different in body build. John
tall and rather stocky, while Ned is __18__ and quite
__19__.

5 big
6 short
7 fat
8 tall
18 (5) (6) (7) (8)

1 husky
2 strong
3 broad
4 thin
19 (1) (2) (3) (4)

ost active life on earth cannot exist at temperatures
low the freezing point or __20__ the boiling point of
ater. Some cold-blooded animals, however, may be
ozen and yet live if they are very slowly thawed out.
acteria and fungi have survived the freezing effects of
fourteen-mile-high balloon trip. At the other ex-
eme, some bacterial spores have been __21__ in water
r hours without dying. However, warm-blooded
imals cannot withstand such extremes in __22__.

5 below
6 under
7 above
8 through
20 (5) (6) (7) (8)

1 frozen
2 boiled
3 suspended
4 left
21 (1) (2) (3) (4)

5 distance
6 water
7 time
8 temperature
22 (5) (6) (7) (8)

ippocrates, often called the father of medicine, lived
uring the golden age of Greece. His main contribution
the medical profession, as we know it today, was his
ttempt to separate medicine from magic and superstiti-
on. Many of his standards and beliefs about __23__ are
ntained in the "Hippocratic Oath," which is still re-
uired of students upon graduation from __24__ schools.

1 medicine
2 health
3 magic
4 superstition
23 (1) (2) (3) (4)

5 high
6 magician
7 medical
8 religious
24 (5) (6) (7) (8)

John is able to swim the length of the pool in 25 seconds. In order to determine how fast he can swim, one must know the __25__.

25 1 depth of the pool at each end
2 length of the pool
3 type of stroke he uses
4 area of the pool
25 (1) (2) (3) (4)

The amount of stress or tension needed to snap a rope or cable is what determines its breaking point. The more __26__ a rope can stand, the higher is its __27__. Surprisingly enough, ten men pulling on a cable which is tied to a tree exert the same amount of __28__ as is exerted on a rope which ten men are pulling from each end.

26 5 cable
6 breaking point
7 stress
8 amount
26 (5) (6) (7) (8)

27 1 stress
2 breaking point
3 tension
4 cable
27 (1) (2) (3) (4)

28 5 tension
6 breaking point
7 cable
8 elasticity
28 (5) (6) (7) (8)

Vibrations in the air which we hear as sound are called sound waves. The length of the wave makes the pitch of sound. The shorter the wave, the higher the __29__. Waves shorter than one-fourth inch are not __30__ to the human ear.

29 1 loudness
2 wind
3 pitch
4 heat
29 (1) (2) (3) (4)

30 5 audible
6 visible
7 measurable
8 dangerous
30 (5) (6) (7) (8)

Our sense of smell strongly influences our sense of taste. When we have a cold, it impedes first our sense of __31__, which in turn affects our sense of __32__. We have four basic tastes. We taste bitter flavors with the back of the tongue, sweet and salt at the tip and the edges. To enjoy candy the most, we should chew it __33__.

31 1 touch
2 hearing
3 smell
4 taste
31 (1) (2) (3) (4)

32 5 taste
6 smell
7 touch
8 reason
32 (5) (6) (7) (8)

33 1 at the back of the mouth
2 away from the tongue
3 at the top of the mouth
4 at the front of the mouth
33 (1) (2) (3) (4)

GO ON TO THE NEXT PAGE ▶

A strange fact is that ice is lighter than liquid water, even though it is colder. The general rule is that things get heavier (per unit of volume) as they get colder, and lighter (again, per unit of __34__) as they get hotter. This is because heat expands them and cold __35__ them. But at the freezing point, water does not obey this rule; it begins to expand before it reaches its freezing point. This is why unprotected water pipes sometimes __36__ in winter.

34
5 area
6 weight
7 volume
8 surface
5 6 7 8 — 34

35
1 extends
2 freezes
3 spreads
4 contracts
1 2 3 4 — 35

36
5 burst
6 shrink
7 rust
8 stretch
5 6 7 8 — 36

Puerto Rico is a rough, mountainous island. A range of mountains, from 2000 to 3500 feet in height, runs the length of the island, east to west, dividing it so that the northern section is twice the size of the southern. The eastern and western ends of the mountain range plunge precipitously into the sea. There is little coastal plain along the north coast, but along the south coast this plain is several miles wide.

The best title for this paragraph would be __37__.

37
1 Puerto Rico, Island Paradise
2 A Caribbean Island
3 Puerto Rico — Our Next State?
4 The Geography of Puerto Rico
1 2 3 4 — 37

The information in the passage suggests that you could not cross Puerto Rico from north to south by boat because __38__.

38
5 the rivers all run from east to west
6 rivers do not flow across mountain ranges
7 there are no rivers
8 Puerto Ricans do not own boats
5 6 7 8 — 38

The long axis of Puerto Rico runs from __39__.

39
1 north to south
2 southwest to northeast
3 east to west
4 southeast to northwest
1 2 3 4 — 39

Rice, a crop which grows best in low, flat areas, would probably grow best on the __40__ coast of Puerto Rico.

40
5 north
6 east
7 west
8 south
5 6 7 8 — 40

From reading the paragraph, one could say that the writer was being __41__.

41
1 imaginative
2 allegorical
3 scientific
4 poetic
1 2 3 4 — 41

Does getting wet and chilly produce colds? English searchers studied three groups of people. Group one v inoculated with cold virus and kept warm and dry. Gro two was inoculated with cold virus and kept wet a chilled. Group three was kept wet and cold but was n inoculated with __42__. Equal numbers in groups c and two caught cold, but no one in group three caugh cold. The evidence from this experiment indicates th getting wet and cold __43__.

42
5 cold water
6 cold virus
7 warm virus
8 wet and cold
5 6 7 — 42

43
1 causes colds
2 does not cause colds
3 helps you to catch cold
4 helps you stay healthy
1 2 3 — 43

Don Quixote thought that the windmills were giant and he was determined to engage in a dreadful comb with them. He believed that the sails were moving arm He covered himself with his shield and rushed with utmo speed upon the first windmill, running his lance into o of the sails. The wind whirled the sails about with su swiftness that their momentum broke the lance in pieces and hurled away both knight and horse.

Don Quixote was actually defeated in this combat b __44__.

44
5 the wind
6 his horse
7 his lance
8 a giant
5 6 7 — 44

"Knight" in the last sentence refers to __45__.

45
1 Don Quixote
2 a giant
3 a windmill
4 Don Quixote's companion
1 2 3 — 45

It is apparent that Don Quixote was __46__.

46
5 inaccurate with a lance
6 not very brave
7 blind
8 a bit confused
5 6 7 — 46

The word "running" in the third sentence means __47__

47
1 thrusting
2 pulling
3 following
4 spinning
1 2 3 — 47

The "sails" referred to are most like the __48__.

48
5 hands of a clock
6 branches of a tree
7 blades of a fan
8 sails on a ship
5 6 7 — 48

tinum sometimes occurs as a native metal; that is, found in the ground in an almost pure state. __49__ is ıetimes also found as a chemical impurity in other ı_, especially gold, copper, and nickel.

1 Gold
2 Copper
3 Platinum
4 Nickel

49 ○ ○ ○ ○ (1 2 3 4)

5 stones
6 metals
7 earths
8 chemicals

50 ○ ○ ○ ○ (5 6 7 8)

1528 Panfilo de Narvaez tried but failed to establish a ınish settlement near Tampa, Florida. He tried to urn to Cuba, but was blown off course by easterly ıds and wrecked on the coast of Texas, far __51__ of destination. A survivor of the expedition, Alvar de ca, finally arrived in Mexico City in 1536, __52__ years er, once again in touch with his __53__ townsmen.

1 west
2 east
3 south
4 southeast

51 ○ ○ ○ ○ (1 2 3 4)

5 seven
6 twelve
7 eight
8 two

52 ○ ○ ○ ○ (5 6 7 8)

1 Mexican
2 Cuban
3 American
4 Spanish

53 ○ ○ ○ ○ (1 2 3 4)

---

e must bear in mind that most of Shakespeare's come- es and tragedies were founded on stories he did not vent himself. Some of the __54__ had been favorites ng before the poet made use of them for his plays. ıey might have been forgotten forever if he had not 55 them by means of the characters he created, and in s own wonderfully beautiful __56__.

4 5 comedies
6 stories
7 songs
8 actors

54 ○ ○ ○ ○ (5 6 7 8)

5 1 invented
2 altered
3 erased
4 preserved

55 ○ ○ ○ ○ (1 2 3 4)

6 5 colors
6 language
7 designs
8 music

56 ○ ○ ○ ○ (5 6 7 8)

Running from north to south, the countries which make up Central America are British Honduras, a little larger than Massachusetts; Guatemala, about the size of Virginia; Honduras, roughly equal in size to Mississippi; El Salvador, slightly larger than Massachusetts; Nicaragua, about equal to New York; Costa Rica, about twice the size of Maryland; and Panama, about the size of Maine. The total area is about 206,000 square miles, or roughly twice the area of Colorado.

The smallest and largest of the states mentioned in the paragraph are Massachusetts and New York; therefore, the largest Central American country would be __57__.

57 1 British Honduras
2 Guatemala
3 Honduras
4 Nicaragua

57 ○ ○ ○ ○ (1 2 3 4)

This passage is probably taken from a book on __58__.

58 5 politics
6 geography
7 history
8 Nicaragua

58 ○ ○ ○ ○ (5 6 7 8)

The southernmost country in Central America is __59__.

59 1 British Honduras
2 Colorado
3 Maryland
4 Panama

59 ○ ○ ○ ○ (1 2 3 4)

Colorado is about one half the area of __60__.

60 5 Costa Rica
6 Nicaragua
7 Central America
8 Panama

60 ○ ○ ○ ○ (5 6 7 8)

There are __61__ countries in Central America.

61 1 seven
2 six
3 eight
4 fifteen

61 ○ ○ ○ ○ (1 2 3 4)

The historical development of the English language shows three main periods: before 1100, the period of Old English, a Germanic language spoken by the Angles and Saxons; the Middle English, a period of French influence, from 1100 to 1450; and the period of Modern English, from 1450 to the present. Chaucer, who died in 1400, wrote in __62__. The story of Beowulf, an 8th century Saxon and Danish hero, is written in __63__. Shakespeare, who was born in 1564, wrote his plays in __64__.

62 5 French
6 Old English
7 Middle English
8 Modern English

62 ○ ○ ○ ○ (5 6 7 8)

63 1 Danish
2 Old English
3 Middle English
4 Modern English

63 ○ ○ ○ ○ (1 2 3 4)

64 5 Saxon
6 Old English
7 Middle English
8 Modern English

64 ○ ○ ○ ○ (5 6 7 8)

STOP

No. Right	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Gr. Score	Below 20				20	21	22	23	24	25	26	28	29	30	32	34	36	38	39	41	42	43	44	46	47	48	49	50	52	53	54	56	57	59	60	61	62	63	64	65	66	67	68	69	70	72	73	75	77	78	80

No. Right (cont'd)	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Gr. Score	82	84	87	92	96	100	104	106	109	112	116	120	124	129

DIRECTIONS: Read each of the groups of words below. One of the words in each group is misspelled. Find the word that has been misspelled. Look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same number as the word you have chosen.

SAMPLES

A	1 dog 2 boy	3 walk 4 yse	1 2 3 4 A ○ ○ ○ ●
B	5 this 6 kap	7 cold 8 tell	5 6 7 8 B ○ ○ ○ ○

1	1 suddenly 2 justly	3 fiting 4 rare	1 2 3 4 1 ○ ○ ○ ○
2	5 hospetal 6 rifle	7 pennies 8 support	5 6 7 8 2 ○ ○ ○ ○
3	1 tried 2 noticed	3 gone 4 allthough	1 2 3 4 3 ○ ○ ○ ○
4	5 vacation 6 empty	7 kichen 8 watched	5 6 7 8 4 ○ ○ ○ ○
5	1 idel 2 courage	3 signal 4 countries	1 2 3 4 5 ○ ○ ○ ○
6	5 raised 6 jumped	7 suger 8 figure	5 6 7 8 6 ○ ○ ○ ○
7	1 heavey 2 sign	3 invented 4 station	1 2 3 4 7 ○ ○ ○ ○
8	5 divided 6 moddern	7 ought 8 perfume	5 6 7 8 8 ○ ○ ○ ○
9	1 sorrow 2 climet	3 punish 4 mixture	1 2 3 4 9 ○ ○ ○ ○
10	5 healthy 6 laid	7 automobile 8 stoped	5 6 7 8 10 ○ ○ ○ ○
11	1 division 2 importence	3 consider 4 length	1 2 3 4 11 ○ ○ ○ ○
12	5 suits 6 ladys	7 crowd 8 struck	5 6 7 12 ○ ○ ○
13	1 governed 2 happily	3 stepped 4 satesfied	1 2 3 13 ○ ○ ○
14	5 progam 6 slide	7 none 8 sort	5 6 7 14 ○ ○ ○
15	1 tools 2 press	3 slip 4 boxs	1 2 3 15 ○ ○ ○
16	5 leaf 6 matches	7 during 8 cryed	5 6 7 16 ○ ○ ○
17	1 industry 2 gaurd	3 allowed 4 presents	1 2 3 17 ○ ○ ○
18	5 style 6 favorite	7 developped 8 exact	5 6 7 18 ○ ○ ○
19	1 inocent 2 naturally	3 diameter 4 completely	1 2 3 19 ○ ○ ○
20	5 merchants 6 tardy	7 sword 8 colection	5 6 7 20 ○ ○ ○
21	1 flys 2 dwell	3 curtains 4 fairly	1 2 3 21 ○ ○ ○
22	5 afterwards 6 tennis	7 choosen 8 joined	5 6 7 22 ○ ○ ○
23	1 capable 2 custom	3 fedral 4 construction	1 2 3 23 ○ ○ ○
24	5 assistance 6 socity	7 reference 8 educational	5 6 7 24 ○ ○ ○
25	1 encurraging 2 distinction	3 veil 4 convenient	1 2 3 25 ○ ○ ○
26	5 alfalfa 6 appreciate	7 conference 8 phisical	5 6 7 26 ○ ○ ○
27	1 criminal 2 gradualy	3 paragraph 4 tendency	1 2 3 27 ○ ○ ○

GO ON TO THE NEXT PAGE

5 oppisite	7 blossoms		5	6	7	8
6 prettiest	8 splendid	28	○	○	○	○
1 journal	3 fortunate		1	2	3	4
2 hearty	4 continuelly	29	○	○	○	○
5 poet	7 barrel		5	6	7	8
6 forgotton	8 verses	30	○	○	○	○
1 paradise	3 elaberate		1	2	3	4
2 inquiry	4 successfully	31	○	○	○	○
5 parden	7 tickled		5	6	7	8
6 seat	8 ability	32	○	○	○	○
1 bycicle	3 pigeon		1	2	3	4
2 transferred	4 thorough	33	○	○	○	○
5 courteous	7 liability		5	6	7	8
6 enclosure	8 merchandize	34	○	○	○	○
1 medium	3 canned		1	2	3	4
2 desided	4 addition	35	○	○	○	○
5 dismissed	7 apointed		5	6	7	8
6 happier	8 against	36	○	○	○	○
1 engineers	3 ambition		1	2	3	4
2 celabrate	4 practicing	37	○	○	○	○
5 semester	7 relize		5	6	7	8
6 opera	8 whisper	38	○	○	○	○
1 interior	3 discusted		1	2	3	4
2 drowned	4 sleigh	39	○	○	○	○
5 goverment	7 caution		5	6	7	8
6 gathering	8 position	40	○	○	○	○
1 stretch	3 temporary		1	2	3	4
2 certificate	4 exersize	41	○	○	○	○
5 exist	7 interrupt		5	6	7	8
6 gilty	8 endure	42	○	○	○	○

43 1 descend	3 boundary		1	2	3	4
2 sugestions	4 leisure	43	○	○	○	○
44 5 carriage	7 principal		5	6	7	8
6 exceptions	8 servent	44	○	○	○	○
45 1 temperture	3 curious		1	2	3	4
2 particular	4 grammar	45	○	○	○	○
46 5 advertisement	7 emergancy		5	6	7	8
6 institution	8 sacrifice	46	○	○	○	○
47 1 advantages	3 carring		1	2	3	4
2 salmon	4 historical	47	○	○	○	○
48 5 begining	7 continent		5	6	7	8
6 auditorium	8 knowledge	48	○	○	○	○
49 1 squirrel	3 receipt		1	2	3	4
2 affectionately	4 comunities	49	○	○	○	○
50 5 reasonably	7 wrought		5	6	7	8
6 equiped	8 graduate	50	○	○	○	○
51 1 opportunity	3 deny		1	2	3	4
2 communication	4 originaly	51	○	○	○	○
52 5 struggle	7 discribe		5	6	7	8
6 horrible	8 composition	52	○	○	○	○
53 1 apperance	3 benefits		1	2	3	4
2 definition	4 illustrations	53	○	○	○	○
54 5 wretched	7 enthusiasm		5	6	7	8
6 recieving	8 grief	54	○	○	○	○
55 1 pamphlets	3 aquaint		1	2	3	4
2 bureau	4 crisis	55	○	○	○	○
56 5 businesses	7 economics		5	6	7	8
6 fortune	8 simpathy	56	○	○	○	○

No. Right	1 2 3 4	5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39 40	41 42 43 44 45 46 47 48 49 50
Gr. Score	Below 20	20 22 23 25 26 28	30 31 34 36 37 39 41 43 44 45	47 48 50 51 53 54 56 57 59 60	62 63 64 66 67 68 69 70 71 73	75 76 77 78 80 82 85 88 92 97

No. Right (cont'd)	51	52	53	54	55	56
Gr. Score	102	105	110	115	122	129

STOP

DIRECTIONS: Read each sentence below. Decide which, *if either*, of the two choices in each sentence is correct in *standard written English*. Look at the answer spaces at the right or on your answer sheet (if you have one). If the choice numbered 1 is correct, fill in the space under the 1. If the choice numbered 2 is correct, fill in the space under the 2. If neither choice 1 nor choice 2 is correct, fill in the space under the N. ("N" stands for "neither.")

SAMPLES

A Joe 1 set / 2 sat in the chair. . . . . A (1) (2●) (N)

B Sally 1 ain't / 2 aren't here. . . . . B (1) (2) (N)

1 Has the May queen been 1 choosed / 2 chosen yet? 1 (1) (2) (N)

2 Why didn't you 1 brought / 2 brung your old clothes? . . . . . 2 (1) (2) (N)

3 Fred hurt 1 hisself / 2 himself playing hockey. . . 3 (1) (2) (N)

4 Your suitcase fits into the car 1 easy. / 2 easily. 4 (1) (2) (N)

5 The ducks have 1 flown / 2 flew south. . . . . 5 (1) (2) (N)

6 How much snow has already 1 fell? / 2 fallen? 6 (1) (2) (N)

7 Every day last week he 1 comes / 2 come to our house. . . . . 7 (1) (2) (N)

8 Have you ever 1 blew / 2 blown bubbles before? 8 (1) (2) (N)

9 1 Them / 2 These kind of ice cream is my favorite. 9 (1) (2) (N)

10 Have they found 1 they're / 2 their pencils? . . . 10 (1) (2) (N)

11 Has that horse been 1 ridden / 2 rode before? . 11 (1) (2) (N)

12 Our car has been 1 driven / 2 drove 75,000 miles. 12 (1) (2) (N)

13 Did you already 1 threw / 2 thrown away your old toys? . . . . . 13 (1) (2) (N)

14 When he slipped, he 1 is falling / 2 falls on the ice. . . . . 14 (1) (2) (N)

15 An earthquake has 1 shaken / 2 shook all the houses. . . . . 15 (1) (2) (N)

16 A fire truck and 1 a / 2 an ambulance roared by. . . . . 16 (1) (2) (N)

17 At sunrise the soldiers 1 rose / 2 raised the flag. 17 (1) (2) (N)

18 Do you want 1 that I should / 2 for me to bring my bat? 18 (1) (2)

19 He is lazy; he 1 lies / 2 lays in bed all day. . . 19 (1) (2)

20 Yesterday I 1 asks / 2 told her, "May I go too?" 20 (1) (2)

21 When I called to 1 him and her, / 2 he and she, they came. 21 (1) (2)

22 Billy has 1 drew / 2 drawed a dog in his picture. 22 (1) (2)

23 Mr. Ray gave the awards to Bob and 1 I. / 2 me. 23 (1) (2)

24 I 1 haven't / 2 have hardly any stamps from India. 24 (1) (2)

25 1 They was / 2 There were no time for playing. . . . 25 (1) (2)

26 She should never 1 have ate / 2 of eaten so much. . 26 (1) (2)

27 I don't know why Peg and 1 she / 2 her weren't asked. 27 (1) (2)

28 When the line 1 breaks, / 2 had broke, the fish escaped. 28 (1) (2)

29 If you had spoken, I would 1 of known / 2 have knew you. 29 (1) (2)

30 I don't know how long I had 1 lain / 2 laid there. 30 (1) (2)

31 By noon, water 1 had rose / 2 is rising above the dikes. 31 (1) (2)

32 I would 1 have went / 2 go with you last week. 32 (1) (2)

33 Which one of the boys 1 is / 2 are going first? 33 (1) (2)

34 There 1 goes / 2 go the jet planes. 34 (1) (2)

35 For years the men 1 has spoken / 2 have spoke to no one. 35 (1) (2)

36 Enter the room 1 more quiet / 2 quieter next time. 36 (1) (2)

37 Which of the twins can swim the 1 faster? / 2 fastest? 37 (1) (2)

38 The coach asked 1 me and Tom / 2 Tom and I to report. 38 (1) (2)

STO

DIRECTIONS: In this part, all punctuation marks and capital letters have been left out. Decide which mark of punctuation, if any, is needed after each *underlined* word. If a punctuation mark is needed, find the punctuation mark in the row at the right that has the same number as the underlined word. Then look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same letter as the letter beside the punctuation mark you have chosen. If no punctuation mark is needed, fill in the space under the NP. ("NP" stands for "no punctuation needed.")

MPLES

terday we had a holiday
C

ther served cake and ice cream
D

			a	b	NP
C	a (.)	b (,)	●	○	○
D	c (.)	d (,)	c ○	d ○	NP ○

a hundred dollars to spend

nr sanders[39] do you mean this hundred dollars is all mine[40] i asked[41]

r eyes popping when the banker told me[42] that i had won the award[43]

en i thanked him and took the crisp[44] one hundred dollar bill

one hundred dollars[45] how would i spend it[46] i have always wanted

horse[47] but in our apartment where could we keep a horse[48] no[49] i would

ve to postpone that dream

my father said[50] you should invest half of it[51] i will help you to buy

me stocks

then i remembered the jimmy fund i sent five dollars[52] to this worthy

ause with some of the forty-five dollars left i bought camping equip-

ent i got a sleeping bag[53] a knapsack and a mess kit

coming out of the sports store[54] i stopped outside a pet shop in the

vindow was a black[55] and white puppy he was just begging me to buy

im since you can have a puppy even in an apartment[56] i could not resist

that hundred dollars went fast but it bought a lot of happiness

			a	b	NP
39	a (,)	b (?)	○	○	○
40	c (?)	d (?")	c ○	d ○	NP ○
41	a (.)	b (,)	○	○	○
42	c (,)	d (,")	c ○	d ○	NP ○
43	a (.)	b (,)	○	○	○
44	c (,)	d (;)	c ○	d ○	NP ○
45	a (!)	b (?)	○	○	○
46	c (!)	d (?)	c ○	d ○	NP ○
47	a (,)	b (,")	○	○	○
48	c (.)	d (?)	c ○	d ○	NP ○
49	a (,)	b (,")	○	○	○
50	c (,")	d (,)	c ○	d ○	NP ○
51	a (.)	b (,")	○	○	○
52	c (.)	d (,)	c ○	d ○	NP ○
53	a (.)	b (,)	○	○	○
54	c (.)	d (,)	c ○	d ○	NP ○
55	a (.)	b (,)	○	○	○
56	c (.)	d (,)	c ○	d ○	NP ○

STOP

DIRECTIONS: In this part, all capital letters and most of the punctuation marks have been left out. You are to decide whether certain words should be capitalized. These words are *underlined* and have a number above them. You are not to do anything with words that are not underlined. Look at the answer spaces at the right or on your answer sheet (if you have one). Be sure that the number beside the answer space agrees with the number of the word. If the word or phrase should be capitalized, fill in the space under the letter C. ("C" stands for "capital letter.") If a small letter is correct, fill in the space under the letter s. ("s" stands for "small letter.")

SAMPLES

mary and E tom are going

they will leave F tomorrow

	C	s
E	●	○
F	○	○

our class has been studying the 57 history and 58 geography of 59 germany we are learning many interesting facts for example we have read about famous german 60 musicians and 61 scientists we also studied the events of 62 world 63 war II i was especially interested in this because my 64 father was a 65 sergeant in the 66 air 67 force after the 68 war he was stationed in 69 west 70 berlin

in 1945 germany was defeated the 71 nazi 72 dictator adolf hitler was dead the germans had no 73 government for several years the united states france and britain were the government in 74 western 75 germany in the eastern zone 76 russian 77 troops took over

several pupils in our class have 78 pen 79 pals in west germany i write to a girl named marta who lives in a small town on the 80 rhine 81 river near the 82 capital bonn marta wrote to me about their 83 christmas 84 celebration it is something like ours they go to midnight mass and sing 85 carols marta's family are 86 roman 87 catholic marta's father is a 88 professor at the 89 university of 90 frankfurt she sent me a present it is a book of 91 fairy tales by the 92 brothers grimm

	C	s
57	○	○
58	○	○
59	○	○
60	○	○
61	○	○
62	○	○
63	○	○
64	○	○
65	○	○
66	○	○
67	○	○
68	○	○
69	○	○
70	○	○
71	○	○
72	○	○
73	○	○
74	○	○
75	○	○
76	○	○
77	○	○
78	○	○
79	○	○
80	○	○
81	○	○
82	○	○
83	○	○
84	○	○
85	○	○
86	○	○
87	○	○
88	○	○
89	○	○
90	○	○
91	○	○
92	○	○

DIRECTIONS: This is a test of your ability to use a dictionary. There are two sections. In this section four words (in boxes) are shown as they might appear in a dictionary, with four definitions given for each word. Below the box for each word are four questions. In the first two questions, the given word is used in a sentence. Read each sentence, then decide which dictionary definition *best* defines the word as it is being used in the sentence. Look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same *number* as the definition you have chosen. Two other questions are asked about each word. For each of these, decide which answer is *best* and mark the space which has the same *letter* as the answer you have chosen.

MPLES

check (chek) 1. *n.* A pattern in squares of different colors. 2. *v.* To prove true or right. 3. *n.* A mark showing that something has been examined or compared. 4. *v.* To hold back or control.

Miss Jones made a **check** beside each example. — G ○ ○ ● ○ (1 2 3 4)

The word **check** in the sentence above is —

a a noun b a verb c an adjective d an adverb — H ○ ○ ○ ○ (a b c d)

for tune (fôr'chən) *n.* 1. Great deal of money or property; riches; wealth. 2. Luck; chance; what happens. 3. Good luck; success; prosperity. 4. Fate; destiny; what is going to happen.

3 The young man went West to seek a **fortune** in the gold rush. — 93 ○ ○ ○ ○ (1 2 3 4)

4 The gypsy told the girl's **fortune** by reading tea leaves. — 94 ○ ○ ○ ○ (1 2 3 4)

5 **Fortune** is the root word (or stem) for all the following except —

a fortunate b unfortunately c fortress d misfortune — 95 ○ ○ ○ ○ (a b c d)

6 The second definition of **fortune** applies to all the following except —

e "wheel of fortune" f "a fortune in jewels" g "What fortune befell the hero?" h "by bad fortune" — 96 ○ ○ ○ ○ (e f g h)

in spi ra tion (in' spə rā' shən) *n.* 1. Influence of thought and strong feelings on action. 2. Influence from God which helped men to write the Bible. 3. An idea that is inspired. 4. Breathing in; drawing air into the lungs.

17 Tom had an **inspiration**; he attached the wire to the cylinder. — 97 ○ ○ ○ ○ (1 2 3 4)

18 The **inspiration** to write that poem came from the poet's mother. — 98 ○ ○ ○ ○ (1 2 3 4)

19 On which syllable is the word **inspiration** strongly accented?

a first b second c third d fourth — 99 ○ ○ ○ ○ (a b c d)

20 A word that means the opposite of one meaning of **inspiration** is —

e inspirational f expiration g expectation h unintentional — 100 ○ ○ ○ ○ (e f g h)

bit ter (bit'ər) *adj.* 1. Having a disagreeable taste like quinine or grass. 2. Painful; distressing. 3. Showing grief or pain. 4. Harsh; cruel; stinging; cutting. *adv.* **bit ter ly.**

21 When Mary heard the news, she wept **bitterly.** — 101 ○ ○ ○ ○ (1 2 3 4)

22 The old captain had a **bitter** tongue. — 102 ○ ○ ○ ○ (1 2 3 4)

23 All the following are correct uses of **bitter** except —

a "bitter pill" b "bitter street" c "bitter wind" d "bitter tears" — 103 ○ ○ ○ ○ (a b c d)

24 **Soft** and **gentle** are antonyms (words that mean the opposite) of **bitter** when it has the meaning given in definition number —

e 1 f 2 g 3 h 4 — 104 ○ ○ ○ ○ (e f g h)

nar row (nar′ō) 1. *adj.* Less wide than usual for its kind. 2. *adj.* Limited, small. 3. *v.* To decrease in width. 4. *adj.* Close; with a small margin.

105 Jim had a **narrow** escape from the runaway horse. 105 1 2 3

106 The sign warns motorists that the road **narrows**. 106 1 2 3

107 The first definition fits the use of **narrow** in all the following phrases except —
a "narrow ribbon" b "a narrow road" c "narrow-minded" d "a narrow hall" 107 a b c

108 All the definitions of **narrow** explain its use as an adjective except the definition numbered —
e 1 f 2 g 3 h 4 108 e f g

DIRECTIONS: In each sentence in this section, you are to decide how to pronounce the underlined word. Do not depend upon the way you think the word is pronounced. Use the pronunciation guide at the foot of this page to help you. Choose the word or phrase that completes the sentence *best*, and then in the answer spaces at the right or on your answer sheet (if you have one) mark the space which has the same number.

SAMPLES

I **Rein** (rān) rhymes with — 1 plan 2 main 3 fawn 4 men I 1 2 3

J The vowel sound in **cough** (kôf) is the same as the vowel sound in —
5 couch 6 corn 7 hot 8 hope J 5 6 7

109 The word **even** (ē′vən) contains —
1 a short "e" sound
2 a syllable that rhymes with seen
3 a long "e" sound
4 an initial vowel sound like that in ever 109 1 2 3

110 The first three letters in **thrall** (thrôl) have the same sound as the first letters in —
5 through 6 this 7 thou 8 that 110 5 6 7

111 **Fissure** (fish′ər) rhymes most closely with —
1 this year 2 pressure 3 tissue 4 wisher 111 1 2 3

112 The word **solder** (sod′ər) contains —
5 a silent letter 6 the sound of "o" as in soda 7 two unaccented vowels 8 a diphthong 112 5 6 7

113 The word **beau** (bō) is pronounced the same as —
1 the first syllable of beauty 2 a blue bow 3 bow to the lady 4 to cry "boo" 113 1 2 3

114 In the word **moderation** (mod′ ər ā′ shən) there are —
5 more than two accented syllables
6 one heavily and one lightly accented syllable
7 two heavily accented syllables
8 two lightly accented syllables 114 5 6 7

115 **Sieve** (siv) rhymes with —
1 siege 2 thrive 3 give 4 sift 115 1 2 3

116 The vowel sound in the accented syllable in **broaden** (brôd′ ən) is like the accented vowel sound in —
5 brawn 6 broiling 7 broker 8 brown 116 5 6 7

hat, āge, cāre, făr; let, ēqual, tėrm; it, īce; hot, ōpen, ôrder; oil, out; cup, pụt, rüle, ūse; ch, child; ng, long; th, thin; th, then; zh, measure; ə represents *a* in *about*, *e* in *taken*, *i* in *pencil*, *o* in *lemon*, *u* in *circus*.

STO

RECTIONS: Read each group of words below. cide if the words make *one complete sentence, more than complete sentence,* or *no complete sentence.* Look at answer spaces at the right or on your answer sheet you have one). If the group of words *can* be cor-tly punctuated as one sentence by merely putting a iod or question mark at the end, fill in the space under 1. If the group of words *could* be punctuated as two tences (without changing or omitting any words), fill the space under the 2. If the group of words is just t of a sentence, fill in the space under the N. ("N" nds for "not a complete sentence.")

MPLES

In 1818 the flag had twenty stars . . . K ● ○ ○ (1 2 N)

In the right-hand corner of the flag . . L ○ ○ ○ (1 2 N)

7 Autumn is my favorite season of the year . . . . . 117 ○ ○ ○ (1 2 N)

8 Going back to school, meeting old friends and new teachers . . . . . 118 ○ ○ ○ (1 2 N)

9 Not that summer vacation isn't fun, too, with beach parties and baseball games to go to . . . . . 119 ○ ○ ○ (1 2 N)

0 Autumn, however, has so many pleasures I mean there are many holidays . . . . . 120 ○ ○ ○ (1 2 N)

1 At school we celebrate these occasions in many different ways . . . . . 121 ○ ○ ○ (1 2 N)

2 Such as planning for our class Halloween party . . . . . 122 ○ ○ ○ (1 2 N)

3 We decorate the room, bring refreshments, and plan special programs . 123 ○ ○ ○ (1 2 N)

124 Last year a prize was given for the best decorated room . . . . . 124 ○ ○ ○ (1 2 N)

125 Since our room was decorated with skeletons, wicked-looking witches, yellow pumpkins, and black cats . . 125 ○ ○ ○ (1 2 N)

126 We thought that we would win the prize however the sixth grade was the winner . . . . . 126 ○ ○ ○ (1 2 N)

127 So this year we'll try even harder we may win . . . . . 127 ○ ○ ○ (1 2 N)

128 There are many other wonderful things to do in the fall there are hay rides and football games . . . . . 128 ○ ○ ○ (1 2 N)

129 Also the weather, which in New England is usually clear and cool . . . . 129 ○ ○ ○ (1 2 N)

130 And the bright colors of the falling leaves . . . . . 130 ○ ○ ○ (1 2 N)

131 Raking the leaves into piles and jumping into the piles . . . . . 131 ○ ○ ○ (1 2 N)

132 The smell of burning leaves fills the air . . . . . 132 ○ ○ ○ (1 2 N)

133 Also in autumn we play football it is my favorite sport . . . . . 133 ○ ○ ○ (1 2 N)

134 I look forward to doing all these things with my friends whom I haven't seen during the summer . . 134 ○ ○ ○ (1 2 N)

STOP

No. Right	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Gr. Score																														Below 20	20	20	20	21	21	22	22	23	23	24	24	25	25	25	26	26	27	28	28	29	29
No. Right (cont'd)	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Gr. Score	30	31	31	32	32	33	34	34	35	36	37	37	38	39	40	41	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	69	70	71	72	73	74	75	77	79
No. Right (cont'd)	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134																
Gr. Score	80	82	85	88	90	93	95	97	98	100	102	104	105	107	108	109	110	111	113	114	115	117	118	119	120	121	123	124	125	126	127	129	129+																

DIRECTIONS: Work the example in each box. Then look at the possible answers at the right side of the box and see if your answer is given. If it is, fill in the space at the right or on your answer sheet (if you have one) which has the same letter as the answer you have chosen. If your answer is *not* given, fill in the space which has the same letter as the letter beside the NG (which means "not given"). Use a separate sheet of paper for figuring.

SAMPLE A

$$\begin{array}{r} 64 \\ -23 \\ \hline 41 \end{array}$$

a 31
b 40
c 41
d 42
e NG

A a b c ● d

1

$3\overline{)174}$

a 54, rem 2
b 58
c 57
d 61, rem 1
e NG

2

$$\begin{array}{r} 359 \\ 77 \\ 798 \\ +\ 79 \\ \hline \end{array}$$

f 1212
g 1213
h 1303
i 1312
j NG

3

$$\begin{array}{r} \$6.05 \\ -\ 5.67 \\ \hline \end{array}$$

a $ .38
b $ .48
c $1.38
d $1.48
e NG

1 a b c d
2 f g h i
3 a b c d

4

$$\begin{array}{r} 359 \\ 7495 \\ +5788 \\ \hline \end{array}$$

f 12,642
g 13,542
h 13,642
i 13,632
j NG

5

$$\begin{array}{r} 10183 \\ -\ 2694 \\ \hline \end{array}$$

a 7489
b 7487
c 7589
d 8489
e NG

6

$$\begin{array}{r} 14515 \\ -\ 8936 \\ \hline \end{array}$$

f 5589
g 5679
h 5689
i 6579
j NG

4 f g h i
5 a b c d
6 f g h i

7

$$\begin{array}{r} 435 \\ \times\ 45 \\ \hline \end{array}$$

a 18,575
b 19,375
c 20,575
d 19,575
e NG

8

$$\begin{array}{r} 96 \\ \times 78 \\ \hline \end{array}$$

f 7468
g 7478
h 7488
i 7588
j NG

9

$5\overline{)3015}$

a 60, rem 3
b 603
c 63
d 605
e NG

7 a b c d
8 f g h i
9 a b c d

10

$$\begin{array}{r} 13803 \\ -\ 7957 \\ \hline \end{array}$$

f 5846
g 5836
h 5746
i 6846
j NG

11

$$\begin{array}{r} 6677 \\ 9998 \\ +7568 \\ \hline \end{array}$$

a 23,243
b 24,143
c 24,243
d 24,233
e NG

12

$$\begin{array}{r} 758 \\ 7668 \\ +8789 \\ \hline \end{array}$$

f 16,215
g 17,115
h 17,205
i 17,215
j NG

10 f g h i
11 a b c d
12 f g h i

13

$9\overline{)8802}$

a $911\frac{3}{9}$
b 978
c 977
d $989\frac{1}{9}$
e NG

14

$$\begin{array}{r} 423 \\ \times 302 \\ \hline \end{array}$$

f 13,536
g 127,446
h 137,746
i 127,746
j NG

15

$24\overline{)848}$

a 35
b $35\frac{1}{8}$
c $35\frac{1}{4}$
d $35\frac{3}{8}$
e NG

13 a b c d
14 f g h i
15 a b c d

16

$\frac{2}{3} + \frac{2}{3} =$

f $\frac{4}{9}$
g $\frac{3}{4}$
h $1\frac{1}{3}$
i $1\frac{1}{4}$
j NG

17

What is the average of 4, 7, 3, 6?

a 4
b 5
c 7
d 20
e NG

18

$48\overline{)3792}$

f $76\frac{44}{48}$
g 79
h $79\frac{10}{48}$
i 709
j NG

16 f g h i
17 a b c d
18 f g h i

GO ON TO THE NEXT PAGE

4860

a $60\frac{3}{4}$
b $67\frac{1}{2}$
c 607
d $607\frac{1}{2}$
e NG

20

$$\begin{array}{r} 748 \\ \times\ 860 \end{array}$$

f 10,472
g 10,572
h 643,280
i 642,280
j NG

21

$78\overline{)6715}$

a $86\frac{7}{78}$
b $86\frac{17}{78}$
c $88\frac{71}{78}$
d $89\frac{73}{78}$
e NG

19 a b c d e
20 f g h i j
21 a b c d e

$$\begin{array}{r} \frac{1}{4} \\ -\ 1\frac{2}{3} \end{array}$$

f $1\frac{3}{4}$
g 2
h $1\frac{11}{12}$
i $2\frac{1}{3}$
j NG

23

$$\begin{array}{r} 1\frac{1}{6} \\ -\ \frac{1}{2} \end{array}$$

a $\frac{1}{2}$
b $\frac{3}{4}$
c $1\frac{1}{4}$
d $1\frac{1}{6}$
e NG

24

$\frac{3}{5} \times 10 =$

f 6
g $10\frac{3}{5}$
h $16\frac{2}{3}$
i 30
j NG

22 f g h i j
23 a b c d e
24 f g h i j

$\times$ 0.25 =

a 0.05
b 0.5
c 1.25
d 5.0
e NG

26

$\frac{2}{5} \times \frac{1}{4} =$

f $\frac{3}{9}$
g $\frac{1}{10}$
h $\frac{3}{20}$
i $1\frac{2}{5}$
j NG

27

$$\begin{array}{r} 5 \text{ ft. } 8 \text{ in.} \\ +\ 3 \text{ ft. } 8 \text{ in.} \end{array}$$

a 8 ft. 4 in.
b 8 ft. 6 in.
c 9 ft. 6 in.
d 9 ft. 4 in.
e NG

25 a b c d e
26 f g h i j
27 a b c d e

$$\begin{array}{r} 112 \\ <\ 1.5 \end{array}$$

f 1.680
g 16.80
h 168.0
i 1680
j NG

29

$2\frac{2}{5} - 1\frac{4}{5} =$

a $\frac{3}{5}$
b $\frac{2}{5}$
c $1\frac{2}{5}$
d $1\frac{3}{5}$
e NG

30

$\frac{2}{3} \div \frac{1}{6} =$

f 4
g $\frac{1}{4}$
h $\frac{2}{9}$
i 12
j NG

28 f g h i j
29 a b c d e
30 f g h i j

What is the average of 15 in., 12 in., 21 in.?

a 12 in.
b 16 in.
c 21 in.
d 48 in.
e NG

32

12 $\div \frac{3}{4} =$

f $\frac{1}{16}$
g $\frac{4}{4}$
h $12\frac{3}{4}$
i 16
j NG

33

2.48 $\div$ 4 =

a .062
b 0.62
c 6.2
d 62
e NG

31 a b c d e
32 f g h i j
33 a b c d e

$$\begin{array}{r} \$87.49 \\ \times\ \quad 79 \end{array}$$

f $6911.71
g $6811.71
h $6901.71
i $7911.71
j NG

35

$\frac{1}{3}$ of 4 ft. 3 in. =

a 1 ft. 1 in.
b 1 ft. 4 in.
c 1 ft. 5 in.
d 1 ft. 13 in.
e NG

36

8 $\div$ 0.4 =

f .32
g 20
h 5
i 2.0
j NG

34 f g h i j
35 a b c d e
36 f g h i j

What is 20% of 40?

a 8
b 2
c 5
d 20
e NG

38

What is the quotient rounded to tenths?

$35\overline{)163}$

f 4.2
g 4.4
h 4.6
i 4.7
j 4.8

39

20 is what per cent of 80?

a 4
b 20
c 40
d 25
e NG

37 a b c d e
38 f g h i j
39 a b c d e

STOP

No. Right	1	2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39
Gr. Score	Below 20	22 26 29 33 35 37 38 41 44	46 48 50 52 54 56 58 59 60 62	63 65 66 68 71 74 77 79 82 85	88 94 99 105 112 117 122 126 129

DIRECTIONS: Read each question. Decide which of the answers given below is correct. Look at the answer spaces at the right or on your answer sheet (if you have one). Fill in the space which has the same letter as the answer you have chosen.

SAMPLE

A A dime is worth how many cents?

a 2 c 10
b 5 d 25

a b c d
A ○ ○ ● ○

1 Which term does not belong in this set?

a twenty-five c ninety
b forty d ten

a b c d
1 ○ ○ ○ ○

2  What fractional part of this figure is shaded?

e $\frac{1}{3}$ g $\frac{2}{3}$
f $\frac{1}{2}$ h $\frac{3}{4}$

e f g h
2 ○ ○ ○ ○

3 Which of the following is fourteen thousand fourteen?

a 14,14 c 140,014
b 14,014 d 1,400,014

a b c d
3 ○ ○ ○ ○

4 By estimation, choose the example that will have the largest product.

e 8×1379 g 8×1475
f 8×1388 h 8×1476

e f g h
4 ○ ○ ○ ○

5 In the number 1382, place value makes which digit worth most?

a 2 c 3
b 1 d 8

a b c d
5 ○ ○ ○ ○

6 Which is the smallest common denominator for $\frac{1}{4}$ and $\frac{1}{6}$?

e 4 g 12
f 6 h 24

e f g h
6 ○ ○ ○ ○

7 What is the average of 6 and 10?

a 4 c 7
b 8 d 16

a b c d
7 ○ ○ ○ ○

8 If N minus 6 is 8, what could be the value of N?

e 2 g 8
f 6 h 14

e f g
8 ○ ○ ○

9 $12 - 8 =$ ☐ Which numbers, if put in t box, would make the sentence true?

a $6 - 4$ c $10 - 6$
b $2 + 4$ d $4 + 4$

a b c
9 ○ ○ ○

10 In which figure are all angles equal?

e  g 

f  h 

e f g
10 ○ ○ ○

11 What is the value of N if $\frac{N}{25} = \frac{80}{100}$?

a 50 c 20
b $2\frac{1}{2}$ d 80

a b c
11 ○ ○ ○

12 In which of the following has the 6 the greatest valu

e 64 g 6.432
f 3.46 h 56

e f g
12 ○ ○ ○

13 This set of numbers has a certain relationshi
48 24 12 6 Which number comes next?

a 5 c 1
b 3 d 0

a b c
13 ○ ○ ○

14 Bob's answer for an addition example was 5647. Th
6 should have been 8. How large was his error?

e 2 g 200
f 20 h 2000

e f g h
14 ○ ○ ○ ○

15 One third of what number is 6?

a 2 c 12
b 3 d 18

a b c d
15 ○ ○ ○ ○

GO ON TO THE NEXT PAGE

Which of the following means 8 tens, 3 ones, and 5 hundreds?

e 583 g 853
f 835 h 538

16 e f g h

$3\frac{1}{2}$ equals —

a $0.3\frac{1}{2}$ c 3.50
b $3.00\frac{1}{2}$ d $0.003\frac{1}{2}$

17 a b c d

What is the multiplicand if the product is 12 and the multiplier is 2?

e 2 g 6
f 12 h 24

18 e f g h

Which fraction is expressed in lowest terms?

a $\frac{29}{291}$ c $\frac{405}{6000}$
b $\frac{486}{1350}$ d $\frac{93}{153}$

19 a b c d

How many hours pass from 11:15 A.M. to 1:30 P.M.?

e $2\frac{1}{4}$ g $2\frac{3}{4}$
f $2\frac{1}{2}$ h $9\frac{3}{4}$

20 e f g h

What does LXIV mean?

a 5115 c 1104
b 64 d 514

21 a b c d

What is 3752 rounded to thousands?

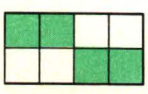
e 3700 g 4000
f 3750 h 3800

22 e f g h

Which of these fractional parts is the largest?

a $\frac{3}{7}$ c $\frac{4}{9}$
b $\frac{4}{7}$ d $\frac{2}{9}$

23 a b c d



What per cent of this figure is shaded?

e 4 g 40
f 25 h 50

24 e f g h

25 If x is some number greater than zero, which is $x \div x$?

a 1 c less than 1
b 0 d more than 1

25 a b c d

26 What is 0.197 rounded to hundredths?

e 0.2 g 0.19
f 0.20 h 0.198

26 e f g h

27 What is 4 divided by 8?

a $\frac{1}{2}$ c 2
b $\frac{1}{4}$ d 32

27 a b c d

28 What is the difference between a temperature of 12° above zero and 8° below zero?

e 4° g 12°
f 8° h 20°

28 e f g h

29 Which of the following cannot be divided (without a remainder) excepting by itself and 1?

a 37 c 51
b 24 d 68

29 a b c d

30 4 is what per cent of 8?

e 2 g 200
f 5 h 50

30 e f g h

31 0.04×9.8 is approximately —

a 0.04 c 4
b 0.4 d 40

31 a b c d

32 $4330 \div 34.64 =$

e 0.125 g 12.5
f 1.25 h 125

32 e f g h

No. Right	1	2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32
Gr. Score	Below 20	22 26 31 36 40 43 46 49 52	54 56 59 61 63 65 66 68 70 73	76 78 80 82 85 88 95 103 111 118	124 129

STOP

DIRECTIONS: Work each problem. Then look at the possible answers under the problem and see if your answer is given. If it is, fill in the answer space at the right or on your answer sheet (if you have one) which has the same letter as the answer you have chosen. If your answer is not given, fill in the space which has the same letter as the letter beside NG (which means "not given"). If NG is not listed for an example, one of the given answers is the correct answer. There is no sales tax in any problem on the test unless you are told otherwise. Use a separate sheet of paper for all figuring.

1 One hundred fifty children come to school on three buses. What is the average number of children on a bus?
a 30 b 50 c 100 d 450 e NG — 1 (a b c d)

2 Candy bars are 6 for 25¢. How many could you buy for $1.00?
f 12 g 30 h 24 i 60 j NG — 2 (f g h i)

3 Adults' tickets are 90¢ and children's are 35¢. How much will 3 children's and 2 adults' tickets cost?
a $2.85 b $1.25 c $1.80 d $1.05 e NG — 3 (a b c d)

4 Tony can stay a quarter of an hour. That is —
f 10 min. g 15 min. h 25 min. i 30 min. j NG — 4 (f g h i)

5 Dick bought one toy at 70¢ and one at 85¢. He gave the clerk $2.00. How much change should he get back?
a 45¢ b 15¢ c 83¢ d $1.55 e NG — 5 (a b c d)

6 How much did Andy spend in all? He bought 2 fish at 30¢ each and 2 boxes of fish food at 25¢ each.
f 55¢ g 80¢ h 85¢ i $1.10 j NG — 6 (f g h i)

Today is Bank Day at school. Here are some of our money problems.

7 Betty's average deposit is 50¢ per week. What would the total for 25 weeks be?
a 75¢ b $5.00 c $25.50 d $125.00 e NG — 7 (a b c d)

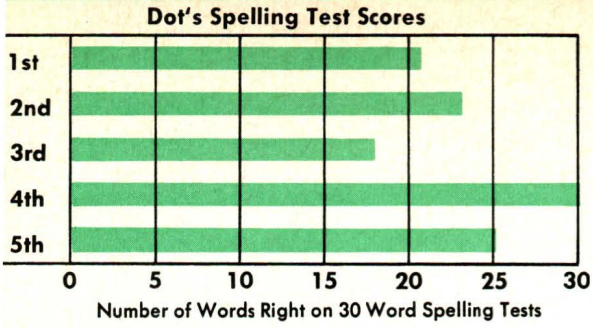
8 Total deposits this week are $8.25. Don says that is 75¢ more than last week. What was last week's amount?
f $7.50 g $7.00 h $7.75 i $9.00 j NG — 8 (f g h i)

9 The first two deposits were for 25¢ each and the next three for 50¢ each. How much is this in all?
a 50¢ b 75¢ c $2.00 d $1.50 e NG — 9 (a b c d)

10 Someone from the bank will come at 10:15 A.M. Our bag must be in the office at 9:30 A.M. How much ahead of time is this?
f 15 min. g 30 min. h 45 min. i 1 hr. 15 min. j NG — 10 (f g h i j)

11 "I am one fourth through this book," said Gloria, as she reached page 60. How many pages has her book?
a 15 b 30 c 180 d 240 e NG — 11 (a b c d e)

GO ON TO THE NEXT PAGE



12 How many words did Dot miss the last 2 weeks?
f 5 g 1 h 10 i 55 j NG — f g h i j — 12 ○ ○ ○ ○ ○

13 Which week did Dot score 23?
a 1st b 4th c 3rd d 2nd e NG — a b c d e — 13 ○ ○ ○ ○ ○

14 How many words better was she for the 4th week than for the 3rd week?
f 3 g 10 h 15 i 22 j NG — f g h i j — 14 ○ ○ ○ ○ ○

What is each girl's equal share for a party? You know the total cost. What else do you need to know?
a how many guests there were
b the cost of the cakes
c the date of the party
d the number of girls who share
e No other information is needed.
a b c d e — 15 ○ ○ ○ ○ ○

There are 250 children in our school. Ten per cent of them were absent because of the hurricane. What is 10% of 250?
f 25 g 5 h 50 i 2500 j NG — f g h i j — 16 ○ ○ ○ ○ ○

Our class will visit the TV station. Here are some of our problems.

Miss Martin's class will go just two weeks later. What date will that be? To answer this you must know —
a how many pupils can go
b the date we go
c how many parents go
d which TV station it is
e the number of pupils who will go
a b c d e — 17 ○ ○ ○ ○ ○

How many cars will we need for 30 pupils, 11 parents, and our teacher? Each car will take 6.
f 5 g 7 h 6 i 8 j NG — f g h i j — 18 ○ ○ ○ ○ ○

The number of TV listeners from 6 P.M. to 10 P.M. is estimated at an average of 15,000 in our city of 60,000. This is one person in every —
a 4 b $2\frac{1}{2}$ c 15,000 d 45,000 e NG — a b c d e — 19 ○ ○ ○ ○ ○

We have our appointment at 10:15 A.M. When should we leave if we allow 10 minutes to load, 40 minutes to go, and 15 minutes to park and go into the station?
f 11:20 A.M. g 9:15 A.M. h 9:50 A.M. i 9:10 A.M. j NG — f g h i j — 20 ○ ○ ○ ○ ○

Fred can spell 12 words. This is 50% of the total. How many words is the total?
a 6 b 12 c 24 d 17 e NG — a b c d e — 21 ○ ○ ○ ○ ○

Harry has 40 4-cent stamps. Steve has 10. Steve has what fraction of the number of stamps Harry has?
f $\frac{1}{4}$ g $\frac{1}{10}$ h $\frac{3}{10}$ i $\frac{1}{3}$ j NG — f g h i j — 22 ○ ○ ○ ○ ○

One inch on a map is 4 miles. How far is $1\frac{1}{2}$ inches on the map?
a $1\frac{1}{2}$ mi. b 6 mi. c $5\frac{1}{2}$ mi. d 4 mi. e NG — a b c d e — 23 ○ ○ ○ ○ ○

We need 2 melons for every 5 people. How many melons will we need for 30 people?
f 10 g 75 h 15 i 12 j NG — f g h i j — 24 ○ ○ ○ ○ ○

Ted has 6¢ and Joe has 30¢. Ted's money is what fraction of Joe's?
a $\frac{1}{4}$ b $\frac{1}{6}$ c $\frac{1}{8}$ d $\frac{1}{30}$ e NG — a b c d e — 25 ○ ○ ○ ○ ○

Mother, Sue, and Dave are shopping for new clothes. Here are some of their problems. Figure sales tax for number 28 only.

26 Jeans made of 10-ounce denim sell at 2 pair for $4.98. How much is this per pair?
f 50¢ g $2.44 h $2.99 i $9.96 j NG — 26 (f g h i)

27 What is the difference between the cost of a suit at $22.95 and the total cost of slacks at $7.95 and a sport coat at $12.95?
a $2.05 b $1.05 c 95¢ d $2.95 e NG — 27 (a b c d)

28 If the sales tax is 3¢ for each dollar spent, how much would it be for a dress at $8.50 and a sweater at $6.50?
f 26¢ g 45¢ h 42¢ i $19\frac{1}{2}$¢ j NG — 28 (f g h i)

29 Socks are 3 pair for $1.34 and 6 pair for $2.65. How much would a person save by buying the larger number of pairs?
a $\frac{1}{2}$¢ b 1¢ c $1.34 d 3¢ e NG — 29 (a b c d)

Road Distance in Miles

	Troy	Kane	York	Clay	Burr
Kane	80				
York	40	50			
Clay	50	120	70		
Burr	35	95	45	25	
Rice	50	85	35	45	30

30 From York to Clay is how much farther than from Troy to York?
f 5 mi. g 10 mi. h 30 mi. i 20 mi. j NG — 30 (f g h i)

31 Which town is farthest from Kane?
a Clay b York c Troy d Rice e Burr — 31 (a b c d)

32 Which town is nearest to York?
f Troy g Kane h Rice i Clay j Burr — 32 (f g h i)

33 Alice bought 4 pounds of fruit. Her change from a dollar bill was 40¢. What did the fruit cost per pound?
a 5¢ b 15¢ c 10¢ d 60¢ e NG — 33 (a b c d)

A = 4 C = 5
B = 8 D = 12

34 How many is (3 × B) − A − C?
f 1 g 15 h 2 i 17 j NG — 34 (f g h i)

35 Bill worked 15 problems out of 20. What per cent is that?
a $\frac{3}{4}$ b 15 c 50 d 75 e NG — 35 (a b c d)

36 A sales tax of 3% on $10 would be —
f $3\frac{1}{3}$¢ g $33\frac{1}{3}$¢ h 30¢ i $3.00 j NG — 36 (f g h i)

37 The girls are what fraction of our class? To find out, —
a divide number of boys by girls
b add boys and girls; divide by 2
c divide total class by girls
d divide number of girls by number in class
e subtract boys from girls
— 37 (a b c d)

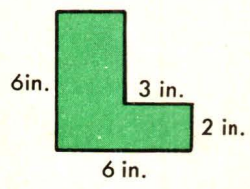


Figure A

38 How many square inches are there in Figure A?
f 17 g 30 h 24 i 36 j NG — 38 (f g h i)

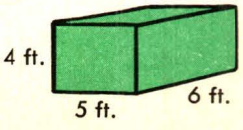


Figure B

39 How many cubic feet will the box in Figure B hold?
a 20 b 24 c 120 d 30 e NG — 39 (a b c d)

No. Right	1 2 3 4 5 6 7 8 9 10	11 12 13 14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30	31 32 33 34 35 36 37 38 39
Gr. Score	23 25 27 29 31 34 36 38 40 42	44 46 49 51 54 56 57 59 61 63	65 66 68 71 74 77 80 83 86 91	96 101 106 111 115 119 122 125 129

THE GUILFORD-ZIMMERMAN APTITUDE SURVEY

Part IV Perceptual Speed

Form A

ame_____ Date_____ Score_____

earest Age (encircle): 10 15 20 25 30 35 45 55 65 75 Sex: M F

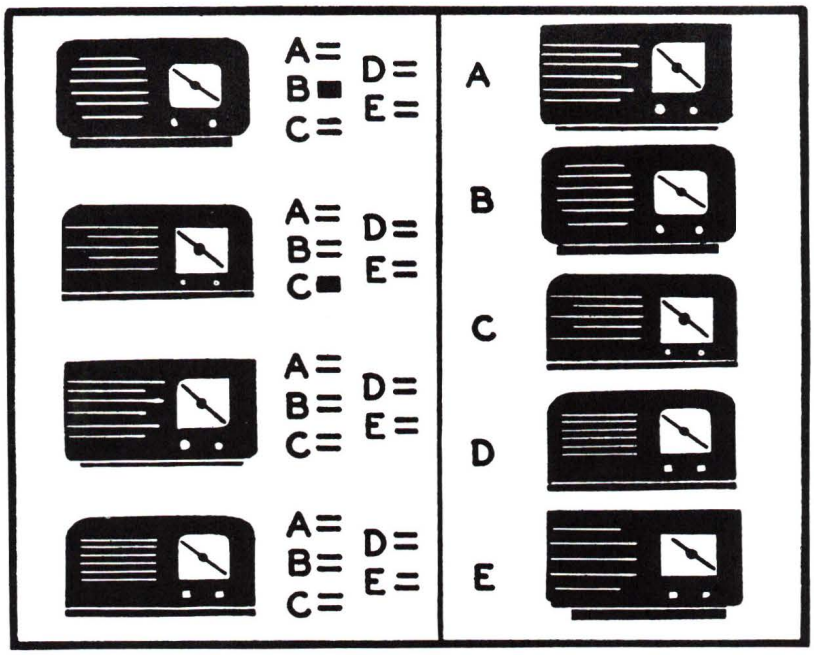
ears of school completed: 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Instructions.—This is a test of how rapidly and accurately you can see objects in order to match them.

Look at the first radio at the left. Which one of the five at the right is most nearly like it? Radio B is e one, so answer space B has been blackened.

Look at the second radio at the left. Which radio at the right is most nearly like it? Radio C is the rrect answer, so answer space C is blackened.

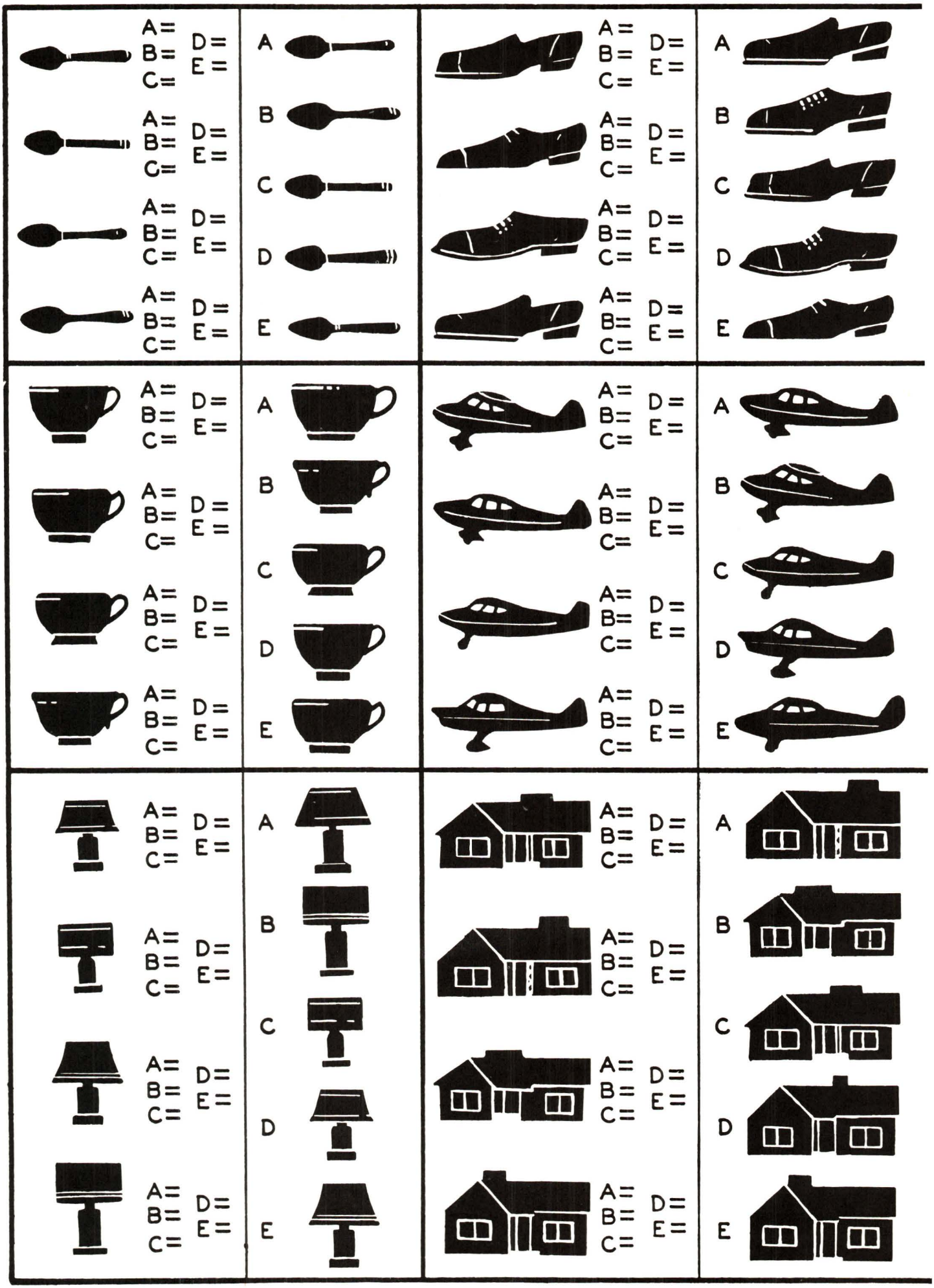
Now find the radios most nearly matching the third and fourth ones at the left and blacken the correct nswer spaces.

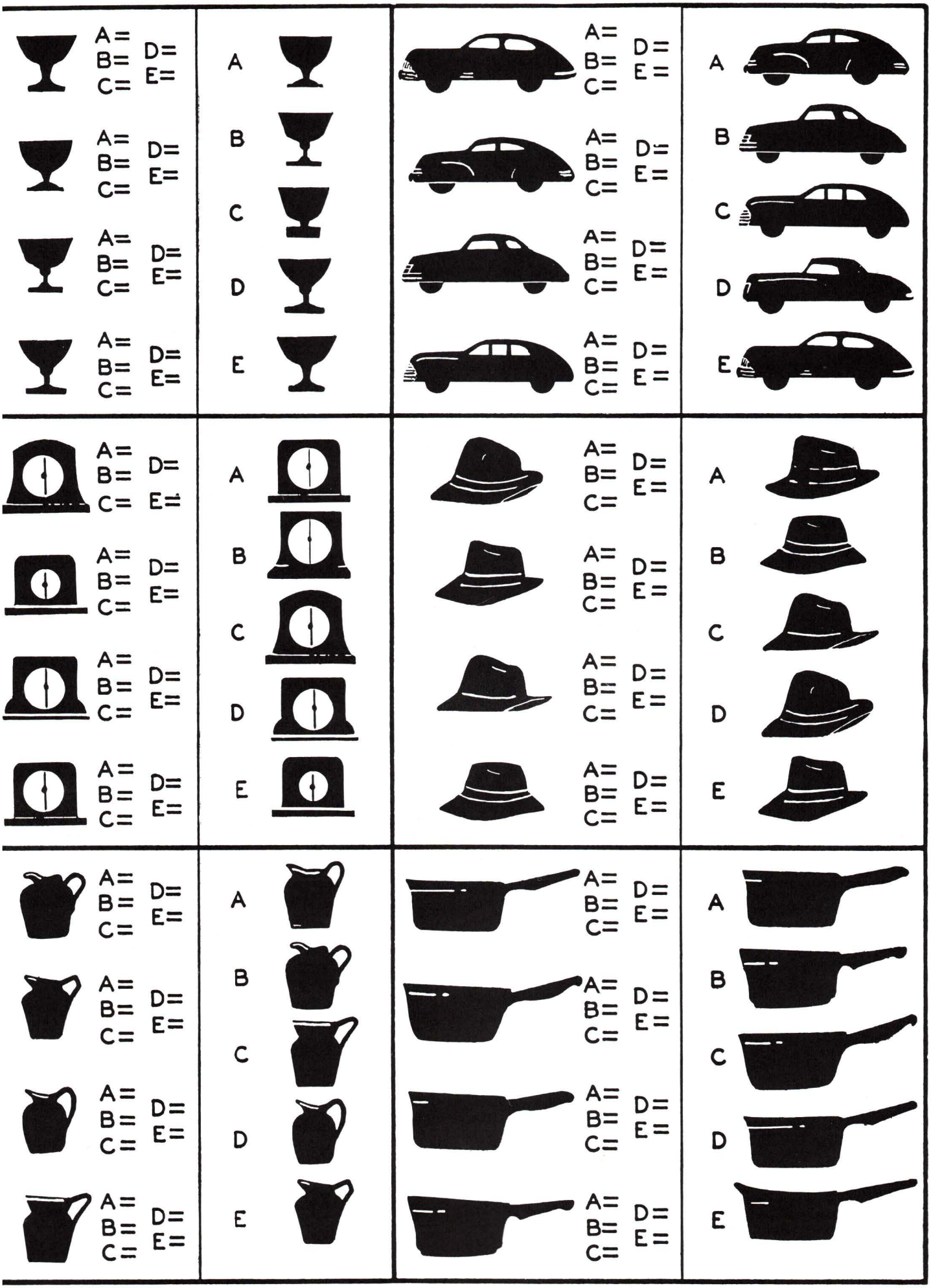


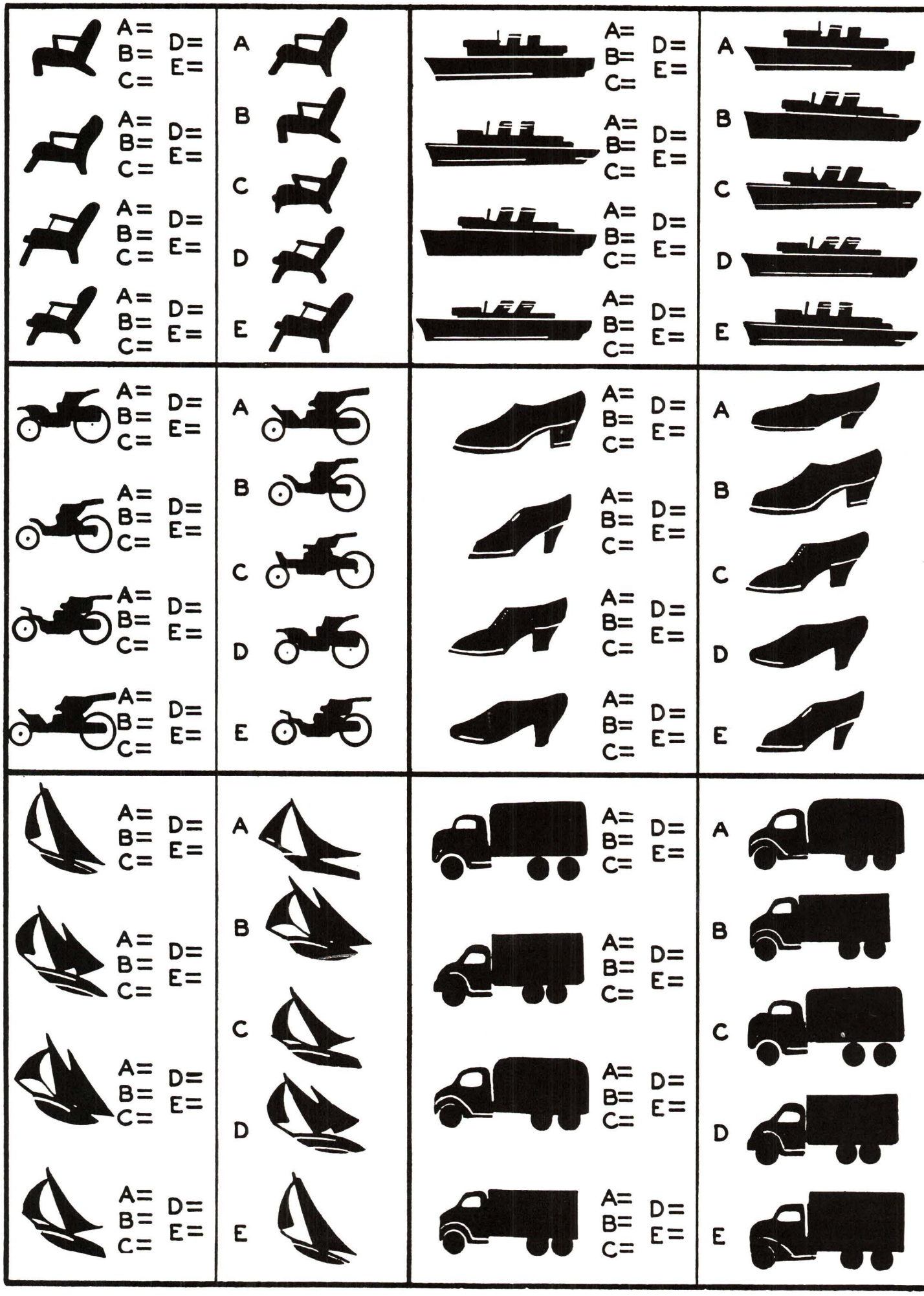
You should have blackened space A for the third radio and space D for the fourth.
If you have any questions, ask them NOW.

When the examiner gives you the signal, NOT BEFORE, turn the page and begin on the test. This is speed test, so work rapidly. You will have five minutes to work on this test. There are THREE pages of ems. WAIT FOR THE SIGNAL TO BEGIN. WHEN THE EXAMINER SAYS "STOP," STOP INSTANTLY.

WORK DOWN THE COLUMN




A= B= C= D= E=
A
B
C
D
E


A=
B=
C=
D=
E=
A
B
C
D
E

THE GUILFORD-ZIMMERMAN APTITUDE SURVEY

Part V Spatial Orientation

Form A

Name_____ Date_____ Score_____

Nearest age: 10 15 20 25 30 35 45 55 65 75 Sex: M F

Years of school completed: 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

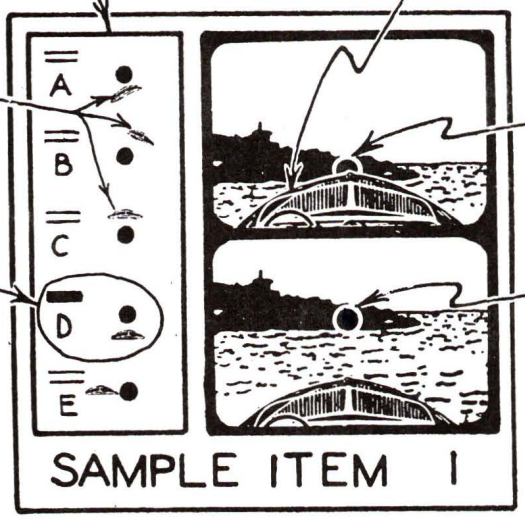
Instructions.—This is a test of your ability to see changes in direction and position. In each item you are to note how the position of the boat has changed in the second picture from its original position in the first picture.

Here is a sample item.

hese are the five possible answers to the item.

hese are tiny pictures of the oat's prow.

his is the correct answer. It hows that the prow of the boat as dropped below the aiming oint.



This is the prow (front end) of a motor boat in which ***you*** are riding.

This is the aiming point. It is the exact spot you would see on land if you sighted right over the point of the prow.

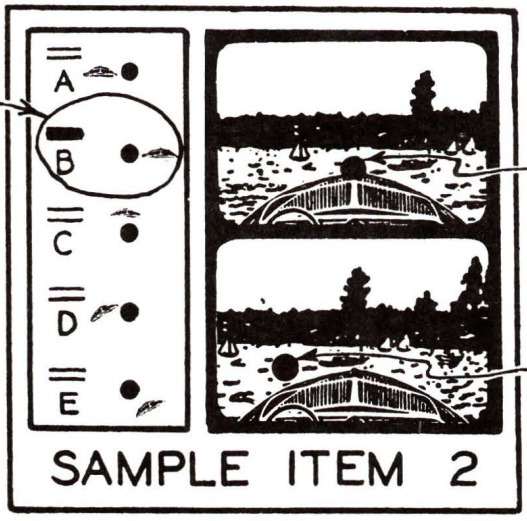
This is the same aiming point shown above. Note that the prow of the motor boat has dropped below it.

(If the prow had risen, instead of dropped, the correct answer would have been C, instead of D.)

Other items in the test are very similar to SAMPLE ITEM 1. To work each item: ***First,*** look at the top picture. See where the motor boat is headed. ***Second,*** look at the bottom picture and note the CHANGE in the boat's heading. ***Third,*** mark the answer that shows the same change.

Try Sample Item 2.

s also shows that the prow of boat is to the right of the ning point. So, it is the cor- t answer.



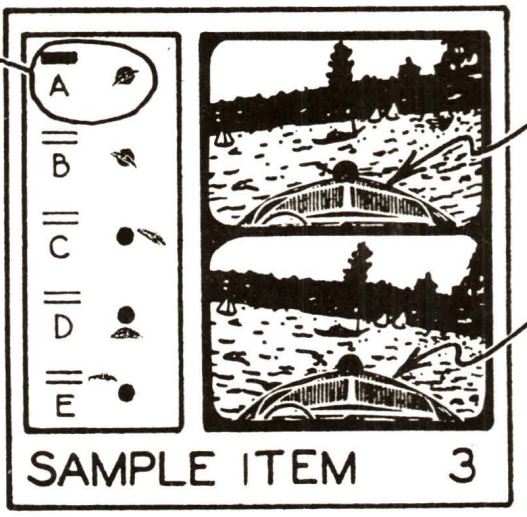
This is the aiming point.

This is the same aiming point. The motor boat is now headed to the right of it.

(If the boat had turned to the left, instead of to the right, the correct answer would have been A.)

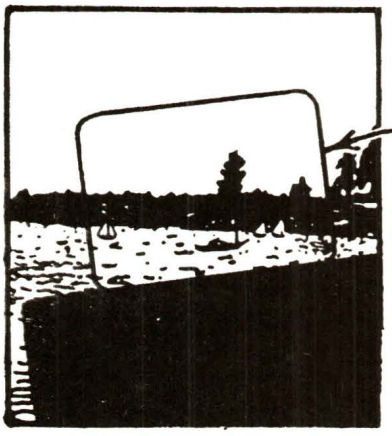
Now try Sample Item 3.

This is the correct answer. It shows that the motor boat changed its slant to the left, but that it is still heading toward the aiming point.



Here the motor boat is slant slightly to the right. (Note th the horizon appears to slant the opposite direction.)

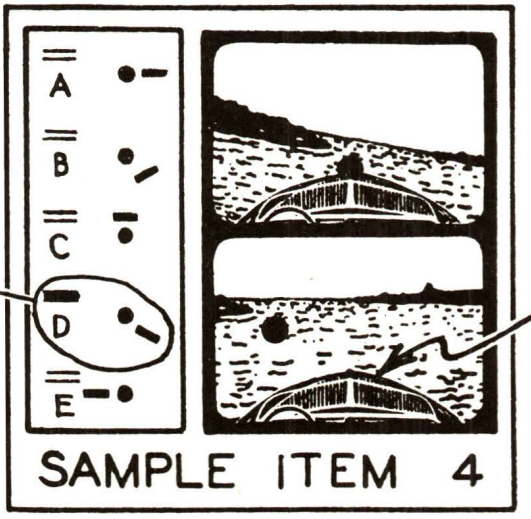
Here the boat has changed slant toward the left. (See e planation below.)



Imagine that these pictures were taken with a motion picture camera. The camera is fastened rigidly to the boat so that it bobs up and down, turns and slants with the boat. Thus, when the boat tips or slants to the left (as in the lower picture in SAMPLE ITEM 3), the scene through the camera view finder looks slanted like this.

Look at Sample Item 4.

D is the correct answer. It shows that the boat (from now on only a bar will be shown in the answer in place of the tiny picture of the boat's prow) changed its heading both downward and to the right; also that it changed its slant toward the right. (In the top picture the boat was slanting left. To become level, the boat slanted back toward the right.



The prow of the boat h moved downward and towa the right. Also it has change its slant toward the right. was slanted left in the top pi ture, and it became level. become level, it had to sla back toward the right.)

Now Do Practice Items 5, 6, and 7. Record Your Answers.

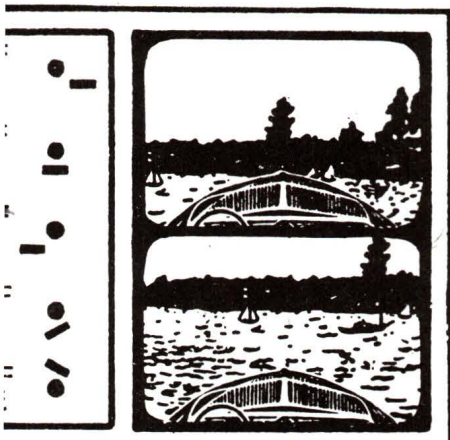
The aiming point is not marked in the test items. You must see the change in the boat's position without the l of the dots.

To Review:

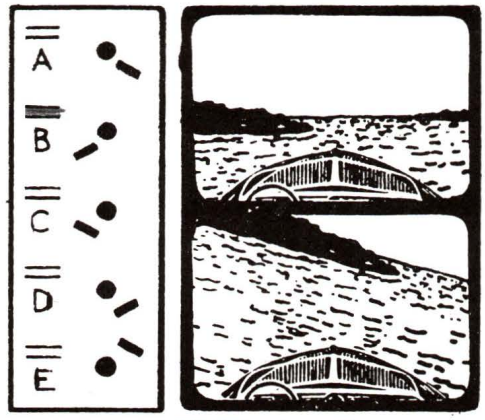
First — Look at the top picture. See where the motor boat is headed.

Second — Look at the bottom picture. Note the change in the boat's heading.

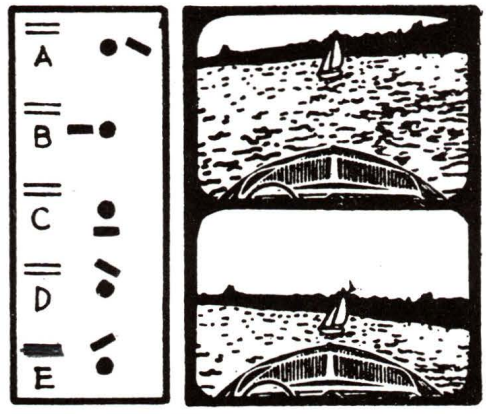
Third — Mark the answer that shows the same change (in reference to the aiming point before the change).



ITEM 5



ITEM 6



ITEM 7

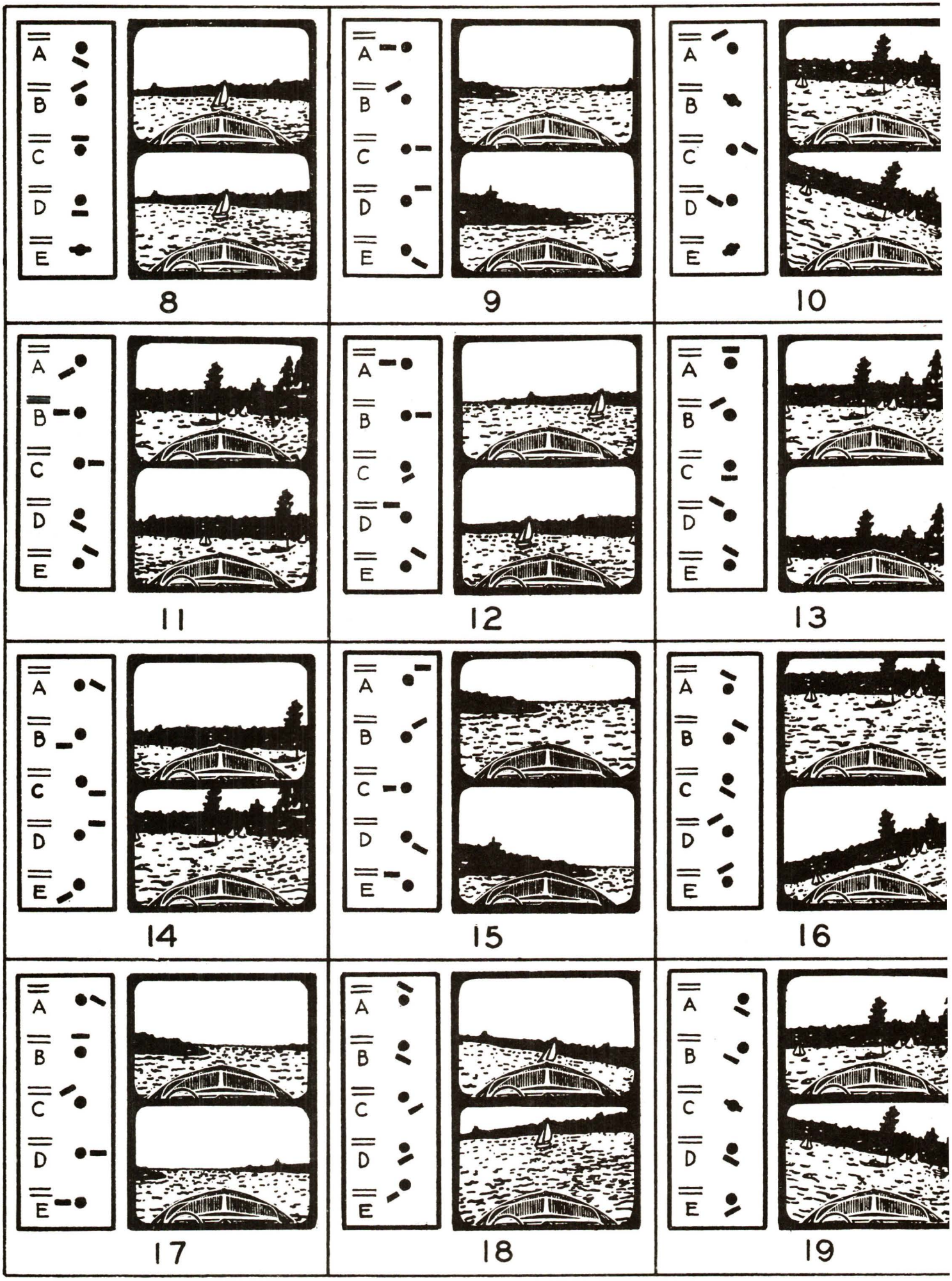
is the correct answer. The prow ppears to have moved to the left nd downward. It has not hanged its slant.

B is the correct answer. The prow appears to have moved to the left and downward. Also, it has changed its slant to the left.

E is the correct answer. The prow appears to have moved upward, and to have tipped left. It has not turned.

If you have any questions, ask them now.

At the signal from the examiner, not before, turn the page and begin working on the test. Work rapidly. If you are not sure about any item, you may guess, but avoid wild guessing. Your score will be the number of answers correct minus a small fraction of the number wrong. You will have ten minutes to work on the test. Wait for the signal to begin.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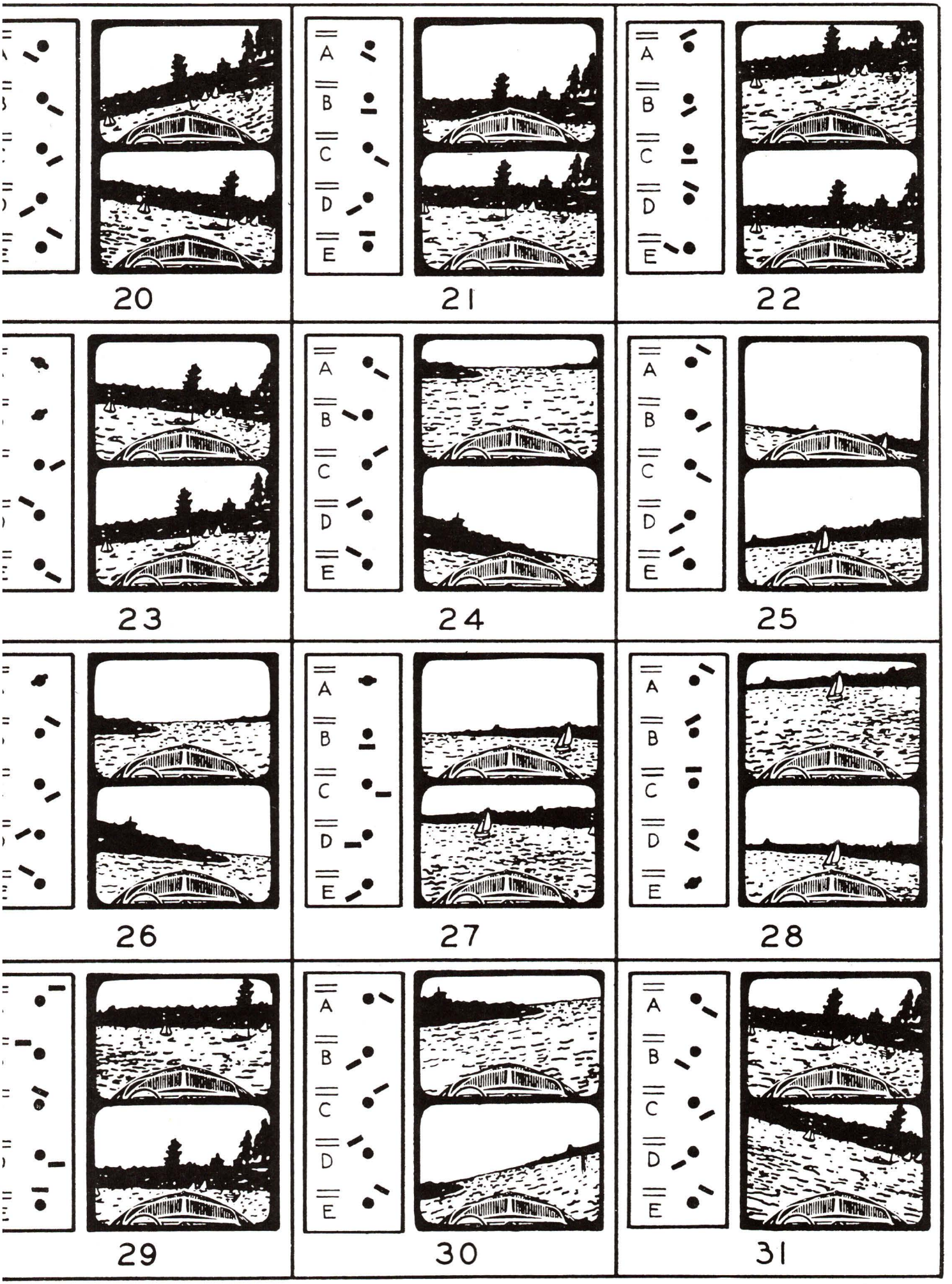
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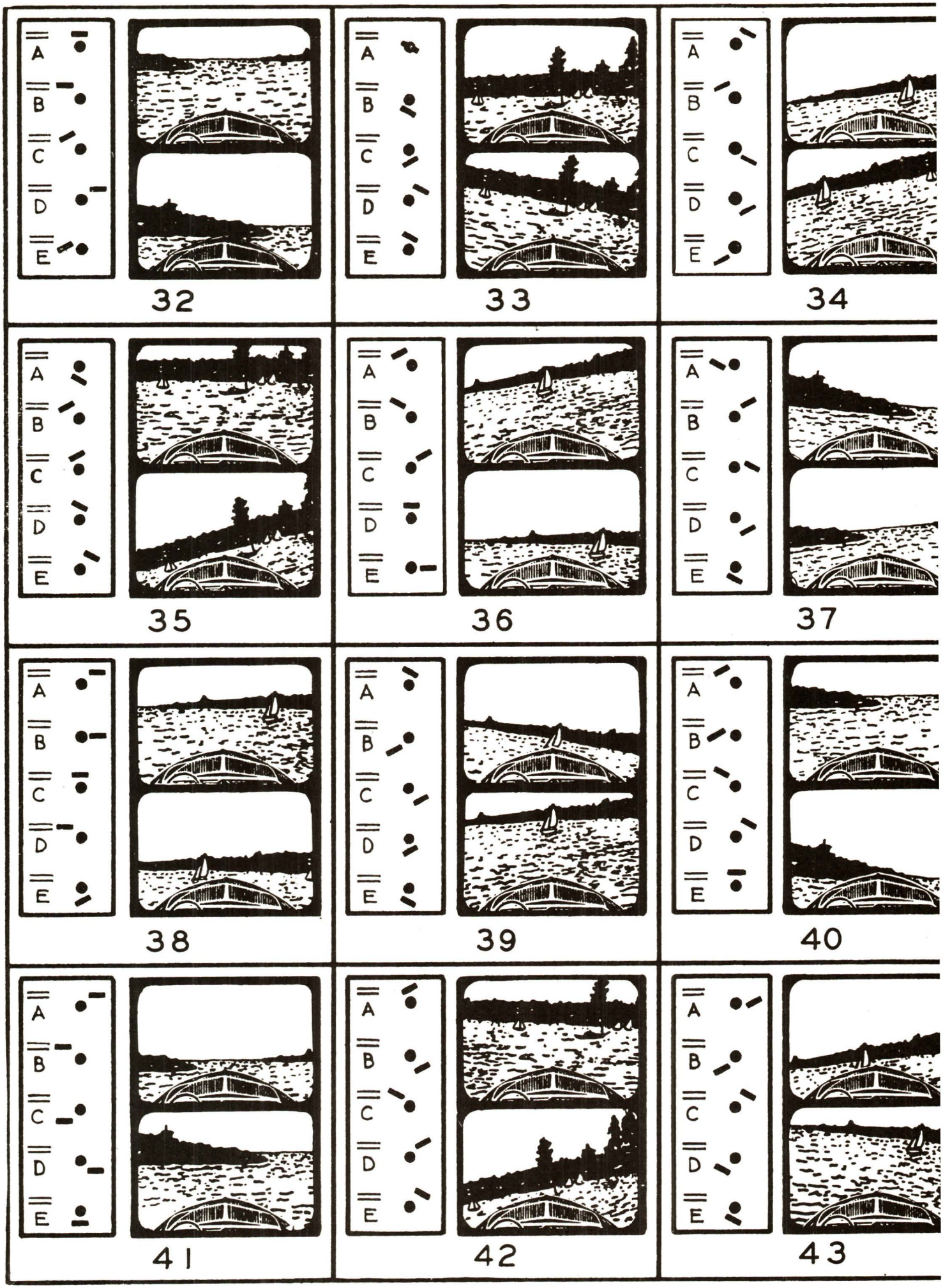
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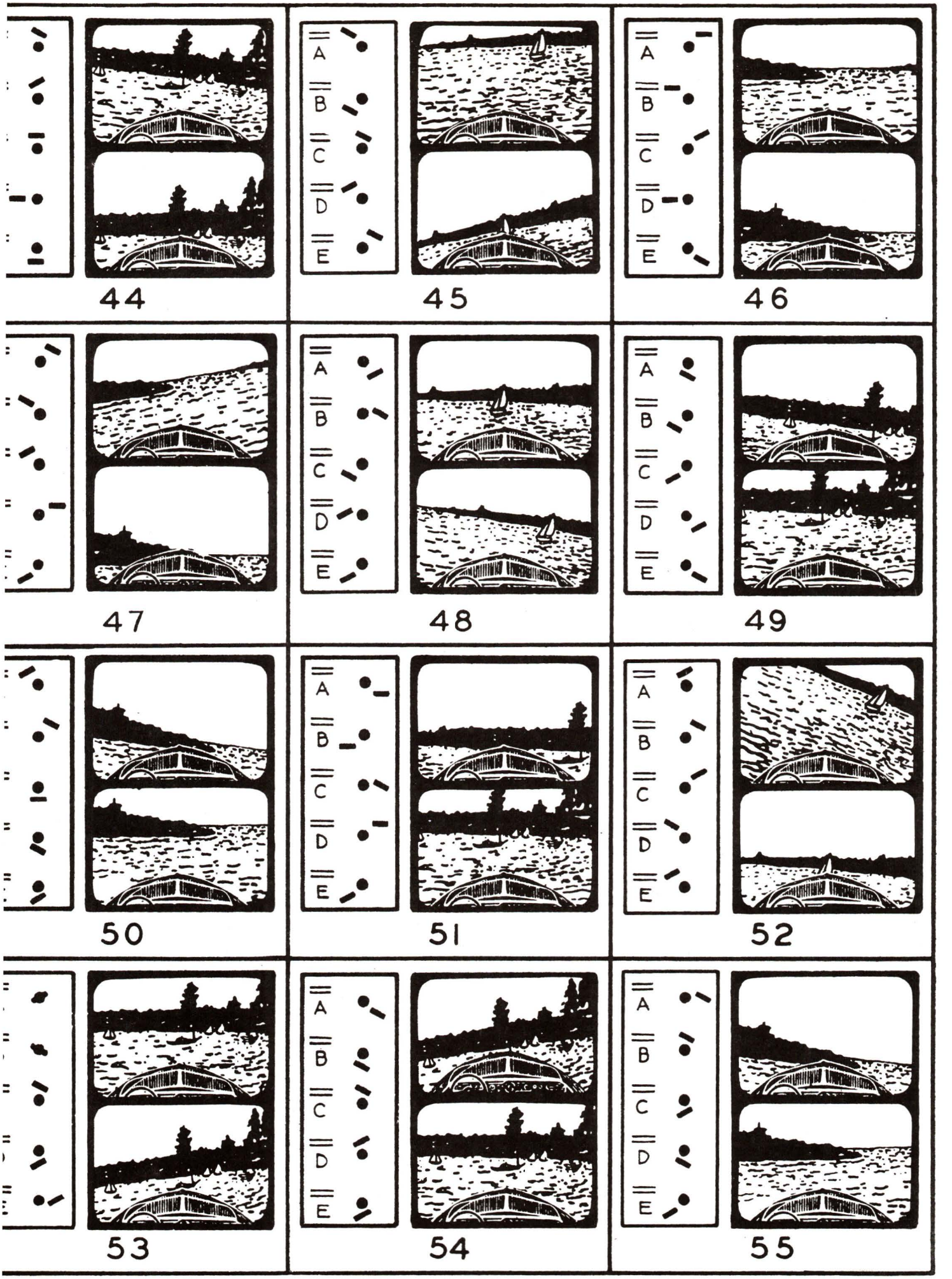
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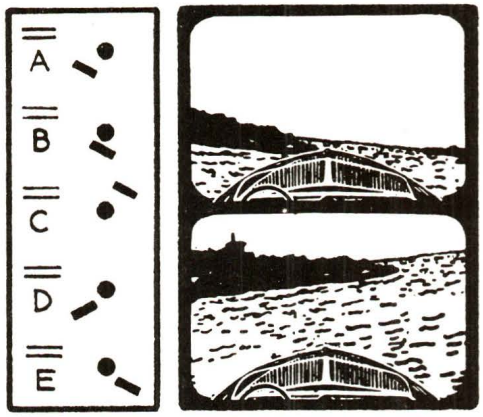

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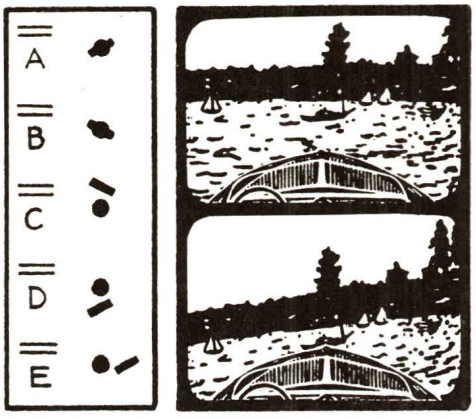

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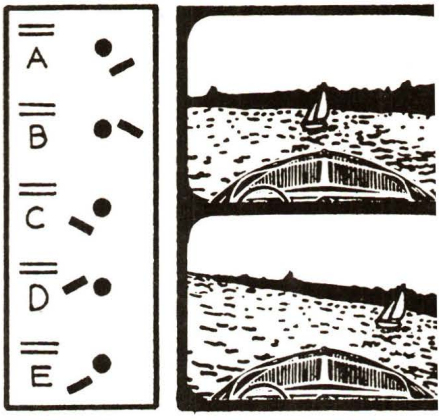

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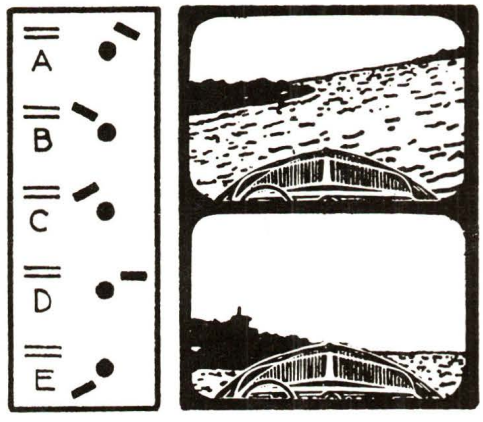

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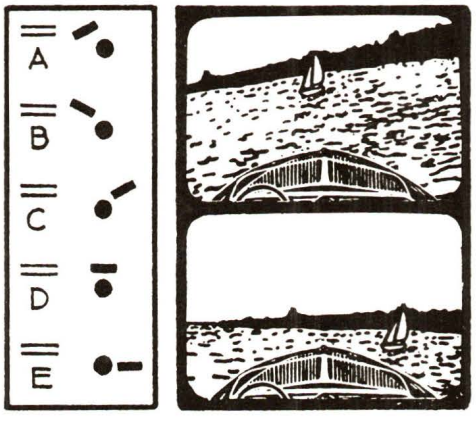

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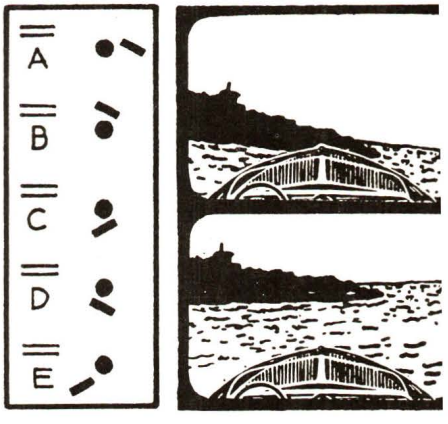

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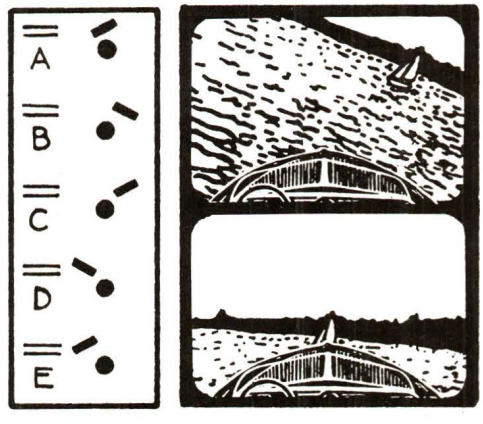

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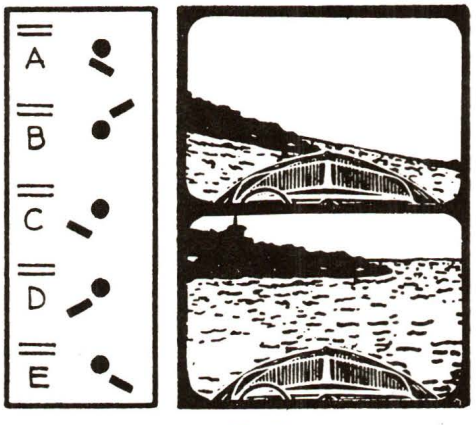

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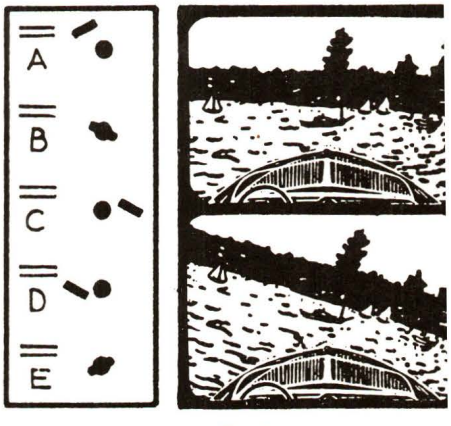

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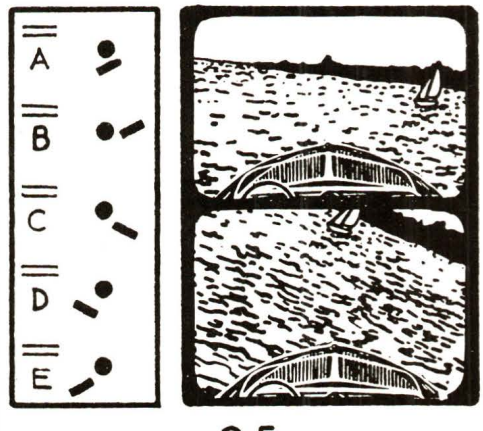

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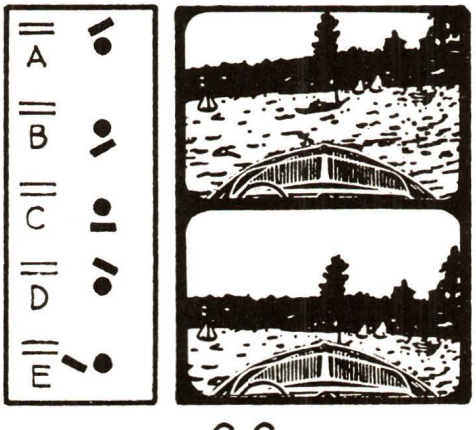

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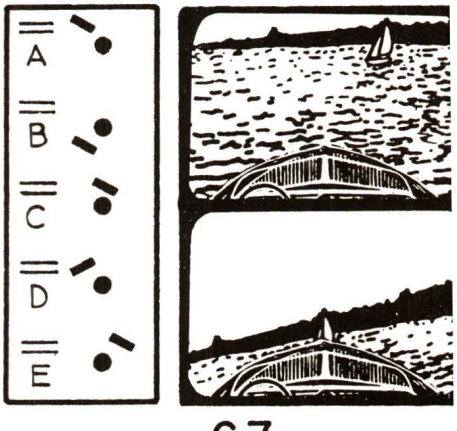


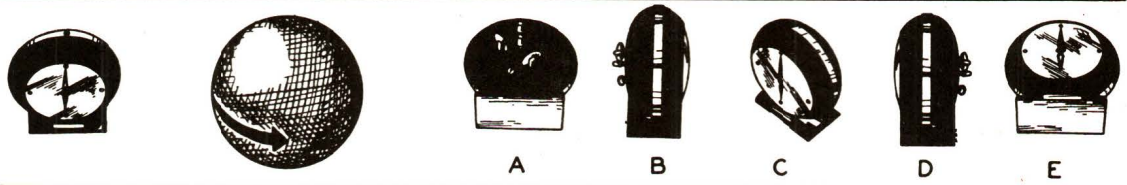
67

THE GUILFORD-ZIMMERMAN APTITUDE SURVEY

Part VI Spatial Visualization

Form B

I

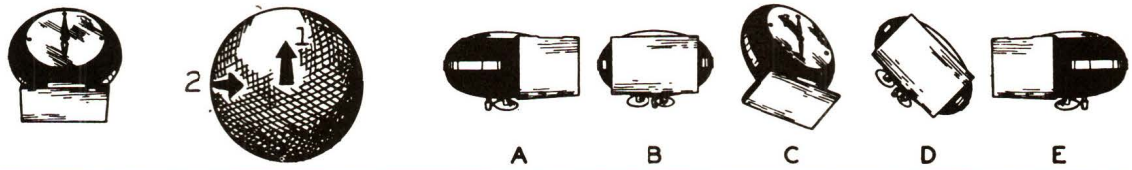


The first picture at the left shows a clock. Next to it is a sphere with an arrow marked on it. The arrow shows how the clock is to be moved. This move is illustrated (in two steps) in the picture below. When the clock is moved the one-quarter turn shown by the arrow, it is then in position B. B is therefore the correct answer. You would record this by blackening the answer space right below B on your answer sheet. (But do not record answers to sample items.)

Original position

Position after the move has been completed.

II



Two movements of the clock are called for by the two arrows on the sphere. Move number 1 must be visualized first. Move number 2 must then be started from the clock's position after the first move. In item II, each arrow shows one-eighth of a turn. The two moves, if visualized correctly, would place the clock in position A. The pictures below illustrate, in two steps, how the two moves should be visualized, one following the other.

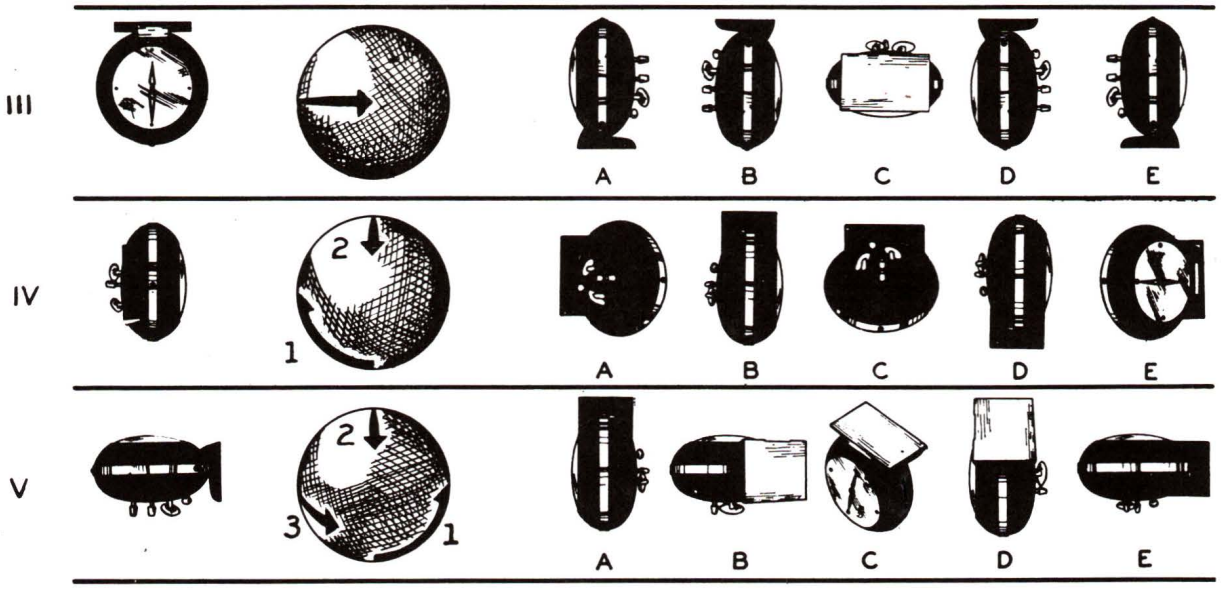
Original Position

Position after move number 1

Position after move number 2

In some of the items, three moves will be called for. Remember that each move, after the first, must be started from the clock's position after the move just before has been completed.

Now try sample items III, IV, and V:



The correct answers are: III, B; IV, C; V, C. If you did not get these answers, look over the items again to see where you made your mistakes.

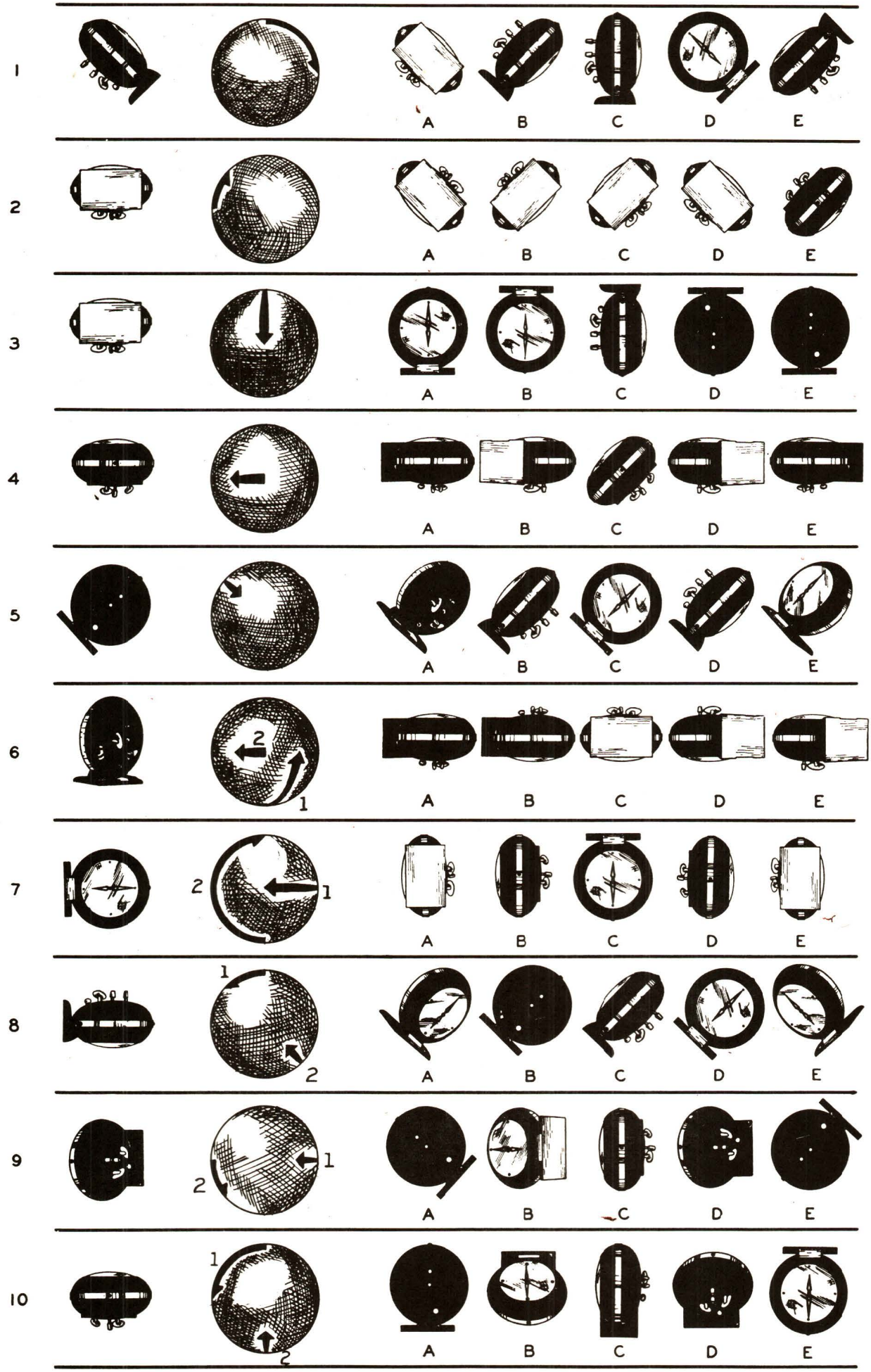
If you have any questions, ask them NOW.

You will have 10 minutes to work on this test. Do not spend too much time on any one item. If you finish before time is called, you may go back and check your work.

If you are not sure about the answer to any item, you may guess, but avoid wild guessing. Your score will be the number of correct answers minus a fraction of the number wrong.

WAIT FOR THE SIGNAL TO BEGIN.

DO NOT WRITE IN THIS BOOKLET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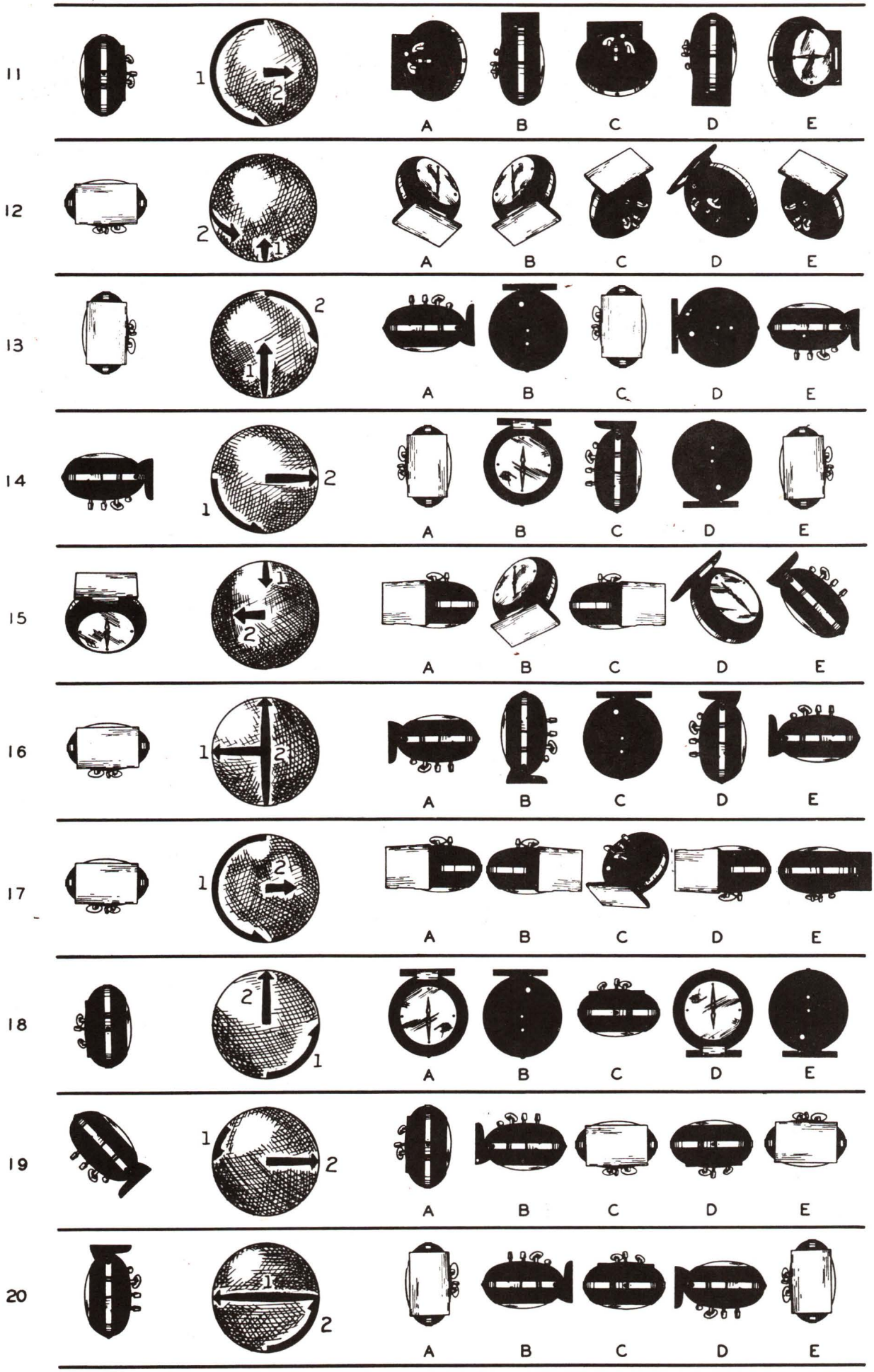
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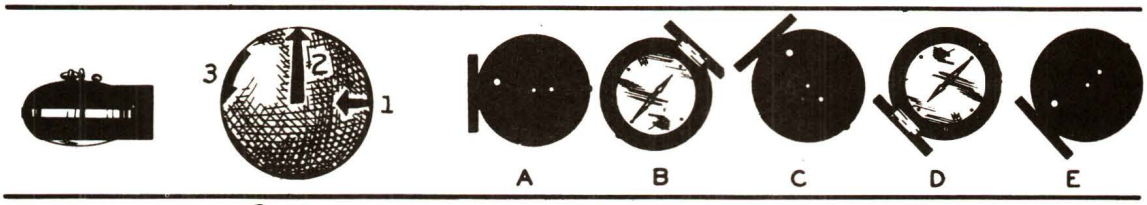

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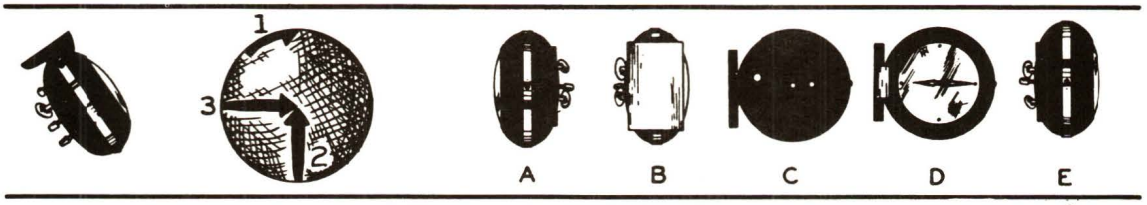

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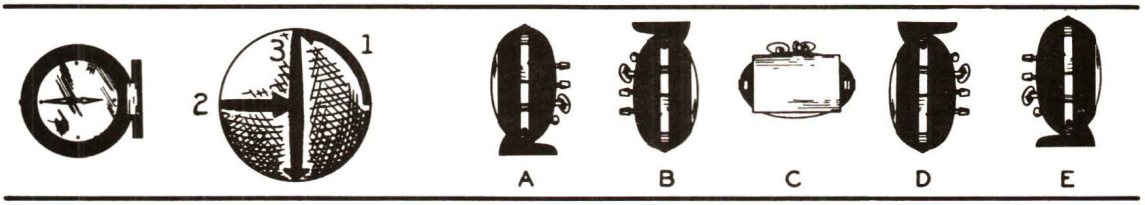

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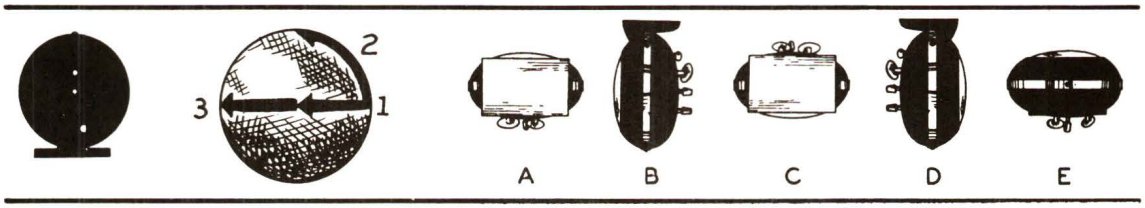
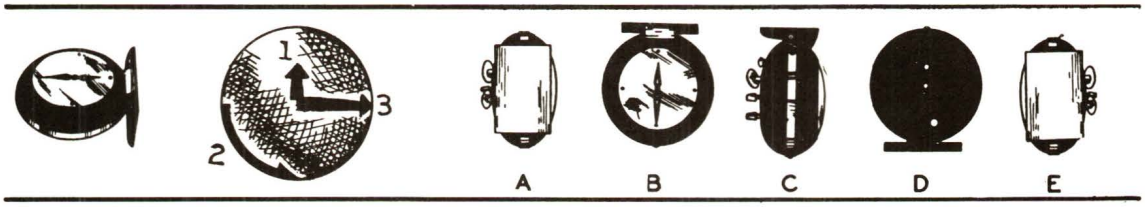


25



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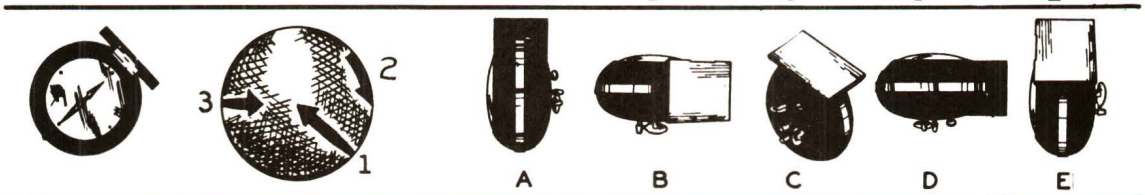

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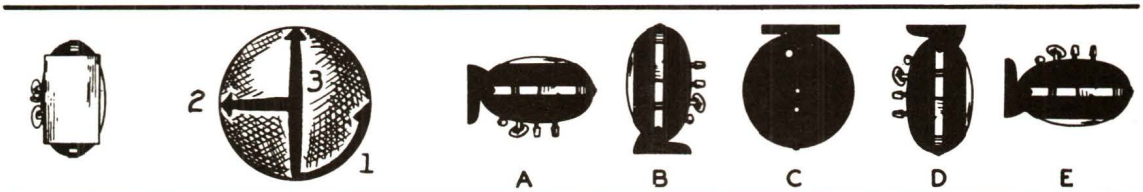

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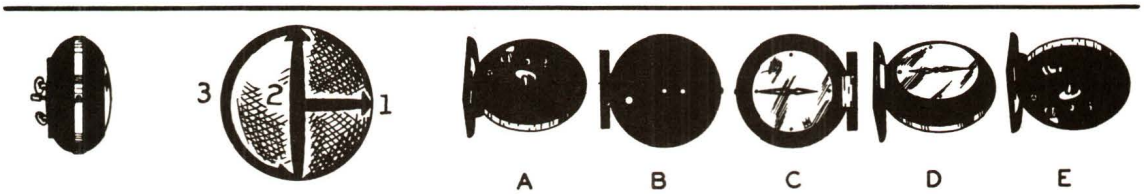

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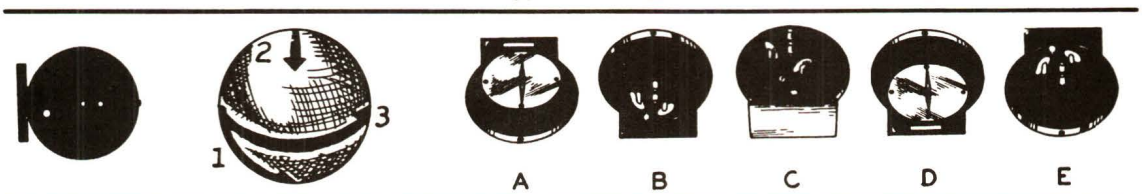

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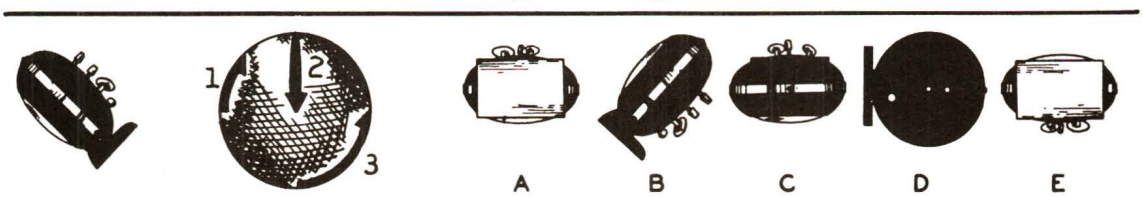

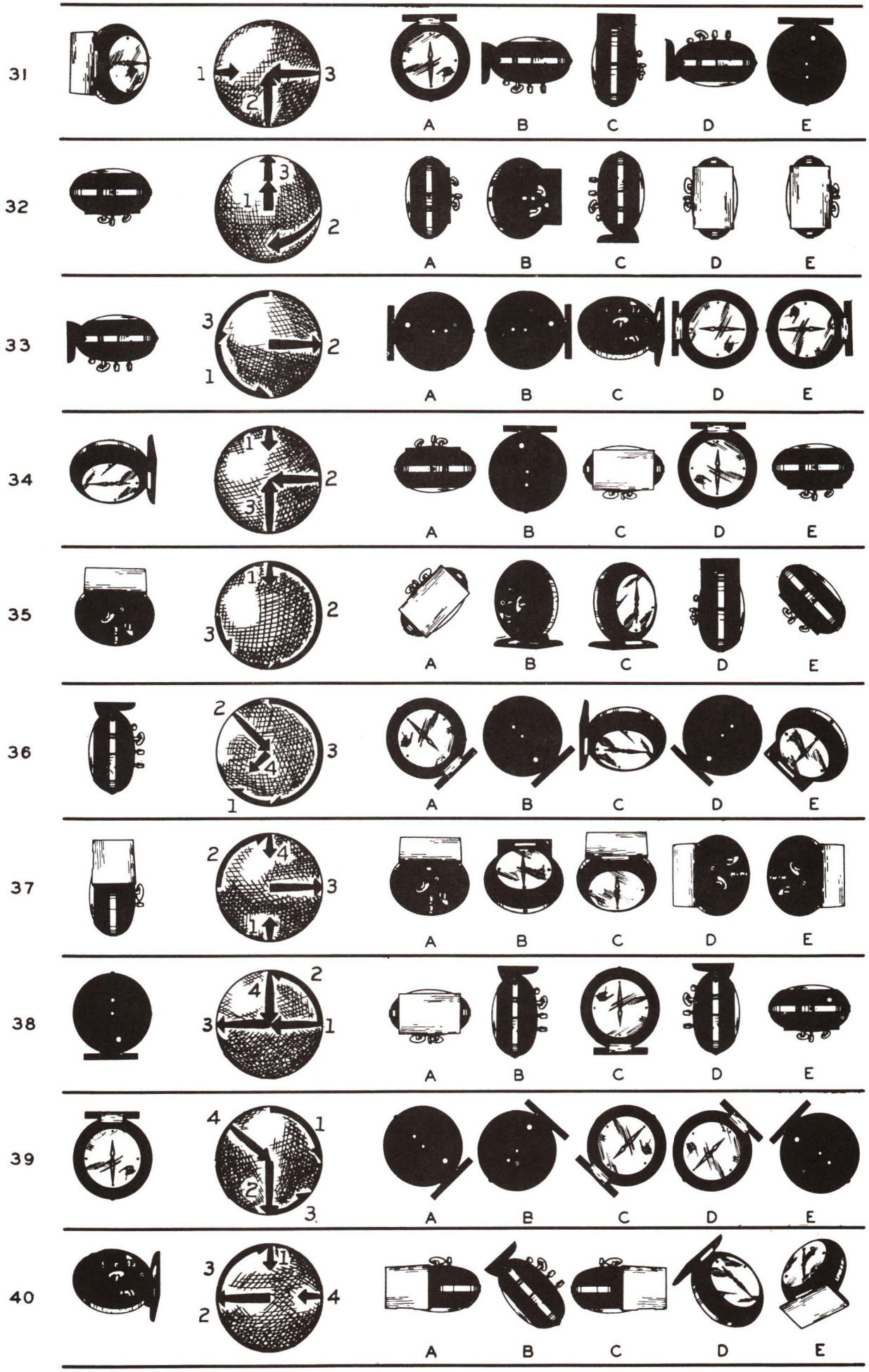
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APPENDIX VII

TABULATION OF RAW SCORES

FOR

THE STANFORD ACHIEVEMENT TEST

GUILFORD ZIMMERMAN PERCEPTUAL TESTS

AND

WORD SCORES FOR LEARNING TASKS

Student Number	Experimental Group	ACHIEVEMENT TESTS							PERCEPTUAL TESTS			WORD SCORES SYMBOLIC			ICONIC				
		Word Meaning	Paragraph Meaning	Spelling	Language	Arithmetic Computation	Arithmetic Concepts	Arithmetic Applications	Perceptual Speed	Spatial Orientation	Spatial Visualization	Trial One	Trial Two	Trial Three	Trial One	Trial Two	Trial Three	Post-Test-A	Post-Test-C
1	111	46	96	43	56	28	21	29	45	13	17	12	10	10	5	10	12	13	23
2	121	30	93	40	53	13	14	16	65	16	9	7	11	14	12	5	9	5	15
3	123	36	87	37	46	12	20	27	28	19	9	8	12	11	8	6	12	14	27
4	121	30	73	29	43	25	14	21	46	29	15	8	13	14	7	12	13	8	24
5	113	35	82	32	39	20	21	30	29	13	6	9	11	13	12	9	8	19	25
6	111			23	26	11	9	6	34	10	5	11	10	12	5	13	14	10	20
7	433	26	82	24	41	17	16	21	51	4	10	7	7	9	8	6	6	9	24
8	11-	48	97	33	41	29	25	28	40	22	17	10	13	5	8	9	3	12	21
9	112	18	48	28	20	11	8	16	44	13	10	10	10	11	10	10	10	12	10
10	433	23	71	25	22	9	8	11	35	9	8	8	5	7	7	9	13	12	21
11	112	48	97	38	56	21	26	30	43	11	8	13	8	11	8	12	14	12	24
12	112	50	88	44	51	30	18	23	46	15	7	13	10	11	11	12	11		
13	121	28	69	22	31	15	15	14	41	19	8	8	13	11	7	12	12	2	17
14	121	39	94	24	38	20	12	19	43	7	6	5	6	5	10	10	9		
15	211	38	75	35	52	26	24	25	70	18	9	11	10	13	9	7	14	17	24
16	121	28	76	21	32	14	14	20	52	11	8	10	8	10	6	11	13	23	31
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18	111	52	97	33	44	28	25	31	55	10	4	11	9	14		10	12	9	24
19	113	28	84	29	40	19	17	30	37	7	5	10	10	12	13	12	13	11	22
20	123	38	67	35	51	18	14	20	28	23	12	6	10	11	11	12	8	11	4
21	111	54	93	40	53	23	23	33	36	24	19	5	12	15	11	12	15	16	25
22	223	47	103	26	41	22	13	11	50	5	3	7	8	7	9	5	7		

Student Number	Experimental Group	ACHIEVEMENT TESTS							PERCEPTUAL TESTS			WORD SCORES SYMBOLIC			WORD SCORES ICONIC				
		Word Meaning	Paragraph Meaning	Spelling	Language	Arithmetic Computation	Arithmetic Concepts	Arithmetic Applications	Perceptual Speed	Spatial Orientation	Spatial Visualization	Trial One	Trial Two	Trial three	Trial One	Trial Two	Trial Three	Post-Test-A	Post-Test-C
23	433	27	64	24	26	14	9	13	37	12	7	7	7	7	10	8	13	14	21
24	433	28	70	19	23	11	13	14	49	7	6	7	8	7	9	7	6	5	21
25	111	53	93	34	48	29	23	28	56	22	14	10	9	8	10	14	13	6	21
26	111	55	120	44	60	31	30	35	44	18	13	13	11	12	9	13	14	12	22
27	211	34	82	29	51	28	21	25	67	28	12	9	4	9	7	6	9		
28	131	23	61	22	25	7	12	11	60	17	7	5	4	5	12	10	12	17	23
29	113	35	94	31	49	18	17	28	32	10	9	8	9	11	9	10	11	0	24
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35	121	34	78	27	34	10	16	16	49	18	4	8	7	9	10	12	14	7	17
36	123	75	61	39	25	11	20	12	20	7	8	13	10	12	7	10	14	12	23
37	122	30	78	31	37	13	17	25	41	14	6	10	11	10	8	9	12	12	21
38	122	38	96	33	43	16	20	22	40	16	7	11	13	9	11	11	12	9	18
39	133	37	75	34	55	15	11	18	34	8	0	12	10	12	8	10	13	9	26
40	111	46	90	39	52	32	29	36	56	10	6	11	10	7	14	15	14	14	22
41	113			31	42	20	19	26	31	12	9	12	10	10	12	14	14	11	23
42	---	37	88	33	46	16	21	21	49	11	7							16	26
43	132	48	76	21	35	8	13	23	36	13	8	10	7	11	13	11	10		
44	222	41	91	37	44	10	21	23	38	15	11	9	6	6	3	3	6		

Student Number	Experimental Group	ACHIEVEMENT TESTS							PERCEPTUAL TESTS			WORD SCORES SYMBOLIC			ICONIC				
		Word Meaning	Paragraph Meaning	Spelling	Language	Arithmetic Computation	Arithmetic Concepts	Arithmetic Applications	Perceptual Speed	Spatial Orientation	Spatial Visualization	Trial One	Trial Two	Trial Three	Trial One	Trial Two	Trial Three	Post Test-A	Post-Test-C
45	333	29	83	29	23	9	16	14	36	7	8	8	8	10	11	7	10	19	25
46	131	31	73	31	40	13	10	14	57	34	10	9	10	9	12	13	12	14	29
47	112	52	86	43	40	29	24	33	29	15	13	8	8	12	13	9	6	20	26
48	12-	32	68	28	44	23	18	15	60	7	8	10	11	10	10	13	14		
49	121	10	70	24	24	16	13	16	39	20	9	11	10	9	10	9	12	10	16
50	221	56	94	35	47	20	13	21	62	10	8	5	5	6	6	8	10		
51	121	41	90	30	51	24	15	21	49	10	10	12	10	12	8	11	12	13	20
52	123	29	72	25	25	16	17	25	37	9	6	8	9	8	10	15	13	15	21
53	111	46	96	34	53	29	27	35	47	23	20	10	13	9	9	15	14	7	16
54	123	34	58	37	35	13	19	24	36	10	12	11	11	12	10	12	12	12	24
55	112	46	73	27	44	17	19	26	43	15	2	8	7	11	14	11	8	17	19
56	433	37	82	28	43	5	16	21	28	5	6	8	12	8	9	10	12	12	16
57	123	50	91	34	40	16	19	22	52	6	6	11	11	10	9	11	14	15	23
58	311	43	68	28	42	21	20	23	49	12	10	9	12	9	11	6	10	13	28
59	111	19	78	28	42	14	23	26	53	17	4	7	10	7	11	12	11	10	21
60	111	46	94	31	46	24	22	27	32	21	16	12	11	10	9	15	13	11	20
61	433	40	77	25	26	20	15	10	28	14	3	9	8	11	9	12	15	4	17
62	123	34	77	25	29	15	19	21	32	13	2	11	5	11	3	12	15	12	26
63	122	30	81	28	14	20	18	12	43	12	9	8	7	10	14	13	13	13	25
64	131	32	60	22	20	8	6	10	62	17	6	10	9	11	10	11	13		
65	112	31	69	21	35	29	21	29	45	8	10	11	10	13	10	13	11	23	30
66	123	29	85	36	47	24	13	25	37	14	5	11	14	11	7	10	10	17	8

Student Number	Experimental Group	ACHIEVEMENT TESTS							PERCEPTUAL TESTS			WORD SCORES SYMBOLIC			ICONIC				
		Word Meaning	Paragraph Meaning	Spelling	Language	Arithmetic Computation	Arithmetic Concepts	Arithmetic Applications	Perceptual Speed	Spatial Orientation	Spatial Visualization	Trial One	Trial Two	Trial Three	Trial One	Trial Two	Trial Three	POst-Test-A	Post-Test-C
67	133	15	63	28	29	4	7	13	34	5	7	9	7	12	9	10	11	15	22
68	12-	42	74	30	44	9	18	29	29	14	11	11	6	9	8	10	11	8	16
69	113	51		44	53	24	24	29	31	12	9	10	12	12	7	12	13	17	9
70	11	44	89	37	47	22	19	25	44	22	11	6	8	9	8	6	9	12	23
71	122	33	79	30	42	19	15	13	38	20	3	10	9	12	10	10	8	10	22
72	123	37	75	29	23	5	9	19	41	15	6	9	9	12	10	13	14	6	12
73	132	34	64	21	24	8	9	8	42	17	7	9	9	6	10	10	6	11	28
74		45	85	23	32	17	16	19	49	9	0								
75	133	50	71	26	22	15	14	9	29	12	10	11	12	11	15	9	9	9	25
76	132	29	62	26	30	18	11	9	43	8	14	14	8	10	12	12	13	14	17
77	123	37	81	34	41	25	25	26	32	11	6	11	8	11	10	12	12		
78	121	27	61	27	33	21	10	11	5	14	11	11	10	12	8	11	11		
79	121	34	75	25	34	19	18	14	58	14	13	12	11	12	10	11	12	22	30
80	433	26	53	27	26	10	13	6	41	6	9	5	9	8	13	7	11	15	26
81	131	25	76	21	27	11	19	14	33	22	16	10	10	7	9	10	9	4	15
82	533	25	55	21	17	9	7	8	37	10	9	7	6	7	6	10	11	13	19
83	111	23	82	29	34	20	25	33	62	27	77	10	10	8	7	9	11	2	13
84	311	28	81	38	52	19	23	29	47	29	11	5	6	5	7	12	9	4	13
85	222	42	89	29	42	16	11	25	50	13	4	11	8	14	12	13	13	17	15
86	113	40	73	44	53	24	23	26	36	13	4	11	10	12	10	13	14	14	18
87	133	40	65	23	43	9	13	19	33	2	4	9	10	15	9	12	10	15	25
88		52	105	34	52	29	27	34	45	4	10								

		ACHIEVEMENT TESTS							PERCEPTUAL TESTS			WORD SCORES SYMBOLIC			WORD SCORES ICONIC				
Student Number	Experimental Group	Word Meaning	Paragraph Meaning	Spelling	Language	Arithmetic Computation	Arithmetic Concepts	Arithmetic Applications	Perceptual Speed	Spatial Orientation	Spatial Visualization	Trial One	Trial Two	Trial Three	Trial One	Trial Two	Trial Three	Post-Test-A	Post-Test-C
89	123	45	71	34	42	3	15	24	27	8	8	13	6	11	8	12	14	3	29
90	133	28	76	34	32	9	10	14	51	6	5	8	10	11	11	5	14	6	19
91	133	36	70	23	23	12	14	22	29	7	10	11	9	6	12	11	13	10	22
92	133	53	95	31	41	14	11	13	39	7	6	9	11	9	12	11	12	23	28
93	122	27	79	22	23	7	11	12	39	15	9	10	8	6	7	11	13	10	17
94	433	31	70	22	30	13	9	16	35	20	5	8	8	5	7	10	12	10	16
95	111	43	94	39	42	26	23	31	70	13	29	10	13	8	11	12	10	18	28
96	123	17	57	19	15	12	11	10	3	6	7	6	6	5	7	7	5	20	23
97	123	42	79	33	50	10	15	23	35	10	11	11	10	12	5	13	13	13	25
98	233	47	90	36	41	15	11	16	47	9	1	4	6	9	8	7	9		
99	122	42	88	30	46	17	16	25	53	11	2	12	6	13	11	12	12	6	22
100	121	50	95	22	45	15	17	27	48	18	15	10	9	13	10	12	12	14	22

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