EFFECT OF EMPHASIS ON TIME-TO-SOLUTION AND VERBAL VERSUS

SPATIAL STIMULI ON ATTRIBUTE IDENTIFICATION PERFORMANCE

by

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ABSTRACT

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Four hundred and thirteen students in twenty-four intact Grade Xl classes, under the direction of their regular teachers, from three secondary schools in Victoria, B.C., participated in two concept learning experiments. The aim was to test (1) the effect of instructions which emphasize speed and (2) the effect of spatial versus verbal stimulus materials on performance on an attribute identification task. The stimuli were twenty cards representing either four or six two-value dimensions (shape, size, color, number; and, location, outline). Two problems, each of twenty cards, were contained in a booklet. The responses of Ss to the stimuli were observed in terms of the number of cards to solution.

The results indicate that: (1) Ss who were instructed to work as quickly as possible solved proportionally fewer tasks and used more cards to solution in terms of a 5-point scale than Ss who were instructed to ignore time and to work as carefully as possible: and (2) Ss on verbal stimulus materials solved proportionally more tasks, achieved the solution with fewer card choices (in terms of a 15-point scale), and used fewer cards to solution (in terms of a 5-point scale), than Ss on spatial stimulus materials.

These findings suggest that speed and "goodness" of a response may not be interchangeable attributes; that the use of speed instructions in either an experimental situation or in classroom testing is questionable; and that spatial and verbal stimulus materials representing the same construct may not elicit equivalent responses. The validity of generalizing the results from experimental studies of attribute identification with geometric stimuli to normal concept learning situations in the everyday life classroom is questioned.

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1. INTRODUCTION

1.1 Purposes of the study

Two problems are investigated in the research to be reported in this dissertation: (1) the effect of emphasis on speed of performance and (2) the effect of geometric stimulus materials on an aspect of concept learning behaviour. These problems are related to the more general methodological issue of the application of the findings of laboratory experiments to real life situations.

Attempts are sometimes made to explain complex conceptual behaviour by extending the findings from laboratory studies of simple behaviour conducted under highly rigorous conditions. Often in such studies geometric figures have been used as the stimulus materials and time-to-solution has been emphasized either directly through the instructions to Ss or indirectly by the test-like situation in which the experiment is conducted (Wasilewski, 1972). Although the findings from such studies have been criticized on the grounds that their generalizability to more natural settings may be of questionable validity (Ausubel, 1962; Carroll, 1964; Bourne, 1966; Glaser, 1970), others (Underwood and Richardson, 1956; Cronbach, 1970) have continued to assert that their methods are superior because they best facilitate inter-laboratory communication and continuity of research. In actual practice, the use of simple geometric figures combined with the emphasis on time-to-solution appears to prevail today in laboratory studies of conceptual behaviour.

With regard to the validity of the experimental stimuli, Ausubel has suggested (1962) that choosing the degree of methodological rigour associated with the use of meaningless stimuli materials (such as simple geometric figures or nonsense syllables) may have restricted the applicability of the resultant findings only to simple rote learning situations. Hence, for example, the continuous and predominant use of geometric (spatial) figures as stimulus materials in laboratory studies of conceptual behaviour (as observed by Bourne, 1966) may raise doubts about the generalizability of their findings to typical classroom learning situations where verbal concepts are used predominantly.

Similarly, the emphasis on speed which may be implied in laboratory experimental designs where time-to-solution is measured, may raise doubts about the generalizability of the results of such experiments to everyday concept learning situations. While it seems obvious that the faster one arrives at a "correct" concept the more efficient is the individual's learning behaviour, nevertheless a previous study (Wasilewski, 1972) has demonstrated that efficiency in attribute identification may be affected negatively by an emphasis on speedy solution. In terms of the number of stimulus cards-to-solution, Ss' performance was less efficient under conditions where Ss were instructed to work as quickly as possible or in situations where Ss were placed in a test-like situation which implied an emphasis on speedy solutions.

The research which will be reported here was designed to investigate the effect on performance in an attribute identification task of: (1) (a) explicit speeding instructions and (b) implied instructions to speed which are inherent in a test-like situation; and (2) (a) spatial (geometric figures) as compared with (b) verbal (written words) as stimulus materials.

1.2 Definition of terms

Since some of the terms used in the area of psychology in which this study is situated have variations in usage, it seems advisable to note how these terms will be used in this dissertation:

Concept: a class name which refers to the abstracted properties (attributes) shared by the members of a class, which distinguish them from other objects or events of the environment.

Concept learning: the continuous process encompassing both concept formation and concept attainment behaviours.

Concept formation: the process of classifying objects or events of the environment into meaningful sets of classes in the interest of ordering their diversity (Bruner, Goodnow, and Austin, 1956).

Concept attainment: the processes of finding the predictive attributes and a rule which governs the relationship between the attributes, that distinguish the exemplars of a concept to be attained from the nonexemplars.

Attribute identification: a process of concept attainment limited to finding only the predictive attributes.

Rule identification: a process of concept attainment limited to finding only the rule which governs the relationship between the attributes.

Cognitive structure: a postulated hierarchical organization of knowledge for a given individual in terms of progressively more inclusive concepts and principles, under which are subsumed less inclusive subconcepts as well as traces of specific informational data (Ausubel, 1963).

Meaningful stimulus material: a postulated potential relationship between the stimulus and the cognitive structure of a given individual. When he can relate the stimulus material to relevant concepts in his cognitive structure, then the material is considered as potentially meaningful to him. The criterion of potential meaningfulness applies solely to the total stimulus and not to " . . . any of its structural elements which may already be meaningful, such as the component letters of a nonsense syllable, each member of an adjective pair, or the component words of a scrambled sentence" (Ausubel, 1966 (a), p. 93).

Meaningful learning set: a readiness to " . . . relate substantive (as opposed to verbatim) aspects of new concepts, information or situations to relevant components of existing cognitive structure in various ways that make possible the incorporation of derivative, elaborative, descriptive, supportive, qualifying or representational relationships" (Ausubel, 1966 (a), p. 92).

1.3 Theoretical considerations

Rationale for a theoretical structure.

Vygotski has suggested that psychological findings often suffer from duality reflected in the incongruity between " . . . theoretical structures, with their metaphysical, idealistic overtones, and the empiric bases on which they are erected" (1962, p. 10), and he has proposed that experimenters should concentrate more on reporting the facts rather than involving themselves in the development of psychological theories from their limited observations. It has been noted also (Kendler, 1964) that the prevailing over-concern with postulated theoretical models often results in a greater interest in demonstrating how the behaviour investigated is like the postulated model than in studying the nature of the behaviour itself.

> The flow of influence in a model is entirely from the conceptual to the empirical level. That is to say, once a particular model has been selected, the researcher is not concerned at all about modifying the model itself on the basis of data obtained by means of it.
> (Marx, 1963, pp. 14-15).

On the other hand, it has been recognized that theoretical discussions are a necessary precondition to and a complement of the experimental part of any scientific study. It has been urged, furthermore, that they should provide direction for empirical investigation. Marx observes that although

> . . .The significance of a proposition - its potential theoretical or implied importance - is independent of the empirical support it may subsequently

> receive . . . The place for daring and imagination, the time for striking boldly in new and previously unchartered directions - this is obviously the context of discovery,[1], just as the place for caution and restraint and for the careful evaluation of hypothesis and data is in the context of confirmation.[2] We need to recognize most explicitly that both discovery and confirmation are necessary to effective scientific work (1963, p. 13).

In a field such as educational psychology, where the scientific development is still in its initial stages, the lack of an adequate and generally acceptable theory of human behaviour presents problems for a systematic investigation of the cognitive processes. It is possible that the lack of an adequate theory may be partially due to the lack of an adequate experimental method of investigating human behaviour.

> With few exceptions . . . no systematic series of experiments has been built around a single task. While this lack of task standardization attests to the ingenuity of individual workers in constructing new materials, the situation may not be entirely satisfactory for efficient development of laws and theories (Underwood and Richardson, 1956, p. 84).

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[1] discovery is equated with conceptual theorizing

[2] confirmation is equated with empirical investigation

In order to provide direction to this present empirical investigation a provisional theoretical framework has been developed, and this will be offered in the sections which follow. These tentative theoretical considerations do not constitute a logically or deductively organized cluster of laws where the emphasis is distinctly upon the conceptual structure and its substantive validity. One justification for the more tentative theoretical framework preferred here is that it may not blind the investigator to alternative views, or give false appearance of too much certainty and knowledge, or encourage undue speculation as to formal and logical relationships (Marx, 1963). Hopefully, it will be acceptable as a conceptual analogue designed primarily to guide the empirical research.

Concept learning.

Bruner has suggested that concept learning behaviour may be the result of two human abilities: firstly, the power to discriminate the unique particulars of objects and events in our environment, and, secondly, the ability to group these objects and events into classes:

> . . . were we to utilize fully our capacity for registering the differences in things and to respond to each event encountered as unique, we would soon be overwhelmed by the complexity of our environment . . . The resolution . . . is achieved by man's capacity to categorize. To categorize is to render discriminably different things equivalent, to group the objects and events and people around us into classes, and to respond to them in terms of their class membership rather than their uniqueness (Bruner, et al, 1956, p. 1).

The two problems investigated in the present study are in the domain of concept learning. There appear to be two main approaches in the development of theories of conceptual behaviour.

The first considers the organism as a passive participant in the learning process. It postulates that the organism receives information about the concept from the exemplars and nonexemplars of the concept-to-be-learned, and that the information common to the exemplars (i.e., the relevant attributes and the rule governing the relationship between the attributes) is reinforced whereas the information irrelevant to the concept, is not reinforced. Eventually, a "picture" of a new concept is developed without the organism's active participation. In this approach, concept learning is considered as a process where a response is gradually connected with a set of stimuli (Hull, 1920; Skinner, 1953).

The other approach considers the organism as an active participant in the process of concept learning. When the organism is presented with the first exemplar of a new concept, it generates a hypothesis about the relevancy of the exemplar's attributes and a rule. The succeeding exemplars and nonexemplars provide the organism with an opportunity to test the hypothesis. If the hypothesis becomes untenable, then the organism generates a new hypothesis for testing. Eventually a correct hypothesis is confirmed by the exemplars and/or the non-exemplars, and a new concept is learned (Krechevsky, 1932; Bruner, et al, 1956; Hovland and Hunt, 1960; Restle, 1962; Ausubel, 1962; Levine, 1963). Although this approach originated with the cognitive psychologists, it has been adopted also by some contemporary S-R theorists. Furthermore, it has been generally assumed that concepts are learned in terms of abstract properties. Thus, when an individual acquires a concept of a class of stimuli, his behaviour in relation to these stimuli is controlled " . . . not by particular stimuli that can be identified in specific physical terms, but by abstract properties of such stimuli" (Gagne, 1965, p. 52). If the response to a class of stimuli were based solely on the physical properties common to the membership of the class ("identical elements", Osgood, 1953, p. 666), then the process might be a simple discriminating labeling and not the abstract conceptualization which has been postulated as necessary for concept learning. Osgood suggests that " . . . the abstract level of using concepts is quite distinct from simple transposition in terms of stimulus similarities" (1953, p. 667), and that a "true concept" is learned only when the varying stimuli patterns elicit a common response which serves as a cue for the conceptual behaviour. Thus concepts may be regarded as " . . . a network of sign-significate inferences by which one goes beyond a set of observed criterial properties exhibited by an object or event to the class identity of the object or event in question, and thence to additional inferences about the unobserved properties of the object or event" (Bruner, et al, 1956, p. 244).

Both approaches nevertheless, have been considered by some investigators as too simple for the explanation of a highly complex conceptual behaviour (Bourne, 1966).

<u>The utility of the S-R versus the cognitive model in the investigation of concept learning.</u>

Theoretical development in the field of conceptual behaviour may be broadly divided into (1) the S-R and (2) the cognitive approaches based on the postulated relationship between the material-physical events and the mental-cognitive events.

The cognitive approach is represented by the contention that the relationship between signs and meanings " . . . can be defined only in terms of differentiated cognitive experience and the cognitive operations giving rise to such experience, and . . . [that] related behavioural events merely define affective and attitudinal connotations associated with meaning rather than meaning per se" (Ausubel, 1966 (b), p. 60).

The S-R approach however, rejects the dualistic view and considers meaning and its underlying "organismic, essentially behavioural" process, as the same. It treats meaning as a conditioned response and criticizes the cognitive position as failing to define the "organismic mediation process with respect to materialistic observables" (Osgood, Suci, and Tannenbaum, 1957, p. 4). But the S-R position attempts also to explain the relationship between signs and meanings through a hypothetical construct of a representational mediation process.

In order to make a relative evaluation of the two models, certain critical issues need to be considered. The discussion of these issues which follows is intended to provide an explanation for the selection of one model in preference to the other.

The first issue concerns connotative versus denotative meaning. The weakness of the representational mediation construct seems to lie in its inability to explain fully the nature of generic meaning. It can identify the affective connotations - but fails to define the denotative meaning. Since the same concept can elicit different connotative responses (for example, fear and happiness) consistent with its denotative meaning, the connotation alone appears to be an insufficient index of conceptual meaning. Although for some S-R theorists connotative aspects are the only bases of meaning (Osgood, 1961), others (Mowrer, 1960; Staats, 1968) have attempted to enlarge the S-R position by admitting the conditioned sensory responses to the organismic basis of meaning. This concession brings them closer to the cognitive view. However, it still appears to be not entirely satisfactory.

> . . . it strains credulity to conceive of the cognitive content evoked by a sign or significate as a sensory _response_ . . . the term "conditioning" hardly describes the psychological process whereby symbols acquire meaning since, by definition, it refers to the noncognitive operation in which an originally inadequate stimulus, . . . comes _automatically_ . . . to elicit part of the same response evoked by the adequate stimulus (Ausubel, 1966 (b), p. 65).

Staats' (1968) contention that classical conditioning of a meaning response by pairing a word on each trial with a different word, where all of the latter have the same meaning component, corresponds to syntactical conditioning, where a meaning response elicited by the predicate is conditioned to the subject of the sentence (Mowrer, 1960), ignores the fact that the acquisition of meaning in Mowrer's model occurs on one trial, whereas in the experiment of Staats and Staats (1957) " . . . one conditioning trial might not establish a sufficiently strong association between the nonsense syllable and meaning response" (p. 74). (Staats and Staats equate nonsense syllable to a concept). Furthermore, the conclusion that " . . . the meaning of stimuli may be learned without awareness" (p. 79) could not be drawn legitimately from the experiment, since "meaning" was measured by the semantic differential method and thus only the connotative aspects of meaning were actually investigated. Mowrer's (1960) explanation of the acquisition of meaning in terms of reciprocal conditioning of meaning responses of the subject and predicate in a sentence appears oversimplified and does not seem to be able to cope with the differences in meaning elicited by the same stimuli (for example, "John hits Mary" and "Mary hits John"). It seems that the acquisition of meaning "Tom is a thief" is better explained by a postulated process where a potentially meaningful proposition is related to and incorporated within a cognitive structure on a non-arbitrary basis (Ausubel, 1966 (b)) than by a postulated process of conditioning the meaning response "thief" to "Tom".

Possibly conditioning is limited to connotative meaning and, for the investigation of concept learning which is based primarily on denotative meaning, a more elaborate model of cognitive operations may be necessary. It seems that in concept learning, denotative aspects of meaning cannot be separated from the connotative aspects. Therefore a model which fails to account for both would not be considered as satisfactory.

> Their separation . . . is a major weakness of traditional psychology . . . Unit analysis points the way to the solution . . . It demonstrates the existence of a dynamic system of meaning in which the affective and the intellectual unite. It shows that every idea contains a transmuted affective attitude toward the bit of reality to which it refers (Vygotski, 1962, p. 8).

Another important issue involves the explanatory powers of the two models in the investigation of verbal conceptual behaviour. It appears that, after childhood, concepts are predominantly embodied in words (Brown, in Bruner et al, 1956, p. 269). The attempt to generalize the results from the studies based on the S-R model, as exemplified by Skinner's (1957) account of verbal behaviour, to highly complex human conceptual behaviour has not been considered legitimate by some theorists (Chomsky, 1959). It has been proposed that the use of S-R terminology in the study of verbal conceptual behaviour is only " . . . justifiable when used to describe the way in which the experimenter has manipulated the experimental situation; it should not be used as a description or explanation of subjects' behaviour" (Herriot, 1970, p. 161). It has also been suggested that the employment of S-R terminology may lead to a description of conceptual behaviour only as a complex skill and thus limit information about the role of meaning in verbal behaviour (Miller, 1956).

It has been demonstrated that animals are capable of reacting to stimuli which of themselves have no biological significance for them (Pavlov, 1963), and that humans can learn some concepts without verbal ability (Vygotski, 1962; Inhelder and Piaget, 1964; Bugelski, 1970). Some findings appear to contradict the contention that language facilitates cognitive behaviour. For example, results from experiments using double alternation problems indicate that these can be solved by young (3½ years old) children and monkeys, but the rules cannot be verbalized by children until the age of five (Carroll, 1964). Other findings indicate that the verbal ability of Ss' does not alter their capacity to discriminate among similar objects (Brown and Lennenberg, 1954). Bruner et al even suggest that concept learning with meaningful materials may be more difficult than with less meaningful materials (Bruner, et al, 1956). These observations indicate that some form of cognitive behaviour is possible without language. Nevertheless, humans are the only species to develop a second-system based on language where the immediate sense impressions are transformed. Therefore they alone have been able to escape the immediate limitations of the animal world. This second-system allows the user to learn essentially unrepeatable objects and events and to go beyond the observable into the direction of generalization and abstraction. It appears that in this system of language the emphasis is placed on the role played by the meaning which is conveyed by the stimuli rather than on the perceived physical characteristics of the stimuli.

The progressive influence of verbal behaviour is suggested by the early stages of cognitive development. Initially, the development of covert, internalized, representational responses around the perceptual invariants, which leads to a lower-order concept learning, is facilitated by the knowledge of names (labels). During the development of understanding of relationships between the perceptual invariants, words provide cues (of content and of context) for the formation of new and higher-order concepts, eventually allowing for the categorization of nearly all experience. Once the concepts are learned, their meaningfulness is "enriched" through verbal behaviour. The sequential characteristic of language enables the user to observe the position a word takes in a given sentence and also the relationship of a given word to other words with which it occurs. This allows the user to place that word in a logical object and logical subject category.

It needs also to be considered whether the effect of context on meaningfulness in concept learning may have been generally underrated. The early attempts to define and measure meaning of word-units in terms of their associative strength (Noble, 1952) seem to have ignored the effect of verbal context. Treating words as isolated units of meaning without reference to their context seems to have led to some confusion and a loss of contact with real life conditions.

It has been noted that in the early stages of language development when children are asked to give word associations they are unlikely to offer words in the same form class as the stimuli. But as they gain more experience in encountering words in sentences, they become more likely to use paradigmatic associations (Brown, 1957). One explanation of these phenomena is in terms of anticipation (Ervin, 1963). The hearer of a sentence anticipates at each stage a number of words fitting into a sentence frame, and as the frequency of this experience increases so does the associative strength between words anticipated. This hypothesis was supported by McNeill's (1963) findings. It may be that in young children the tendency for syntagmatic associations could be influenced by "continuity of meaning" (sequential approach) whereas with adults, the development of association strength may involve the "similarity of meaning" (associative approach).

The effect of context on associative strength has been further demonstrated in the study by Howes and Osgood (1954). They found that the strength of association of response increased with the number of words preceding the stimulus word that have themselves been associated with the response. These findings are supported also by the results of Colman's (1964) study.

The above observations suggest that context cannot be ignored in verbal learning. Indeed, when it is ignored, apparently absurd situations become possible. Bugelski remarks that the Minnesota Norms state that 84% of Ss will respond CHAIR to a stimulus TABLE, whereas " . . . such an assumption is manifestly absurd as no one in his right mind would think of a CHAIR when someone said TABLE under any other conditions than those of a verbal association test" (Bugelski, 1970, p. 1004).

The behaviorists' attempts to explain in S-R terms the implications of context in verbal behaviour appear to be unsatisfactory. They propose that word associations determine the order of word sequences and that " . . . a child acquires verbal behaviour when relatively unpatterned vocalizations, selectively reinforced, gradually assume forms which produce appropriate consequences in a given community" (Skinner, 1957, p. 31). Children are said to develop the concepts of syntactic classes and their place in a sentence, and, when a new word is conditioned to those stimuli in the child's repertoire which elicits the "exemplar of the class", then the child can use the new word in a sentence grammatically correct (Staats, 1968). The findings from studies by Brown and Berko (1960) and Brown and Fraser (1961) support the above proposition. However, others (Miller and Chomsky, 1963; McNeill, 1970) have criticized it and they contend that the S-R model leads to a finite-state device. For example, Staats (1968) considers the development of correct associations between the ending of the word in a subject position and the ending in a predicate position in a sentence as the mechansim controlling grammatical correctness. But if the stimulus (subject) and the response (predicate) are separated by a large number of other words, then the number of transitions spanning the "X" grammatical categories may become quite unrealistic. Miller and Chomsky (1963, p. 430) give the example of two words separated by fifteen other words in a sentence. When it is assumed that an average of four grammatical categories occur at any point in a sentence then the above situation leads to $4^{15} = 10^{9}$ different transitions for a childhood lasting only 10^{8} seconds.

The discussion of verbal conceptual behaviour leads into the very difficult problem of meaning and its measurement. The assumption that the origin of language lies in human goal-orientated activity has led to an emphasis on the response. Although it has been proposed that sign relations develop along syntactical, semantical, and pragmatical dimensions (Hormann, 1971, p. 159), the behaviourists appear to have arrived at the conclusion that meaning equals behaviour. "Experimentally determine all of the organized responses a given object can call forth in a given individual, and you have exhausted all possible 'meanings' of that object for that individual" (Watson, 1924, pp. 354-355). This has resulted in a number of attempts to measure meaning in terms of a single behavioural dimension (Noble, 1952; Osgood, 1952; Underwood and Schulz, 1960; Paivio, 1969). But this, it has been proposed, may not satisfy the requirements of construct validity. Nunnally suggests that this may be due to the failure of investigators to specify the domain of observable reactions to the construct and their failure to determine the extent to which these dependent variables correlate with each other. These omissions may limit the inquiry to the question whether the postulated measures act as if they do measure the construct (Nunnally, 1967, p. 87).

In summary, there appears to be a lack of parallelism in the development of verbal and cognitive abilities during early childhood (Kohler, 1947; Inhelder and Piaget, 1958; Vygotski, 1962), but when the child becomes capable of thinking in terms of logical propositions and understanding the relationships between concepts, then language becomes a vital requirement for all types of learning (McNeill, 1970). Thus the overall effect of language on behaviour is demonstrated in the gradual change that occurs in a child's responses to his environment. Whereas early responses tend to be direct, the mature child appears to respond " . . . in terms of concept rather than in terms of direct perception of stimuli" (Carroll, 1964, p. 98).

The S-R model attempts to account for the acquisition of meaning in terms of an automatic process in which the conditioned response becomes only a fraction of the unconditioned response. If concept learning is " . . . a creative, not mechanical, passive, process: [where] . . . concept emerges and takes shape in the course of a complex operation aimed at the solution of some problem: [and] . . . the mere presence of external conditions favouring a mechanical linking of word and object does not suffice to produce a concept" (Vygotski, 1962, p. 54), then the S-R model may be too simple to account for all aspects of concept learning.

The cognitive model, represented by Ausubel's subsumption theory of meaningful learning (1962), rather than concentrating on S-R connections and their organismic mediators, provides the organizational and functional principles which account for the differentiated and clearly articulated conscious experience.

> . . . The model of cognitive organization proposed for the learning and retention of meaningful materials assumes the existence of a cognitive structure that is hierarchically organized in terms of highly inclusive conceptual traces (hypothetical constructs designed to account for the continuing representation of past experience) under which are subsumed traces of less inclusive sub-concepts as well as traces of specific informational data. The major organizational principle . . . is that of progressive differentiation of trace systems of a given sphere of knowledge from regions of greater to lesser inclusiveness, each linked to the next higher step in the hierarchy through a process of subsumption . . . as new material enters the cognitive field, it interacts with and is appropriately subsumed under a relevant and more inclusive conceptual system. The very fact that it is sub-

> sumable (relatable to stable elements in cognitive structure) accounts for its meaningfulness and makes possible the perception of insightful relationships" (Ausubel, 1962, p. 216).

In terms of the cognitive model, the facilitation of concept learning is dependent on the availability in cognitive structure of relevant components that allow for the incorporation " . . . of derivative, elaborative, descriptive, supportive, qualifying or representational relationships" (Ausubel, 1966 (a), p. 92). The S brings to the learning situation his prior experience which facilitates further learning. This experience is a

> . . . cumulatively acquired, hierarchically organized, and established body of knowledge which is organically relatable to the new learning task rather than as a recently experienced constellation of stimulus-response connections influencing the learning of another discrete set of such connections (Ausubel, 1963, p. 219).

Although the cognitive model has the serious difficulty inherent in an objective investigation of states of consciousness, it has been chosen as the theoretical framework for the present study because of the reasons indicated in the above review and discussion of issues in this field of research.

These introductory theoretical and empirical considerations have been presented as a guide to the more general thinking which led to the conception of the specific problem which will be posed in the next section.

1.4 Empirical considerations

> . . . We must try to connect the forms of complex thinking discovered in the experiment with the forms of thought found in the actual development of the child and check two series of observations against each other . . . an experimentally induced process of concept formation never mirrors . . . exactly [the process of concept learning] as it occurs in life (Vygotski, 1962, p. 69).

The two problems investigated in the present study involve classroom concept learning. It appears from the review of the literature that most empirical research on concept learning has been conducted under laboratory conditions. But to what extent can conditions in the laboratory and conditions in the classroom, as they each affect the process of concept learning, be said to be similar? It is possible that the classroom environment contains certain elements that have not been represented in laboratory studies, and which influence the process of concept learning as it occurs in normal everyday school life. The exclusion of such aspects of the normal classroom situation may, from the applied psychology point of view, invalidate the results of an inquiry conducted in a laboratory.

The teacher is one aspect of the classroom situation which may not be fully replaced by the experimenter. " . . . A teacher who knows and likes a child can often secure more spontaneous and representative performance than a stranger called to administer tests" (Cronbach, 1970, p. 45).

Another difference may be the attitude of S toward the learning task. The student in a classroom is a member in a familiar milieu and normally only mildly interested and aware of the task. In contrast, S in a laboratory is a lonesome visitor in unfamiliar surroundings and normally, having volunteered for the project, is interested and quite aware of the task.

Still another differential element may be the nature of feedback. Most concept learning experiments appear to be based on the assumption that the learner must receive immediate explicit feedback ("correct" or "incorrect", etc.,) to his responses to the stimuli. Students in a classroom situation may not have that kind of feedback. They may be shown or told about, a number of exemplars and nonexemplars of the concept-to-be-learned, and not all students may offer all their hypotheses for testing (by asking all necessary questions). This is not because teachers fail to provide corrective feedback when asked to do so, but because some concepts employed by teachers in their communication with their students may have different meaning to the students than to their teacher. Consequently, students unable to communicate efficiently may have to learn some concepts "on their own" (i.e., without feedback from the teacher). Students' responses to the stimuli are based on their own prior experiences which may not be linked directly to the experience involved in learning a new concept. Downing (1971) noted this deficiency in "cognitive clarity" among young children learning to read, and Ausubel and Fitzgerald discussed the remedy in terms of advanced organizers which would provide the student with " . . . the anchoring post or ideational scaffolding in cognitive structure for the learning" (in Anderson and Ausubel, 1962, p. 244). " . . . (The) new learning depends primarily upon the combining of previously acquired and recalled learned entities" (Gagne, 1968, p. 189), and it is probable that the prior experience of the teacher differs from that of his students. Therefore, it seems reasonable to assume that teachers (even when they are fully aware of this problem) cannot provide all individual students with all the feedback necessary for the reduction of this cognitive confusion. If it is true that concept learning under classroom conditions is based often on the information offered by the stimuli without all necessary confirmatory information provided by feedback, then students in a classroom are much more dependent on the stimulus information than is the subject in the typical laboratory experiment.

2. PROBLEM

2.1 Effect of spatial versus verbal stimulus materials on performance on a concept learning task

It has been observed that meaningless stimulus materials (such as geometric-spatial figures) have often been used in the experimental study of concept learning, and that these materials have been arbitrarily combined into dimensions to represent concepts (such as "one large figure" or "white small figure on top of the stimulus card") that may not be comparable to concepts learned in school settings (Carroll, 1964; Bourne, 1966; Glaser, 1970; Securro and Walls, 1971).

> . . . Concepts learned in school contain a multitude of meaningful and discriminable attributes capable of eliciting thematic experience. Some of the defining attributes, which formally set forth the concept, may be learned by rote, but the criterial attributes, which are used by a student to identify the exemplars of a concept, are accepted by the student only after he makes a judgment as to their relevancy to the concept. Since judgments of individuals vary, concepts formulated in the classroom carry different meanings. When a student makes judgments about the relevancy of the attributes and offers hypotheses because certain attributes appear to him more likely to be relevant than others, the process is highly meaningful. In the experimental situation with abstract geometric stimuli, on the other hand, S has no opportunity to make meaningful judgments, since he is faced with a rather meaningless set of attributes, and with a task of deciding which of the possible combinations of attributes, has been selected by the E as relevant. On what bases can he decide that the

> attributes of "one" and "red" are to be more likely relevant than attributes of "large" and "square?" His choice of one set of attributes over another is not meaningful, and he learns by rote. The process is not learning of a concept but the identification of arbitrarily chosen and meaningless components of an abstract label (Wasilewski, 1971, pp. 1-2).

The early studies of concept learning used both meaningful and rote stimulus materials (Hull, 1920; Smoke, 1932; Reed, 1946; Heidbreder, 1947). But in 1952 Underwood suggested that in order to reduce the ambiguity of stimuli (caused by individual differences in memory and in strength of associations), simple geometric (spatial) figures might be most suitable for the laboratory investigation of concept learning. In 1956 Bruner et al supported the use of spatial stimuli because

> . . . to attain concepts with materials that are meaningful and amenable to familiar forms of grouping leads to several difficulties. In the first place, the problem-solver is likely to fall back upon reasonable and familiar hypotheses about possible groupings. In doing so, he may be led into a modified form of successive scanning [i.e., successive scanning plus remembering the status of as many tested instances as possible]; the strategy par excellence for going through the list of hypotheses. In the second place, the thematic material will, more readily than abstract material, lead certain attributes to have nonrational criteriality: S will "hang on" to these and will formulate hypotheses around them (Bruner, et al, 1956, p. 111).

However, the trend toward the use of meaningless stimulus materials was challenged in 1962 by Ausubel when he observed that investigators of concept learning were content merely with extrapolating general laws derived from the laboratory study of qualitatively different and vastly more simple instances of learning. Yet in 1966 Bourne noted that spatial stimulus materials were still the predominant tool of the laboratory.

Regarding the general problem of relating artificial experimental situations to real life conditions, Marx notes: "The fact that scientific progress results in increasingly less natural and less lifelike concepts and theories obviously increases the difficulties of popularization and translation into practical action, but it is hardly avoidable" (1963, pp. 11-12). This credulity gap between laboratory experiments and everyday life in the area of concept learning seems well illustrated by Bruner's argument quoted above. The use of the modified scanning, which Bruner seeks to avoid, seems more representative of typical classroom concept learning behaviour. For example, a situation where a student, whose task is to learn the concept of "harbour", perceives all attributes of an exemplar (such as "Vancouver harbour") and then systematically tests these attributes one by one, seems to be unnatural and the use of the "ideal" conservative focusing strategy appears unrealistic in this situation. In real life modified scanning may be the strategy most often used in classroom concept learning.

There is some evidence that S's consciousness of the meaningless nature of such stimulus materials does influence his behaviour in experiments. Apparently S's prefer the materials about which they must reason to be meaningful, and their reasoning may be supported by the thematic process rather than only by abstract logic (Heidbreder, 1947; Tolman, 1948; Gagne, 1968). Heidbreder found that Ss prefer the stimulus to be as much "thing-like" as possible (Koffka, 1935), and hence a meaningful rather than a meaningless drawing of a spatial form would be preferable. Heidbreder noticed that Ss read meaning into non-thematic drawings - " . . . In perceiving a drawing as a picture of a tree, S's reaction takes into account an object having full thing-like character, as it does not when he perceives a drawing as circular" (Heidbreder, 1947, p. 109). This observed behaviour suggests an inherent weakness in materials of the artificial spatial stimulus type. The proponents of the use of these materials argue that, by eliminating meaningful associations, they are able to free the responses to these stimuli from the interfering effects of these associations. But it appears that, despite the experimental psychologist's efforts, Ss do make an effort to give meaning to "meaningless" materials, and consequently, their responses to these stimuli are not only affected by the postulated interference (caused by the acquired meaningfulness) but also by additional interference from attempts to attach meaning to these originally "meaningless" stimulus materials.

Even if experimenters can succeed in eliminating meaning from their stimulus materials, then the learning represented under those conditions according to the cognitive model, may be learning of a special type:

> . . . By using meaningless materials in a learning task, it is possible to eliminate the influence of meaningful antecedent experience, which naturally varies from one individual to another. But it is precisely this interaction of new learning tasks with the existing cognitive structure that is the distinctive feature of meaningful learning . . . if one chooses the particular kind of methodological rigour associated with the use of rote materials, one must be also satisfied with only applying the findings from such studies to rote learning situations (Ausubel, 1962, p. 214).

Ausubel's comment widens the credulity gap between artificial laboratory situations and real life classroom conditions where such rote materials are very rarely the object of concept learning tasks.

The controversy over meaningful versus meaningless stimulus materials is related to the issue of the measurement of meaning. Therefore a brief review of some relevant aspects of research in that area seems pertinent here.

Noble's (1952) index of meaningfulness, $\overline{m}$, is the number of word associates elicited by a given word. His basic assumption appears to be that meanings (Hs) which form the hypothetical bonds between the stimulus element and the class of conditioned responses are equal units, may not be valid. Take for example two stimuli (S1 and S2) which are of equal $\overline{m}$ value (and equal physical characteristics). S1 (circular) elicits response R1 (ball, stone, apple) and S2 (circular) elicits response R2 (logic, movement, shape). Now, although the quantity of the elicited responses is equal (i.e., both R1 and R2 have $\overline{m}$ value = 3), the quality of the elicited responses is not "equal". Therefore Noble's assumption that " . . . since by logical analysis, meaning is a relation between terms, . . . meaningfulness . . . [is then] the number of Hs subsisting between S [stimuli] and the several Rs taken together" (p. 422), may not be valid. Furthermore, Noble has presupposed that " . . . the system S-H-R is isomorphic with the system alpha-means-beta" (p. 423). This again may not be true since subjects often provide word-associates which are not the synonyms of the stimulus words and not of "equivalent meaning" (as perceived by the experimenter) to the words which would have been elicited by the stimulus words under natural, non-experimental conditions (Bugelski, 1970, p. 1004). Nobel has emphasised the distinction between the logical (conceptual, hypothetical) and the psychological (empirical, categorical) notions about meaning. He states: " . . . no confusion should result from referring to relations between S [stimulus] and R as psychological meanings, since such relations are (a) purely empirical constructs, and (b) . . . coordinated with an operational index, $\overline{m}$" (p. 423). But if $\overline{m}$ indicates only the number of word-associates elicited by a given word it may be merely another label which contributes little to our understanding of meaning, per se.

Although $\overline{m}$ has been found to correlate highly with some other scaling methods of meaningfulness (Underwood and Schulz, 1960, pp. 15-17) there might be an uncontrolled effect of a "limited-response

-time" variable involved (see the discussion of an unpublished experiment on p. 114 of this dissertation). All these considerations raise questions about the satisfactoriness of Noble's production method of scaling meaningfulness.

Osgood's Semantic Differential (Osgood, 1952) and its application to linguistic theory (Osgood, Suci, and Tannenbaum, 1957), although considered by some as capable of isolating " . . . denotative meanings of adjectives in terms of a finite number of dimensions: evaluation, activity, potency, and (hopefully) others" (Carroll, 1959, p. 76), cannot really measure denotative meaning and should be restricted to its purpose as an index of the connotative values of meaningfulness.

Underwood and Schulz's (1960) scale of meaningfulness has been based on rote materials and therefore would not appear to be satisfactorily applicable to concept learning for reasons presented earlier.

Paivio has developed a scale along the abstract-concrete dimension of meaningfulness (1969) " . . . The higher the concreteness of stimulus items, the more likely are they to evoke sensory images that can function as mediators of associative learning and memory" (p. 243). The results of empirical investigations (Paivio and Yuille, 1967; Smythe and Paivio, 1968) indicate that the image evoking value of the stimulus is more effective in paired-associate (PA) learning than $\overline{m}$ (Noble, 1952), which according to Paivio is the most important alternative to imagery value. In Paivio's model the concreteness-imagery" . . . is a major dimension of word meaning . . . which is noteworthy because such a factor has not emerged in the multitude of studies that have been conducted on semantic dimensions (e.g., Osgood, Suci, and Tannenbaum, 1957)" (1969, p. 247). The imagery model is based on the Conceptual Peg Hypothesis (Paivio, 1965) which states that the ease of learning stimulus-response associations depends particularly on the image-arousing capacity of the stimulus, and that concrete stimuli should be more solid conceptual pegs than abstract stimuli. However, it has been suggested that the bizarre aspects of the association can be more important in learning than the concreteness. Miller, Galanter, and Pribram (1960) reported that up to 500 responses were retained in PA learning when Ss formed bizarre associations. On the other hand " . . . Some researchers stress that bizarre imagery is helpful, but I have not found any need for any special attempts to conjure up bizarre images. Perhaps, like the famous 'purple cow', imagery involving two normally unrelated items is bizarre. But any pair of objects that could have a plausible relationship, . . . , can be readily remembered" (Bugelski, 1970, p. 1008). Paivio himself admitted that although imagery appears to be a more effective variable than $\bar{m}$, nevertheless, his proposition does not " . . . eliminate the possibility that some other unidentified correlate of I [imagery value] might be responsible for the [facilitating] effects" (1969, p. 246).

In a previously unpublished experiment (see Appendix A), Wasilewski asked one group of Ss (N = 136) from Grade XI to provide synonyms, which they considered as more meaningful than the stimuli, to a number of verbal (written) attributes representing four binomial dimensions of the geometric type of stimuli commonly used in experimental studies of concept learning. Dimensions selected were: shape (circular or rectangular); color (white or black); size (small or large); and number (one or two). The number of different responses elicited by the eight stimuli ranged from 32 to 72, and the frequency of a specific response to a given stimulus ranged from 1 to 52. For each of the original eight attributes (the stimuli), one response of the highest frequency was designated by the experimenter as an attribute of high-meaningfulness, whereas the eight original attributes (the stimuli) were designated as attributes of low-meaningfulness. Another group of Ss (N = 128) from another school (Grade XI) was used to test the hypothesis that stimuli of high meaningfulness (the eight responses of the highest frequency, i.e., the high meaningfulness as perceived by Ss) will elicit more word associates than stimuli of low meaningfulness (the original eight attributes used as stimuli with the first group of 136 Ss). The analysis of variance of the results showed that the effect of assigned meaningfulness was only marginally significant ($p = .08$). The comparison of results for each pair of stimuli (i.e., high and low meaningfulness, for example: "clean" and "white") indicated, however, that frequency values (Kucera and Francis, 1967) were reversed for six out of eight pairs, whereas normally there is a high correlation between $\bar{m}$ and frequency (Underwood and Schulz, 1960).

Possibly in Noble's (1952) and in other studies where the production method has been used, the limitation placed on the time of response (60 seconds or less) has affected the performance. In

Wasilewski's study, there was virtually no time limit since Ss were allowed five minutes per stimulus (i.e., 20 minutes for a four stimuli task). Perhaps, under the usual limited-time condition, Ss may be able to recall only those word-associates with a high habit strength, while under the unlimited-time condition in Wasilewski's study, the word-associates with lower habit strength were recallable. If this were the case, then some low-meaning words may have a high frequency count and high $\overline{m}$ (i.e., a small number of word-associates but of high habit strength, and therefore all word-associates recallable under limited-time condition), whereas some high meaning words may have a low frequency count and low $\overline{m}$ (i.e., a large number of word-associates but of low habit strength, and therefore few word-associates recallable under limited-time condition). Thus the number of word-associates elicited by low-meaning words may be higher under these conditions than the number of word-associates elicited by high-meaning words. If the above explanation is correct then measurement of meaningfulness may require a composite and not a unitary index. This proposition is supported by the apparent lack of positive correlation between associative and imagery values (Paivio, 1969, p. 245). It may be that a high $\overline{m}$ is detrimental in concept learning (Bruner, et al, 1956, p. 111) whereas a high imagery value may be facilitating. However, both appear to be considered as attributes of meaning.

The results of Wasilewski's study (described above) suggest that meaningfulness of the stimulus material is not necessarily limited to the amount of information associated nor to the connotative aspects of responses elicited by the stimulus. Meaningfulness may be multi-dimensional. Evanechko and Maguire (1972) have proposed that

> . . . words can stand for different dimensions of relevance of environmental data, . . . Particular words, of course, draw upon only certain dimensions for meaning. A symbol, when it impinges upon the semantic space, can be thought of as resulting in projections upon certain of the dimensions which define the space. The nature of the dimensions is thus a determiner of the quality of the meaning of the concept for which the word is a symbol, and consequently a determiner of the meaning of the word . . . Semantic space, as a hypothetical construct, might be construed as a n-dimensional space which identifies and defines the individual's verbal mediating responses and describes the process or strategy applied by this individual in assigning meaning to verbal data (p. 508).

Kanungo (1972) suggests that meaningfulness may refer to the connotative and denotative, the associative and categorical, or the imaginal and communicative, and concludes that each of these specific meanings may be considered as a multi-featured variable. He suggests that the advancement of a single comprehensive theory of meaning to fit all empirical data should be deferred until our exploration of the construct has been reasonably exhausted.

Returning to the specific problem of this investigation, the above considerations would seem to support the rather gross distinction employed in the experiments to be reported later in this dissertation, i.e., it is assumed in the present study that verbal stimulus materials under normal classroom conditions are more meaningful than the spatial-geometric stimulus materials which are usually presented to Ss under laboratory conditions.

Another aspect of the difference between spatial versus verbal stimulus materials should be considered here. It seems possible that because much of the child's early formative experience is nonverbal, the verbal or nonverbal nature of a stimulus may of itself determine to a degree the nature of cognitive response (Nathan, 1969). Johnson and O'Reily (1964) found verbal stimuli more effective in terms of cards-to-solution than pictorial stimuli on a classification task. Ducharme and Fraisse (1965) found more words recalled than pictures by children, but more pictures than words recalled by adults. Klausmeier and Wiersma (1967) found that verbal materials were more facilitating in reducing the number of errors-to-solution (i.e., number of incorrect hypotheses offered) on a concept attainment task. Shor (1971) found verbal stimuli superior to pictorial on a concept identifaction task. Yarmey and Sayer (1972) have conducted two experiments to investigate Ss' associative learning and pictorial representation of concrete and abstract noun pairs. In the first experiment Ss drew pictures of given nouns. In the second, a different group of Ss chose from the pictures (drawn by the Ss in Exp. 1) those that best represented what they considered to be the subjective meaning of the given nouns. The recall of noun pairs was superior to the recall of picture pairs in both experiments.

Other evidence conflicts with the above findings. Learning picture pairs was easier than learning their concrete noun labels in experiments conducted by Epstein, Rock, and Zuckerman (1960) and by Rohwer (1966). Learning was faster with pictorial than verbal stimuli on: paired-associate tasks (Lumsdaine, 1949; Deno, 1965; Paivio and Yarmey, 1966; Rohwer, Lynch, Suzuki, and Levin, 1967; Dilley and Paivio, 1968; Cole, Sharp, and Kessen, 1968); a serial anticipation task (Herman, Broussard, and Todd, 1951); a concept attainment task (Klausmeier and Wiersma, 1967). It appears that pictures may be better remembered than their verbal referents because " . . . they arouse non-verbal perceptual images directly" (Paivio, 1969, p. 254), whereas verbal stimuli have to be transformed. Bugelski (1970) found that Ss may require from four to eight seconds to form an image of a verbal stimulus. Pictures also carry more information than words (Shepard, 1967). Since human Ss are limited in the amount of information that they can retain from a single exposure to a stimulus (Miller, 1956), the stimulus whose image contains more information is more facilitating in a learning situation than one whose image contains less information. Shepard (1967) noted that this superiority of pictorial stimuli might have been due not only to their memorability value but also to " . . . the adoptation of a self-paced rate (by the S)" (p. 160).

If pictures are better remembered than words then why do some experiments indicate the reverse? One explanation of the conflicting evidence on the effect of spatial versus verbal stimuli may be a lack of standardization (Underwood and Richardson, 1956). Studies have been conducted on a variety of learning tasks and on different types of spatial stimuli (take for example a thematic picture and a drawing of a circle). Because of these differences in tasks and situational conditions (it is said) it is doubtful whether valid conclusions can legitimately be drawn from them about any general effect on concept learning.

Another explanation may be that spatial stimuli are superior when Ss take time to analyze them (Shepard's "self-paced rate", 1967). An analysis of the attribute identification situation, which is the aspect of concept learning investigated in this dissertation, indicates that one of the tasks faced by Ss in the process of analyzing the problem is the initial identification of the attributes of the very first exemplar presented. The success of attribute identification (in terms of minimal number of trials-, cards-, or errors-to-solution, which are postulated as the indicators of the efficiency of Ss' performance) depends on Ss' ability to identify all the attributes of that first exemplar. The identification of attributes on spatial stimuli may be more difficult than on verbal stimuli because the values of some dimensions (especially in geometric figures) are relative (i.e., not readily perceivable from one instance: e.g., "largeness", "singularity", etc.). This proposition is supported by the results of the Lynch and Rohwer (1971) study designed to explain the processes through which pictorial and verbal stimuli promote learning efficiency. The results indicate that pictorial stimuli facilitated learning only when presented in conjunction with sentences which identified for Ss the attributes of the stimuli. Pictures without such sentences failed to produce the same effect.

If verbal stimuli were more meaningful than their spatial referents then their superiority in facilitating concept learning could be explained in terms of the cognitive model (i.e., higher relatability to the subsuming concepts available in the cognitive structure). However, it appears that existing scales of meaningfulness cannot be considered as satisfactory indices because of their failure to account for the postulated high complexity of the construct, and therefore, empirical tests of the hypothesized effects cannot be executed legitimately. Nevertheless, since the research reported in this dissertation is not an isolated study but one of a " . . . systematic series of experiments built around a single task" (Underwood and Richardson, 1956, p. 84), designed to investigate concept learning behaviour of highschool students under standard conditions (Wasilewski, 1971, 1972), the application of variability of meaningfulness may be postponed. In particular, if the same values of dimensions such as shape, size, color, and number can be represented in the drawn-spatial and written-verbal forms, then the problem of scaling their meaningfulness may be postponed and the proposed memory-facilitating ("attribute retention") and perception-interfering ("attribute discrimination") character of the spatial stimulus materials can be investigated in the comparison with the effects of the verbal stimulus materials.

The first part of the problem in the present study is concerned with the differential facilitating effects of spatial and verbal stimuli on the attribute identification aspect of concept learning. Specifically it will be investigated whether attribute identification is facilitated by spatial stimulus materials only when Ss take time to identify all attributes of the first exemplar. Further to this end, it will be investigated whether, when Ss do not have time to identify all attributes at the beginning of the task, the advantage of spatial stimuli due to the "attribute" retention characteristic is overshadowed by the disadvantage due to the "attribute discrimination" characteristic.

2.2. Effect of instructions or test-like situations which place emphasis on speed on performance on a concept learning task

The proposition that speed and "goodness" of a response are interchangeable measures was advanced early in the studies of psychological measurement (Spearman, 1927). This implied that psychological measurements of an individual's ability, achievement, and aptitude should be made with time limited tests. However, " . . . It is something of a surprise to discover that the popularity of time-limit tests is due more to their practical administrative advantages and their demonstrated usefulness than to any experimentally-supported rationale governing the imposition of time limits on performance" (Morrison, 1960, p. 231).

Some empirical evidence suggests that when conditions of limited time are imposed the test scores may differ in factor content from scores under unlimited time conditions (Davidson and Carroll, 1945), and that score variance may be partitioned, among others, into a portion explainable by speed and a portion explainable by the level of ability (Crowder, Morrison, and Demaree, 1954). Gardner proposes that when time limits are imposed in an experimental situation the effect on Ss is to obtain " . . . from one of them a fairly accurate picture of how he preferred to organize the stimuli: from an another, an incomplete stage of approximation in making judgments: from still another, a guess" (Gardner, 1953, p. 217). This contention is supported by the Bugelski, Kidd, and Segmen (1968) study, which indicates the need for permissiveness in timing, in order to allow Ss to set their own presentation rate on learning tasks.

It appears also that speed of performance may not necessarily be related to intelligence. This contention is supported by the experimental evidence in the Jacobson, Millham, and Berger (1970) study. The results of that study according to its authors " . . . provide confirmation of Saltz and Hamilton's (1969) hypothesis that intelligence predicts the frequency with which Ss solve concepts but not the speed of solution among solvers" (p. 338).

However, there is also substantial evidence to the contrary. Furneaux (1960) study provides evidence in support of the view that mental speed may be the main cognitive determinant of problem solving ability on test items. Likewise Roth (1964) has demonstrated that speed of information processing correlated significantly with IQ scores. Bose (1969) found, in an investigation into the relationship between speed of work and intelligence, that high scoring Ss in a matching test scored high on other tests (mental alertness, verbal reasoning, following directions). Lord (1956) studied the intercorrelations for a large battery of tests including ones in vocabulary, arithmetic reasoning, and spatial relations with three different time limits. He found

> All correlations between course grades and the four speed factors, with one small exception, were found to be positive, although not large. It is to be concluded that speed of various kinds plays some part in the course grades studied, and that speediness in the admissions examination is to this extent justified. It would seem that tests on which 50 to 75 per cent of the examinees reach the last item do not involve the speed factors needed; apparently, only very highly speeded tests involve these factors to any appreciable extent (p. 49).

Parrott (1970), using syllogistic reasoning as the focus, examined the effects of speed and standard instructions on reasoning processes. He found that speed instructions reduced reasoning time. Ayers (1953) found only very slight increases in scores on arithmetic reasoning and general information tests as the time limits on these tests were increased, and that the intercorrelations between various time limits, speeded or unspeeded, were as high as the reliabilities.

> . . . what may be involved in problem solving activity may be some kind of scanning mechanism the speed of which determines the probability of the right solution being brought into focus more or less quickly. If we join this notion with that of information processing, we may have here not only the suggestion of a useful theory of intellectual functioning, but also an argument against those who abandoned the whole theory of "speed" as underlying intelligence because of the failure of reaction time experiments to correlate with intelligence tests (Eysenck, 1967, p. 85).

Nunnally suggests that there is " . . . a wealth of circumstantial evidence to indicate that <u>the comfortable time can be decreased appreciably without seriously affecting any of the psychometric properties of tests</u>"

(p. 570). He quotes, among others, Cronbach (1949), Lord (1956), Morrison (1960), and Wesman (1960) as authors supporting his conclusions.

The warning about the speed variable is made by Morrison: " . . . The information needed to understand the effects of time limits and to control them is far from complete. There are many indications, however, that the effects of time-limit variation are complex and are conditioned by other characteristics of the measurement situation" (1960, p. 233).

In view of the above evidence it would be appropriate to assume that speed may be a quite different phenomenon from one setting to another, and in an investigation of the effect of speed on concept learning performance, treat with caution all information from situations other than concept learning.

Concept learning is the special concern of this present dissertation. It is possible that in concept learning, when the speed of performance is emphasized, there may be a corresponding reduction in the quality of the product. Concepts learned quickly may not be learned as "efficiently" in terms of retention, transferability, or relatability as concepts learned slowly. " . . . The greater time required to identify the attributes and values . . . may in turn be associated with more thorough acquisition and retention of the relevant information" (Klausemeier and Wiersma, 1967, p. 362).

Focussing now on studies in the area of concept learning, it must be noted that Laughlin (1964) found no significant difference in performance on an attribute identification task measured by cards-to-solution between the speed instructions treatment, which directed Ss to attain concepts as quickly as possible, and the accuracy instructions treatment, with which in a previous study by Wasilewski (1972) the opposite results were obtained. Ss given accuracy-emphasized instructions, which directed them to attain concepts in as few card choices as possible and which explicitly pointed out the detrimental effects of speed of performance on the achievement of a solution, solved their tasks with a significantly smaller number of cards-to-solution than Ss under speed instructions. Wasilewski suggested that the accuracy instruction in Laughlin's study may have been ineffective because his experiments used a situation which inadvertently created a set to speed. Ss who have spent time in school settings may be conditioned to respond as quickly as possible under any test-like situation, and thus the emphasis on speed of performance may be inherent in any situation which is perceived by Ss as test-like. Wasilewski proposed that this inherent effect could be reduced by emphasizing to Ss the detrimental effects of speed of performance.

The theoretical framework developed for the present study in terms of the cognitive model, has been based on the proposition that concept learning is problem solving behaviour; that problems are solved more efficiently in terms of economy of effort if S follows a strategy-plan rather than a trial-and-error method of solving the problem; and that the potential efficiency of a strategy-plan is roughly proportional to the efficiency of the analytical consideration of factors involved in the problem.

It is postulated from the above propositions that cognitive activities of S in a concept learning task can be classified into three logical phases:

(a) Phase 1. S considers factors relevant to his task and analyzes the problem (or does not).

(b) Phase 2. S formulates a strategy-plan designed to solve the problem (or does not).

(c) Phase 3. S executes a strategy-plan (or attempts to solve the problem through trial-and-error).

Concept learning tasks are represented in the laboratory by concept attainment, attribute identification, and rule identification tasks (see paragraph 1.2). The attribute identification task requires S to search for and test the attributes which can be used to distinguish the exemplars from the nonexemplars of the concept to be attained (Bruner, et al, 1956). The other part of the problem to be investigated in the present study is concerned with the effect of emphasis on speed of performance on the attribute identification aspect of concept learning. Specifically, it will be investigated whether an emphasis on speed of performance, either by explicit instructions to Ss or through the postulated inherent effects of a test-like situation, may cause Ss to fail to analyze the problem (Phase 1) or formulate a strategy-plan (Phase 2).

2.3 Limitations of this empirical investigation

The following limitations are noted:

Population:	Grade XI students from schools located in Greater Victoria District, B.C., Canada.
Behavior:	only those aspects of concept learning which are represented by the performance on an attribute identification task, under reception-strategy conditions, and measured in terms of cards-to-solution efficiency of performance criterion.
Stimuli:	simple visual geometric or verbal stimuli of closed dimensionality (as opposed to open-ended dimensionality, see Schwahn, 1972).
Environmental conditions:	natural classrooms with regular teachers.

2.4 Postulates

From the preceding discussion of previous theory and research and the consideration of the two problems discussed in paragraphs 2.1 and 2.2, it is postulated: (a) that instructions which emphasize speed of performance have a detrimental effect on the attribute identification aspect of concept learning, (b) that implied speed-emphasis instructions are inherent in a test-like situation even though the experimental design may describe them as "neutral instructions", (c) that this inherent implication can be modified by explicit instructions pointing out the detrimental effect of speeding ("accuracy-emphasized instructions" in these experiments) and (d) that this inherent implication cannot be reduced by merely telling people to ignore the implications to speed when they perceive themselves to be in a test-like situation (the usual "accuracy instructions" condition). Furthermore, (e) it is postulated that spatial stimulus materials facilitate concept learning more than verbal stimulus materials under conditions where the implied instruction to speed inherent in a test-like situation is reduced. Also, (f) verbal stimulus materials facilitate concept learning more than spatial stimulus materials under conditions where the implied direction to speed is not reduced by specific instructions.

3. EXPERIMENT 1

3.1 Hypotheses

From the postulates listed in paragraph 2.4 the following hypotheses have been derived:

Hypothesis 1. The Ss under speed instructions will use more cards-to-solution to solve an attribute identification task than Ss under accuracy-emphasized instruction.

Hypothesis 2. The Ss under speed instructions will not differ significantly in number of cards-to-solution on an attribute identification task from Ss under "neutral instructions".

Hypothesis 3. The Ss under accuracy-emphasized instructions will solve an attribute identification task with fewer cards-to-solution than Ss under "neutral instructions".

Hypothesis 4. The Ss under "accuracy instructions" will not differ significantly in number of cards-to-solution on an attribute identification task from Ss under speed instructions and Ss under "neutral instructions".

Hypothesis 5. The Ss under accuracy-emphasized instructions will solve a spatial attribute identification task with fewer cards-to-solution than Ss under "neutral instructions".

Hypothesis 6. The Ss under "neutral instructions" will require fewer cards-to-solution to solve a verbal attribute identification task than to solve a spatial attribute identification task.

An additional instructional condition, speed and accuracy instructions, was added in order to complete all possible combinations of the instructional variable levels. No hypotheses were offered about its possible effect on performance, but if Ss under speed and accuracy instructions solve an attribute identification task with more cards-to-solution than Ss under "neutral instructions", then the effect of speed and accuracy instructions may be considered as detrimental.

3.2 Pilot

In order to test the comprehensibility of written instructions designed to provide Ss with the general learning directions, an illustrative demonstration exemplifying the task, and specific instructional treatments different for each of the five levels of the instructional variable (the instructions and exercises, see paragraph 3.3, Procedure), were administered to a small (N = 26) sample representative of the experimental population. The sample were Grade XI students from the Esquimalt Secondary School, Victoria, B.C.

Immediately after the pilot exercise, discussions were held with the students and their teacher (separately) about the clarity and readability of the instructions. Then, based on their suggestions, certain parts which were considered difficult were changed (for example, the phrase "relevant attributes" was changed to "important characteristics"). The new set of instructions was not tested again before its administration to Ss in the experiment proper.

3.3. Method

Design. A 5 x 2 factorial design was used with independent variables: type of instructions - speed, accuracy, speed and accuracy, no speed and no accuracy (i.e., "neutral"), or accuracy-emphasized and type of stimuli - verbal or spatial. Four extraneous variables: type of task, order of presentation, sex, and school, were stratified within each of the ten treatment cells. There were two tasks (JIB or DAX), each of a conjunctive two-dimensional attribute identification type, randomly selected from twenty four possible combinations of two-dimensional attribute identification tasks derived from a set of stimuli composed of four dimensions each of two values. There were two orders of presentation (JIB-DAX or DAX-JIB). The sex was male or female. There were two schools (Mt. View Secondary or Mt. Douglas Secondary).

The measurement of the dependent variable was taken in terms of number of cards, beyond the necessary number for all information about the concept (see paragraph 3.4), used to solve the two attribute identification tasks.

Subjects. The Ss were 301 (156 females and 145 males) students in 17 intact Grade XI classes at Mt. View Secondary School and Mt. Douglas Secondary School, Victoria, B.C.

Stimulus Materials. The stimuli were 6.0 x 12.0 cm. white cards printed on 21.5 x 28.0 cm. white sheets of paper. There were two sets (verbal and spatial) of twelve cards each, representing the same four dimensions. Each dimension had two values (shape: circular or rectangular; color: white or black; size: small or large; and number: one or two). In each set of twelve cards (for sample cards see Appendix B), sixteen cards contained all possible combinations of the two-value dimensions, and represented four relevant and twenty irrelevant exemplars of the two-dimensional concepts selected for the two attribute identification tasks; and four remaining cards were the four relevant exemplars repeated. Thus each set of twenty cards contained eight exemplars and twenty nonexemplars. The two randomly selected concepts for the two attribute identification tasks which each S had to solve, were: JIB - "one and large" and DAX - "white and small". The twenty sheets containing the stimuli were ordered in terms of the focusing strategy (Bruner, et al, 1956, p. 87). The assignment of attribute values to stimuli in order of presentation for concepts "one and large" and "white and small" are shown in Appendices C and D respectively.

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Procedure. The Ss were in seventeen intact classes in charge of their regular teachers (Es). There were seventeen Es, and each E conducted his own experiment during the first period of the same day at his school. It was attempted to assign all ten treatment cells to each intact class under its E.

Each E issued his Ss with the booklets which contained instructions (on green paper) and exercises (on white paper). The instructions (see Appendix E) contained general learning directions, an illustrative demonstration exemplifying the task, and specific directions different for each of the five levels of the instructional variable. The specific directions were placed at the beginning, in the middle, and at the end of the instructions, to ensure their effectiveness through repetition. In the specific directions Ss under the speed instructional treatment were asked to work as quickly as possible (see Appendix F), Ss under the accuracy instructional treatment were asked to work as carefully as possible (see Appendix G), Ss under the speed and accuracy instructional treatment were asked to work as quickly and carefully as possible (see Appendix H), Ss under the neutral instructional treatment were not given specific directions, and Ss under the accuracy-emphasized instructional treatment were asked to work as carefully as possible and ignore time " . . . because if you work fast then you are going to make mistakes and forget important information" (see Appendix E for sample of instructions). The exercises contained 40 sheets (see Appendix B for sample sheets). The booklets were placed face down on Ss' desks. The Es were briefed (see Appendix I) to ask Ss to "do their best", and to deal with any questions by asking the questioner to reread the instructions. When all booklets were issued to Ss, each E told his Ss to proceed with the exercise. The instructions specified that Ss could not look again at those pages in the exercises which they had already turned over.

The Es were briefed to ensure that this requirement was executed. At the end of the 50 min. period all work was stopped by Es.

3.4 Results

Abbreviations. The following abbreviations were used in all Tables and Figures in this section reporting the results: speed instructions, "SI"; accuracy instructions, "AI"; speed and accuracy instructions, "SAI"; no speed and no accuracy instructions, i.e., neutral, "NI"; accuracy-emphasized instructions, "AEI". In addition, in reporting the results when the instructional variable was collapsed into three levels (see paragraph Analysis of data: Instructional variable collapsed into three levels, below), the following abbreviations were used: speed-emphasized instructions, "SEI"; speed-not-emphasized instructions, "SNEI".

Dependent variable. The responses of Ss were observed in terms of the number of cards used to solve the task after sufficient information for the solution had been presented to S. For the JIB task, cards were ordered in terms of focusing strategy (Bruner, et al, 1956, p. 87), and since the task required the identification of two relevant attributes in four-dimensional stimuli, sufficient information about relevant attributes was available after presentation of the fourth card. For the DAX task, cards were also ordered in terms of focusing strategy, except for two extra cards (number 3 which carried no information, and number 4 which carried disjunctive information, i.e., that either size or number were relevant) which were added in order to make the task more difficult, and therefore sufficient information was available after presentation of the sixth card.

Analysis of data: Instructional variable in five levels 15-point scale

On an arbitrary basis, the responses of Ss were measured in terms of one point for each card used to solve the task beyond the minimal number necessary for all information about the concept to be identified. Thus Ss could obtain from zero to fourteen points on each task. The best possible score was zero points.

A large number of Ss failed to solve one or both tasks (32.77% of Ss on tasks with verbal stimuli, and 58.17% of Ss on tasks with spatial stimuli. For details see Tables 1 and 2). This may seem surprising since the tasks presented were designed to be such that Grade XI Ss should have been able to solve them with the number of cards made available to them (i.e., the minimum necessary plus 14, for a total of 18 on the JIB task, and 20 on the DAX task). This design was based on the information provided by a previous study (Wasilewski, 1972) where Grade XII Ss solved more difficult conceptual problems of two relevant attributes out of six, in terms of cards-to-solution from the focus card, with the means and SDs for speed, accuracy-emphasized, and neutral instructional treatments: 16.53 and 8.29, 7.22 and 1.89, and 14.92 and 7.51, respectively.

The equivalence of the proportions of failures in the five treatment populations was analyzed using the $\underline{X}^2$ test statistic at the overall Type 1 Error of .05, $\underline{df} = 4$, and critical region $\underline{X}^2 = 9.488$. The obtained frequencies for verbal and spatial stimuli tasks are shown in Tables 1 and 2, respectively. The effect of the instructional variable was non-significant, verbal-JIB $\underline{X}^2 = 6.58$, $\underline{p} > .05$; verbal-DAX $\underline{X}^2 = 6.502$, $\underline{p} > .05$; spatial-JIB $\underline{X}^2 = 7.103$, $\underline{p} > .05$; and spatial-DAX $\underline{X}^2 = 6.101$, $\underline{p} > .05$.

It was assumed that failures were not related to task difficulty nor to the instructional treatment, that they were random across the treatments, and that they were probably due to the attitude of Ss towards the experimental tasks. This assumption was substantiated by: (a) information from the analysis of work-booklets of "failure" Ss, and (b) information volunteered by Ss during their de-briefing, which was conducted one day after the experiment.

The analysis of data in the booklets of Ss who failed the task indicated three major types of error: (a) selection of two attributes as relevant with the minimal number of cards and retention of these two attributes throughout the remaining fourteen cards, although the information available in the fourteen cards indicated that the initial selection was incorrect; (b) selection of three or more attributes as relevant on each of the fifteen cards, although it was emphasized in the instructions at six different places that only two attributes are relevant; or (c) selection of two different attributes on the subsequent cards throughout the fifteen cards, thus failing to present one solution on two consecutive cards (a criterion of attributes

TABLE 1

Number and Percentage of Responses (Pass-Fail) under the Five Instructional Conditions on the Verbal Attribute Identification Task

Task	Instructional Treatment	Responses				
		Fail		Pass		Total
		N	%	N	%	N
JIB	SI	13	43.3	17	56.7	30
	AI	8	27.6	21	72.4	29
	SAI	14	50.0	14	50.0	28
	AEI	9	28.1	23	71.9	32
	NI	7	24.1	22	75.9	29
	Total	51		97		148
DAX	SI	14	46.7	16	53.3	30
	AI	8	27.6	21	72.4	29
	SAI	11	39.3	17	60.7	28
	AEI	6	18.8	26	81.2	32
	NI	7	24.1	22	75.9	29
	Total	46		102		148

TABLE 2

Number and Percentage of Responses (Pass-Fail)

under the Five Instructional Conditions

on the Spatial Attribute Identification Task

Task	Instructional Treatment	Responses				
		Fail		Pass		Total
		N	%	N	%	N
JIB	SI	20	68.9	9	31.1	29
	AI	15	46.9	17	53.1	32
	SAI	19	59.3	13	40.7	32
	AEI	12	38.7	19	61.3	31
	NI	13	44.8	16	55.2	29
	Total	79		74		153
DAX	SI	23	79.3	6	20.7	29
	AI	18	56.2	14	43.8	32
	SAI	22	68.8	10	31.2	32
	AEI	21	67.7	10	32.3	31
	NI	15	51.7	14	48.3	29
	Total	99		54		153

identification). It appeared that these errors were probably made by *S*s who were inattentive to the tasks, since these tasks were quite easy (see p. 54). This observation was further substantiated at the debriefing of *S*s, conducted one day after the experiment. The debriefing was made for ethical reasons. It was felt that the purposes of the experiment should be explained to *S*s who participated in it. The attendance was optional but a large number of *S*s (approximately 80%) attended the two debriefings (one in each school). During the question period, *S*s volunteered the information that their own failures were caused by their lack of interest in the experiment. They admitted that the tasks were quite easy, but that, since they had been subjected to all kinds of surveys and experiments in the past, seldom knowing the purposes of these projects and the results of their efforts, they had lost interest in any new projects (for further discussion see paragraph 4.3).

Consequently, based on the assumption that the failures may not have been related to task difficulty nor to the instructional treatment, the data of only the successful *S*s on the JIB or the DAX task were used in the analysis of *S*s' responses in terms of a 15-point scale. The means and *SD*s of the observed responses are shown in Tables 3 and 4. The main effect due to the instructional variable in terms of cards-to-solution was non-significant for the JIB task, $F(4,161) = .81$, $p > .05$ ($p = .5202$); and also non-significant for the DAX task, $F(4,146) = 1.93$, $p > .05$ ($p = .1088$). The main effect due to the stimuli variable in terms of cards-to-solution was non-

TABLE 3

Means and Standard Deviations of Responses under Five Instructional Conditions on Verbal and Spatial Attribute Identification Task JIB in Terms of 15-point Scale*

Treatment	$\overline{X}$	SD
Verbal		
SI	1.24	2.41
AI	0.67	1.62
SAI	2.43	4.97
AEI	0.57	2.31
NI	2.18	4.29
Spatial		
SI	3.11	4.34
AI	2.18	3.81
SAI	1.15	1.91
AEI	1.74	2.66
NI	2.44	4.24

*High score indicates poor performance

TABLE 4

Means and Standard Deviations of Responses under Five Instructional Conditions on Verbal and Spatial Attribute Identification Task DAX in terms of 15-point Scale*

Treatment	$\overline{X}$	SD
Verbal		
SI	4.31	5.11
AI	2.19	4.08
SAI	3.88	5.40
AEI	1.38	3.50
NI	1.68	4.09
Spatial		
SI	4.67	3.98
AI	2.79	4.15
SAI	2.90	3.87
AEI	2.00	2.62
NI	4.21	3.40

* High score indicates poor performance

significant for the DAX task, $F(1,146) = 1.18$, $p > .05$ ($p = .2800$).

5-point scale

It appeared that a considerable amount of information was wasted when the 15-point scale was used because the responses of unsuccessful Ss were not utilized in that analysis. In order to include all data from the experiment in the analysis of results, a new scale was developed. It was assumed that the interval between the response which failed and the response which solved the task with more than the minimal number of cards (see p. 53) may be equal to the interval between the latter and the response that solved the task with the minimal number of cards. Based on this assumption, responses were scaled in terms of zero points for failure on either task, one point for solving a task with more than the minimal number of cards, and two points for solving a task with the minimal number of cards. The total score for each S was the sum of points obtained on both tasks. Thus each S obtained a score ranging from zero to four points.

The means and SDs of the observed responses are shown in Table 5. The graphic distribution of the proportions of Ss in each treatment level on the 5-point scale is shown for verbal and spatial stimuli in Figures 1 and 2, respectively. The main effect due to the instructional variable in terms of cards-to-solution was significant, $F(4,291) = 4.45$, $p < .05$ ($p = .0016$). The main effect due to the stimulus variable in terms of cards-to-solution was also significant, $F(1,291) = 37.37$, $p < .05$ ($p = .000005$). The effect due to the interaction of the instructional variable with the stimulus variable was non-significant, $F(4,291) = .60$, $p > .05$ ($p = .6659$).

The comparison between ordered means was made using Newman-Keuls test (see Winer, 1962) at Alpha level .05. The results for performance on the verbal stimuli are shown in Appendix J. The individual contrasts between speed instructions and accuracy-emphasized instructions; and between speed-and-accuracy instructions and accuracy-emphasized, neutral, and accuracy instructions; were significant, $p < .05$. The individual contrasts between speed instructions and speed-and-accuracy, accuracy, and neutral instructions; between accuracy-emphasized instructions and neutral, and accuracy instructions; and between neutral instructions and accuracy instructions; were non-significant, $p > .05$. On spatial stimuli, all individual contrasts were non-significant, $p > .05$. The individual contrast between means of neutral instructions on verbal stimuli and neutral instructions on spatial stimuli, using Welch's approximation[2], was significant, $t_{48} = 1.779$, $p < .05$.

Analysis of data: Instructional variable collapsed into three levels

It appears from the preceding analyses that when responses are measured in terms of the 15-point scale, a large part of the data obtained in the experiment is not utilized and that the results based only on successful performance are non-significant. However,

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[2] with $\underline{df} = (N_1 - 1)\ (N_2 - 1)/(N_2 - 1)\ C^2 + (N_1 - 1)\ (1 - C)^2$,

and $C = \dfrac{S_1^2 / N_1}{S_1^2 / N_1 + S_2^2 / N_2}$

TABLE 5

Means and Standard Deviations of Responses under Five Instructional Conditions on Verbal and Spatial Attribute Identification Tasks in Terms of 5-point Scale*

Treatment	$\overline{X}$	SD
Verbal		
SI	1.73	1.57
AI	2.52	1.57
SAI	1.75	1.62
AEI	2.76	1.56
NI	2.69	1.58
Spatial		
SI	0.72	1.03
AI	1.56	1.66
SAI	1.13	1.43
AEI	1.39	1.31
NI	1.45	1.38

* Here low score indicates poor performance

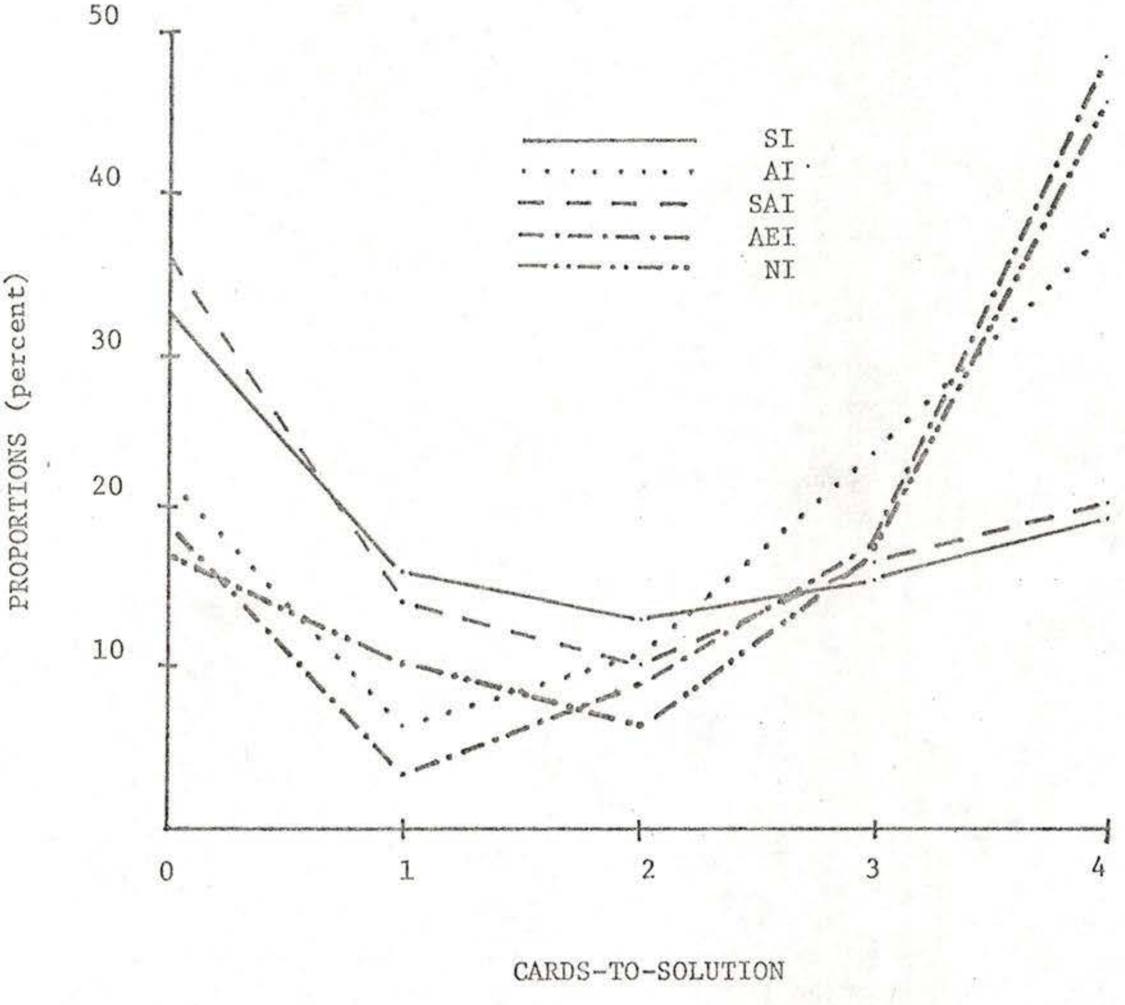

Figure 1. Proportions of Ss' Responses to Verbal Stimuli in Terms of the 5-point Scale for Five Instructional Conditions

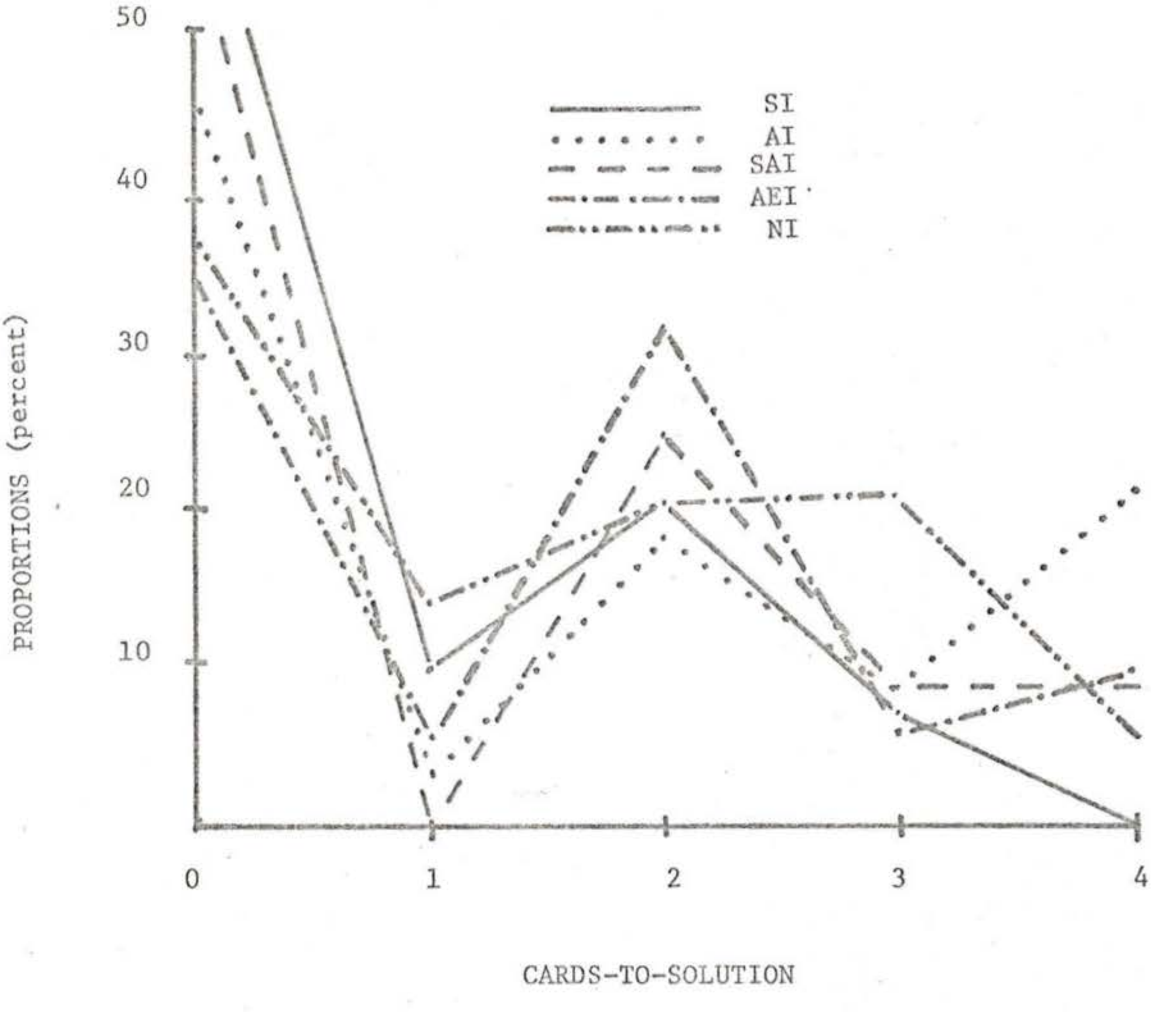

Figure 2. Proportions of Ss' Responses to Spatial Stimuli in Terms of the 5-point Scale for Five Instructional Conditions

when the responses are measured in terms of the 5-point scale which does utilize the data from all Ss in the sample, the results indicate that on verbal stimuli the responses of Ss under instructions where speed is emphasized (SI and SAI) appear to be similar, and that the responses of Ss under instructions where speed is not emphasized and accuracy is emphasized (AI and AEI) appear to be similar. Furthermore, the responses of Ss under the control condition (NI) on verbal stimuli appear to be similar to the responses of Ss under the speed not-emphasized and the accuracy emphasized conditions.

The evidence from the analyses of responses in terms of a 5-point scale suggests that the accuracy instructions may not have been very effective. Assuming that accuracy instructions were not effective, the five levels of the instructional variable were collapsed into three levels: (a) speed-emphasized instructions (SEI) which included speed instructions and speed-and-accuracy instructions; (b) speed-not-emphasized instructions (SNEI) which included accuracy instructions; and between speed-and-accuracy instructions and (c) neutral instructions (NI); and the results were analyzed in terms of 15-point and 5-point scales.

The means and SDs of the observed responses in terms of a 15-point scale are shown in Tables 6 and 7. The main effect due to the instructional variable in terms of cards-to-solution was non-significant for the JIB task, $F(2,165) = 1.56$, $p > .05$ ($p = .2138$); but was significant for the DAX task, $F(2,150) = 3.27$, $p < .05$ ($p = .0408$). The main effect due to the stimulus variable in terms of cards-to-solution was non-significant for the JIB task, $F(1,165) = 2.07$,

$p > .05$ ($p = .1519$); and also non-significant for the DAX task, $F(1,150) = 1.26$, $p > .05$ ($p = .2635$). The effect due to the interaction of the instructional variable with the stimulus variable for the DAX task was non-significant, $F(2,150) = 1.33$, $p > .05$ ($p = .2671$).

The means and SDs of the observed responses in terms of a 5-point scale are shown in Table 8. The main effect due to the instructional variable in terms of cards-to-solution was significant for the sum of responses (JIB + DAX), $F(2,295) = 8.65$, $p < .05$ ($p = .00023$). The main effect due to the stimulus variable in terms of cards-to-solution was significant for the sum of responses (JIB + DAX), $F(1,295) = 37.47$, $p < .05$ ($p = .000007$). The effect due to the interaction of the instructional variable with the stimulus variable was non-significant, $F(2,295) = .64$, $p > .05$ ($p = .5276$).

TABLE 6

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Task JIB in Terms of 15-point Scale *

Treatment	$\overline{X}$	SD
Verbal		
SEI	1.77	3.77
SNEI	0.61	1.99
NI	2.18	4.29
Spatial		
SEI	1.95	3.20
SNEI	1.94	3.22
NI	2.44	4.24

* Here high score indicates poor performance

TABLE 7

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Task DAX in Terms of 15-point Scale *

Treatment	$\overline{X}$	SD
Verbal		
SEI	4.09	5.18
SNEI	1.74	3.75
NI	1.68	4.09
Spatial		
SEI	3.56	3.88
SNEI	2.46	3.55
NI	4.21	3.40

* Here high score indicates poor performance

TABLE 8

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Tasks in Terms of 5-point Scale *

Treatment	$\overline{X}$	SD
Verbal		
SEI	1.74	1.58
SNEI	2.66	1.56
NI	2.69	1.58
Spatial		
SEI	0.93	1.26
SNEI	1.48	1.49
NI	1.45	1.38

* Here low score indicates poor performance

3.5 Discussion

The results provided only partial support for hypothesis 1, that Ss under speed instructions would use more cards-to-solution on an attribute identification task than Ss under accuracy-emphasized instructions. On the 15-point scale there was no significant difference in performance. However, when the 5-point scale was devised to ensure that all the data were accounted for, the results on the verbal attribute identification task showed that Ss under speed and neutral instructions used significantly more cards-to-solution in terms of the 5-point scale than Ss under accuracy-emphasized instructions. But the analysis of performance on the spatial attribute identification task failed to provide supporting evidence for the first hypothesis.

Although the first hypothesis was supported only partially by the results, there seems sufficient evidence to maintain the concern that instructions which emphasize speed of performance may have a detrimental effect on attribute identification tasks, especially since the 5-point scale seems to take account of more of the data than the 15-point scale. It is concluded that further empirical investigation of this problem, including not only speed conditions but also neutral conditions, is necessary.

It was also hypothesized that Ss under speed instructions would not differ significantly in the number of cards-to-solution from Ss under "neutral instructions" (Hypothesis 2), that Ss under accuracy-emphasized instructions would solve the attribute identification task with fewer cards-to-solution than Ss under "neutral instructions" (Hypothesis 3), and that Ss under "accuracy instructions" would not differ significantly in number of cards-to-solution from Ss under speed and Ss under "neutral instructions" (Hypothesis 4). The results do not support these hypotheses. It appears that the accuracy, and accuracy-emphasized instructions may not have been effective. The responses of Ss under the accuracy and accuracy-emphasized instructional conditions seem to be no different (see Appendix J) from the responses of Ss under the control condition (NI). It may be that the written instructions about accuracy, used in the present study, had less effect than oral instructions, which were used in a previous study (Wasilewski, 1972).

The hypothesis that Ss under accuracy-emphasized instructions would solve a spatial attribute identification task with fewer cards-to-solution than Ss under neutral instructions (Hypothesis 5) also is not supported by the results.

The comparison of the performance of Ss under neutral instructions on the verbal stimulus task with the performance of Ss under neutral instructions on the spatial stimulus task significantly supports the hypothesis that Ss under neutral instructions would solve a verbal attribute identification task with fewer cards-to-solution than they would solve a spatial attribute identification task (Hypothesis 6). This evidence suggests that verbal stimulus materials may facilitate the attribute identification aspect of concept learning more than spatial stimulus materials under conditions where the implied direction to work as quickly as possible is not reduced by specific instructions.

In Experiment 1 two scales were used to measure Ss' responses: the 15-point scale and the 5-point scale described above. The 5-point scale was developed only as a methodological expediency to overcome the wastage of information caused by the fact that a large number of S's failed to solve even one of the attribute identification tasks. A fact which could not be accommodated in the original 15-point scale. On the 5-point scale, values could be assigned to all responses, whether successful or unsuccessful. Thus the 5-point scale takes account of more of the data.

As has been noted above, the results, using the 5-point scale, indicate that instructions to work as quickly as possible may have a detrimental effect on performance on verbal, but not on spatial, attribute identification tasks. However, the relative magnitude of the means on spatial tasks was in the expected direction, i.e., the means for Ss under speed instructions were smaller than the means for Ss under accuracy instructions and for Ss under accuracy-emphasized instructions, although the main effect due to the instructional treatment on the spatial variable was non-significant. This evidence provides some support for the proposition that the validity of time-to-solution as a criterion of conceptual behaviour under experimental conditions where verbal stimuli are used predominantly, is questionable and deserves further methodological investigation.

The present results do not indicate that emphasis on accuracy facilitates performance on an attribute identification task. The evidence suggests rather that the accuracy instructions (accuracy, and accuracy-emphasized) may not have been effective, or that the set to solve the problems with an emphasis on accuracy may not have been effective. Some possible causes for the apparent ineffectiveness of the accuracy instructions may be the greater ease in evoking responses to speed instructions than accuracy instructions, or the placement of specific directions at the beginning of instructions, probably resulting in hurried reading of instructions by the group under speed conditions.

When the ineffectiveness of "accuracy" instructions became evident, the results were collapsed into three levels of instructional variable: speed-emphasized, speed-not-emphasized, and neutral, and were analyzed accordingly. The main effects due to the instructional and stimulus variables were then highly significant (at $p = .00023$, and $p = .000007$, respectively). This evidence provides more support for the proposal that speed of performance and geometric stimulus materials may be important factors requiring extensive methodological investigation before the results from such experimental laboratory studies of attribute identification can be legitimately generalized to most classroom concept learning conditions.

The results indicate that verbal stimulus materials may be more facilitating in attribute identification than spatial stimulus materials. Furthermore, they indicate that there is no significant effect of the instructional variable on performance with spatial stimuli, whereas the effect of the instructional variable was significant on performance with verbal stimuli. This evidence supports the contention that when geometric (spatial) stimulus materials are arbitrarily combined into dimensions to represent rote-like concepts, then learning of these concepts may have little relationship to learning of meaningful concepts in school settings where students have the opportunity to make judgments about the relevance of the attributes of the concepts learned on the basis of accumulated experience (Wasilewski, 1971).

The statistical analyses were based on the assumptions necessary for the analysis of variance. In order to account for the possibility that the assumptions of the equality of intervals and the normality of distributions were not satisfied, distribution-free non-parametric tests were administered. This was done although the large size of the samples and the similarity of distribution shapes for the five levels of instructional variable indicated that the F ratios would have been only slightly affected by the violation of the normality of distribution assumption. The data are shown in Appendix K. The results of non-parametric tests support the findings from the analysis of variance, that speed instructions and spatial stimuli may have detrimental effects on performance on an attribute identification task, at Alpha level .01 ($p = .0015$, and $p = .0013$, respectively).

The experiment was deliberately conducted with Ss in intact classes (seventeen sections) each under the direction of a different teacher. This was done in order to remove the situational conditions from the conventional artificial, laboratory-like, experimental environment, to one more like the natural educational, classroom environment (Schwahn, 1972). It was felt that by using regular teachers rather than experimenters unfamiliar to Ss, the performance of Ss' would be more representative of the typical classroom learning performance (Cronbach, 1970). However, no attempt is made to equate this experimental situation to the typical classroom situation.

When the results of the present study (high failure rate on a simple attribute identification task) and the information volunteered by Ss during the debriefing (that Ss lacked the motivation to complete their tasks successfully) were compared with the results from a previous study (Wasilewski, 1972), which was conducted in a conventional experimental situation where the experimenter administered tasks to individual Ss, it became evident that Ss' responses under the former conditions were not as successful in terms of number of cards-to-solution as the responses of Ss under the latter conditions. It may be that the performance of Ss in the present study, conducted under approximately natural classroom conditions, was more representative of classroom learning. Concept formation is different from concept attainment (Bruner, et al, 1956; Schwahn, 1972), and concepts formulated in a classroom are not the result of a one-shot effort, as seems to be the case under experimental conditions. Whereas under experimental conditions Ss may take from a few seconds to an hour to identify the attributes of a given concept, it appears that concept learning in a school setting takes more time. The Ss who failed to identify the attributes of a concept within the fourteen cards in this experiment, would certainly have more time and more opportunity to practice in a natural classroom situation in formulating a new concept. If these Ss were given more time and practice, then their behaviour would probably be as successful (in terms of pass or fail) as the behaviour of Ss in the earlier study of Wasilewski (1972). It may also be that the regular teachers did not motivate their Ss as did the experimenter in the earlier study, though this is contrary to Cronbach's contention (1970, p. 45). This may have been due to failure to arouse the teachers' interest in the present experiment. It may be unreasonable to expect teachers who are probably concerned about their own daily chores, to be as enthusiastic about an experiment as the experimenter who is conducting his own study. Furthermore, Ss in the earlier study (Wasilewski, 1972) were volunteers under experimenter's individual supervision, whose performance was constantly under observation, whereas Ss in this present experiment were in intact classes, enjoying the anonymity offered by group membership.

Although conducting experimental studies under conditions approximating the classroom learning situation presents many difficulties, as this experiment has demonstrated, the apparently different effects of these conditions on Ss' performance from that of a conventional experimental situation would seem to indicate that further investigation of concept learning under more typical school conditions would be warranted.

4. EXPERIMENT 2

4.1 Rationale for second experiment

It is possible that the high proportion of failures in Experiment 1 impaired the validity of its findings. The cause of the high rate of failures appeared, from the observations made during Experiment 1 and the debriefing, to be due to two factors. The first factor seemed to be the apparent lack of interest of the test-administrators (regular classroom teachers) and the effect of their lack of interest on their students' performance (it has been emphasized in paragraph 3.5 that this apparent disinterest might have been due entirely to the failure of this writer to provide motivational incentives). The second factor appeared to be the inadequacy of the motivational inducement in the directions to Ss (which were read to Ss by the test-administrators). Therefore, when it was decided to provide supporting evidence to the findings of Experiment 1 by conducting another experiment with a more acceptable failure rate, it became obvious that the two aspects of motivation must be improved.

In order to improve motivation it was decided to increase the students' and teachers' involvement in the experiment. It was assumed that by appealing to teachers, who were to participate in Experiment 2, for their advice on solving the problem of motivation which had occurred in Experiment 1 and consequently, by giving them an opportunity for a closer identification with the project, their interest in the experiment would be secured. To that end, teachers who were to participate in the pilot study and Experiment 2 were consulted and, based on their suggestions, a new approach was adopted in the motivational directions to Ss. Whereas in Exp. 1 Ss were treated in a rather authoritarian manner (simply told that the exercise was designed to find out how well they can think, that their performance would be scored, and that the score would indicate to their teachers their thinking ability), in Exp. 2 Ss were treated in a more democratic fashion. They were reminded that there are certain conditions in their classroom that affect their learning, that educators do attempt to identify these conditions by conducting experimental studies, and that these conditions can be identified only if Ss who participate in those studies give full cooperation. Furthermore, Ss were told that the project in which they were asked to participate, would be explained to them fully on the day following the experiment. (Not knowing that they would receive this feedback had apparently been the major source of discontent among Ss in Exp. 1). The new directions for test administrators are shown in Appendix L.

4.2 Hypotheses

The following hypotheses were tested in Experiment 2:

Hypothesis 7. The Ss under accuracy-emphasized instructions will:

(a) solve proportionally more attribute identification tasks;

(b) solve attribute identification tasks with fewer cards in terms of the 15-point scale, i.e., number of cards past the minimum necessary for all information about the task;

(c) solve attribute identification tasks with fewer cards-to-solution in terms of the 5-point scale;

(d) take more total time to read the instructions, and solve two verbal attribute identification tasks, and test the correctness of both hypothesized solutions;

(e) not differ in time taken to read the instructions, and solve two spatial attribute identification tasks, and test the correctness of both hypothesized solutions;

than will Ss under speed instructions.

Hypothesis 8. On verbal attribute identification tasks Ss will:

(a) solve proportionally more tasks;

(b) solve tasks with fewer cards in terms of the 15-point scale;

(c) solve tasks with fewer cards in terms of the 5-point scale;

than will Ss on spatial attribute identification tasks.

4.3 Pilot

In order to test the effectiveness of the new directions to Ss designed to improve Ss' motivation, and consequently to reduce the failure rate, a pilot study consisting of two tests, was conducted. In the first test, one intact class of Grade XI students at Esquimalt Senior Secondary School, Victoria, B.C. was used. Twenty-three Ss were given the new directions (which were read to Ss by the teacher/E) and two tasks on spatial stimuli to perform. One half of Ss was given tasks at difficulty level 1, which was exactly the same as in Experiment 1 (i.e., the task was: to identify two out of four attributes as relevant). The other one half of Ss was given tasks at difficulty level 2 (i.e., the task was: to identify two out of six attributes as relevant, where the additional attributes were: high or low and jagged or smooth outline of the geometric figure). The increase in task difficulty was designed to reduce the proportion of the successful solutions with the minimum number of cards necessary for all information about the concept to be identified (i.e., to reduce the apparent abnormality of the distribution, see Figures 1 and 2). Only two levels of the instructional variable were used (speed or accuracy emphasized). In addition to testing the effectiveness of the new directions to Ss, the pilot was utilized to test a second technique of measuring the dependent variable, the total-time-to certainty. This measure was to indicate the total time taken by each S to read the instructions and solve both tasks and also test the correctness of both hypothesized solutions. The test-administrator

(E) recorded the time when all Ss were told to start working on their problems (which began with the reading of instructions), and recorded the time when each individual S returned both exercise booklets and picked up a questionnaire (Appendix M). The questionnaire was a "filler task" designed to provide E with an opportunity (when it was picked up by S) to identify the time of tasks' completion for each individual S, without giving away the fact that the time was being measured (otherwise the effectiveness of the accuracy-emphasized instructions where Ss were asked to ignore the time, would have been reduced).

The results of this first pilot experiment indicated that although Ss appeared well motivated (i.e., all Ss completed their tasks, whether successfully or unsuccessfully, without mutilating or destroying their booklets or without making derogatory remarks about the study as in Experiment 1), the failure rate was not improved (58.17% in Exp. 1, and 61.2% in Exp. 2) by the new directions. The difficulty level (1 or 2) had no significant effect on performance as measured by the proportion of failures, $X^2 = .72$, $p > .05$. The E reported no difficulties with the measurement of total-time-to-certainty.

During the debriefing immediately following Pilot Exp. 1, it became evident that both the teacher (E) and the students were dissatisfied with and irritated by the lengthy instructions (Appendix E). Students volunteered the information that after reading the first page or two of the five-page-instruction, they skipped through the remaining pages. They complained that the instructions were confusing and difficult to follow.

Based on this new information, the instructions were condensed to two pages and modified in order to present to S a set of four demonstration cards together for the ease of comparison of exemplars and non-exemplars and, consequently, for the derivation of the principles underlying the solution of the presented attribute identification problems. The new instructions are shown in Appendix N.

Pilot Experiment 2 was conducted in order to test the effectiveness of the new instructions. Since it was suspected that by limiting tasks to spatial stimuli in Pilot Experiment 1 the postulated effect of the new directions may have been masked (that is, the inherent difficulty of spatial stimuli was so great that even an improvement in motivation would not have been sufficient to overcome it), both spatial and verbal stimulus tasks were administered to Ss in Pilot Experiment 2. A different Grade XI class (N = 26) from the Esquimalt School was administered the new instructions and was given two attribute identification tasks to perform. The proportion of failures on verbal and spatial stimulus tasks was 19% and 42%, respectively; as compared to 32.77% and 58.17% in Experiment 1. The change in the failure rate was in the postulated direction, however, the difference was not significant. It may be that the non-significance was due to the small number of Ss per cell in Pilot Experiment 2 (N = 8 on verbal difficulty level 1 tasks, and N = 6 on spatial difficulty level 1 tasks).

The evidence from Pilot Experiment 2, although not conclusive, was considered as sufficient to warrant the implementation of new instructions and new directions in the proposed main Experiment 2.

4.4 Method

Design. A 3 x 2 factorial design was used with independent variables: type of instructions (speed, accuracy-emphasized, or neutral) and type of stimuli (verbal or spatial). Four extraneous variables: type of task, order of presentation, S's sex, and level of difficulty, were stratified within each of the six treatment cells. The fifth extraneous variable was the teacher. Attempt was made to stratify the independent and extraneous variables within each section under one regular teacher. There were two tasks for each of the two levels of difficulty. The two tasks of difficulty level 1 (JIB and DAX) were exactly the same as the two tasks in Experiment 1. The two tasks of difficulty level 2 (JIK and DAK) were based on the JIB and DAX tasks, respectively, except that instead of stimuli composed of four dimensions (of two values each) the stimuli were composed of six dimensions (also of two values each). This was achieved by adding two dimensions (of two values each) to the original four dimensions. The two new dimensions were: high or low (referring to the position of the geometric figure on the card) and jagged or smooth (referring to the outline of the geometric figure). There were two orders of presentation (J-D or D-J). The sex ratio was approximately the same as in Experiment 1. There were seven different teachers/sections.

The measurement of the dependent variable was taken in terms of:

(a) proportions of passes;

(b) number of cards to solution in terms of the 15-point scale;

(c) number of cards to solution in terms of the 5-point scale;

(d) total-time taken to read the instructions, solve two tasks, and test the correctness of both hypothesized solutions.

The two measures (a) and (c) above, were designed to provide information about the performance of all Ss, regardless of whether their performance was successful or not. The measure of cards to solution in terms of the 15-point scale (b) above, was taken in order to differentiate performance of the successful Ss on each of the two tasks presented to S. The measure of total time (d) above, was taken only for the successful responses on both tasks presented to S.

Subjects. The Ss were 112 (66 females) students in seven intact classes (Grade XI) at Claremont Secondary School, Saanich (a suburb of Victoria), B.C. The socio-economic status of students and the educational standards of the school, were considered equal to that of the two schools in Victoria, whose students participated in Experiment 1.

Stimulus Materials. The stimuli were exactly the same as stimuli used in Experiment 1, except that, in addition to the two sets (verbal and spatial) of twenty cards each representing the same four dimensions and designated as difficulty level 1, there were two other sets (verbal and spatial) representing the same six dimensions. The two new sets of six dimensions designated as difficulty level 2, were constructed by adding the values of the two new dimensions: high or low and jagged or smooth, to the values of the original four dimensions used in Experiment 1 (for sample cards see Appendix O). No change was made in the strategy of presentation, that is, only one attribute was changed on each subsequent card presentation, thus allowing S to follow the focusing strategy. The assignment of attribute values to stimuli in order of presentation for concepts "one and large" (JIK) and "white and small" (DAK) are shown in Appendices P and Q, respectively.

Procedure. Exactly the same procedure was used as in Experiment 1 except the directions read to Ss by Es and the written instructions issued to Ss were modified (see paragraph 4.1). The new directions are shown in Appendix L and the new instructions are shown in Appendix N.

4.5 Results

Abbreviations. The following abbreviations are used in all Tables in this section reporting the results: speed instructions, "SI"; accuracy-emphasized instructions, "AEI"; no speed and no accuracy-emphasized instructions, i.e., neutral, "NI".

Dependent variable. The responses of Ss were observed in terms of number of cards to solution (proportion of passes, 15-point and 5-point scales) and total time to certainty (see paragraph 4.3). All tasks were arranged in terms of the focusing strategy.

Analysis of data: Extraneous variable - level of difficulty

The extraneous variables were stratified within each treatment cell. However, because of inequality of the number of Ss per cell, the effect of level of difficulty was analyzed. The effect was non significant, $F(1,107) = .1676$, $p > .05$ ($p = .683$).

Analysis of data: Proportions of passes (Experiment 1 versus Experiment 2).

The proportion of failures on tasks of difficulty level 1 on verbal and spatial stimuli in Experiment 2 compared with the proportion of failures on verbal and spatial stimuli tasks in Experiment 1 were: 16.7% and 38.1% versus 32.77% and 58.17%, respectively. The equivalence of the proportions of failures in both experiments was analyzed using the Chi-square test statistic at the overall Type 1 Error of .05, $df = 1$, and critical region $X^2 = 3.84$. The obtained frequencies for verbal and spatial stimuli tasks at difficulty level 1 for Experiment 1 and 2 are shown in Table 9. The proportions of failures in Experiment 2 was significantly smaller for verbal-JIB, $X^2 = 4.90$, $p < .05$ and verbal-DAX, $X^2 = 9.66$, $p < .05$; and for spatial-DAX, $X^2 = 26.00$, $p < .05$. The proportion of failures in Experiment 2 was not significantly smaller for spatial-JIB task, however, since each S had performed on both (JIB and DAX) tasks, the change in the desired direction indicated in the comparison of total performance in Experiment 1 and 2 suggests an improvement in performance.

The lower proportion of failures in Experiment 2 is considered as evidence indicating that the new methods implemented in Experiment 2 may have been effective. Furthermore, the smaller failure rate in Experiment 2 than the failure rate in Experiment 1 suggests, that the validity of the dependent variable in the former is higher in comparison with the validity in the latter experiment.

Analysis of data: Effect of the instructional variable on the proportions of successful responses (passes).

It was hypothesized that Ss under accuracy-emphasized instructions will solve proportionally more attribute identification tasks than will Ss under speed instructions (Hypothesis 7 (a)). The equivalence of the proportions of passes in the three treatment populations was analyzed using the Chi-square test statistic at the overall Type 1 Error of .05, df = 2, and critical region $X^2 = 5.99$. The obtained frequencies for the three levels of the instructional treatment are shown in Table 10. The effect of the instructional variable was significant for J (JIB and JIK) tasks, $X^2 = 7.5$, $p < .05$, and also significant for D (DAX and DAK) tasks, $X^2 = 11.4$, $p < .05$. The equivalence of the proportion of passes in the speed and in the accuracy-emphasized treatment populations was analyzed using the Chi-square test statistic at the overall Type 1 Error of .01, df = 1, and critical region $X^2 = 6.663$. The proportion of passes was significantly larger for the accuracy-emphasized treatment on J tasks, $X^2 = 12.7$, $p < .01$, and on D tasks, $X^2 = 11.2$, $p < .01$.

Analysis of data: Effect of the stimulus variable on the proportions of successful responses (passes).

It was hypothesized that on verbal attribute identification tasks Ss will solve proportionally more tasks than will Ss on spatial attribute identification tasks (Hypothesis 8(a)). The equivalence of the proportions of passes in the two treatment populations was analyzed using the Chi-square test statistic at the overall Type 1 Error of .05, $df = 1$, and critical region $X^2 = 3.84$. The obtained frequencies for the two levels of the stimulus treatment are shown in Table 11. The effect of the stimulus variable was significant for J tasks, $X^2 = 5.3$, $p < .05$, but not significant for D tasks (however, the magnitude was in the hypothesized direction).

Analysis of data: Effect of instructional variable on performance in terms of 15-point scale.

It was hypothesized that Ss under accuracy-emphasized instructions will solve attribute identification tasks with fewer cards in terms of the 15-point scale than will Ss under speed instructions (Hypothesis 7(b)). The responses of Ss were measured by assigning one point for each card used to solve the task beyond the minimal number necessary for all information about the concept to be identified. Thus Ss could obtain zero to fourteen points on each of the two tasks. The best possible score was zero points.

The means and SDs of the observed responses are shown in Table 12 for J and D tasks. The main effect due to the instructional variable was non significant for J task, $F(2,73) = 2.50$, $p > .05$ ($p = .089$), and for D task, $F(2,76) = 2.66$, $p > .05$ ($p = .076$).

TABLE 9

Number and Percentage of Responses (Pass-Fail) on
Verbal and Spatial Attribute Identification
Difficulty Level 1 Tasks in Experiment 1 and 2

Stimulus	Experiment	Task	Responses				
			Pass		Fail		Total
			N	%	N	%	N
Verbal	1	JIB	97	65.5	51	34.5	148
		DAX	102	68.9	46	31.1	148
		Total		67.2		32.8	
	2	JIB	31	79.5	8	20.5	39
		DAX	34	87.2	5	12.8	39
		Total		83.3		16.7	
Spatial	1	JIB	74	48.4	79	51.6	153
		DAX	54	35.3	99	64.7	153
		Total		41.8		58.2	
	2	JIB	11	52.4	10	47.6	21
		DAX	15	71.4	6	28.6	21
		Total		61.9		38.1	

TABLE 10

Number and Percentage of Responses (Pass-Fail) under Three Instructional Conditions on Attribute Identification Tasks

Task	Instructional Treatment	Responses				
		Pass		Fail		Total
		N	%	N	%	N
J (JIB/JIK)	SI	27	60.0	18	40.0	45
	AEI	33	86.8	5	13.2	38
	NI	19	65.5	10	34.5	29
D (DAX/DAK)	SI	27	60.0	18	40.0	45
	AEI	35	92.1	3	7.9	38
	NI	22	75.8	7	24.2	29

TABLE 11

Number and Percentage of Responses (Pass-Fail) under Two Stimulus Conditions on Attribute Identification Tasks

Stimulus Treatment	Task	Responses				
		Pass		Fail		Total
		N	%	N	%	N
Verbal	J (JIB/JIK)	52	78.8	14	21.2	66
	D (DAX/DAK)	52	78.8	14	21.2	66
	Total		78.8		21.2	
Spatial	J (JIB/JIK)	27	58.7	19	41.3	46
	D (DAX/DAK)	32	69.5	14	30.5	46
	Total		64.1		35.9	

TABLE 12

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Tasks J and D in Terms of 15-point Scale

Task	Treatment	$\overline{X}$	SD
J	Verbal		
	SI	3.06	4.64
	AEI	1.30	3.15
	NI	2.23	4.87
	Spatial		
	SI	6.90	5.34
	AEI	3.00	4.55
	NI	6.50	4.23
D	Verbal		
	SI	3.78	5.83
	AEI	1.00	2.47
	NI	0.80	1.48
	Spatial		
	SI	6.44	5.81
	AEI	4.17	5.20
	NI	6.60	4.62

Analysis of data: Effect of stimulus variable on performance in terms of the 15-point scale.

It was hypothesized that on verbal attribute identification tasks Ss will solve tasks with fewer cards in terms of the 15-point scale than will Ss on spatial attribute identification tasks (Hypothesis 8 (b)). The means and SDs are shown in Table 12. The main effect due to the stimulus variable was significant for J task, $F(1,73) = 8.72$, $p < .05$ ($p = .004$); and also significant for D task, $F(1,78) = 13.21$, $p < .05$ ($p = .0005$).

Analysis of data: Effect of instructional variable on performance in terms of 5-point scale.

It was hypothesized that Ss under accuracy-emphasized instructions will solve attribute identification tasks with fewer cards-to-solution in terms of the 5-point scale than will Ss under speed instructions (Hypothesis 7(c)). The responses of Ss were measured on the 5-point scale by assigning zero points for failure on either task, one point for solving a task with more than the minimal number of cards, and two points for solving a task with the minimal number of cards. The total score for each S was the sum of points obtained on both tasks. Thus each S obtained a score ranging from zero to four points.

The means and SDs of the observed responses are shown in Table 13. The main effect due to the instructional variable was significant, $F(2,106) = 12.37$, $p < .05$ ($p = .00001$).

The comparison between ordered means was made using Newman-Keuls test (see Winer, 1962) at Alpha level .05. The results are shown in Appendix R. The individual contrast between speed instructions and accuracy-emphasized instructions and between neutral instructions and accuracy-emphasized instructions was significant, $p < .05$.

Analysis of data: Effect of stimulus variable on performance in terms of the 5-point scale.

It was hypothesized that on verbal attribute identification tasks Ss will solve tasks with fewer cards-to-solution in terms of the 5-point scale than will Ss on spatial attribute identification tasks (Hypothesis 8(c)). The means and SDs are shown in Table 13. The main effect due to the stimulus variable was significant, $F(1,106) = 16.79$, $p < .05$ ($p = .00008$).

Analysis of data: Effect of interaction between instructional and stimulus variables on performance in terms of the 5-point scale.

The effect of interaction was non-significant, $F(2,106) = 0.63$, $p > .05$ ($p = .536$).

Analysis of data: Effect of instructional variable on performance in terms of total-time-to-certainty.

It was hypothesized that Ss under accuracy-emphasized instructions will take more total time: to read the instructions, and solve two verbal attribute identification tasks, and test the correctness of both hypothesized solutions, than will Ss under speed instructions (Hypothesis 7(d)). The means and SDs of the observed responses are shown in Table 14. The main effect due to the instructional variable was non-significant, $F(2,58) = 2.47$, $p > .05$ ($p = .0936$).

Furthermore, it was hypothesized that Ss under accuracy-emphasized instructions will not differ in time taken to read the instructions, and solve two spatial attribute identification tasks, and test the correctness of both hypothesized solutions, than will Ss under speed instructions. The comparison between ordered means was made using Newman-Keuls test at Alpha level .05. The results are shown in Appendix S. The individual contrast between speed instructions on spatial stimuli and accuracy-emphasized instructions on spatial stimuli was non-significant, $p > .05$.

TABLE 13

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Tasks in Terms of 5-point Scale

Treatment	$\overline{X}$	SD
Verbal		
SI	2.04	1.50
AEI	3.46	0.93
NI	2.50	1.15
Spatial		
SI	1.41	1.12
AEI	2.36	1.15
NI	1.31	0.85

TABLE 14

Means and Standard Deviations of Responses under Three Instructional Conditions on Verbal and Spatial Attribute Identification Tasks in Terms of Total Time

Treatment	$\overline{X}$	SD
Verbal		
SI	160.77	37.52
AEI	211.59	79.09
NI	216.88	72.85
Spatial		
SI	172.14	40.61
AEI	180.00	42.43
NI	184.00	71.27

4.6 Discussion

The results support most of the hypotheses based on the postulate that instructions which emphasize speed of performance have a detrimental effect on the attribute identification aspect of concept learning (see paragraph 2.4). Under accuracy-emphasized instructions Ss solved proportionally more attribute identification tasks, and solved them with fewer cards in terms of the 5-point scale, than did Ss under speed instructions (Hypotheses 7(a) and 7(c), respectively). The results do not support the hypothesis that Ss under accuracy-emphasized instructions solve attribute identification tasks with fewer cards in terms of the 15-point scale than do Ss under speed instructions (Hypothesis 7(b)). However, these results in terms of the 15-point scale could be considered as approaching marginal significance (p = .089 and p = .076, for J and D tasks, respectively).

The results also support the hypotheses based on the postulate that verbal stimulus materials facilitate concept learning more than spatial stimulus materials. On verbal attribute identification tasks Ss solved proportionally more tasks (Hypothesis 8(a)), solved tasks with fewer cards in terms of the 15-point scale (Hypothesis 8(b)), and solved tasks with fewer cards in terms of the 5-point scale (Hypothesis 8(c)), than Ss on spatial attribute identification tasks.

It was also hypothesized that Ss under accuracy-emphasized instructions will take more total time on verbal attribute identification tasks (Hypothesis 7(d)), and will not differ in total time on spatial attribute identification tasks (Hypothesis 7(e)), than Ss under speed instructions. The results do not support the former but provide some support for the latter hypothesis. However, observations made by teacher Es indicate that the measure of total time to certainty may not be valid since some Ss did not return their booklets (which action if positive, was used as the criterion of "certainty") immediately on completion of all work on the exercises.

The evidence from this experiment provides some support for the position taken by Wasilewski in his earlier study (1972): that instructions emphasizing speed of performance may be detrimental to performance on an attribute identification task. However, the comparison with the earlier study should be made with considerable caution. One reason is that the independent variable, the instructions to Ss, was not exactly the same. Whereas in the 1972 study Ss were told (verbally) what the criterion of performance would be, in the present study the written instructions to Ss did not contain the information about the criterion. Furthermore, the tasks and the situational conditions differed in the two studies. In the 1972 study a selection board (Bruner, et al, 1956) was used and Ss had a choice in the selection of cards for hypothesis testing, and the ratio of E to S was 1:1. In the present study a reception method was used and Ss were presented with cards in a predetermined sequence, and the ratio of E to S was approximately 1:16.

Other limitations of the present study should also be noted. An attempt was made to conduct this study under classroom conditions. However, Ss knew that they were participating in an experiment; the task was artificial and different from the tasks normally encountered in classroom learning; and therefore the generalizations from the results of the present study to a typical classroom situation involving concept learning may not be warranted, or should be made with caution.

There were also certain characteristics of the instructions to Ss which did not fulfill the requirements for an ideal testing situation. The instructions were not clear about the purpose, did not specify the basis for scoring, provided only very limited practice (Cards 1 to 4), did not identify the time limit, and contained no provision for ensuring their comprehension.

It should also be noted that although the independent variable in the present study has been defined as "instructions which emphasize either speed or accuracy", it is possible that other factors besides speed (or accuracy) may have affected Ss' performance. One of these factors could be the nature of the task which required that the solution of the problem be achieved with a minimum number of cards. This may have penalized the speed of performance. However, it has been shown also (although not specifically hypothesized) that in the comparison between the accuracy-emphasized treatment group and neutral treatment group, the former was significantly superior in terms of cards-to-solution on the 5-point scale. Another factor could be the comprehension of instructions. Although the specific directions in Exp. 2 were located at the end of the written instructions and would not have affected the initial reading of instructions, it is possible that these directions may have prevented Ss under speed treatment from reading those instructions again. Thus Ss under speed treatment may have rushed into the exercise without sufficient understanding of instructions, whereas Ss under accuracy treatment were more likely to ensure a satisfactory comprehension of instructions. It is also possible that observation of other Ss handing in their papers may have affected performance of Ss still working on their exercises. These observations may have been reinforcing to speed instructions, thus contributing to the poor results of Ss under speed conditions, and incompatible with accuracy-emphasized instructions.

The evidence from the present study suggests also that attribute identification performance on spatial stimuli differs from that on verbal stimuli, and since "geometric designs are commonly used as stimulus materials in laboratory studies of conceptual behaviour" (Bourne, 1966, p. 6) and their results are frequently generalized to classroom concept learning, it may be necessary to investigate further the possible implications of the differences indicated by the present study.

5. SUMMARY

5.1 The study

Two problems were investigated in the research study reported in this dissertation: the effect of emphasis on speed of performance and the effect of geometric stimulus materials on concept learning behaviour.

The results indicate that on the attribute identification aspect of a concept learning task, Ss who were instructed to work as quickly as possible solved proportionally fewer tasks and used more cards to solution in terms of the 5-point scale, than Ss who were instructed to ignore time and work as carefully as possible.

The results also indicate that on the attribute identification aspect of concept learning task, Ss on verbal stimulus materials solved proportionally more tasks, achieved the solution with fewer card choices (in terms of the 15-point scale), and used fewer cards to solution (in terms of the 5-point scale), than Ss on spatial stimulus materials.

It is therefore concluded that the emphasis on speed of performance and the use of geometric stimulus materials may have a detrimental effect on concept learning behaviour.

5.2 Implications of the study

The evidence from the present study in conjunction with Wasilewski's (1972) earlier findings suggests that speed and "goodness" of a response may not be interchangeable attributes. Although it may reasonably be questioned whether this evidence can be generalized legitimately to typical classroom concept learning situations (as noted in paragraph 4.6), nevertheless the findings lend some support to doubts about the validity of some common practices in laboratory and classroom testing. If concept learning in the school setting is not directed towards the development of those abilities that are dependent on speed of performance, then the use of speed instructions, whether actual or implied, may not be justifiable in testing either in a classroom or in experimental situations. It may be that by employing speed instructions in both conditions, we are measuring only the ability to perform under speed instructions instead of measuring the ability to perform.

Furthermore, the evidence from the present study indicated that when the same construct is presented either in verbal (written) or spatial (drawn) form, then the responses to the former stimuli differ significantly from the responses to the latter. This evidence suggests that generalizations about concept learning processes from the results of experimental studies, where geometric materials only are used as stimuli, to classroom concept learning, where verbal stimuli are much more common, may not be justifiable.

5.3 Suggestions for further research

Evidence from the present study suggests that Ss' behaviour under conventional experimental laboratory-like conditions may not be representative of the more usual less efficient behaviour which is found under natural classroom conditions, and that more research on the effect of situational conditions is required before the results from conventional experimental studies can be legitimately generalized to classroom learning.

It seems that some investigation of concept learning under natural classroom conditions with meaningful stimuli is warranted. It may only generate hypotheses which will have to be tested under more rigorously controlled conditions of a laboratory setting, or it may provide a breakthrough for an investigation of concept learning not limited to attribute identification or rule identification models. If such studies are conducted, the experiences from the present study may provide some suggestions. It seems that the E should be a regular teacher of the classroom where the study is to be conducted, however, he must be thoroughly trained for that role. The experimental method should be gradually introduced into the classroom in order that it will be accepted by students/Ss as part of the normal classroom learning/testing experience, and steps must be taken to ensure comprehension of task by all Ss.

This research, like many other studies in educational psychology, has raised more problems than it has solved. It is suggested that further investigations of the effects of speed instructions and type of stimuli in natural classroom conditions and under better standardized controls to ensure the continuity of the situational structure are needed to resolve the issues raised in this dissertation.

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APPENDIX A

SHORT REPORT

Effect of Meaningfulness of Verbal Stimuli in Terms of Number of Word Associates: A Preliminary Study

Bohdan Wasilewski

Early experimental studies of cognitive behaviour used meaningful and rote (nonsense syllables, geometric figures, etc.) stimulus materials (Hull, 1920; Smoke, 1932; Reed, 1946; Heidbreder, 1947). In 1966 Bourne noted that rote stimuli are used predominantly. The reason for the use of meaningless stimuli appears to be to reduce the ambiguity of stimuli (Underwood, 1952) and nonrational criteriality (Bruner, Goodnow, and Austin, 1956). However the use of meaningless stimulus materials may also limit the generalizability of results to only the rote learning situations (Ausubel, 1962).

Before hypotheses about the effect of meaningfulness can be tested, valid scales for the measurement of meaningfulness must be designed. One model in use is Noble's (1952) Production Method which assigns the degree of meaningfulness ($\overline{m}$) to a given word in terms of number of word associates elicited by that word. The present study tests the validity of $\overline{m}$ as an index of meaningfulness.

Method

Survey. The purpose of the survey was to obtain from Ss a number of words (responses) of "higher meaningfulness" to a set of eight words (stimuli) which represented four binomial dimensions of a geometric type of stimuli used commonly in experimental studies of concept learning. Dimensions selected by E were: (a) shape (circular or rectangular); (b) color (white or black); (c) size (small or large); and (d) number (one or two). 136 Grade XI students (82 males) from Esquimalt Secondary School, Victoria, B.C., were used to provide responses to either of the two sets (A and B) of stimuli. The number of different responses elicited by the eight stimuli ranged from 32 to 72, and the frequency from 1 to 52. From the responses of highest frequency, two sets of stimuli of "higher meaningfulness" (as perceived by Ss) were selected by E and designated as stimuli of high meaningfulness (HM). The eight original stimuli were designated as stimuli of low meaningfulness (LM). Assignment of stimuli to the categories of meaningfulness is shown in Table 101.

Experiment. The purpose of the experiment was to test the hypothesis that HM stimuli (as perceived by Ss in the survey) will elicit more word associates (WA) than LM stimuli. 128 Grade XI students (66 males from Mt. View and Mt. Douglas Secondary Schools, Victoria, B.C., in four intact classes under regular teachers, participated. The major variable was assigned meaningfulness (HM or LM), and the minor variables were: verbal ability (HV or LV) assigned on the basis of final mark in English 10 (HV = "A" and "B"; LV = "C" and "P"; Ss with "C+" were assigned to fill vacancies at both levels equally and constituted no more than 20% of Ss at each level); school (Mt. View or Mt. Douglas); and sex (F or M). The dependent variable was number of WA. The 1:1 ration was maintained for school and sex (the remaining Ss in the intact classes (i.e., those above N = 128) were given filler tasks). The stimulus materials were sixteen verbal attributes (see Table 101) assigned to four groups (Set A-HM; Set A-LM; Set B-HM; and Set B-LM). The four verbal stimuli in each group were assigned to four sequences in a 4 x 4 Counterbalanced Design. Each stimulus was typed on a separate sheet and each four sheets representing one sequence, were stapled to type-written instructions. Each S was assigned to only one task consisting of four verbal stimuli. Ss were given 20 min. to complete their tasks.

Results.

The observed means and SDs for the four variables are shown in Table 102. It was assumed that the effect of school and sex would not be significant and the analysis of variance for these two variables was conducted separately. The effect of assigned meaningfulness was non significant (marginally significant) in terms of WA, $F(1,252) = 3.07$, $p > .05$ ($p = .08$). The effect of verbal ability was significant in terms of WA, $F(1,252) = 15.8$, $P < .05$ ($p = .000095$). The effect of interaction between assigned meaningfulness and verbal ability was non significant.

The effect of school was significant in terms of WA, $F(1,252) =$

18.95, $p < .05$ ($p = .000024$). The effect of sex was non significant in terms of WA, $F(1,252) = .14$ $p > .05$ ($p = .707$).

The means and SDs for the sixteen verbal attributes are shown in Table 103 in conjunction with their frequency values.

Discussion

Minor variables. The fact that verbal ability had a significant effect and that school also had a significant effect on WA performance, is of no direct interest to this study except that in future experiments with WA, Ss should be stratified within each cell in terms of these two variables. Sex as expected had no significant effect.

Major variables. The fact that assigned meaningfulness had no significant effect requires an explanation. The comparison of individual results for each pair (HM - LM) in Table 103 indicates that the direction of magnitude for WA and frequency (Kucera-Francis Scale) are reversed for six out of eight pairs (sets A and B for color, size and number). Normally there is a high correlation between frequency and $\bar{m}$ (Underwood and Schulz, 1960). It is suggested that frequency may be a product of either: (a) minimal number of WA elicited by a given word and maximal frequency of association between a given word and each of WA (and therefore a high habit strength between a given word and each of WA); or (b) maximal number of WA elicited and minimal frequency of association (and therefore a low habit strength between a given word and each of WA); or (c) all possible combinations along a continuum between (a) and (b) for a given frequency. The pro ponents of the production method limited the time of response to 60 seconds or less. In the present study there was virtually no time limit (i.e., five minutes per each stimuli). If habit strength between a given word and its WA vary, then under the time-limited condition Ss may be able to recall only those WA with high habit strength, while under unlimited-time condition the WA with lower habit strength may be recallable. If this is true, then some LM words may have high frequency count and high $\overline{m}$ (i.e., a small number of WA but of high habit strength, and therefore all WA recallable under limited-time condition), whereas some HM words may have a low frequency count and low $\overline{m}$ (i.e., a large number of WA but of low habit strength, and therefore few WA recallable under limited-time condition), and thus the number of WA elicited by LM words may be higher under these conditions than the number of WA elicited by HM words.

Although the results require further experimental clarification, they appear to indicate multi-dimensional complexity of the concept of meaningfulness.

TABLE 101

Assignment of Stimuli to Categories of Meaningfulness

Dimension	Set	Meaningfulness LM	Meaningfulness HM
shape	A	circular	round
	B	rectangular	oblong
color	A	white	clean
	B	black	gloomy
size	A	small	tiny
	B	large	gigantic
number	A	one	alone
	B	two	together

TABLE 102

Means and Standard Deviations under Four Variables

in Terms of Number of Word Associates

Variable	Level	X	SD
Meaningfulness	HM	8.44	4.11
	LM	7.57	3.83
Verbal ability	HV	9.00	3.93
	LV	7.01	4.01
School	Mt. View	6.92	3.97
	Mt. Douglas	9.09	4.01
Sex	F	8.10	3.88
	M	7.91	4.10

TABLE 103

Means and Standard Deviations in Terms of Number of Word Associates for Sixteen Verbal Stimuli

Dimension	Set	Meaning-fulness	Stimuli	Frequency T-L*	Frequency K-F**	WA $\overline{X}$	WA SD
shape	A	HM	round	AA	81	9.12	4.47
	A	LM	circular	21	21	8.25	4.29
	B	HM	oblong	3	1	5.18	2.51
	B	LM	rectan-gular	4	5	5.87	3.24
color	A	HM	clean	AA	70	9.93	4.71
	A	LM	white	AA	365	7.87	5.18
	B	HM	gloomy	19	3	9.43	4.60
	B	LM	black	AA	203	7.00	4.16
size	A	HM	tiny	A	50	8.81	3.16
	A	LM	small	AA	542	8.37	3.32
	B	HM	gigantic	13	10	9.74	3.90
	B	LM	large	AA	361	9.00	4.27
number	A	HM	alone	AA	195	8.37	4.12
	A	LM	one	AA	3292	7.43	3.72
	B	HM	together	AA	267	6.93	4.38
	B	LM	two	AA	1412	6.75	3.15

* T-L means Thorndike-Lorge Scale

** K-F means Kucera-Francis Scale

APPENDIX B

SAMPLES OF THE FOUR-ATTRIBUTE EXERCISE SHEETS ISSUED TO Ss

(a) Page 112 - CARD 17 for verbal DAX task containing attributes: circular, white, large, two.

(b) Page 113 - CARD 17 for spatial DAX task containing attributes: circular, white, large, two.

CARD 17

circular white large two

This <u>is not</u> DAX

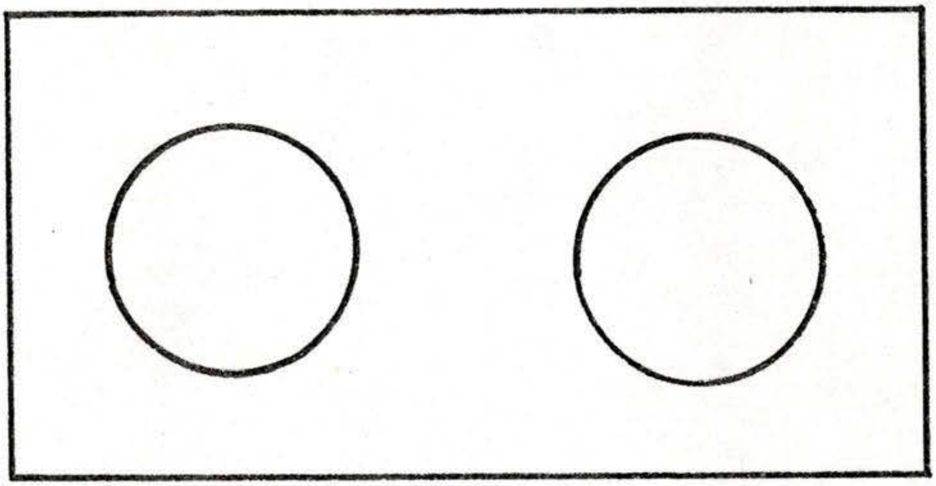
What is DAX?

DAX is . . . . and . . . .

REMEMBER THAT ONCE YOU HAVE TURNED THE PAGE

YOU CAN NOT SEE IT AGAIN

CARD 17



This is <u>is not</u> DAX

What is DAX?

DAX is . . . . and . . . .

REMEMBER THAT ONCE YOU HAVE TURNED THE PAGE

YOU CAN NOT SEE IT AGAIN

APPENDIX C

ASSIGNMENT OF ATTRIBUTE VALUES TO STIMULI IN ORDER OF PRESENTATION FOR JIB ("ONE AND LARGE") CONCEPTUAL TASK

Card	Exemplar	Dimension							
		Shape		Color		Size		Number	
		C	R	W	B	S	L	O	T
1	x	I[a]			I		R[b]	R	
2	x	I		I			R	R	
3		I		I		I		R	
4	x		I	I			R	R	
5			I	I			R		I
6	x		I		I		R	R	
7		I			I	I		R	
8			I		I	I			I
9	x		I	I			R	R	
10		I			I		R		I
11		I		I		I			I
12	x	I		I			R	R	
13			I	I		I		R	
14			I		I		R		I
15	x		I		I		R	R	
16			I	I		I			I
17		I			I	I			I
18	x	I			I		R	R	
19			I	I		I		R	
20		I		I			R		I

a I means "irrelevant attribute"

b R means "relevant attribute"

APPENDIX D

ASSIGNMENT OF ATTRIBUTE VALUES TO STIMULI IN ORDER OF PRESENTATION FOR DAX ("WHITE AND SMALL") CONCEPTUAL TASK

Card	Exemplar	Dimension							
		Shape		Color		Size		Number	
		C	R	W	B	S	L	O	T
1	x		I[a]	R[b]		R			I
2			I		I	R			I
3			I		I	R		I	
4			I	R			I	I	
5	x	I		R		R			I
6	x	I		R		R		I	
7			I		I		I		I
8		I			I	R		I	
9	x	I		R		R		I	
10			I	R			I		I
11		I			I		I	I	
12	x		I	R		R			I
13		I		R			I	I	
14		I			I	R			I
15	x	I		R		R			I
16			I		I		I	I	
17		I		R			I		I
18	x		I	R		R		I	
19		I			I		I		I
20	x		I	R		R		I	

a I means "irrelevant attribute"

b R means "relevant attribute"

APPENDIX E

SAMPLE INSTRUCTIONS ISSUED TO Ss

(a) Instructions (accuracy-emphasized on spatial stimuli) — pages 125 - 129

(b) Problem cards (verbal stimuli) — pages 130 - 131

(c) Specific directions:

speed	APPENDIX F
accuracy	APPENDIX G
speed and accuracy	APPENDIX H

accuracy-emphasized (see sample Instructions on pages 117-121)

neutral (no specific directions)

INSTRUCTIONS

The booklet contains two exercises which you will do during this period. You must work as carefully as possible and ignore time, because if you work fast then you are going to make mistakes and forget important information. In order to do a good job you must work slowly and be accurate.

In each exercise you have to find out what are the important characteristics of a concept. The concept may be a name familiar to you, or it may be an unfamiliar name such as XAB. Imagine for example that you are studying the animals of Australia and each time the teacher shows you a picture of an animal, he identifies it by saying: "this is XAB" or "this is not XAB". If he will not tell you what XAB is, how can you find it out from these pictures?

When the teacher shows you the pictures, you notice that these animals have many characteristics: some have short ears - others have long ears; some have tails - others do not; some are tall - others are short; some are spotted - others are not; etc. In order to find out which of these are important characteristics of XAB, you must determine which characteristics are common to all animals called XAB and not common to all other animals.

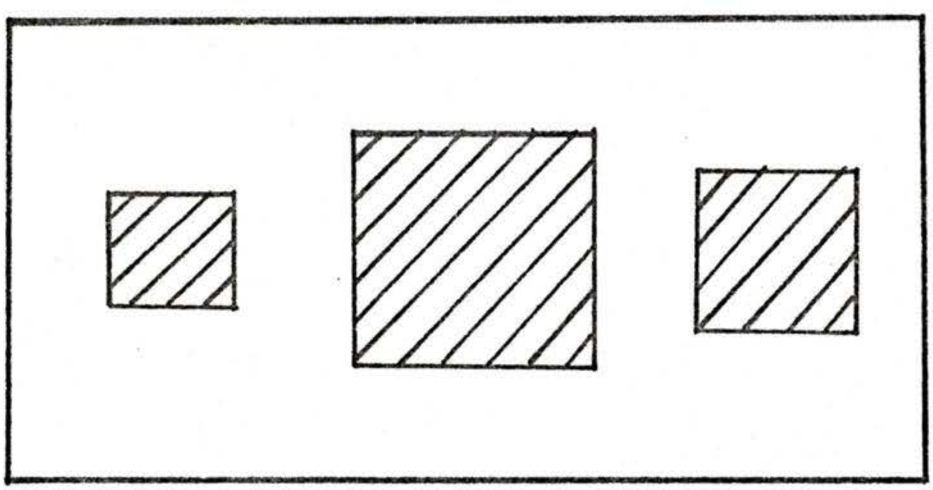
Your job in the two exercises is similar. In each exercise there are twenty white pages. On each page there is a card (a picture) with four characteristics and a statement saying: "This is XAB" or "This is not XAB" (other names such as DAX or JIB, etc., may be used). Your job is to find out which two of these four characteristics are important for the concept of XAB.

Remember, you will have to be accurate and work slowly, because if you work fast then you will make mistakes and will not do a good job.

Following are examples of what you might see on the cards if "three" and "square" were the important characteristics of XAB.

Card 1 is XAB because both important characteristics ("three" and "square") are on it:

CARD 1

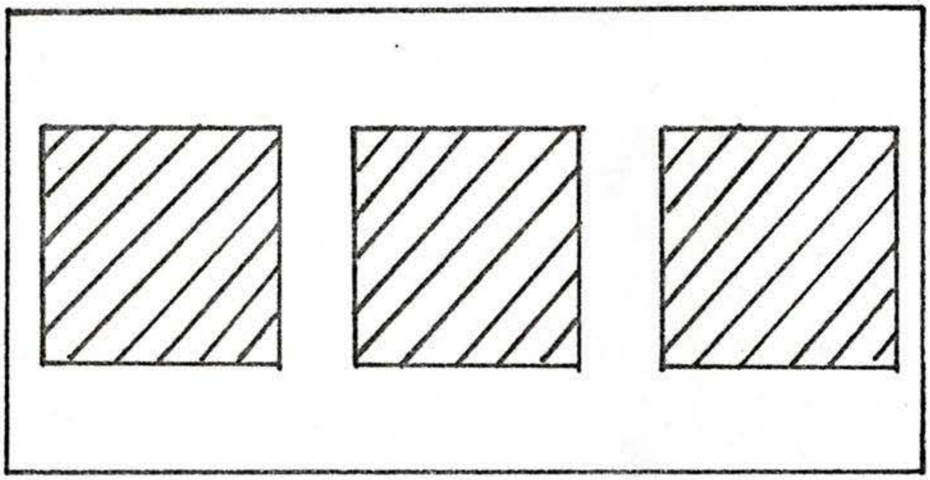


This is XAB

PLEASE TURN THE PAGE

Card 2 is also XAB because both important characteristics ("three" and "square") are on it:

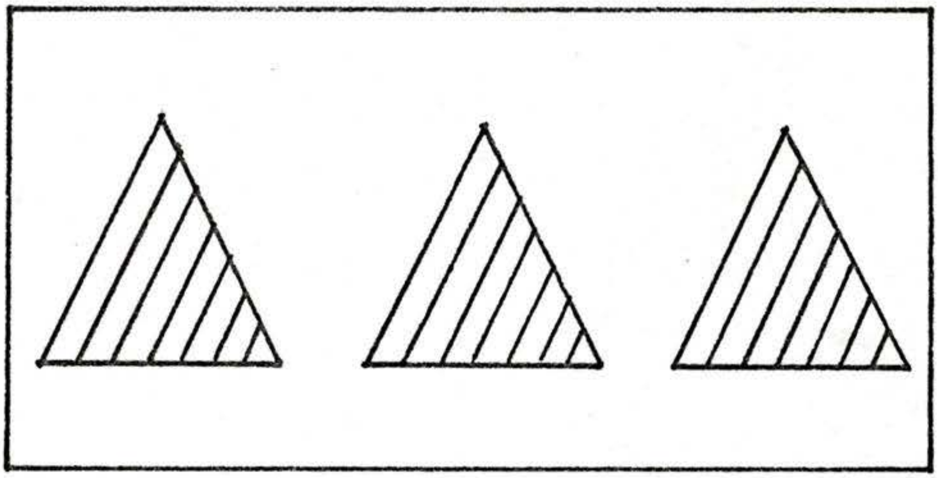
CARD 2



This is XAB

Card 3 is not XAB because only one important characteristic is on it:

CARD 3



This is not XAB

PLEASE TURN THE PAGE

Remember that all cards provide some information about the concept, whether they have or do not have the important characteristics on them.

The concept in the first exercise is DAX. Turn the white pages one by one, remembering that once you turn the page - <u>you can not look at it again</u>. The card on each page has <u>four</u> characteristics. Your job is to find out which <u>two</u> out of <u>four</u> are important characteristics of DAX. If the card is DAX, then it must have two important characteristics on it. If it is not DAX, then either one or both important characteristics must be missing. On the fourth page you are asked to write down what you think are the important characteristics of DAX. The same question is asked on all pages from 4 to 20. If your answer on page 4 is correct, then it will be confirmed by the information offered by the cards on the remaining pages, and you will just repeat your original answer on each succeeding page (5 to 20). But if your answer on page 4 is not correct, then the information offered on the succeeding pages should indicate to you that your answer is not correct and should also help you to make a correct answer. You may give several incorrect answers before you make a correct one.

When you finish the first exercise (the first twenty white pages), start working on the second exercise (the second twenty white pages). The second exercise is the very same as the first except that you have to find out the <u>two</u> important characteristics of a different concept, JIB.

PLEASE TURN THE PAGE

Remember that when you are working on your exercises (white pages), you can not look again at the white pages that you have turned down, but you can look back at the green pages containing the instructions, at any time.

Remember also that you must work as carefully as possible and ignore time. If you do not work slowly, then you will make more mistakes than you would have done if you took time to concentrate and be accurate. Time is not important. You can only do a good job and get a high score if you do not make many mistakes. It is therefore very important to work slowly and carefully and make as few mistakes as possible.

PLEASE TURN THE PAGE

CARD 1

three

square

unequal

shaded

This is XAB

PLEASE TURN THE PAGE

CARD 2

three square equal shaded

This <u>is</u> XAB

CARD 3

three triangular equal shaded

This <u>is</u> <u>not</u> XAB

APPENDIX F

SPECIFIC DIRECTIONS FOR SPEED INSTRUCTIONAL TREATMENT

A You must work as quickly as possible in order to complete both exercises within the time limit. If you work slowly, then you will fail to finish on time.

B Remember, you will have to work quickly in order to complete both exercises.

C Remember also that you must work as quickly as possible. If you do not work quickly, then you will not finish these exercises, and your score depends on whether you find out the important characteristics within the time limit.

It is therefore very important to work fast.

APPENDIX G

SPECIFIC DIRECTIONS FOR ACCURACY INSTRUCTIONAL TREATMENT

A You must work as carefully as possible in order to do a good job. If you are not accurate, then you will not do a good job.

B Remember, you will have to be accurate in order to do a good job.

C Remember also that you must work as carefully as possible. If you are not accurate, then you will not do a good job and get a high score. <u>It is therefore very important to work carefully</u>.

APPENDIX H

SPECIFIC DIRECTIONS FOR SPEED AND ACCURACY INSTRUCTIONAL TREATMENT

A You must work as quickly and carefully as possible. If you work slowly and are not accurate, then you will not do a good job.

B Remember, you will have to be accurate and work quickly in order to do a good job.

C Remember also that you must work as quickly and carefully as possible. If you work slowly and are not accurate, then you will not do a good job and get a high score. It is therefore very important to work quickly and carefully.

APPENDIX I

SAMPLE OF INSTRUCTIONS ISSUED TO Es

The regular teachers who were used as Es, were briefed by the author of this dissertation verbally. In addition, they were issued the following written instructions, which were contained on a single sheet.

INSTRUCTIONS FOR TEST ADMINISTRATORS

1. This test is designed to measure the effect of instructions and type of learning material (stimuli) on performance on concept learning (attribute identification) task. It is to be administered during one regular classroom period (50 min). The booklet contains the INSTRUCTIONS (green pages) and the EXERCISES (white pages). All necessary directions for test-takers are included in the INSTRUCTIONS. If any questions are asked, tell students to read the INSTRUCTIONS again. Test-takers can look at the green pages at any time during the test, but they can not look at the white pages that they have already turned over.
2. Your tasks are:
   a. Issue the booklets to students, placing them face-down. The student's name is on the booklet. Check whether all students to whom booklets have been assigned, are present. Give booklets of absent students to those students to whom booklets have not been assigned (2 - 3 in each class).

If all students are present, then issue extra booklets (without names) to students without booklets.

b. Tell students (in your own words): that this exercise is designed to find out how well they can think, that it will be scored, and that the score will indicate to you (the teacher) their thinking ability. Add a sentence to motivate them to do their best.

c. Tell them to start working, and note the time. Ensure that students do not look at the white pages that they have already turned over. Use your class seating plan to note the time when each student completes the test. Don't let them know that you are noting time. At the end of the period, collect all booklets and turn them over to me (Staff room).

Thank you very much.

APPENDIX J

COMPARISON BETWEEN ORDERED MEANS ON VERBAL STIMULI

NEWMAN-KEULS TEST (ASSUMED EQUAL CELLS N=30)

Rank	1	2	3	4	5	q_r	R_r
Treatment	SI	SAI	AI	NI	AEI		
$\overline{X}$	1.73	1.75	2.52	2.69	2.78		
Totals	51.9	52.5	75.6	80.7	83.4		
1	-	-	-	-	31.5	q_2= 2.77	R_2= 22.49
2	-	-	23.1	28.2	30.9	q_3= 3.31	R_3= 26.87
3	-	-	-	-	-	q_4= 3.63	R_4= 29.47
4	-	-	-	-	-	q_5= 3.86	R_5= 31.34

Notes: df_e = 291

MS_e = 2.2

APPENDIX K

NON-PARAMETRIC ANALYSIS OF RESULTS

In order to account for the possibility that the assumptions of the equality of intervals and the normality of distributions were not satisfied, distribution-free non-parametric tests were administered.

15-point scale - three levels of instructional variable

The ranking of Ss on Kruskal-Wallis test for the JIB and the DAX task, from lowest (14 points on the 15-point scale) to highest (0 points on the 15-point scale) is shown in Table 15 for the verbal stimuli. Alpha level of .05 was selected. Since samples were large (JIB N = 97, and DAX N = 102), the test statistic H is approximately distributed as Chi square with $df = 2$. Critical values $X^2_{2;.05;} = 5.99146$.

The squared sums of averaged ranks for the three levels of the instructional variable on the JIB and the DAX task are shown in Table 16. There was no significant difference between the average ranks for the JIB task on verbal stimuli, $H = 2.32$, and corrected for ties $H_c = 4.05$, $p > .05$. There was a significant difference between the average ranks for the DAX task on verbal stimuli, $H = 4.75$, and corrected for ties $H_c = 6.934$, $p < .05$.

TABLE 15

Frequency of Responses under Three Levels of Instructional Variable on Verbal Tasks in Terms of 15-point Scale

Cards to solution	JIB					DAX				
	Frequency			Rank		Frequency			Rank	
	SEI	SNEI	NI	$\overline{X}$	Range	SEI	SNEI	NI	$\overline{X}$	Range
14	2	0	0	1.5	1-2	0	0	1		1
13	0	0	0			4	1	0	4.0	2-6
12	0	0	0			2	3	1	9.5	7-12
11	0	1	4	5.0	3-7	2	0	0	13.5	13-14
10	0	0	0			0	0	0		
9	1	0	0	8.0	8	0	1	0	15.0	15
8	0	0	0			1	0	1	16.5	16-17
7	0	1	0	9.0	9	1	0	0	18.0	18
6	0	0	0			1	2	0	20.0	19-21
5	1	0	0	10.0	10	1	1	0	22.5	22-23
4	0	0	0			0	0	0		
3	0	0	0			3	0	1	25.5	24-27
2	6	4	2	16.5	11-22	1	2	0	29.0	28-30
1	1	1	0	23.5	23-24	0	3	0	32.0	31-33
0	20	37	16	61.0	25-97	17	34	18	68.0	34-102
Nj	31	44	22	Total =	97	33	47	22	Total =	102

TABLE 16

Squared Sums of Averaged Ranks for Three Levels

of Instructional Variable on Verbal Tasks

Task and Treatment Level	Tj	Tj^2	Tj^2/Nj
JIB			
SEI	1363.5	1,859,132.25	59,972.00
SNEI	2360.5	5,571,960.25	126,635.46
NI	1029.0	1,058,778.00	48,126.25
DAX			
SEI	1400.5	1,961,400.25	59,436.37
SNEI	2576.0	6,635,776.00	141,186.72
NI	1276.5	1,629,451.25	74,065.96

5-point scale - three levels of instructional variable

The ranking of Ss on Kruskal-Wallis test for total scores (JIB + DAX), from the lowest (0 points on the 5-point scale) to the highest (4 points on the 5-point scale), is shown in Table 17 for verbal stimuli. There was a significant difference between the average ranks for total scores, $H = 9.51$, and corrected for ties $H_c = 10.53$, $p < .05$ ($p = .001$).

5-point scale - SNEI versus SEI effect

In order to determine whether Ss in the SNEI population had consistently higher ranks than Ss in the SEI population, the Mann-Whitney U test was administered at Alpha level of .01. The total ranks for SNEI and SEI Ss were: 4192.0 and 2904.5, respectively. The results were significant, $z_U = 2.96$, $p < .01$ ($p = .0015$).

5-point scale - spatial versus verbal stimuli effect

In order to determine whether Ss in NI population on verbal stimuli had consistently higher ranks than Ss in NI population on spatial stimuli, the Mann-Whitney U test was administered at Alpha level of .01. The total ranks for NI-verbal and NI-spatial Ss were: 1049.5 and 661.5, respectively. The results were significant, $z_U = 3.01$, $p < .01$ ($p = .0013$).

TABLE 17

Frequency of Responses under Three Levels of Instructional Variable on Verbal Tasks in Terms of 5-point Scale

Cards-to solu-tion	Frequency			Rank	
	SEI	SNEI	NI	$\overline{X}$	Range
0	20	12	5	19	1-37
1	9	3	3	45	38-52
2	7	6	2	60	53-67
3	10	13	5	81.5	68-95
4	12	27	14	122	96-148
Nj	58	61	29	Total = 148	
Tj	3484.0	5076.5	2465.5		
Tj^2	12138256.0	25770852.25	6078690.25		
Tj^2/Nj	209280.27	419194.29	20961.00		

APPENDIX L

SAMPLE OF INSTRUCTIONS FOR TEST ADMINISTRATORS

1. Issue booklets to students placing them face down.
2. Place red questionnaire sheets on a separate desk.
3. Read to students the directions attached as Annex 1 to these instructions (pages 2 and 3).
4. Tell students: "Please turn your papers over and start working. Remember that the Instructions (green pages) are very important. Read both pages". Note the time.
5. Observe students and ensure that they do not look back at the white pages which they have already turned over (students can look at the green pages at any time during the test).
6. Note on your seating plan the time each student completes the test (and picks up the red questionnaire). Please be careful not to let the students know that you are recording the time.
7. At the end of the period (50 min.) collect all booklets and issue the questionnaires to those students who have not picked them up. Allow them to complete these questionnaires.

ANNEX 1

DIRECTIONS TO STUDENTS

"You are probably aware that certain conditions affect classroom learning. For example, you may learn better with one teacher than with another teacher.

The educators attempt to find out what conditions facilitate learning and what conditions have detrimental effect on learning. In order to identify those conditions they conduct experimental studies where the conditions under investigation are varied and all other conditions are kept constant. In this way they can establish a cause-and-effect relationship between a condition and the learning behaviour. This can be achieved only with the co-operation of subjects who participate in those experiments. It is vital for the success of the experiment that subjects follow the instructions and try to do their best on the tasks given to them.

The present study is designed to find out the effect of certain conditions on students' problem solving performance. Your success on the two tasks which you are asked to perform, will indicate how well you can think under certain conditions. The results will be valid only if you cooperate and try to do your best.

This study will be explained to you tomorrow at . . . . hours. You will have an opportunity to ask questions and find out how well you did on the exercises.

When you finish both exercises please bring them to this desk (point to the desk with red questionnaires) and pick up one of these red papers. It is the second part of the test. It is very short and you should be able to complete it in a few minutes."

APPENDIX M

QUESTIONNAIRE

. . . .
Name

	Not at all	No	Yes	Fairly well	Very much
	1	2	3	4	5
1. Did you enjoy working on the exercises?					
2. Were the exercises very difficult?					
3. Did you give your best effort?					
4. Did you find the tasks very easy?					

5. Did you work:

a. very quickly Yes No

b. very carefully Yes No

6. How many times (approximately) did you look back at the instructions (green pages)? . . . . .

7. What do you think about this exercise?

. . . .

. . . .

. . . .

. . . .

. . . .

THANK YOU VERY MUCH FOR YOUR PARTICIPATION IN THIS EXERCISE.

BOHDAN WASILEWSKI

APPENDIX N

SAMPLE INSTRUCTIONS ISSUED TO Ss

(EXPERIMENT 2)

(a) Instructions (accuracy-emphasized) pages 148-149

NOTES:

(1) Verbal stimuli were used on all problem cards. This was done to ensure that Ss on spatial stimulus tasks were well aware of the number of attributes present in all exemplars/non exemplars.

(2) Instructions for difficulty level 1 tasks had four attributes, and for difficulty level 2 tasks had six attributes (see paragraph 4.4, Stimulus Materials).

(b) Specific directions:
(which were given only at the end of the Instructions)

speed page 143

accuracy-emphasized (see sample Instructions on page 142)

neutral (no specific directions)

INSTRUCTIONS

You have two problems to solve. One is in the first booklet, the other is in the second booklet. Both booklets have twenty pages. Each page has a card in the middle. On the card are six characteristics. You have to find out which two characteristics out of the six are present in all the cards which have the same code name. If the code name was XAB then the two characteristics must be present on every card marked "This is XAB", and either one of the characteristics or both of them must be missing on every card marked "This is not XAB".

For example, if these were the cards:

CARD 1	CARD 2	CARD 3	CARD 4
three	three	four	four
square	triangle	triangle	square
dark	dark	dark	light
unequal	equal	equal	equal
left	right	left	right
unbroken	broken	broken	broken
This is XAB	This is XAB	This is not XAB	This is not XAB

Then XAB must be "three" and "dark". Why? Because:

(1) these are the only two characteristics which are present in all the XAB cards, and because

(2) either one or both of these two characteristics is missing in all cards which are not XAB.

When you work on your problems remember this rule. Once you have turned a page in your booklet - you are not allowed to look at it again. But you are allowed to look at the INSTRUCTIONS at any time you like.

When you get to CARD 6 in your first booklet you will be asked to write down what you think the two characteristics of the code name are. The same question will be asked on every page from Card 6 to CARD 20. Write down your answer on every page until you are sure that it is correct. When you are certain that your answer is correct, stop working on the first problem. Even if there are some pages left over in the first booklet, stop working on it, and start working on the second booklet. When you are sure that your answer to the second problem is correct, return both booklets to your teacher and pick up your final task (the red page).

In order to make this research scientific your full cooperation is necessary. Please try to work as carefully as possible and ignore time. Because if you work fast then you are going to make mistakes and forget important information which you need to solve these problems. Accuracy in solving these two problems is very important. If you don't work slowly and carefully then your score will not be as good as it will be if you take time to concentrate and be accurate.

PLEASE TURN THIS PAGE AND START
WORKING ON THE PROBLEMS

THANK YOU AND GOOD LUCK!

SPECIFIC DIRECTIONS FOR SPEED INSTRUCTIONAL TREATMENT

In order to make this research scientific your full cooperation is necessary. Please try to work as quickly as possible. Speed in solving these two problems is very important. If you don't work as fast as you can then your score will not be as good as it will be if you work fast.

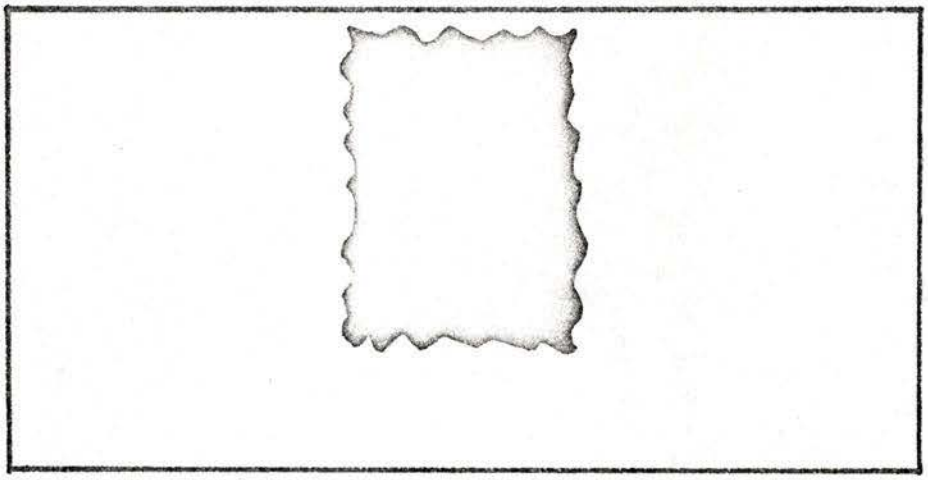
APPENDIX O

SAMPLES OF THE SIX-ATTRIBUTE EXERCISE SHEETS ISSUED TO Ss

(a) Page 145 - CARD 16 for spatial DAK task containing attributes: rectangular, black, large, one, top, jagged.

(b) Page 146 - CARD 17 for spatial DAK task containing attributes: circular, white, large, two, bottom, smooth.

CARD 16



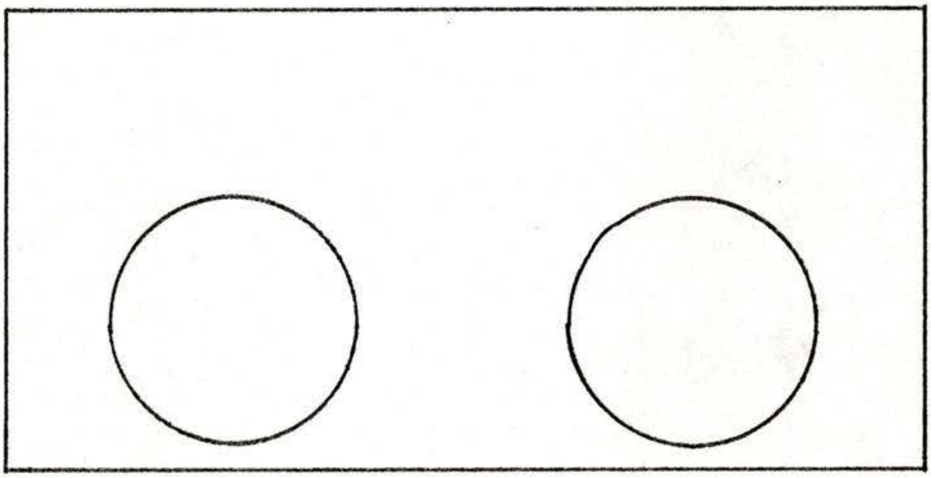
This is not DAK

What is DAK?

DAK is . . . . and . . . .

REMEMBER THAT ONCE YOU HAVE TURNED THE PAGE YOU CAN NOT SEE IT AGAIN

CARD 17



This is not DAK

What is DAK?

DAK is . . . . and . . . .

REMEMBER THAT ONCE YOU HAVE TURNED THE PAGE YOU CAN NOT SEE

IT AGAIN

APPENDIX P

ASSIGNMENT OF ATTRIBUTE VALUES TO STIMULI IN ORDER OF PRESENTATION FOR JIK ("ONE AND LARGE") CONCEPTUAL TASK

Card	Exemplar	Dimension											
		Shape		Color		Size		Number		Location		Outline	
		C	R	W	B	S	L	O	T	T	B	J	S
1	x	I[a]			I		R[b]	R		I			I
2	x	I		I			R	R		I			I
3		I		I		I		R		I			I
4	x		I	I			R	R		I			I
5	x		I	I			R	R			I		I
6	x		I	I			R	R			I	I	
7		I			I	I				I		I	
8			I		I	I			I	I		I	
9	x		I	I			R	R			I	I	
10		I			I		R		I		I		I
11		I		I		I			I		I		I
12	x	I			I		R	R			I	I	
13			I	I		I		R			I		I
14			I		I		R		I	I		I	
15	x		I		I		R	R		I		I	
16			I	I		I			I	I		I	
17		I			I	I			I		I		I
18	x	I			I		R	R			I	I	
19			I	I		I			I		I	I	
20		I		I			R		I	I			I

[a] I means "irrelevant attribute"

[b] R means "relevant attribute"

APPENDIX Q

ASSIGNMENT OF ATTRIBUTE VALUES TO STIMULI IN ORDER OF PRESENTATION FOR DAK ("WHITE AND SMALL") CONCEPTUAL TASK

Card	Exemplar	Dimension											
		Shape		Color		Size		Number		Location			Outline
		C	R	W	B	S	L	O	T	T	B	J	S
1	x		I[a]	R[b]		R			I	I			I
2			I		I	R			I	I			I
3	x		I	R		R		I		I			I
4	x	I		R		R		I		I			I
5	x		I	R		R			I		I		I
6	x	I		R		R		I			I	I	
7			I		I		I		I	I		I	
8		I			I	R		I		I		I	
9		I		R			I	I			I	I	
10			I	R			I		I		I		I
11		I			I		I	I			I		I
12	x		I	R		R			I		I	I	
13		I		R			I	I			I		I
14			I		I	R			I	I		I	
15		I			I	R			I	I		I	
16			I		I		I	I		I		I	
17		I		R			I		I		I		I
18	x	I		R		R		I			I	I	
19		I			I		I		I		I	I	
20	x		I	R		R		I	I				I

[a] I means "irrelevant attribute"

[b] R means "relevant attribute"

APPENDIX R

COMPARISON BETWEEN ORDERED MEANS ON VERBAL (ASSUMED EQUAL CELLS N = 20) AND SPATIAL (ASSUMED EQUAL CELLS N = 15) STIMULI NEWMAN-KEULS TEST

	SPATIAL			VERBAL		
Rank	1	2	3	1	2	3
Treatment	SI	NI	AEI	NI	SI	AEI
$\overline{X}$	2.04	2.50	3.46	1.31	1.41	2.36
Totals	40.8	50.0	69.2	19.65	21.15	35.40
1	-	-	28.4	-	-	15.75
2	-	-	19.2	-	-	14.25
q_2= 2.80	R_2= 14.74			R_2= 12.60		
q_3= 3.36	R_3= 17.81			R_3= 15.12		

Notes:

$\underline{df}_e$ = 106

$\underline{MS}_e$ = 1.39

APPENDIX S

COMPARISON BETWEEN ORDERED MEANS ON SPATIAL STIMULI

NEWMAN-KEULS TEST (ASSUMED EQUAL CELLS N = 7)

Rank	1	2	3
Treatment	SI	AEI	NI
$\overline{X}$	172	180	184
Totals	1204	1260	1288
1	-	-	-
2	-	-	-

$q_2 = 2.83$ $R_2 = 470.9$

$q_3 = 3.40$ $R_3 = 565.8$

Notes:

$\underline{df}_e = 58$

$\underline{MS}_e = 3965$