MAGNE NYBORG

The Effect of Possessing Verbal "Analyzers" upon Concept Learning in Mentally Retarded Children

UNIVERSITETSFORLAGET

THE EFFECT OF POSSESSING VERBAL "ANALYZORS" UPON CONCEPT LEARNING IN MENTALLY RETARDED CHILDREN

NORWEGIAN STUDIES IN EDUCATION

No. 4

No. 1: Per Rand: Distortion and Selectivity. A study of behavior toward achievement-related information. 1963.

No. 2: Per Rand: Achievement Motivation and School Performance. 1965.

No. 3: Svein Stensaasen: Interstudent Attraction and Social Perception in the School Class. An inquiry into the operation of preference for the balanced state among members of the classroom group. 1970.

No. 4: Magne Nyborg: The Effect of Possessing Verbal "Analyzors" upon Concept Learning in Mentally Retarded Children. 1971.

Magne Nyborg

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Both the research behind and the printing of
this book is sponsored by The Norwegian
Research Council for Science and the Humanities

Printed in Norway
by Trykningssentralen

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FOREWORD

The present work is the third and final report on a research project which lasted from the rise of 1965 to the fall of 1969.

When reviewing these years in my memory, they are recalled as years of rich experiences, but also as years of hard work with many kinds of problems to solve.

On this occasion, however, I should like to draw the reader's attention to the fact that the project could never have been accomplished without the cooperation of and support from several institutions and individuals, to whom I owe my thanks.

First of all, my thanks are given to the Research Council for Science and the Humanities (NAVF), whose trust and financial support have been the basic conditions for doing this work. Also considerable financial support was granted to me from the Department of Education for the field experiment (Kirke- og Undervisningsdepartementet).

Second, I would like to thank director, Prof. Johs. Sandven, who has in a valuable way provided me with the technical aids and other resources available at the Institute of Educational Research, University of Oslo. Without these aids my work should at best have been considerably delayed.

Third, I am indebted to several special educational institutions, whose positive cooperation provided the practical conditions for doing both the laboratory experiments and the field experiment. My special thanks are given to pupils and teachers in Torshov off. skole, and to the retired principal, Mr. Ingolf Eik, who repeatedly encouraged me to continue my work. My special thanks are given, also, to the special school teachers who carried the burden of being field experimental teachers, i.e., Mrs. Anne Berg, Mr. Egil Eidval, Miss Birgit Kolberg, and Mrs. Inger Ree-Pedersen, and to Mrs. Ragnhild Hope, who has for a short time been my assistant and has provided me with invaluable feedback information by adapting the experimental procedures to a natural classroom teaching of mentally retarded children. Her work, prior to the field experiment, served the pur-

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pose of being a pilot study, and has later served as an extended, though less systematic support for the field experimental results.

Finally, I give my thanks to stud. mag. art. Turid Lyngstad, without whose assistance I should not have been able to accomplish the field experiment, to Prof. Per Rand, Institute of Educational Research, for having read all my manuscripts, and to Prof. Per Saugstad, Institute of Psychology, for using very much of his occupied time in reading and discussing the present report with me. A set of improvements in the manuscript may be considered generated within the frame of those discussions.

To all those persons and institutions with whom I have collaborated - also those not mentioned - I dedicate the present work.

Drammen, October 1970 Magne Nyborg

I INTRODUCTION

THE NATURE OF THE PROBLEM. THE PROBLEM RELATED TO SPECIAL EDUCATIONAL RESEARCH

The work to be reported in the subsequent sections primarily lends itself to the special education of developmentally retarded children.

The particular area of investigation selected, that is, concept learning, probably has wider implications, lying at the heart of all teaching.

In the present work, however, concept learning will be related to the special education of mentally retarded children.

The "special" in special education, it appears to the present writer, ought to be the localization of one or more main "defects" in the deviating person, drawing upon this knowledge as a starting point for an intensive remedial training.

It has been observed, however, that mentally retarded children, as a sub-population, constitute a heterogeneous sample of individuals, whose patterns of developmental retardation differ considerably, as do the etiological categories to which they may be assigned.

Remedial training, therefore, ought to be adapted to the individual child and to his specific pattern of developmental problems.

Psychological and educational research, in contrast, is ultimately aimed at the detection of regular interrelationships between variables or classes of observations.

A problem relevant to special educational research, therefore, would be of the following kind: What constitutes the main "defect" (or defects) common to most of or even all members of a sub-population, and how should they be trained in order to counteract the detrimental consequences of that "defect"?

By definition (HEBER, 1959; NYBORG, 1969), mentally retarded persons score below "normal" when evaluated by tests of general intelligence.

This fact, of course, would scarcely be worth our concern if low psychometric intelligence did not frequently prove to be accompanied by "impairment in adaptive behavior" (HEBER, 1961), most markedly manifested, perhaps, in complex learning, problem solving and abstract thinking.

In practical school work and administration, retarded learning, rather than low psychometric intelligence, may be considered the more reliable and important criterion for assigning pupils to special education.

The learning deficits prevailing in mentally retarded children seem to call upon a learning psychology approach to remedial treatment, the learning psychology, of course, being intimately related to the general and specific problems revealed in retardate learning and development.

SYNOPSIS

In chapter III, mental retardation will be reviewed in terms of a failure to develop and learn both basic and more "abstract" concepts.

Chapter II

Before proceeding to chapter III, however, the wide-range importance that may be assigned the acquisition and adequate utilization of concepts will be considered in chapter II.

Concept formation and learning, it will be argued, is a complex learning process, the successful solution of which depends upon the adequate solution of several sub-processes.

Particular attention will be paid to the stimulus selection part of concept learning, which requires the subject to analyze (abstract) and select relevant aspects of environmental objects and events, and utilize the response, previously conditioned to a relevant cue, to objects and events containing equivalent cues.

Chapter III

In chapter III, mental retardates will be evaluated in terms of their capability of successfully (or unsuccessfully) performing the several sub-processes involved in concept learning.

While elucidating the multiprocess nature of concept learning and the specific problems apparent in retardate concept learning, it will be necessary to draw upon several results reported and various theoretical notions available in literature.

From the set of constructs reviewed, the more relevant will be selected, thus providing the basis for a set of hypotheses and simultaneously concluding the discussion lead in chapters II and III.

The hypotheses, of course, have governed the collection of data and involve the predictions relevant to experimental results.

Chapter IV

In chapter IV, data bearing upon the hypotheses will be presented and discussed.

Thus a series of concept learning experiments need to be reported, some of which have been performed in laboratory settings and one being performed in small groups within natural school settings.

Chapter V

In chapter V, a sub-set of data, only partially relevant to our hypotheses, will be reported and discussed.

Thus, in V. 1, a set of data bearing upon the multiple causation of retardate learning deficits will be presented and evaluated, and in V. 2, data relevant to the continuity-discontinuity controversy of learning psychology will be discussed.

Chapter VI

The last chapter (VI) will contain a summary and final discussion of experimental results.

II NON-VERBAL CONCEPT LEARNING

II.1 INTRODUCTION

A comprehensive analysis relevant to the present topic has been presented in a previous report (NYBORG, 1970a). The reader, therefore, is referred to that study in order to obtain the full range of information drawn upon.

II.1.1 Terminological Considerations

In subsequent sections and chapters authors who utilize an S-R-language in describing concept learning will repeatedly be referred to.

It is beyond the scope of this work (1) to make a thorough analysis of the "meaning" attached to the terms "stimulus" and "response" (and of the relations between S and R proposed) by each author, or (2) to evaluate the relevance of that terminology for a description of concept learning.

Though being aware of the limitations of the S-R-language and of the simplifications inherent in a stimulus-response description of concept learning, this conceptual frame has nevertheless been chosen by the present writer as a starting point - for convenient reasons. It has become extended, however, to include "implicit" responses and stimuli as well as environmental stimuli and observable responses.

Subsequently, the S-R-language will be replaced, in part, by a set of concepts generated within information-processing models.

When the words stimulus and stimuli are used independently by the present writer, they may be taken to denote environmental objects and events (S) or events taking place within the organism (s).

Environmental S

In the environment, S is used to denote (natural or artificial) objects and events which may, but need not, give rise to stimulation of an organism.

Stimulation (e.g., GIBSON, 1959), in turn, is taken to denote those patterns of energies, produced by environmental stimuli, that reach the surface of an organism and may be transformed into patterns of sense energies, and subsequently into patterns of afferent nerve impulses.

The proximity of S to the organism and the observing responses and receptor adjustments necessary in order for an optimal reception to occur are taken for granted during experimental learning conditions.

When the term stimulus variable and values along stimulus variables are used, they should not be conceived of as systematic changes in the energies impinging upon the surface of an organism.

They denote a mode of ordering or classifying environmental stimuli (in the sense formerly described) which refers to a social convention of which selected aspects of the environment may be treated equivalently by a concept learner (in the present report frequently referred to as GOSS, category I stimuli).

The kinds of stimulus variables and values employed in our experimental tasks have been exemplified in table II. 1, p. 7. They may be coordinated to nominal (category) and ordinal scales, more seldomly to interval scales of the statistic language (e.g. SIEGEL, 1966).

Table II. 1 Stimulus Variables and Values utilized in our Laboratory Experiments.

STIMULUS VARIABLE	SCALE	VALUES
SHAPE	Nominal	Triangles, Squares, Rectangle, Circles, Ellipse
COLOR	Nominal	Red, Green, Blue, etc.
SIZE	Ordinal	Large, Small
SUBSTANCE	Nominal	Wooden, Metallic
"PATTERN"	Nominal	Dotted, Squared, Striped
PATTERN SIZE	Ordinal	Small, Medium, Large
ORIENTATION	Nominal	Vertical, Oblique

Events Presumed to Take Place within the Organism (s)

So far we have been concerned with stimulation which originates in environmental stimuli and may ultimately activate different parts of the central nervous system.

In addition, a set of stimulating events generated within the organism may be presumed to take place in close temporary succession with afferent impulses from surface receptors.

These events, which have loosely been termed "implicit" or "mediational" responses (r) and stimuli (s) by several theorists (e.g., KENDLER & KENDLER, 1962), may be said to occur <u>independently</u> of surface receptor energies in the sense of being a reactivation of <u>previous experiences</u> made by the organism.

To the extent that previous experiences may be inferred from the history of an organism, they may be utilized by an experimenter to make assumptions concerning stimulating events within the organism.

Events within the organism may further be assumed to affect the organism's <u>selection</u> of specific features of the present pattern of environmental stimulation (i.e., at different "levels of attention") and the organism's interpretation or identification of stimulus "input" (e.g., HEBB, 1949; PENFIELD & ROBERTS, 1959).

Environmental and "implicit" stimulation may, but need not, be assumed to have immediate behavioral consequences, and observable "responses" may, but need not, be regularly related to environmental stimulus variation.

Whenever behavior is initiated without any observable environmental cause, events within the organism, though difficult to define in terms of variables of stimulation, may be assumed to be reflected in behavior.

Responses

The terms "response" or "terminating response" (R) will be used by the present writer to denote a limited unit of behavior being available for observation by the experimenter and specified to the human subject by means of an instruction.

In the concept learning tasks to be described, each response represents a choice, on the part of a subject, from a set of experimenter-defined response alternatives (including, sometimes, no response as an adequate alternative).

They may be described as verbal, usually on the level of single words, or non-verbal motor identifying responses.

The subject's task, after having learned the set of "correct" responses, involves the detection of the kinds of S-R-relations which maximize positive feedback signals from the experimenter.

Learning

In our laboratory experiments, the experimental conditions permit a definition of learning in terms of a change from apparently irregular or "incorrect" regular to "correct" regular relations between environmental stimulus variation and observable response variation.

The change may be thought to take place as a result of an interplay between environmental stimuli, relatively independent events within the organism, the resulting choice of terminating responses, and the effects produced by those responses upon the environment (i. e., positive and negative feedback information).

It may appear from the preceding paragraphs that the present writer takes an eclectic position, this position being reflected in a choice of concepts from among different theoretical formulations.

The choice of concepts has been governed in each case by the nature of the problem under discussion, in the first place, and by the "need" of an economy of description, in the second place.

Thus the learning tasks and some of the processes involved in concept learning, lend themselves to a description in terms of environmental stimuli (S) and observable responses (R).

When turning to the processes taking place within the organism, the S-R-language seems more difficult to maintain, however.

"Independent" changes within the central nervous system, presumed to accompany afferent impulses from surface receptors, no doubt may be termed changes in energies, that is, stimulating events.

Whether one postulates an "implicit response" (r) which is supposed to precede each s, or not, seems to be a matter of preference rather than a description of different realities, however.

What appears more important to the present writer, is that "implicit stimulating events", whether they be labeled "responses" and "stimuli" or "cognitions", become intimately tied, in psychological models, (1) to the nature of the organism studied, (2) to previous experiences made by that organism, and (3) to relationships between environmental stimuli (including those following a response) and responses utilized in the experiment in which the organism participates.

With the foregoing terminological reservations in mind, the reader is invited to return to the main theme of the present chapter, that is, "non-verbal" concept learning.

II. 1. 2 Concept Learning

A series of definitions have been discussed (NYBORG, 1970a), indicating, when compared, that concept learning probably denotes a diversity of learning phenomena.

The most comprehensive definition, perhaps, has been offered by T. S. KENDLER (1961), proposing that

> Concept formation is taken to imply the acquisition or utilization, or both, of a common response to dissimilar stimuli.
>
> (T. S. KENDLER, 1961, p. 447).

This definition, though probably adequate for all concept learning situations, fails to specify the stimulus similarity contained in a concept learning task.

As has been pointed out by many investigators in this area, stimuli in a concept learning task have to contain a similarity, being either physical and thus

<u>observable</u> (GOSS, 1961, types I and II stimulus sets) or <u>representational</u> in nature (OSGOOD, 1953; GOSS, type III stimulus sets).

Concept Learning and SG

As has been noticed by GOSS (1961), also, the definition proposed by KENDLER may scarcely be distinguished from a definition of primary Stimulus Generalization (SG), in which a common response may be emitted to dissimilar (and, of course, similar) stimuli.

The failure of T. S. KENDLER's definition to distinguish concept learning and stimulus generalization, it seems likely to assume, has motivated GOSS (ibid.) to suggest that concept learning should be taken to denote the learning of a task in which two or more terminating responses may be associated with each of two or more sub-sets of stimuli contained in the entire set of task stimuli (fig. II. 1, p. 20; fig. II. 6, p. 25).

According to this distinction, a simple concept learning task would include at least two SG-tasks.

Stimulus Multivariation

A further distinction between concept learning and primary SG has been suggested by GARNER (1962), claiming that stimuli in a concept learning task must be multivariate in nature.

Experimental primary SG stimuli, it may be recognized by the reader, have frequently been varied along a <u>single</u> stimulus variable or dimension at one time (NYBORG, 1970<u>a</u>, p. 58).

According to GARNER, the concept learning task is required to vary along several stimulus variables, a sub-set of which contain the <u>values</u> or <u>cues</u> relevant to task solution.

GOSS, contrasted to GARNER, is willing to dispense with the latter requirement. Concept learning task stimuli, according to GOSS, may be, but need not be, multivariate.

Concept Acquisition and Identification

Returning now to the KENDLER definition, a seemingly useful distinction appears between acquisition and utilization "of a common response to dissimilar stimuli".

This distinction has been further elaborated by H. H. KENDLER (1964), replacing, however, the term "concept utilization" with another term, that is, "concept identification".

Concept acquisition, according to H. H. KENDLER, may be taken to denote the learning "from scratch" of a concept.

Concept identification, in contrast, denotes the invention, within a new context, of a concept previously acquired.

Concept identification, therefore, may be replaced by an instruction, that is, a verbal pointing out of stimulus criteria relevant to task solution. An instruction, however, would not substitute for concept acquisition. The concept has to be acquired prior to (or simultaneously with) being identified.

The distinction between concept acquisition and concept identification, according to H. H. KENDLER, does not rest upon the subject's age level only, since, at different levels of age (or maturity), a person may identify concepts, but has to acquire concepts not previously learned.

While considering the hierarchical nature of many concepts (e.g., WELCH, 1947), it may be safe to assume, however, that the acquisition of a higher--

order or more "abstract" concept, frequently depends upon the successful identification of one or several lower-order concepts.

The present assumption, of course, implies that concepts ought to be learned in a definite and carefully devised order, the more basic concepts being trained prior to higher-order ones, thus facilitating the higher-order concept learning (i.e., concept acquisition and identification).

This notion is relevant and importantly related to the present work, since, it will be claimed, the teaching of basic concepts has frequently been neglected in schools, including our special schools.

This point will be further discussed in a following section stressing the importance of concept learning and conceptual behavior for an optimal mental development.

Non-Verbal Concept Learning

The term non-verbal has been utilized to denote the nature of stimuli involved in a concept learning problem. A concept learning task so denoted, in this report, may be supposed to include non-verbal stimuli or discriminada (in the present report: stimuli which are not mediated by words or other kinds of language), the nature of responses (implicitly or explicitly emitted) being either verbal or non-verbal.

Non-verbal stimuli, according to GOSS (1961), may belong to either of three categories distinguished according to the kind of systematic variance and invariance existing among separate members of a stimulus set (NYBORG, 1970a, pp. 26-32).

GOSS type I (also HOVLAND, 1952) stimuli may vary through two or more separate values along one or several physical stimulus dimensions (genuine or derived). The stimulus similarity in this sub-category of stimulus sets may be identified as one or more values common to all the members of a sub-set of stimuli (fig. II. 6, p. 25).

In the second category of stimulus sets pointed out by GOSS, the members of a sub-set of stimuli contain one or more physical elements in common, or they share a common physical relation between component stimulus elements (NYBORG, 1970a, p. 29).

Finally, a third category of stimulus sets has been suggested by GOSS, in which no systematic physical similarity exists among separate members. They may, however, represent a similarity not evident in the stimulus set. The detection of similarity, in such a case, depends upon what has previously been associated with the individual members of a stimulus set.

Verbal Concept Learning

In the mature human, auditorily and visually presented words probably constitute the main part of all type III stimulus sets (NYBORG, 1970a, p. 31).

While being responded to in the manner formerly described, that is, each response being emitted to a sub-group of verbal stimuli, the words may be considered parts of a verbal concept learning task.

An adequate utilization and a "meaningful" comprehension of words, however, frequently may be assumed to depend upon the representativeness of associations previously established between the individual word and a set of non-verbal stimuli containing some kind of similarity, thus constituting the "conceptual "meaning" of the word.

This, of course, need not always be true. Thus GAGNE

(1965) has suggested a useful distinction between "concepts by observation" and "concepts by definition", the learning of the latter category of concepts being dependent upon explanations conveyed by means of chains of verbal stimuli.

The similarity between persons denoted "uncle", for instance, may be established only by means of a verbal explanation describing a set of inter-relations among members of a family.

II. 1. 3
The Importance of Concept Learning and Conceptual Behavior

Verbal concept learning will not become a main theme in this report. On the contrary, "concepts by observation", probably constituting the more basic concepts, will be our principle concern.

Verbal concept learning has been introduced, however, in order to elucidate the extreme importance that may be attributed concept learning and conceptual behavior.

C. L. and Formal Education (School Achievement)

GAGNE (ibid.) has stressed the importance of concept learning in formal education. In the subsequent paragraphs his notions will be elaborated and partly extended.

Words and verbal chains constitute essential parts of inter-human communication, education, of course, being only one kind of communication.

Most of the words used in communication, it may be recognized, represent (or ought to represent) class concepts, in the sense of being symbols for classes of phenomena somehow similar.

The student (or pupil), it would be safe to presume, is every day impinged upon by masses of words and other symbols, and he himself emits a lot of symbolic responses.

Unless all these words, frequently linked into verbal chains, convey a clear conceptual "meaning" to him, his learning would at best be ineffective.

On the other hand, unless the words emitted by the student have been activated by class concepts, he would not be able to communicate a clear "meaning" to his teachers and to his classmates.

The practical implication for teaching involved in these notions would be that every word or number taught, whenever possible, should be taught as representative of a class concept.

The primary schoolteacher, it appears to the present writer, frequently teaches reading, articulation, spelling and number combinations, leaving the class concepts to be formed by the pupil himself through more or less randomly recurring experiences.

This, perhaps, is why the term concept formation has been used to denote the development of concepts in children.

The possibility exists, therefore, that mere verbal chains, rather than conceptual chains, constitute the "knowledge" acquired by many pupils in school.

Mere verbal chains, it may be assumed, will easily be forgotten.

Concept learning has been used throughout this report in order to indicate that the teaching of concepts has to be taken seriously in school, being systematically dealt with in all topics taught.

C. L. and Adaptive Behavior

The importance of concept learning and category formation, however, is not confined to verbal learning (verbal learning, of course, constituting an achievement specific to man).

Several investigators have stressed the probable impact of categorizing activity and conceptual behavior upon a general adaptation to the environment.

Thus, as has been pointed out by BRUNER, GOODNOW & AUSTIN (1956),

> By categorizing as equivalent discriminable different events, the organism reduces the complexity of its environment.
>
> (BRUNER, GOODNOW & AUSTIN, 1956, p. 11).

This reduction of environmental complexity, DEESE (1958) has reasoned, is necessary so that the environment may be dealt with by our mental processes.

If complexity is not being reduced, we may conclude, the organism would not be capable of adequately controlling his environment.

Categorizing activity (or concept utilization), BRUNER et al. further argues, "is the means by which the objects of the world about us are identified" (i. e., placed into classes), it "reduces the necessity of constant learning", "provides the direction for instrumental activity", and "permits an ordering and inter-relating of classes of events".

What has recently been reviewed points to the extreme and far-reaching importance to the mature individual of having formed or learned concepts. If concepts have not been formed in the course of development, they have to be learned in order to provide an optimal development on the part of an individual.

C. L. and General Tests of Mental Abilities

The importance of conceptual behavior for a general intellectual development, it seems likely to assume, has been recognized also by test psychologists.

Thus the typical general test of intelligence draws heavily upon the conceptual development of the subject tested.

This, perhaps, is most clearly evident in non-verbal tests like RAVEN's Progressive Matrices and Columbia Mental Maturity Scale.

As has been noted by INHELDER & PIAGET (1964), RAVEN's Matrices requires the subject to select and classify patterns according to one or several concepts (multiple classification); and Columbia Mental Maturity Scale, it has been recognized by JENSEN (1966), may be considered a concept identification test.

Verbal tests (e.g., The Stanford-Binet Revisions) usually contain only a few items testing the content of specific concepts.

The instructions, however, ordinarily consists of verbal chains, each link of which has to communicate a clear conceptual meaning in order for the task to be adequately solved by the subject. We may safely conclude therefore, that test results heavily depend upon the level of conceptual achievement reached by the subject. This conclusion appears to be empirically supported by data reported, indicating a high correlation between conceptual language measures and tests of general intelligence (e.g., D. McCARTHY, 1963).

Conclusion

The importance of concept learning has been discussed at length in order to evaluate the possible interrelationships between intellectual and conceptual development.

It may be noted that the variables frequently used to define mental retardation, that is, psychometric intelligence and levels of "adaptive behavior" seem to be intimately related to level of conceptual achievement.

This notion, of course, should not be taken as a proof for a view, regarding the conceptual deficit to be the only deficit in mental retardates.

It does support the notion suggested in chapter III, however, that at least one cardinal deficit in mentally retarded persons is a failure to develop and learn concepts.

II. 2 SUB-PROCESSES IN CONCEPT LEARNING

Concept learning, it has already been argued, is a complex learning process, the correct solution to which depends upon the successful solution of several sub-processes.

In this section, an attempt will be made (1) to show that this argument is sound, and (2) to identify the main sub-processes that may be presumed to operate in non-verbal concept learning.

In general, the analyses will be kept within the frame of GOSS' category I concept learning tasks, since the tasks used in our experiments have been sampled from that category (table II. 1, p. 7).

The sub-processes presumed to be involved in concept learning have been identified by comparing concept learning with several other psychological processes, all of which are probably more "basic" than concept learning (NYBORG, 1970a, pp. 49-95).

It may be necessary, therefore, to initiate this section with an outline of the results obtained in that analysis.

II. 2. 1 C. L. and Primary Stimulus Generalization (PSG)

Primary stimulus generalization (PSG), it has been shown, seems to be intimately related to concept learning. Thus a simple concept learning task in which stimuli have been varied along a single variable (x) may be considered almost equivalent to a combination of two or more PSG situations (almost is used because concept learning frequently includes reinforcement, while an experimental PSG situation never does).

The specific interrelations existing between a simple concept learning task and PSG have been displayed in figure II. 1.

Fig. II. 1

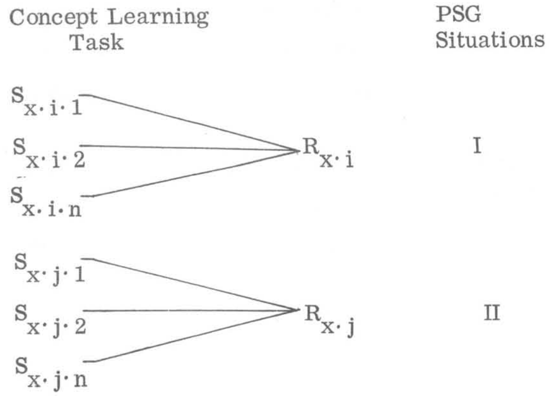


Fig. II. 1. Relations of a Simple C. L. Task with PSG. S = Initiating Stimuli; R = Terminating Responses; x = Relevant Stimulus Variable; _i_ and _j_ = Value Intervals; 1-n = Sub-Values within Intervals _i_ and _j_ (e. g. , different green and red colors).

It may be safe to conclude, therefore, that PSG is always involved in non-verbal concept learning. Secondary of mediated stimulus generalization, in contrast, may be assumed to prevail in verbal concept learning.

II. 2. 2
C. L. and Paired--Associates Learning (PAL)

Preceding PSG, however, another process has to take place, that is, an association process, in which a single value from each separate SG "task" (e. g. , i· 1 and j. 1) has to be conditioned to the corresponding response ($R_{x\cdot i}$; $R_{x\cdot j}$). The associated value within each SG stimulus set, of course, corresponds to S_o in an experimental PSG-situation.

The learning task, before PSG is permitted to take place, therefore, may be depicted as a list of paired associates, in which one-to-one correspondence exists between stimulus and response alternatives (fig. II. 2).

Fig. II. 2

Initiating Stimuli — Terminating Responses

$$S_{x\cdot i\cdot 1} \longrightarrow R_{x\cdot i}$$

$$S_{x\cdot j\cdot 1} \longrightarrow R_{x\cdot j}$$

Fig. II. 2 PA-Learning which may precede PSG in the Concept Learning Task represented in Fig. II. 1.

The relations made obvious in figure II. 2, of course, are consistent with the view held by several investigators (e.g., HEIDBREDER, 1946, 1947; BAUM, 1954), that a concept learning task may be considered composed of two or several lists of paired associates.

In figure II. 3, this view has been applied to the concept learning task formerly displayed (fig. II. 1).

The learning of a single list of paired-associates has frequently been denoted paired-associates (PA) learning, this label, perhaps, indicating the nature of the process prevailing whenever a single response becomes conditioned to or <u>associated</u> with a distinct stimulus.

The association process itself may not be observed, however, only the behavioral consequences of it.

Fig. II. 3

List of PA	Initiating Stimuli		Terminating Responses
I	$S_{x \cdot i \cdot 1}$	$\longrightarrow$	$R_{x \cdot i}$
	$S_{x \cdot j \cdot 1}$	$\longrightarrow$	$R_{x \cdot j}$
II	$S_{x \cdot i \cdot 2}$	$\longrightarrow$	$R_{x \cdot i}$
	$S_{x \cdot j \cdot 2}$	$\longrightarrow$	$R_{x \cdot j}$
N	$S_{x \cdot i \cdot n}$	$\longrightarrow$	$R_{x \cdot i}$
	$S_{x \cdot j \cdot n}$	$\longrightarrow$	$R_{x \cdot j}$

Fig. II. 3. The Concept Learning Task formerly described rearranged into Lists of Paired Associates.

What goes on within the organism while establishing a connection between a distinct stimulus and a distinct response may only be assumed at present.

Several theories have been advanced, however, some of which will be reviewed in a subsequent section.

We may assume that the kind of association described has to be formed prior to stimulus generalization and concept learning, thus constituting a necessary condition for concept learning to occur.

II. 2. 3 C. L. and Discrimination Learning

If the sub-tasks represented in figure II. 2 are to be learned at the same time or in close succession, a new process enters the learning process: the subject has to discriminate two distinct values along the x variable and, therefore, has to respond differentially to them.

This fact, of course, has been realized by GAGNE (1965) while using the term multiple-discrimination to denote the learning of a list of paired-associates.

The combined effect of stimulus discrimination and response differentiation has frequently been investigated within a learning paradigma denoted discrimination learning, indicating the main process to be studied during task solution.

The tasks represented in figures II. 1 and II. 2 may easily be changed in order to fit a discrimination learning paradigma.

Thus in figure II. 4, the PA-learning task depicted in figure II. 2 has been transformed into a discrimination learning paradigma.

Fig. II. 4

Initiating S (simultaneously presented)		Response Alternatives	Reinforcement
$S_{x\cdot i\cdot 1}$	$\longleftarrow$	$R_{x\cdot i}$	+
$S_{x\cdot j\cdot 1}$	$\longleftarrow$	$R_{x\cdot j}$	(no response)

Fig. II. 4. A Single Trial of a Discrimination Learning Task corresponding to the PA-Learning Task depicted in Fig. II. 2.

Stimuli in the present task should be simultaneously presented, and the subject is expected to choose one of them as "correct", the choice being reinforced according to an <u>a priori</u> defined schedule of reinforcement.

The task still includes two response alternatives, only one of them constituting an overt response, however. Yet response differentiation may be said to occur if "no response" is accepted as a response alternative.

Usually the task would be repeated until learning has occurred, the position of stimuli being randomly interchanged from one trial to another.

When reaching the learning criterion, a <u>discrimination learning process</u>, manifested in a consistently differential responding to two distinct values ($i \cdot 1$ and $j \cdot 1$) along <u>x</u>, may be said to have occurred in the subject.

In a similar way the tasks depicted in figures II. 1 and II. 3 may be changed in order to fit a discrimination learning paradigma (fig. II. 5).

Fig. II. 5

Discr. Task	Initiating Stimuli presented in pairs		Response Alternatives		Schedule Reinforcement
I	$S_{x \cdot i \cdot 1}$	$\longleftarrow$	$R_{x \cdot i}$		+
	$S_{x \cdot j \cdot 1}$	——	$R_{x \cdot j}$	(no R)	
II	$S_{x \cdot i \cdot 2}$	$\longleftarrow$	$R_{x \cdot i}$		+
	$S_{x \cdot j \cdot 2}$	——	$R_{x \cdot j}$	(no R)	
N	$S_{x \cdot i . n}$	$\longleftarrow$	$R_{x \cdot i}$		+
	$S_{x \cdot j \cdot n}$	——	$R_{x \cdot j}$	(no R)	

Fig. II. 5. The Concept Learning Task formerly described (fig. II. 1 and II. 3) transformed into a Set of Discrimination Learning Tasks.

In figure II. 5, the concept learning task formerly presented has been transformed into several discrimination learning tasks (I-N), each of which resembles the paradigma displayed in figure II. 4.

The nature of a concept learning task is evident in the sub-division of the stimulus set into two sub-sets, (S_{xi}, S_{xj}), each of which corresponds to a different response alternative.

The discriminations to be performed are made more obvious, however.

In a single task the subject may learn to discriminate two distinct values along x (e.g., i·1 and j·1). Solving the entire set of problems, however, involves a higher-order discrimination of two value intervals along x (that is, i and j), each of which is represented by n sub-values.

The discrimination, in the latter case, probably has to be accompanied by a generalization within each interval (NYBORG, 1970a, p. 81).

If genuine physical dimensions (e.g., frequencies, intensity, pitch, size, etc.) constitute the task stimulus variables, discriminations probably depend upon the nature of and conditions in sense organs and the inherent characteristica of the nervous system.

Yet discrimination learning may be used in order to denote the learning of a correct choice among response alternatives.

When derived stimulus variables (e.g., complex stimulus shape) are involved in the task, discrimination is probably dependent upon several conditions including prior experiences and learning, and the nature of receptors and the central nervous system (e.g. HEBB, 1949, p. 19).

Whatever contributes to an adequate discrimination, however, discrimination processes have to take place so that concept learning may occur.

II. 2. 4 Stimulus Analysis and Selection in Concept Learning

It may be noted that, even while dealing with simple concept learning, three basic processes may be presumed to occur, all of which determine the final concept learning process.

The picture becomes even more complicated, if, as will ordinarily be the case, the stimulus set in a concept learning task is composed of items varied along <u>two or several</u> stimulus variables.

A task has been represented in figure II. 6, in which the stimulus set is systematically varied along three variables or attributes (x,y and z), each of which involves two distinct values (1 and 2).

Fig. II. 6

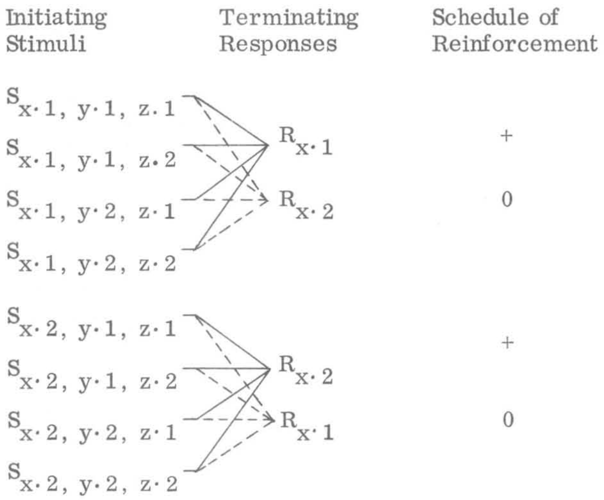


Fig. II. 6. Complex Concept Learning Task, in which Stimuli have been varied along Three Stimulus Variables (x,y and z), each represented by Two Values (1,2).

The x-variable, it may be noted, constitutes the <u>relevant</u> stimulus variable, the remaining two variables being <u>irrelevant</u> to task solution.

A correct learning of the present task, of course, need not be essentially different from solving the former concept learning task (fig. II. 1), provided that the values along the relevant stimulus variable have already been abstracted and selected as "occasions" for differential responding.

Two additional processes, therefore, may be assumed to precede the correct associations, discriminations and generalizations involved in a complex concept learning process.

In the first place: the subject, while attending to a stimulus item, has to (attend to, or) abstract from a compound of three values the value belonging to the relevant variable.

This, of course, may happen in the first trial. The mathematical probability of a first-trial correct abstraction, however, is only 1/3.

It is likely to assume, therefore, that a more comprehensive analysis, including several tentative abstractions, has to be performed by the subject prior to a correct selection.

In the second place: During this analysis, one variable at a time may be selected as a tentative "hypothesis" (e.g., LEVINE, 1963). The "hypothesis", while transformed into choice behavior may be tested against the schedule of reinforcement.

The "hypothesis", of course, may be "conscious" and verbal, vocal or sub-vocal, in the mature human.

It need not be assumed to be "conscious" or verbal, however, in the premature human and cannot be verbal in infra-human organisms.

Yet analysis and selection may be assumed to take place in the latter kind of organisms, provided that the task is not too complex (e.g., LASHLEY, 1930).

II. 2.5 Conclusion

In summary, a second kind of "discrimination" process has been identified in complex concept learning in which the subject is required to discriminate a set of relevant and a set of irrelevant stimulus variables or attributes.

A successful "discrimination", in this case, probably depends upon the dual process of analyzing (or abstracting) stimulus attributes involved in the task, and selecting the relevant one as a cue for differential responding.

In complex concept learning, the processes formerly described (association, discrimination, and generalization), therefore, may be assumed to be selective in nature, that is, confined to the relevant stimulus variables.

Thus they may not adequately take place in complex concept learning until the analyzing and selecting phases have been successfully performed.

The latter notion, inferred from the nature of concept learning tasks, is consistent with the position held by ZEAMAN & HOUSE (1963) and BOWER & TRABASSO (1964) while evaluating the possible all-or-none nature of concept learning.

This topic will be dealt with in the next section, including, besides, several theoretical notions invoked in order to explain concept learning.

A further discussion of the probable sub-processes operating in complex concept learning must be postponed until that section, since the theories, it may be noted, contain several cues to the understanding of processes represented in the present section in terms of observable stimulus and response conditions.

II. 3 THEORIES OF CONCEPT LEARNING

Introduction

Several theories and constructs have been advanced in order to represent, that is, explain and predict concept learning (NYBORG, 1970a, sections B and C).

Only a few theories relevant to our empirical work will be reviewed in the present report, however.

In section II. 3. 1, the psychological implications of an all-or-none performance in concept learning will be considered.

The BOWER & TRABASSO (1964) notions, relevant to the all-or-none problem, conveniently lend themselves to a mediated learning interpretation of several sub-- processes in concept learning. Theories of mediated learning, therefore, will constitute the main topic of section II. 3a.

Two additional sub-processes will be suggested in section II. 3. 2, both of which may be interpreted in terms of the impact of previous learning and development (that is, representational mediational processes) upon the learning of a new and different concept problem.

In section II. 3. 3, mediated learning and mediational processes will be related to general mental development, thus preparing the transition from the topic of concept learning to the problem of mentally retarded development to be dealt with in chapter III.

II. 3. 1 Psychological Interpretation of All-or-None Performance in C. L.

Several investigators (e. g. , SUPPES & GINSBURG, 1963; ZEAMAN & HOUSE, 1963; BOWER & TRABASSO, 1964) have observed the "all-or-none" nature of performance that may prevail in concept learning (NYBORG, 1970a, chapter V. 5).

"All-or-none", in the reports referred to, has been used to denote two distinct states of performance revealed in the specific learning curves utilized.

Before proceeding, a review of the kind of learning curves observed may be in order.

BOWER & TRABASSO (1964) plotted the mean learning curves by means of scores obtained in blocks of trials prior to solution. Thus, a subject, while reaching the learning criterion, would be dropped from the sample whose scores contributed to the mean learning curve.

This procedure produced an approximately linear learning curve running at a constant distance from the abscissa, thus indicating a constant probability ($p < 1$) of being correct in each block of trials.

ZEAMAN & HOUSE (1963) applied a different procedure. First, a post-experimental sub-division of a previously heterogene sample of subjects produced several homogeneously learning sub-groups. Second, the backward learning curve for each of the sub-groups was plotted and evaluated.

The latter procedure produced several mean learning curves corresponding to the number of sub-groups of subjects.

A non-learning sub-group produced a mean learning curve comparable to those obtained by BOWER & TRABASSO.

The mean learning curve produced by fast learners, in contrast, quickly departed from the chance level and rose to a constant probability of being correct in each block of trials ($p = 1$).

Finally, slow learners remained on a chance level for several blocks of trials, but then quickly rose (as did the fast learners) to a probability of 1 of being correct in each block of trials.

We are now in a position to return to the all-or-none distinction.

The first, or "-non" state, may be observed in the mean learning curve as a constant probability ($p < 1$) of making correct responses in each block of trials.

This state has been interpreted (e.g., BOWER & TRABASSO, 1964) as denoting an unlearned, guessing state, in which the subject is assumed to sample cues from trial to trial according to a chance principle. It may, of course, be further interpreted in terms of analyzing and selecting processes in which stimulus variables are abstracted and a sub-sample of relevant variables and values are selected as the correct "occasion" for emitting responses.

Following the constant chance level of performance, a quick transition may be observed in which the subject leaves the un-learned state and enters a new, learned or "absorbing" state ($p = 1$ of being correct) and remains there.

The quick transition has been interpreted as being a phase, in which relevant cues (i.e., values along relevant stimulus variables), previously analyzed and selected, become conditioned to the corresponding responses.

Thus the fast conditioning (or association process), including, of course, the necessary discriminations and generalizations, may be assumed to depend upon and follow a time-consuming stimulus analysis and selection phase.

This sequence of events, it may be remembered, has been inferred in the previous analyses of sub-processes in concept learning.

The different times used to solve the two sets of sub-processes further indicate that the stimulus analyzing and selecting phases probably constitute the more difficult sub-processes, as compared with the remaining processes.

This seems to be the view held by ZEAMEN & HOUSE (1963) while considering the performance of "moderately" retarded (that is, imbecile) children in combined concept learning and discrimination learning tasks:

> A theory has been developed in this chapter that the visual discrimination learning of moderately retarded children requires the acquisition of a chain of two responses: (1) attending to the relevant stimulus dimension and (2) approaching the correct cue of that dimension. The difficulty that retardates have in discrimination learning is related to limitations in the first, or attention, phase of this dual process rather than the second.
>
> (ZEAMEN & HOUSE, 1963, p. 220).

A similar view has been advanced by BOWER & TRABASSO (1964), while evaluating the results obtained with college students in several concept identification tasks:

> Thus, we will speak of a stimulus-selection process whereby the subject comes to attend principally to the values of the relevant stimulus dimension, and of a conditioning process whereby he learns, in paired-associate fashion, the associations between the various values of the relevant dimension and their assigned responses..... it will be assumed that the stimulus-selection process is being observed throughout, with the necessary paired-associate learning occurring very quickly at the end..... the relative difficulty of the stimulus-selection and the paired-associate phases can be manipulated experimentally. To lengthen the paired-associate phase, one increases the number of specific values in the relevant dimension, each to be associated with a unique identifying response. Correspondingly, the stimulus-selection phase can be shortened by reducing the number of irrelevant attributes. The limit of this process is a paired associate task in which there is no irrelevant cues..... The theory thus identifies an experimental continuum from concept identification to paired-associate learning.
>
> (BOWER & TRABASSO, 1964, pp. 40-41).

Some words of caution, perhaps, may be necessary here in order to prevent a too wide generalization of the preceding conclusions.

They have been based exclusively upon the observation of performance in GOSS category I learning tasks, in which stimuli may vary along two or several dimensions or variables (each containing two or three values), and, in which responses per se need not be learned, only the correct choice of response to each sub-set of stimuli.

Some of our data to be dealt with in chapter V indicate that when an entirely new set of responses, e.g., nonsense syllables, has to be learned, some degree of continuity enters the overall picture of dis-continuity.

Our data have revealed, also, that whenever three-choice tasks have been applied, one of the choices may be easier to learn, thus introducing further continuity into a picture in which, however, discontinuity still prevails.

Conclusion

Evidence has been advanced in the present section to support the view held by several investigators, including the present writer, that the stimulus selection processes in concept learning are the more time-consuming and are probably more difficult to solve than the remaining sub-processes.

It seems reasonable, therefore, to concentrate upon the former processes in order to search for a useful answer to each of the following questions:

(1) What may be the real nature of stimulus selection processes in concept learning?

(2) Which factors may contribute to an effective stimulus selection?

(3) Which factors may be assumed to interfere with stimulus selection in concept learning?

A set of theories relevant to our specific hypotheses and to educational research have been selected in order to elucidate the problems inherent in those questions.

II. 3. 2
Theories of Mediated Concept Learning

Several investigators (e. g. , WYCKOFF, 1952; ZEAMAN & HOUSE, 1963) have dealt with stimulus selection processes in terms of peripherical orienting acts.

Mediational Processes in C. L.

The view to be taken here is that stimulus selection may be considered essentially facilitated by central or implicit processes being both verbal and non-verbal in nature.

Central processes, which, of course, are taking place within the organism, are not readily available for inspection.

They may, therefore, at least at the present stage of knowledge, be attributed the status of intervening variables or hypothetical constructs, depending upon the view held by the investigator in question.

Their impact upon behavior may be observed, however, if behavior becomes intimately related to well-defined stimulus conditions (e. g. , LEVINE, 1963, 1966).

The nature of central processes (or intervening variables) may be inferred only from a dual consideration of (1) the specific task conditions utilized, and (2) the phylogenetic and ontogenetic developmental level of the organism considered (e. g. , KENDLER & KENDLER, 1962).

LAWRENCE (1963)

LAWRENCE has suggested a set of constructs adequate for the present topic. They contain the advantage, as compared with several other sets of constructs, of being "open-ended", that is, the constructs may be further interpreted according to the specific task conditions and organisms utilized by an investigator.

According to LAWRENCE, at any time of wakefulness a large sample of distal (or potential) stimuli impinge upon the organism, only a minor sub-sample of which, however, becomes selected on the part of the organism by means of peripherical orienting or observing responses (NYBORG, 1970a, p. 163).

The sub-sample of effective or proximal stimuli may be further coded or analyzed by means of one or several coding operations centrally facilitated by one or several coding systems.

Stimulus-as-Coded (s-a-c), if previously conditioned to a terminating response may elicit that response, or a new terminating response may be associated with s-a-c.

The coding system, which is presumed to mediate the coding operation and thus, s-a-c, has to be present in order for the coding operation and s-a-c to occur.

It may be assumed, therefore, that coding systems represent previous experiences of the organisms into which the present stimuli can be "assimilated". What the real nature of coding system is, has not been considered by LAWRENCE. They may probably be coordinated to conceptual systems already developed in the organism; but "a conceptual system" is no more than another label used to denote the "unknown".

HEBB (1949)

Only a few psychologists (e.g., HEBB, 1949) have run the risk of reasoning, in a speculative way, from what may be considered facts about the physiology and anatomy of the nervous system, thus making assumptions about how prior experiences have become represented in the organism (NYBORG, 1969, ch. IV.3).

According to HEBB (1949 and 1955), the nervous system of man in the course of development becomes a conceptual nervous system, in which prior experiences are represented in terms of definite, hierarchical cell structures (cell assemblies $\longrightarrow$ phase sequences $\longrightarrow$ phase cycles).

These central nervous system (CNS) structures, which may be considered interconnected nets of many single cells located in different parts of the brain, are presumed to develop over a long period of time, depending upon both the nature and amount of experiences met by the organism in the outer world, and upon a (synaptical) nervous system growth process following those experiences.

If one of the sub-structures thus developed becomes activated by afferent impulses (e.g., released by effective input stimuli), the whole hierarchical structure (e.g., a coding system) may be activated due to the facilitation made possible by prior growth.

The conceptual growth may not adequately take place if the organism, as may be the case, has been deprived of experiences in the course of development. The facilitation may not occur, either, if the experiences represented in the nervous system have not become adequately integrated, and therefore, of course, do not constitute parts of a conceptual nervous system.
The latter notions are significantly related to one of our main postulates to be considered in chapter III.

The HEBBian constructs, it may be realized, adequately explain the development of and facilitation due to coding systems, but fail to specify how the inhibition of irrelevant coding systems takes place.

In other words, the HEBBian theory may account, in part, for the neurological basis of stimulus analysis, but does not account for the selection process.

Thus stimulus analysis may be considered the correlate of a neutral transition of impulse activity from one phase sequence to another, from the second to a third, etc.

But <u>how</u> (and why), it may be asked, does a transition take place, and how may activity in a previously activated phase sequence be inhibited?

MILNER (1957) drawing upon the recent findings of neuro-physiology, has proposed a change in and extension of HEBB's theory, including, among other things, the role attributed to the <u>reticular activating system</u> in the total functioning of CNS.

The problem of complex facilitation and inhibition has not been solved, however, neither in physiology nor in psychology.

HEBB's theory, particularly some of the neurological implications of the theory, has been critically reviewed by several investigators including HEBB himself (1959).

What appears to be sound in the theory, however, at least to the present writer, is that man, in the early periods of development, gradually and slowly develops a <u>conceptual nervous system</u>, the conceptual nature being dependent (1) upon the nature of and conditions in the nervous system,(2) upon the nature and number of experiences made by the organism, and (3) upon the <u>integration</u> of innumerous separate experience into conceptual systems, acting later as "regulators" of effective perception (e.g., coding systems) and of "correct" behavior.

TRABASSO & BOWER (1968)

Now, returning from the sphere of speculative neuro-psychology to an application of LAWRENCE's constructs to a concept learning problem.

TRABASSO & BOWER (1968) have represented the current view of attention in learning, in terms of LAWRENCE's theory, applied to what may be considered a concept learning task (fig. II. 7):

Fig. II. 7

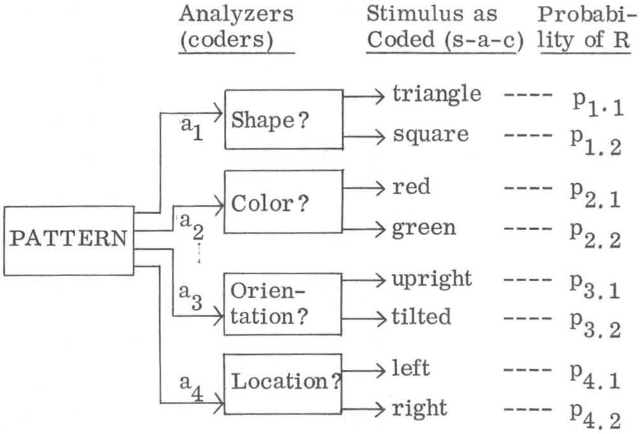


Fig. II. 7. Pattern Analyzers for Discrimination Responding. (TRABASSO & BOWER, 1968, fig. 1.1., p. 12).

The nature of a concept learning task is evident in the stimulus variables analyzed and the values coded, providing, if orthogonally combined, a stimulus set containing $2^4 = 16$ members.

This set, of course, may be sub-divided into several sub-sets, each of which may be assigned a different response.

Two sets of mediating events have been suggested by TRABASSO & BOWER, each of which may be considered stimuli for new responses, that is, for other implicit responses and for explicit or terminating responses, respectively.

The first, or analyzing responses (analyzers or coders), which may be generated within the frame of one or several coding systems (in the present task: four systems), each produces the cues for two separate implicit s-a-c's. Not at the same time, of course, since usually a CL stimulus item would not simultaneously contain two values along the same variable.

Each s-a-c, in turn, may serve as a cue for an explicit or terminating response.

Stimulus selection, that is, the selection of a sub-set of relevant analyzers, has not been indicated in figure II.7, only the probabilities of being selected before a schedule of reinforcement has been introduced.

This way of representing "attention", that is, in terms of an "attribute-value" coding of stimulus items, is common to several theories of concept learning (NYBORG, 1970a), including the theories of GOSS (1961), KENDLER & KENDLER (1962), LEVINE (1963,1966), BOWER & TRABASSO (1964), and HUNT, MARIN & STONE (1966), all of whom have made a different experimental and theoretical approach to the problem of concept learning.

This multiple coincidence of theories may be considered a strong support for a view to be taken by the present writer as well.

Memory Processes in CL

Corresponding to the attribute-value coding of stimuli, several investigators (e.G., HUNT, MARIN & STONE, 1966; BOWER, 1967) have represented memory processes in terms of an attribute-value listing of information previously coded.

These lists, while stored in a long-term memory, may be considered equivalent to coding systems available and utilized during coding operations.

BOWER (1967) has proposed an information processing model in which memory has been represented in terms of two separate processes, one short-term store and one long-term store (fig. II. 8).

Fig. II. 8

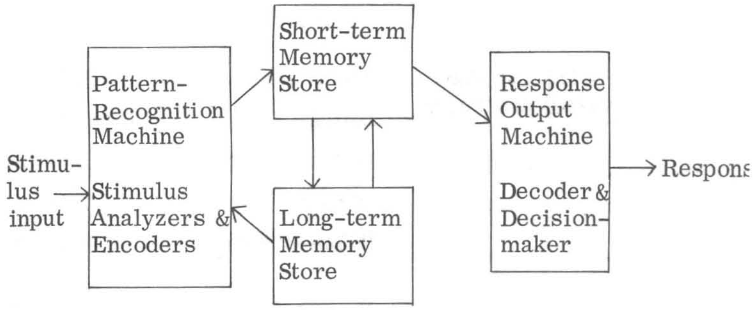


Fig. II. 8. Block Diagram representing the Flow of Information through the Theoretical System. See Text for Explanation. (BOWER, 1967, fig. 1, p. 232).

The present representation, of course, though being differentially termed, corresponds to the view held by several investigators (e.g., HEBB, 1949; ELLIS, 1963; NAUTA, 1966), including both neuro-physiologists and psychologists, that retention may be considered a dual process.

According to ELLIS (1963),

> Short-term memory would be measured in seconds or minutes as contrasted with long-term memory measured by hours, days or even years ...
> (ELLIS, 1963, p. 134).

The importance of long-term memory for concept learning has already been stressed, while coordinating a "stored list of attributes and values" to several "coding systems", which in turn may be assumed to facilitate stimulus selection processes.

Several processes also, in concept learning, may be considered dependent upon short-term retention.

Thus a comparison of stimulus items successively presented in order to discriminate, generalize, analyze, select and connect, requires the subjet to "keep in memory" at least some of the instances previously presented.

Verbal and Non-Verbal Mediation

The utilization of verbal labels, that is, labels denoting stimulus variables (analyzers) and values (s-a-c), in such a case, may be considered a facilitating condition in order for a "memory trace" to be preserved. (GOSS, 1961; LEVINE, 1963).

By introducing verbal labels, however, a new problem has been attended to, that is, the distinction between non-verbal and verbal mediation.

BOWER (1967)

BOWER (1967) has approached this problem in terms of a primary and a secondary code.

The primary code may be interpreted as a non-verbal code corresponding to the attribute-value listing of stimulus input:

> ...., for the present purpose, the important point is that the stimulus is represented in coded form as an ordered list of attributes with their corresponding values. This listing will be called the primary code.
>
> (BOWER, 1967, p. 233).

The secondary code, in contrast, seems to be mainly a verbal or verbal-motor code:

> Let us suppose that the primary code may elicit an identifying label and, if so, that this label is fed into the short-term store. If it is subvocalized, the sub-vocalization constitutes a feedback stimulus that is itself represented in coded form as a list of vocal features (that is, as a list of auditory or phonetic sound features, or as the movements of the speech musculature involved in vocalizing the label). This will be called the secondary code of the input stimulus. It consists of a small "program" which, when fed to the motor-output machine, suffices for the speech apparatur to output a verbal label for the stimulus.
>
> (Ibid., p. 233).

STAATS (1961)

The primary code may be coordinated with the hierarchical neural structures in HEBB's theory, and with a set of representational sensory (or meaning) responses (r_m) in the 1961-theory of A. W. STAATS.

The secondary code has been formulated by STAATS in terms of the HULLian (1934) verbal habit-family construct (fig. II. 9) in which r_g is replaced by r_m:

$$S \longrightarrow rg \; - \; sg \left\langle \begin{array}{l} R_1 \; - \; s_1 \\ R_2 \; - \; s_2 \\ R_3 \; - \; s_3 \end{array} \right\rangle \begin{array}{l} Rg \\ rg \end{array}$$

Fig. II. 9. A Habit Family . . .(STAATS), 1961, p. 190).

According to STAATS, effective stimulus input may be presumed to elicit in the subject one or several implicit "sensory or meaning (goal)responses", each of which tends to elicit a hierarchy of verbal responses, each of which, in turn, tends to elicit a common final response, part of which is the anticipatory goal response.

The importance of human verbal abilities has been heavily emphasized in STAATS' theory of mediated concept learning.

Thus verbal labels or language, STAATS would claim, may be assumed to mediate abstraction (that is, stimulus analysis) in man:

> Osgood was correct in stating that a rat cannot understand a concept - not, however, because it cannot form a common response to a class of stimulus objects. This part of the concept learning the animal would be capable of. However, the rat is not capable of acquiring verbal habit-families to correspond to such concept mechanisms and the power of abstraction is thus lost to the animal.
>
> (STAATS, 1961, p. 199).

By introducing verbal abilities and verbal achievement, a new set of problems has entered our discussion:

What may be the difference between learnings in verbal and non-verbal organisms?

At what stage of mental development in a human being may language be assumed to acquire a mediating, and thereby, a regulating function?

These questions will be discussed in section 3.3.

Conclusion

At present, it may be assumed that mediating events (i.e., the utilization of "coding systems" or "analyzers" being conceptual in nature) which depend upon previous experiences, stored and integrated in long-term memory, probably facilitate concept learning.

This, of course, need not always be true (e.g., GOSS, 1961). Inadequate mediating responses, on the contrary, may interfere with concept learning.

In general, however, mediating processes may be considered necessary conditions for an adequate stimulus analysis and selection to occur.

Mediating processes are assumed to be either verbal or non-verbal, or more likely, verbal and non-verbal mediating processes may be considered concurrent events in man.

A special and wide-range importance is assigned verbal mediating responses in man (i.e., identifying words denoting previously learned concepts), since these processes, it may be claimed, determine the high degree of abstraction proved possible in mature human beings.

Two memory processes, one of which (i.e., long-term memory) has already been related to stimulus selection processes, may be assumed to operate in concept learning.

Short-term retention, another memory process partially dependent upon coding systems available in long-term memory, may be presumed to facilitate several subprocesses in concept learning.

II. 3. 3
Mediated Learning and General Development Related

It has been argued (p. 33) that the nature of mediating processes may be inferred only from a dual consideration of (1) the specific task conditions utilized and the behavior observed, and (2) of the phylogenetic and ontogenetic developmental level of the organisms considered.

In the present section the latter argument will be considered and discussed.

Several investigators (e.g., KENDLER & D'AMATO, 1955; LEVINE, 1963, 1966) have stressed the probable importance of verbal mediation in mature human concept learning.

Only a few psychologists, however, have investigated the effect of human development upon mediational processes in concept learning (e.g., the KENDLER group).

KENDLER & KENDLER (1962)

KENDLER & KENDLER (and several collaborators), in a series of experiments, have investigated this problem by means of a reversal-non-reversal learning technique (NYBORG, 1970a, ch. VI. 2).

Experimental Technique

Reversal and non-reversal learning has been used to denote the learning of a dual task, the first (or pretraining) part of which involves the learning, within a discrimination technique, of a simple concept learning task.

Usually the task would include a stimulus set systematically varied along two or several binary stimulus variables or dimensions.

During the second or test-training part, the schedule of reinforcement would be replaced by a new one requiring one sub-group of subjects to learn an intra-dimensional shift, that is, a shift from the previously relevant value to the opposite value along the same stimulus variable (reversal learning).

In a different sub-group of subjects, the original schedule of reinforcement would be replaced by a new one requiring the subjects in this sub-group to learn an extra-dimensional shift, that is, a shift from a previously relevant value to a value along a new and previously irrelevant stimulus dimension (non-reversal shift).

Single-Unit S-R-Theory

According to a single-unit non-mediational S-R-theory, a non-reversal shift would become more easily (or faster) learned because the new or test-training habit in non-reversal learning received partial reinforcement during pretraining, while the new habit in reversal learning did not.

Mediated Learning Theory

According to mediated learning theory, the opposite would be true, that is, reversal rather than non-reversal shift would be easier to learn.

Thus a mediating response to the relevant stimulus variable selected during pretraining would facilitate the learning of the opposite value along the binary, relevant stimulus dimension (that is, reversal learning) during test-training.

Following a non-reversal shift, a new relevant dimension has to be selected before conditioning may take place, thus delaying the final learning.

Test of Theories

In 1953, BUSS, who tested a <u>single-unit</u> S-R-theory in a reversal-non-reversal concept learning task, observed that students learned a <u>reversal</u> shift faster than a <u>non-reversal</u> shift.

This observation was contrary to the one predicted by BUSS.

He explained the unexpected result in terms of an interfering effect of partial reinforcement received by the inadequate non-reversal habit during <u>test-training</u>.

Partial or intermittent reinforcement received during pretraining, it was claimed, would facilitate test-training non-reversal learning (as has been pointed out). During test-training, however, intermittent re-inforcement received by the habit already established during pretraining, but inadequate during test-training, would prevent a faster non-reversal learning.

Thus two opposite effects of partial reinforcement were predicted for non-reversal learning, the relative weight of which, however, could not be predicted.

The crucial test of S-R-theory as contrasted with mediated learning theory, therefore, would involve an elimination of partial reinforcement - during test-training - of the (inadequate) habit acquired during pretraining.

The test was performed by BUSS (1956) and KENDLER & D'AMATO (1955) with subjects sampled from a college student population.

The tests monotonously supported a mediated learning theory interpretation, that is, the reversal shift appeared to be more easily learned than a non-reversal shift in these subjects. The results, when further tested, proved to be highly significant.

So far, no one had observed that non-reversal shift may occur faster than reversal shift, that is, learning in a non-mediated fashion.

Non-mediated learning, however, in the sense formerly described, was observed by KELLEHER (1957) in rats, and by KENDLER, KENDLER & WELLS (1960) in nursery schoolchildren (2 9/12 years - 5 3/12 years).

Thus a technique had been developed whereby the experimenter would be able to distinguish mediated and non-mediated learning.

Transition from Non-Mediated to Mediated Learning

This technique has been utilized by H. H. & T. S. KENDLER (1959, 1961) in order to determine an <u>interval</u> of human development, in which <u>mediated</u> learning may be presumed to replace <u>non-mediated</u> learning (NYBORG, 1970<u>a</u>, sect. VI. 2).

The results obtained by means of this technique (KENDLER & KENDLER, 1959) indicate that in the interval between four and six years of mental age, children seem to be in a state of transition from a predominantly non-mediated to a predominantly mediated fashion of learning (so far as non-verbal GOSS category I concept tasks are concerned).

This, at least, was the interpretation suggested by KENDLER & KENDLER (1959) of experimental results obtained in a sample of children aged 4 8/12 to 5 6/12 years in a simple concept (and discrimination) learning task.

These children, while taken as one group, did not manifest a significant difference between reversal and non-reversal learning.

When dichotomized according to learning rate into a fast and a slow group of pretraining learners, however, a difference appeared between the two groups.

Thus the "fast" group learned in a manner consistent with mediated learning theory, while results obtained in the "slow" group conformed to a single-unit S-R-theory.

Verbal Mediation

A further introduction of verbal training during pretraining sessions (KENDLER & KENDLER, 1961) indicates that the transition from non-mediated to mediated learning, in these children, is accompanied and probably is caused by a change in the role of language from a mere communicative function to a combined communicative and regulatory function.

Thus the effect of verbal pretraining upon a reversal shift in children of four years (mean CA = 4 8/12) proved to be significantly lower than in children of seven years (mean CA = 7 9/12), while mutually compared and compared with non-verbalizing control groups (NYBORG, 1970a, pp. 194-199).

Both relevant and irrelevant verbalization (i.e., labeling to-be relevant or irrelevant values, respectively) proved effective in the lower CA-group.

Only irrelevant verbalization, however, proved effective in the higher CA-group.

The latter result was interpreted as indicating that, in general, children at a mental age of 7 years have acquired the verbal labels adequate for the stimulus analysis in question (i.e., black, white; large, small), thereby rendering a further relevant pretraining ineffective.

While being trained to emit irrelevant labels, a strong verbal and perceptual set for selecting the irrelevant values may be assumed to occur, thus interfering with an adequate test-training stimulus selection.

In children of four, verbal pretraining was effective, that is, showed positive or negative transfer to test-training depending upon the kind of verbal pretraining (relevant or irrelevant, respectively).

The effect was less pronounced, however.

This observation was taken to indicate that children of four, even while possessing adequate verbal labels, would not be capable of effectively utilizing them during test-training stimulus analysis and selection.

According to KENDLER & KENDLER (1962), increased CA (or MA), therefore, may contribute in two ways to the transition from non-mediated to mediated learning:

(1) Increased CA involving a great number of verbal and non-verbal experiences may result in the acquisition of several new and task-relevant verbal labels or habits.

(2) Increased MA may promote an integration of verbal habits with "behavioral chains on different vertical levels", thus providing the necessary additional conditions in the child in order for a verbal "coding" of stimulus input to occur.

These assumptions appear to be sound, at least to the present write

What remains to be answered, however, is whether verbal pretraining was adequate in the lower CA-group in order for verbal labels to acquire the necessary property of a "regulating mechanism" in stimulus selection.

Only value labels were emitted in a relatively short pretraining period, while the variable names, which may be considered the facilitating mediating responses in reversal shift, were left untrained (KENDLER & KENDLER, 1961).

Thus the labels of "color" (or "brightness") and "size" may be acquired and associated with non-verbal stimuli, in the interval between four and seven years of age, providing the older subjects with a probable pre-experimental "training" not "given" to the lower CA-group.

The value labels (black, white; large, small), may have occurred even more frequently in the environment experienced between four and seven, and have probably been emitted in the presence of adequate non-verbal stimuli.

Thus a greater amount of pre-experimental verbal and non-verbal experiences promoting and facilitating the integration of non-verbal with verbal chains of behavior may be considered the plausible result of an interval of three years of normal mental development.

Notions relevant to Our Hypotheses

Since accelerated mental development may be considered desirable in mentally retarded children, a prolonged and, perhaps, a distributed verbal training, therefore, would be necessary in order for the integration process to occur in lower MA-children.

It will further be proposed in our hypotheses, that not only value names, but variable names as well, should be trained so that an adequate stimulus selection may occur in lower MA-groups.

Finally, in order to facilitate the detection and selection of relevant similarity in separate members of a stimulus set, which, of course, may be considered the cardinal process in complex concept learning, the concept of partial "similarity" should be trained and verbalized.

This may be possible, if the subject is provided with an opportunity to compare simultaneously presented stimuli and to name the abstracted similarity (e.g., similar shape, similar color, etc.) which may exist between separate stimulus items.

Thus the failure of detecting partial or "abstracted" similarity (i.e., "abstracted" or "selective" generalization), it will be argued, may be considered a learning deficit specific to mentally retarded persons.

The Relation of KENDLER & KENDLER's Theory to other Theories of Child Development

The observations made by KENDLER & KENDLER *et al.* receive support from two entirely different sources of investigation, e.g., from the works of LURIA and J. PIAGET.

In the first place, it appears reasonable to coordinate the developmental point of view held by KENDLER & KENDLER (1962), with the notions proposed at length by PIAGET and his co-workers (FLAVELL, 1963).

PIAGET

Thus PIAGET has claimed that the child, when reaching a mental age of seven, enters a period of development in which he is capable of operating within complete cognitive or representational systems.

A cognitive system in the theory of PIAGET may be coordinated to a mediating "coding system" in terms of LAWRENCE's constructs, serving as a system into which environmental stimuli may be "assimilated" or coded.

Even prior to this period (the sub-period of concrete operations), however, the child may be able to operate on a representational level.

Thus in the "sub-period of pre-operational thought", the child may be able to distinguish symbols (i.e., private and primarily non-verbal representations) and signs, the latter of which are verbal "signifiers", and therefore, may transfer a "social meaning" during inter-human communication.

The child in this period of development, however, would not be capable of adequately reviewing and integrating his experiences, at least not to the same degree as could an older child.

This notion, of course, might as well be derived from the theory of HEBB (1949). According to HEBB, however, an enriched environment might be expected to accelerate development.

The latter, or HEBBian point of view, may be considered a support for the notions, which are to be involved in our hypotheses, that an extended non-verbal and verbal training is necessary in order to provide an accelerated integration process in lower MA children.

LURIA

The early communicative function of language in the child has been recognized by A. R. LURIA (e.g., 1957, 1961 and 1963) as well.

According to LURIA, however, in the normal child of five or more, language gradually acquires a new and significant additional function, that is, the function of a regulating mechanism in behavior.

Thus LURIA concludes that

> In the early stages of child development, speech is only a means or communication with adults and other children.... Subsequently it becomes also a means whereby he organizes his own experience and regulates his own actions. So the child's activity is mediated through words.
>
> (LURIA, 1957., p. 116).

Elsewhere LURIA (1961) claims that even in the early stages of child development, speech acquires a regulatory function. Thus, prior to the age of $4\frac{1}{2}$, words may serve as "impulses" to behavior. Subsequently, however, speech gradually acquires an "analytic" function. At that time,

> the regulatory function is steadily transferred from the impulse side of speech to the analytic system of elective significative connexions which are produced by speech. Moreover, and this is most interesting, it simultaneously shifts from the external to the internal speech of a child. ... Experimental facts prove that the radical change just mentioned takes place in the child at the age of four-and-a-half to five-and-a-half. ... This formation of internal speech, which is closely bound up with thought, leads to a new, specifically human stage of development. The verbal analysis of the situation begins to play an important role in the establishment of new connexions; the child orients himself to the given signals with the help of the rules he has verbally formulated for himself; this abstracting and generalizing function of speech mediates the stimuli acting upon the child...
>
> (LURIA, 1961, pp. 59-62).

It is, of course, the latter or analytic function of language that may facilitate concept learning.

The conclusions cited have been based upon a long series of experiments performed by LURIA and several co-workers over a long period of time utilizing a "method of verbal reinforcement" to classical conditioning (NYBORG, 1969, pp. 90-92).

Conclusion

It is not possible within this frame to review in detail the experiments and theories reported by PIAGET and LURIA.

They have been introduced in order to support the <u>theoretical</u> notions and <u>empirical</u> observations made by the KENDLER group.

Again a multiple coincidence of theories, each of which represents a different approach to the problem of conceptual development in the child, has been noted.

This coincidence may be considered a support for the view taken by the present writer, while adopting, in part, the KENDLER group position.

An extension of the KENDLER & KENDLER theory has been (and will be) suggested, however, in order to meet the problem of retarded conceptual development.

III MENTAL RETARDATION REVIEWED IN TERMS OF RETARDED CONCEPTUAL DEVELOPMENT AND CONCEPT LEARNING. HYPOTHESES

III.1 INTRODUCTION

In a previous work (NYBORG, 1969), the concept of mental retardation has been extensively reviewed in terms of definitions, classifications, and theories.

In the present report, only selected issues relevant to our hypotheses will be reviewed. In order to obtain the full range of information, therefore, the reader is referred to that study.

III.1.1 General Definition

The AAMD definition advanced by RICK HEBER (1959 and 1961) has been accepted in the present report as a general definition of the mental retardation phenomenon.

The arguments for selecting that specific definition are given in the study previously referred to.

According to HEBER,

> Mental retardation refers to subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behavior.
>
> (HEBER, 1961, p. 499).

Several concepts involved in the present definition need to be further elucidated.

Subaverage

Thus "subaverage"

> refers to performance which is greater than one Standard Deviation below the population mean of the age group involved in measures of general intellectual functioning.
>
> (HEBER, 1959, p. 3).

This definition of "subaverage" renders the concept of mental retardation an extensive one involving approximately 16 per cent of a normal population, while estimated in terms of areas under a normal distribution curve.

One standard deviation below normal, corresponding to an IQ-score in the interval between 80 and 90, represents a rather high upper limit as compared with limits suggested by other investigators.

This part of the definition need not be further discussed in the present report, however, since our subjects have been sampled from an IQ-interval widely accepted as belonging to the "retarded" area (i.e., IQ = 50-70).

General Intellectual Functioning

"General intellectual functioning", according to HEBER, may be assessed

> by performance on one or more of the various objective tests which have been developed for that purpose
>
> (HEBER, 1959, p. 3).

Since several and different tests may be used, the present definition contains the advantage, as compared with other definitions, that it specifies mental retardation in terms of standard deviations rather than IQ-scores.

SD intervals have not been employed as sampling criteria by the present writer, however, (1) since only one test (i.e., The Stanford-Binet Test) provided the basis for selecting subjects, and (2) because the corresponding SD-intervals did not coincide with the criteria used to sample pupils to special schools in Norway.

Developmental Period

The concept of "developmental period" seems to be more loosely defined:

> Though the upper age limit of the "developmental period" cannot be precisely specified it may be regarded, for practical purposes, as being at approximately sixteen

> years. This criterion is in accord with the traditional concept of mental retardation with respect to age . . .
>
> (Ibid., p. 3).

This definition, of course, acquires a full meaning only if the additional specification is made, that mental retardation has been manifested during most of the period covering an age interval from early childhood until 16 years (NYBORG, 1969, p. 16).

Finally, "impairment in adaptive behavior", according to HEBER, may be taken to denote impairment (1) in maturation, (2) in learning, and (3) in social adjustment, each of which has been coordinated to a separate interval of age, thus defining different sets of "developmental tasks" delayed:

> Rate of maturation refers to the rate of sequential development of self-help skills of infancy and early childhood such as, sitting, crawling, standing, walking, talking, habit training, and interaction with age peers. In the first few years of life adaptive behavior is assessed almost completely in terms of these and other manifestations of sensorimotor development. Consequently, delay in acquisition of early developmental skills is of prime importance as a criterion of mental retardation during the preschool years.
>
> Learning ability refers to the facilitation with which knowledge is acquired as a function of experience. Learning difficulties are usually most manifest in the academic situation and if mild in degree may not even become apparent until the child enters school. Impaired learning abilities therefore, is particularly important as a qualifying condition of mental retardation during the school years.
>
> Social adjustment is particularly important as a qualifying condition of mental retardation at the adult level where it is assessed in terms of the degree to which the individual is able to maintain himself independently in the community and in gainful employment as well as by his ability to meet and conform to other personal and social responsibilities and standards set by the community. During the preschools and school age years

social adjustment is reflected, in large measures, in the level and manner in which the child relates to parents, other adults, and age peers...

(Ibid., p. 3).

Since all of our subjects are within "school age", impairment of learning may be considered an important supplement to psychometric intelligence as a sampling criterion.

Mental Retardation viewed as a Current Status

It may be noticed that HEBER does not consider mental retardation an "absorbing state". A person who enters the state of mental retardation, frequently remains in that state throughout his life. According to HEBER, this need not always be true, however:

Within the frame of the present definition mental retardation is a term descriptive of the current status of the individual with respect to intellectual functioning and adaptive behavior. Consequently, an individual may meet the criteria of mental retardation at one time and not at another. A person may change status as a result of changes in social standards or conditions or as a result of changes in efficiency of intellectual functioning, with level of efficiency always being determined in relation to the behavioral standards and norms for the individual's age group.

(Ibid., 1959, p. 4).

The notions involved in the paragraph cited may be differently interpreted.

In the first place, they may be considered a rejection of the distinction between "genuine" retardation and "pseudo" retardation frequently met in literature.

In the second place, they may be a consequence of the observation made that an adequate treatment (in a wide sense of the word) may positively change the intellectual functioning and the level of "adaptive behavior" in a mentally retarded child.

In the third place, they may be considered a warning to the special school teacher who places too great faith in the capability of psychometric tests to assess the "true" level of intellectual capacity in the child, and therefore, perhaps, loses his faith in the positive effect of "treatment".

III. 1. 2
Classification and Sampling

The two criteria prevailing in the AAMD definition, that is, "subaverage general intellectual functioning", and "impairment in adaptive behavior", have been utilized by the present writer in order to sample subjects in several experiments in concept learning.

IQ-Classification

In terms of the HEBER categories of classification, most of our subjects belong to the mild or fourth sub-category of intellectually retarded children.

A minor group of our subjects, however, have been sampled from the moderate (or third) and from the borderline (fifth) sub-categories (NYBORG, 1969, p. 32).

Our samples, therefore, belong roughly to a level of intellectual functioning denoted moron (or debile) and educably mentally retarded by other investigators or institutions (NYBORG, 1969, p. 31).

Level of Adaption

Comparably, our subjects, if evaluated in terms of a four-point dimension of adaptive behavior, would belong to the moderate or third sub-category (NYBORG, 1969, pp. 35-36).

Etiological Classification

Etiological classification has not been utilized explicitly as a sampling criterion while selecting experimental subjects.

It may be assumed, however, that our subjects belong mainly to sub-categories A and C in table III. 1, taken from an article written by E. A. ANDERSON (1965):

Table III. 1 Classification of Mental Retardation by Etiology and Severity.

	Mild Retardation IQ > 50	Severe Retardation IQ < 50
Single Major Cause	A Some cases with metabolic defect or birth trauma.	B Metabolic defect. Chromosomal anomaly. Birth trauma. Low birth weight.
Many Factors involved	C Polygenic traits interacting with environmental factors.	D Assumed to be infrequent. Severe environmental deprivation.

III. 1. 3
Synopsis of the Remaining Parts of Chapter III.

In the following sections, the mental retardation phenomenon will be reviewed in terms of retarded conceptual development (sect. III. 2) and in terms of learning deficits which may be assumed to prevent retardate concept learning and conceptual development (sect. III. 3).

Finally, in section III. 4, the notions elaborated in chapters II and III will be reformulated into several hypotheses, which have been tested in a series of experiments to be reported in chapter IV.

III. 2 MENTAL RETARDATION REVIEWED IN TERMS OF RETARDED CONCEPTUAL DEVELOPMENT

Two different approaches will be made to the present topic, in terms of low test scores, in the first place, and in terms of the construct of CNS-anomaly, in the second.

III. 2. 1 Interpretation of Low Test Scores

It has been argued in chapter II that conceptual development may be considered intimately related to and reflected in the results obtained by a subject in general tests of intellectual functioning.

Three different tests frequently utilized for classificatory purposes have been reviewed in terms of a subject's level of conceptual development and his achievement in concept identification (p. 18).

A low score in those tests, in turn, is widely accepted as one of two main criteria used to classify a person as mentally retarded.

The position is taken by the present writer, therefore, that several low scores obtained in general tests of intellectual functioning under satisfying emotional and motivational conditions are highly indicative of a retarded conceptual development in the person considered.

This conclusion, of course, will be considered valid only when low test scores and a low level of adaptive behavior may simultaneously be observed in the person.

It will be considered axiomatic, therefore, in the present report <u>that retarded conceptual development and concept learning are fundamental</u> (though not necessarily the only) <u>determinants of mentally retarded development</u>.

Further reasons for accepting this axiom will be suggested and discussed in subsequent sections.

III. 2. 2 The Construct of CNS-Anomaly

Several investigators (e.g., STRAUSS & LEHTINEN, 1947; LURIA, 1963; SPITZ, 1963; ELLIS, 1963; BENOIT, 1957, 1959) have invoked the concept of central nervous system anomaly in order to explain mentally retarded development (NYBORG, 1969).

Their notions involve the assumption that CNS-anomaly, while being a permanent state over many years, may severly affect the learning and development of a child.

In this section, a set of theories will be reviewed in which CNS-anomaly plays the role of a cardinal explanatory and predictory construct.

STRAUSS & WERNER

In the theory of STRAUSS & WERNER (e.g., STRAUSS & LEHTINEN, 1947), the concept of minor brain injury has been used to explain the presumed behavioral differences between two etiologically different groups, that is, endogenously and exogeneously mentally retarded children.

This problem is not relevant to the present report, however, since our subjects have not been selected according to an etiological classification.

H. H. SPITZ (1963)

H. H. SPITZ, who made an approach to the mental retardation phenomenon in terms of Gestalt or Field theory, takes the position that all mentally retarded persons may be assumed to suffer from brain damage, being localized in the structure and/or in the functioning of CNS (NYBORG, 1969, pp. 63-74).

A deviating performance was observed in mentally retarded older children and adult persons belonging to "higher" categories of mentally retarded, when compared to normal control groups in reports of figural after-effects and reversal figures.

The deviating performance,that is, a slow "satiation", was neurologically interpreted in terms of deviating electrical, chemical, and physical states in the retardate CNS, producing, in turn, a "lowered capacity for cellular modifiability".

"Reduced cortical modifiability", in turn, was assumed to have a detrimental effect upon several psychological processes, including perception, learning, and problem solving.

According to postulate III in the theory of SPITZ, the organization and reorganization of experiences would be prevented in retardate learning and problem solving:

> In order to solve a problem, one must bring out certain aspects and inhibit others. Since there must be a reorganization of the field, the prediction for retardates is obvious. But of particular importance is the application of Postulate III to this area...
> (SPITZ, 1963, p. 34).

A flexible stimulus analysis and selection, therefore, would be prevented in retardate concept learning (which, of course, may be considered one important kind of problem solving), thus delaying the conceptual development.

The concept of "reduced cortical modifiability" may be considered a neurological counterpart to the behavioral concept of "rigidity" in the theories of LEWIN (1935) and KOUNIN (1941).

LURIA (1963) It may be considered a counterpart, also, to the LURIA (and PAVLOVian) concept of "reduced mobility in the higher nervous processes" in mentally retarded children (NYBORG, 1969, pp. 89 - 101).

Mobility

Nervous processes, according to LURIA,

> may differ in their mobility... manifested in the fact that the human being is able to inhibit certain systems of connections rapidly and pass to others.
> (LURIA, 1963, p. 370).

It is not evident in this paragraph, what constitutes the systems among which mobility may occur.

Signal Systems

We may assume, however, that LURIA refers to the PAVLOVian concept of signal systems, the first of which constitutes the "system of direct signals of reality".

The second signal system according to LURIA,

> consists of words, which embody and express our social experience, and of connections between them ... (It) possesses the properties of abstraction and special generalization and constitutes the foundation of our thinking; it forms a component part of the mental reality in which man lives. At the same time it is a powerful means of regulating his behavior...
> (LURIA, 1963, p. 371).

Classification of Retardates

LURIA defined two categories of mentally retarded children, oligophrenic or feebleminded, "in whom severe cerebral lesions endured in early... childhood engendered profound derangements of the processes of abstraction and conceptual thinking", and cerebro-asthenics, "who at an early age suffered from traumas of the head, inflammatory processes, arachnitis, severe general infections", etc.

Since LURIA (like most USSR investigators) does not define his categories of subjects in terms of test scores and levels of "adaptive behavior", it is difficult to coordinate his classification of retardates with the classifications used in western countries.

From what has been elsewhere stated by LURIA it may be assumed, however, that the oligophrenic category (mild or severe forms) corresponds to levels I, II, and III, in the HEBER classification, while the cerebro-astenic group consists of retardates belonging to levels IV and V.

Defects

Only oligophrenics, according to LURIA, display a pronounced disturbance of mobility, as manifested in a dissociation between the first and the second signal system.

The cerebro-astenics, in contrast, frequently manifest a reduced strength of "higher nervous system processes", and a disturbed equilibrium between excitatory and inhibitory processes, being therefore either extremely excitable or extremely inhibitable.

The second signal system is intact in the latter children and may be utilized during remedial "treatment" in order to compensate for the disturbed "strength and equilibrium of higher nervous system processes".

Some words of caution are necessary before we proceed.

LURIA and his co-workers, of course, have not observed pathological conditions in the "higher nervous system processes" (which may be considered psychological in nature) only the behavioral effects of the presumed pathological conditions.

On the other hand, whenever a CNS-defect has been observed, a defect in the anatomy or physiology of the nervous system has been observed rather than a defect in psychological processes.

"Strength, equilibrium, and mobility of higher nervous system processes", therefore, may be considered intervening variables or hypothetical constructs, invoked as explanatory concepts in order to relate manifested behavioral deficits to observed CNS--defects.

Relation to our Hypotheses

Evidently, LURIA has been concerned solely with exogeneously mentally retarded persons, and even denies the existence of an endogeneously determined category.

Within this frame of reference, however, his observations and concepts may be utilized in order to elucidate the problems formulated in our hypotheses.

Cerebro-Asthenics

In the first place: since an adequate utilization of the second signal system may compensate for several defects in the cerebro-asthenic child, we may conclude that prior to "remedial" training, his verbal system is not adequately developed or it is not adequately integrated with other chains of behavior.

In other words, for one reason or another, language does not spontaneously play the role of a regulatory mechanism in his perception and behavior.

It has been pointed out by LURIA that this specific and important role of language may be revealed at an age of five or more in the normal child.

A retarded child who has attained an IQ of 60 (near the mean IQ of our subjects), if evaluated in terms of mental age, would reach a comparable stage of development at a chronological age of 8-9 years.

Unfortunately, however, we do not know exactly what constitutes the relation between a psychometrically evaluated mental age and the role of language as a regulatory mechanism.

Several investigators (e.g., D. McCARTHY, 1959; CARROLL, 1964) have reported, however, what seems to be a close relation between MA and IQ, on the one hand, and general measures of language development, on the other.

Thus McCARTHY (1959) obtained a correlation coefficient of .91 between a set of language measures and measures of general intelligence when testing mentally retarded children belonging to different levels of retardation and to different levels of CA.

According to many sources of investigation (e.g., as reviewed by WEBB & KINDE, 1967), we may safely conclude that general language development is consistently delayed in mentally retarded, though less pronounced in higher grade (that is, mild or borderline cateries) than in the lower grade retarded children.

So far we have been concerned mostly with cerebro--asthenics whose prognosis is fairly good according to LURIA.

We may expect, therefore, that a combined verbal and non-verbal training in these children will facilitate stimulus analysis and selection, and thus, concept learning.

Oligophrenics

The prognosis for oligophrenic or feebleminded persons is not so promising, however, because of the dissociation, observed by LURIA, between the first and the second signal systems in these children.

If oligophrenics, in the LURIAn sense of the word, are included in our samples, we may not expect, therefore, that they will benefit from being verbally trained.

Verbal pretraining, it will become evident, constitutes the main difference between experimental and control conditions in our laboratory experiments.

ELLIS (1963): Retention Deficit

The concept of CNS-anomaly is a fundamental construct in the theory of ELLIS (1963) as well (NYBORG, 1969, pp. 102-111).

In this theory a consistently disturbed CNS-integrity in mentally retarded persons is presumed to diminish the duration and amplitude of stimulus traces, which in turn, may be considered the fundamental determinant of short-term memory.

The concepts of "stimulus trace" and "CNS-integrity" have not been neurologically defined, however.

Thus stimulus trace (s_t)

> is defined antecedently by an environmental stimulus event (S) and consequently by a behavioral event (B) ... s_t parameters are dependent upon S, such as receptor stimulated, intensity and duration, as well as upon more complex dimensions, as meaning.
>
> (ELLIS, 1963, p. 138).

and "central nervous system integrity", defined

> by an intelligence score or other indices of adaptability, serving as a limiting function for s_t...
>
> (Ibid., p. 163).

It may be noticed that the stimulus trace is considered dependent upon the "meaning" attributed to stimulus, as well as upon other stimulus parameters.

By introducing "meaning" as a possible parameter, ELLIS implicitly invokes mediational processes as determinants of short-term memory.

This appears to be an important point, but has not been elaborated on by ELLIS.

Thus it has been argued (and will be argued in later sections) that the conceptual "meaning" of words, implicitly activated or explicitly emitted, may enhance the capacity of short-term memory, and thus, the capacity for integrating events separated by short-time intervals.

A set of measures, that is, test items, delayed response measures, paired-associates learning in which pairs of items had been separated by different time intervals, EEG-measures, etc., all of which may be considered dependent upon short-term memory, were selected and used by ELLIS <u>et al.</u> in order to reveal a possible defect in short-term retention in mentally retarded persons.

Several results were obtained, all of which indicate a retardate deficit in short-term memory:

> The research bearing on the theory holds promise for defining a significant component of behavioral inadequacy in the human with CNS pathology. These data suggest that temporal properties of the retardate's environment are important in the determination of his behavior. It seems likely that the retardate's "slow learning" is not universally true but that his inadequacy depends upon temporal relations in the learning task and upon the <u>meaningfulness</u> or <u>familiarity</u> of the materials....
>
> (Ibid., p. 154).

Short-Term Retention in Concept Learning

Two points of view will be advanced in order to evaluate the role of short-term retention in concept learning.

In the first place: if limited short-term retention is considered the fundamental deficit in mentally retarded persons, their concept learning (and thus, conceptual development) should be delayed or prevented because several sub-processes in concept learning may be considered dependent upon short-term memory (ch. II).

The opposite view may be proposed, however, holding that short-term retention, at least in part, is dependent upon the level of conceptual achievement attained by the subject.

According to the latter point of view, short-term retention may be considered facilitated by verbal and non-verbal conceptual <u>coding systems</u> (e.g., BOWER, 1967) the verbal part of which probably contributes in an important way to human mediated abstraction, stimulus selection and generalization (e.g., STAATS, 1961; LURIA, 1961).

As has been pointed out, language development may be considered consistently retarded in mentally retarded persons.

The dual position will be taken by the present writer, therefore, that the level of conceptual achievement reached by the subject restricts the limits of short-term memory.

A short-term memory deficit, in turn, interferes with a further concept learning and conceptual development in mentally retarded persons.

HEBB/BENOIT: Incidental Learning Deficit

A restricted short-term memory, of course, would be detrimental to the growth processes assumed by HEBB (1949) to occur during and shortly after stimulating events, thus delaying the establishment of "cell assemblies", "phase sequences" and "phase cycles".

These hierarchical nervous system structures, while activated, constitute the neural correlates of conceptual facilitation in behavior.

BENOIT (1957, 1959), while relating HEBBian constructs to the phenomenon of mental retardation, has not emphasized this specific relation, however (NYBORG, 1969, pp. 75-88).

BENOIT stresses a possible diminished efficiency of the retardate nervous system (which, of course, need not be contrary to ELLIS's point of view).

Definition

According to BENOIT,

mental retardation may be viewed as a deficit of intel-

lectual function resulting from varied intrapersonal and/or extrapersonal determinants, but having as a common proximate cause a diminished efficiency of the nervous system (beginning with an impaired irritability and further involving a lowered capacity for impulse transmission and for developing primitive and integrating cell chains through interfacilitating interneuronal connections), thus entailing a lessened general capacity for growth in perceptual and conceptual integration and consequently in environmental adjustment.
(BENOIT, 1959, p. 561).

Emphasis is places by BENOIT upon a possible defect in neuronal integration, which, in turn, may be considered fundamental to a "lessened capacity for growth in perceptual and conceptual integration".

Etiology and Treatment

The diminished efficiency, which is assumed to prevent or delay the development of a "conceptual nervous system", may be ascribed different etiological factors.

It may be determined by a CNS-defect originated in the early periods of a person's life.

The development of a conceptual (and therefore an efficient) nervous system, may be prevented also, (1) by one or several sensory deficits, (2) by a "poor" environment, provided in the early and important periods of development, or (3) by an emotional or social "blocking", which prevents the interaction of a child with the reality in which he lives.

The HEBBian theory, provides the rationale for a multiple causation of mentally retarded development, which, of course, is the view accepted by most investigators in the area of mental retardation today.

The theory, however, while ascribing mental retardation to a heterogeneity of causes, may be taken to prescribe a homogeneous treatment, that is, in terms of an intensive and prolonged perceptual and conceptual training.

III. 3
RETARDATE LEARNING DEFICITS

Although an impairment of "adaptive behavior" per definition may be observed in all mentally retarded persons, this fact has not been monotonously demonstrated in comparative learning studies dealing with mentally retarded and normal children (e.g., STEVESON, 1963; DENNY, 1965; BAUMEISTER, 1967).

Most of the learning paradigma utilized, however, may be considered more "primary" and less complex than a concept learning task.

Thus SHELDON ROSENBERG (1963), who has reviewed learning studies in the areas of concept learning and mental retardation, claimed that

> Experimental studies of the concept formation process, as outlined earlier (i.e., involving abstraction and generalization) are virtually nonexisting in the area of mental deficiency. This is surprising from both a practical and a theoretical standpoint. Special educators and clinicians working with the retarded are often heard describing them as being deficient in the area of conceptual behavior. However, the primary research activity has been the comparative study of difference in abstract and concrete behavior.
> (ROSENBERG, 1963, p. 445).

This appears to be an unfortunate state of affairs, since learning tasks that require verbal mediation, abstraction, and conceptualization correlate higher with tests of intelligence than do other learning tasks (JOHNSON, 1955; OSLER & FIRELL, 1961; OSLER & TRAUTMAN, 1961).

The latter notion may be considered as support for our fundamental axiom, however, that retarded concept learning and conceptual development constitute essential components of mentally retarded development.

III. 3. 1
Outline of Empirical Trends

It is not possible within the frame of the present report to review in detail the large number of results obtained with mentally retarded in the learning laboratories.

Several results have already been outlined in section III.2 in terms of theories (e.g., ELLIS, 1963; LURIA, 1963, 1961).

Some further general results will be outlined in the following paragraphs.

Generalized Expectancy of Failure

Several investigators (e.g., CROMWELL, 1963; ZIGLER, 1966) have concluded that mentally retarded children usually start their learning in an unfavorable motivational condition (NYBORG, 1969, ch. VI.1 and VI.4).

Thus CROMWELL (1963) has reviewed several reports supporting the notion that mentally retarded children, in the course of many failure experiences, develop a generalized expectancy of failure.

This notion, which has received further support from ZEAMAN & HOUSE (1962), is relevant to all retardate learning, however, not particularly to concept learning.

Task-Specific Learning Deficits

Another essential observation has been reported by BAUMEISTER (1967), that retardate learning deficits need not be general, but may be restricted to specific processes and learning tasks.

Attention Deficits

Thus a combined attention (i.e., analysis) and inhibition (i.e., selection) deficit has been manifested in retardate discrimination learning (e.g., ZEAMAN & HOUSE, 1963; DENNY, 1965).

In the learning of simple discrimination tasks, the attention-inhibition deficit seems to be more pronounced in severly retarded persons (ZEAMAN & HOUSE, 1963).

Mediated Learning

During the learning of more complex tasks, which require the subject to mediate his learning, the attention-inhibition deficit has been manifested in broader categories of mentally retarded.

Verbal Mediation

When verbal mediators may considerably facilitate the learning of a task, retardates appear to be in an even more unfavorable position compared to normal controls.

"With respect to verbal learning", BAUMEISTER concludes a review of learning abilities in mentally retarded,

> we are probably safe in concluding that mediation (i.e., assigning distinctive "labels" to cues) is a crucial aspect of efficient performance. Quite likely mental retardates not only have a smaller reservoir of mediators than normals, but also less experience in the use of them. Measures that are taken to promote mediational responses are found to markedly facilitate verbal learning by retardates. The same holds true in discrimination learning.
>
> (BAUMEISTER, 1967, pp. 293-294).

The very same conclusion has been reached in the present report through several other and different approaches.

III. 3. 2 Conclusion

This short outline of trends revealed in learning data obtained with mentally retarded subjects confirm the view advanced in previous sections that stimulus selection processes (1) are the more difficult processes in concept learning, and (2) constitute the processes in which retardates are inferior to normals. (3) The inferiority may be localized in the failure of retardates to develop verbal skills and to utilize "speech" as a means of regulating his perception and behavior.

Stimulus selection processes, of course, may prevail in several kinds of learning.

But since retarded concept learning and conceptual development may be considered important determiners of retarded development, it will be considered an important "treatment" approach to provide mentally retarded children with verbal mediators, which, in turn, may facilitate their concept learning.

Their prognosis, at least as far as the mild and borderline cases are concerned, may be considered a fairly good one.

III.4 FINAL CONCLUSIONS AND HYPOTHESES

Axiom I

It has been considered axiomatic in the present report that retarded concept learning and conceptual development constitute cardinal components of mentally retarded development.

Evidence and theories have been reviewed, however, in order to demonstrate the likelihood of that axiom.

Axiom II

It will also be considered an axiom that the retarded conceptual development is due to a failure on the part of a retarded organism to integrate an innumerous number of early experience, through several neurological processes, into a conceptual nervous system.

III.4.1 Final Conclusions

It has been necessary, therefore, to evaluate a set of sub-processes, which may be presumed to operate in concept learning, in order to make a valid conceptualization of (1) which may be the more difficult sub-processes in concept learning, (2) which may be the more difficult sub-processes in retardate concept learning, and (3) how impaired concept learning may be remediated in retardates.

(1) Several sub-processes, notably, a set of stimulus selection processes, including stimulus analysis (i. e., abstraction) and stimulus selection (i. e., attending to relevant and inhibition of irrelevant cues), may be considered the more difficult sub-processes in concept learning.

These processes may be considered facilitated in the mature human by verbal and non-verbal mediational processes, the former of which constitute a specific human achievement.

In terms of human development, mediational processes may be assumed to operate in concept learning from the age of five or six in the normal child.

The transition from non-mediational to mediational learning has been observed to take place in the course of a developmental period in which language simultaneously takes on a new and significant role in the child.

Prior to the age of five, language serves mainly as an instrument for social communication. Subsequently, however, language acquires the additional function of a mediational or regulatory mechanism in the child's perception and behavior.

It has been considered safe to assume, therefore, that adequate verbal labels, implicitly or explicitly emitted, constitute important mediators of human concept learning, including, of course, abstraction, selection, discrimination and generalization.

(2) Evidence and theories have been collected and presented in previous sections in order to support the notion that concept learning in mentally retarded is specifically prevented by the poor stimulus selection processes manifested in different kinds of learning, including concept learning.

The stimulus selection deficits may be further attributed to a lack of mediators, particularly verbal mediating responses in the retardates.

Thus retardates may be assumed to have (1) either a limited repertoire of adequate mediators, or (2) verbal "labels", which may serve as important mediating mechanisms, have not been adequately integrated with other chains of behavior, and thus, have not attained the status of regulatory mechanisms in their stimulus analysis and selection.

(3) A "remedial treatment" has been proposed, therefore,

in which verbal and non-verbal training is combined (1) in order to facilitate the development of a greater repertoire of adequate "labels" in the mentally retarded child (specific and general language training), and (2) in order to promote the integration of verbal with non-verbal experiences.

A set of hypotheses will be formulated in the following section in order to predict specific effects of such training.

III.4.2 Treatments and Hypotheses

According to KENDLER & KENDLER (1962), low MA-children ("normal" children with a mean CA of 4 8/12 years), though possessing verbal labels for relevant stimulus values, do not adequately utilize them as mediators of stimulus selection in reversal concept learning.

The present writer has suggested, however, that verbal pretraining was inadequate in several respects in the KENDLER experiments (pp. 44-50).

Thus (1) it appeared to last for a relatively short period of time, and therefore, may be considered unfavorable for the integration process to occur in lower MA-children. (2) It was further restricted to involve the training of relevant stimulus value labels, while the corresponding variable names may be assumed to mediate the facilitation in reversal learning.

The verbal pretraining used in our experiments has become extended, therefore, in order to facilitate the low MA-subject's selection of the relevant stimulus variable in test-training, and in order to facilitate discrimination and generalization along this variable.

Treatments

The effect of differential pretraining treatments (A) upon test-training criterion task learning has been investigated in mentally retarded children belonging to the same IQ interval and two CA-intervals.

Non-verbalizing control groups (A_1) have been compared with verbalizing experimental groups (A_2 and A_3) in concept learning criterion tasks consisting of GOSS type I non-verbal stimuli and verbal responses.

Thus during pretraining (in a task whose stimuli resembled the criterion task stimuli), A_2 subjects verbalized the to-become-relevant stimulus variable and values, while A_3 subjects, in addition, verbalized abstracted similarity among separate stimulus items, simultaneously presented (e.g., "similar SHAPE", "similar COLOR", "similar ORIENTATION", etc.).

The latter or specific A_3 verbalization was introduced in order to facilitate the detection of partial or abstracted similarity, and thus, the integration, in the subject, of separate and partially different stimulus events (HEBB/BENOIT).

Both pretrainings and test-trainings were given according to a distributed schedule of training, thus providing an extended time for the integration of verbal with non-verbal experiences to occur (KENDLER & KENDLER, 1962).

Predicted Effects

Two separate kinds of experimental effects have been predicted, that is (1) MA (or CA) effects, and (2) treatment effects, respectively, the latter of which, however, constitute our principal prediction.

Main Hypothesis (Hyp. I): Treatment Effects

Our first and main hypothesis contained the prediction that experimental groups would excel the criterion task learning of control groups according to the following formulas (p. 79):

A_1 inferior to A_2

A_1 inferior to A_3

H-I-1

More specifically, the number of learning subjects should be greater in experimental groups as compared to control groups. Inversely, the number of Non-Learners should be greater in the control groups.

H-I-2

The mean number of series of trials to task solution should be lower in experimental groups as compared with control groups.

H-I-3

The mean number of correct responses in all trials of an experiment is expected to be greater in experimental groups as compared with control groups.

H-I-4

The A_1-A_2 and A_1-A_3 differences in all criterion measures are expected to exceed the A_2-A_3 differences.

Secondary Hypothesis (H-II): MA-Effects

According to KENDLER & KENDLER (e.g., 1962), MA-differences between two sub-groups ($MA_{L1} < MA_{L2}$) should affect the criterion task learning in terms of a better utilization of verbal labels acquired during pretraining in the higher MA-groups.

The stimulus selection, and thus, the concept learning, should be facilitated in L_2 (and L_3) subjects.

H-II-1

According to this hypothesis, L_2 (exp. II:L_3)groups should contain fewer Non-Learners and more fast Learners than L_1 groups.

H-II-2

Since an extended and distributed (non-verbal and) verbal training be used in our experiments, we should not expect that L_1-L_2 differences would reach a high level, however.

Hypothesis III: Treatment and MA--Effects in the Field--Experiment

If no specific training is given to control groups (A_1) and a prolonged verbal and non-verbal concept training is given to experimental groups (A_2) (the field experiment), it would be expected that (1) A_1 and A_2 subjects, subsequent to the experimental period, belong to different parent populations so far as the criterion measure is concerned, and (2) that L_1A_1-L_2A_1 differences would exceed L_1A_2-L_2A_2 differences in a criterion test measure.

H-III-1

More specifically, A_2 subjects, in general, would be expected to emit more adequate labels in the face of test stimuli as compared with A_1 subjects (verbal scores), and

H-III-2

A_2 subjects would be expected to utilize verbal labels more effectively during the solution of concept test problems as compared with A_1 subjects (non-verbal and combined scores).

H-III-3

The differences between L_1 and L_2 subjects would become indistinct in experimental groups, while they may be expected to remain distinct in control groups. That is, the experimental treatment (A_2) is expected to reduce the distance between CA-levels.

IV EXPERIMENTAL DATA BEARING UPON THE HYPOTHESES

IV. 1 INTRODUCTION

The hypotheses so far developed have been tested in a series of experiments performed during an interval of $3\frac{1}{2}$ years starting in 1965 and ending in the last part of 1968.

The series consisted of four laboratory experiments and one field experiment, all of which have been arranged in a "post-test only control group design" (CAMPBELL & STANLEY, 1965). CAMPBELL & STANLEY have described this design in terms of three distinct symbols, R (randomness of sampling), X (treatments), and O (observations), combined in the following way:

R	X	O
R		O

The subjects have been sampled from special schools for mentally retarded children, situated in the eastern and southern region of Norway in or near the capital.

This region was selected for practical purposes: (1) the population density is high in this part of the country, and (2) all of the participating schools were situated within a reasonable distance from our research center (University of Oslo).

The entire sample of subjects consisted of intellectually retarded children belonging to moron or debile category as evaluated by means of the Norwegian edition of the Stanford-Binet test (Oslo, u. å.).

In Norway, children belonging to this category receive their education mainly in one category of special schools (Statens Spesialskoler for evneveike), the schools being either residential or non-residential.

Residential as well as non-residential schools are represented in our sample. But except for one part of experiment I, all of the laboratory experiments have been performed with samples of subjects drawn from one single residential school.

This residential school (Torshov offentlige skole, Oslo), however, also receives day school pupils who live at home in Oslo.

These circumstances contribute to reduce the meaningfulness of the residential-non-residential school distinction, which, under different circumstances might be an experimental variable of considerable importance (ZIGLER, 1966).

Anyway, residential as well as non-residential pupils participated in our Torshov laboratory experiments rendering this dichotomy inadequate.

IV. 2 THE LABORATORY EXPERIMENTS

The four laboratory experiments are designed in very much the same way and we shall initiate this section with an outline of the general aspects common to all of them.

IV. 2. 1 Aspects Common to all Laboratory Experiments

Each experiment consisted of a pretraining and a test-training period.

Schedules of Training

The training periods were scheduled as a distributed practice, each subject being trained twice or three times a week for 3-5 weeks.

Each training session lasted for an interval of 5-15 minutes depending upon the treatment given. During this interval the subject left his classroom and received the training in a separate room or even a separate building.

According to CAMPBELL & STANLEY, this training procedure might provide sources of experimental errors termed "reactive arrangements" threatening the external validity of the experimental results.

However, leaving the classroom to attend individual training is a common part of the school routine for these special schoolchildren. For these reasons it seems plausible to rule out this factor as a restricting one.

The distributed practice is a time-consuming training procedure, thus providing the possibility of differential subject "histories" to be confounded with the treatment effect. However, according to CAMPBELL & STANLEY, the random distribution of subjects to experimental and control groups randomizes the effect of possible individual experiences relevant to the experimental tasks.

IV. 2. 1. 1
Training Tasks

Both pretraining and test-training tasks may be considered concept learning tasks, the former with emphasis placed upon concept acquisition, the latter with emphasis upon concept identification (H. H. KENDLER, 1964).

Test Training Tasks (O in the Design)

In the latter case, all subjects in one experiment were required to learn the same task.

Stimuli

On the stimulus side, an experimental test-training task consisted of a series of non-verbal stimuli, individually presented through a window in a vertical presentation panel (fig. IV. 2, p. 97).

(In order to obtain detailed information concerning test-training tasks, the reader is referred to table IV. 8, p. 115, table IV. 15, p. 127, table IV. 24, p. 140, table IV. 33, p. 149, and table IV. 40, p. 163.)

Figure IV. 1 (p. 84) provides a description of two test-training tasks employed, i. e., the experiment I and IV tasks represented in terms of general

Fig. IV. 1 Experiment I and IV Test-Training Tasks represented in Terms of General Learning Paradigma:

Exp. I

$$\left.\begin{matrix} S_{x1,y1} \\ S_{x1,y2} \\ S_{x1,y3} \end{matrix}\right\} \rightarrow R_{x1} \text{ (KEV)}$$

$$\left.\begin{matrix} S_{x2,y1} \\ S_{x2,y2} \\ S_{x2,y3} \end{matrix}\right\} \rightarrow R_{x2} \text{ (VUK)}$$

$$\left.\begin{matrix} S_{x3,y1} \\ S_{x3,y2} \\ S_{x3,y3} \end{matrix}\right\} \rightarrow R_{x3} \text{ (HOB)}$$

X - SHAPE (relevant)

x_1 - triangle

x_2 - rectangle

x_3 - ellipse

Y - COLOR

y_1 - green

y_2 - blue

y_3 - red

Exp. IV

$$\left.\begin{matrix} S_{x1,y1,z1,v1} \\ S_{x1,y1,z2,v2} \\ S_{x1,y1,z2,v3} \\ S_{x1,y2,z1,v4} \\ S_{x1,y2,z1,v5} \\ S_{x1,y2,z2,v6} \end{matrix}\right\} \rightarrow R_{x1} \text{ (ONE)}$$

$$\left.\begin{matrix} S_{x2,y1,z1,v7} \\ S_{x2,y1,z2,v8} \\ S_{x2,y1,z2,v9} \\ S_{x2,y2,z1,v10} \\ S_{x2,y2,z1,v11} \\ S_{x2,y2,z2,v12} \end{matrix}\right\} \rightarrow R_{x2} \text{ (TWO)}$$

X - COMPONENT LINE ORIENTATION (relevant)

x_1 - vertical, x_2-oblique

Y - COLOR, y_1 - green, y_2 - red

Z - SIZE, z_1 - large, z_2 - small

V - COMPOUND SHAPE (i. e., twelve letters)

v_{1-6} - B, F, T, P, E, H

v_{7-12} - Æ, Z, Y, A, Ø, V

learning paradigma. Each stimulus constituted a combination of values along two or four stimulus variables.

The stimulus variables were orthogonally combined in one of the experiments (Exp. I) and only partially orthogonally combined in the remaining three experiments.

The length of series varied numerically from one experiment to another (from 8 to 12 members); so did the length of the sub-categories constituting an entire series (table IV,40, p. 163).

Each stimulus series constituted an assembly of two or three sub-categories a priori defined by the experimenter on the basis of specific values along the relevant stimulus variable (or stimulus variables).

The ratio of relevant to irrelevant stimulus variables varied through two distinct values, 1 : 1 (two experiments) and 1 : 3 (two exp.). This distinction has been utilized in the final four-dimensional analysis of treatment effects (section IV. 2. 6).

Responses

The test training tasks required the subject to learn two or three verbal responses, each of which corresponded to a distinct value along the relevant stimulus variable (or variables) and consequently to a subgroup of stimulus members.

The distinction between two- and three-choice situations constitutes another experimental variable applied to the final analysis of results.

The verbal responses were either a priori nonsense, three-letter words (Exp. I, II and III) or presumptive well-known one-syllable words (Exp. Iv).

The responses were auditorily presented to the subject at the beginning of each individual training session, the subject being required to imitate and repeat the "names" until he was able to execute one correct pronunciation.

If the subject displayed specific articulatory disorders, an incomplete pronunciation was accepted as correct.

Presentation and Reinforcement

Stimuli were successively presented for intervals of 6 seconds each. During this interval the subject was allowed to emit only one response.

A correct response was immediately followed by a green light signal, a priori given the signal value of "a correct response".

A wrong response or no response was followed by a red light signal indicating to the subject that he had not succeeded in solving this sub-problem.

At the end of the presentation interval, the experimenter pronounced the correct word, thus providing further feedback information and at the same time a correction when an incorrect term had been used by the subject.

Finally, following each correct response, the subject received a money reward (25 øre). The experimenter dropped the coin into a savings-box, bearing the subject's name and having a transparent cover, thus allowing the subject to see as well as hear the coin falling to the bottom of the box.

The money reward was chosen because of its presumed high incentive value to most children, including mentally retarded children, thus securing a comparable motivational condition in all or in most of the subjects (HEBER, 1959; NYBORG, 1969, p. 124).

It is possible to argue against the savings-box accumulation of reward in that it delays "gratifications" thus favoring a possible and uncontrolled "Delayed-Gratification-Pattern" group (BIALER, 1960, NYBORG, 1969, pp. 143-145).

However, most of our subjects displayed great interest in the saving of money, probably because the money constituted a possible resource for buying individually valued incentives.

Pretraining Tasks

Stimuli

Detailed descriptions of individual pretraining tasks have been provided in tables IV. 6, p. 113, IV. 13, p. 126, IV. 22, p. 137, and IV. 31, p. 147.
In each experiment, test-training and pretraining stimuli represented the same or nearly the same sample of stimulus variables.

The relevant test-task stimulus variable was always represented in the pretraining stimuli, and the values along the to-become-relevant variable were similar, but not identical in the two tasks.

In other words: they were similar enough to justify the utilization of the same verbal labels to pretraining and test-training stimuli, but sufficiently different to render necessary a transfer or generalization from pretraining to test-training values.

This point is significantly related to the differentiation of treatments, and consequently to the mediated learning hypothesis. The point will be further elaborated in the description of treatments given below.

Pretraining stimuli consisted of two series of stimuli, one of which provided the basis for a motor choice response. The latter series of stimuli was presented centrally in the panel, and will accordingly be represented by the letters CPS (centrally presented stimulus, fig. IV. 2, p. 97).

The second series of stimuli was introduced for the purpose of demonstrating similarity or dissimilarity along stimulus variables (peripherically presented stimulus = PPS, fig. IV. 2).

Stimuli were presented in pairs, each pair constituting a combination of one member from each of the series mentioned above.

The CPS-member of the stimulus pair was presented in front of the subject in a centrally located presentation window, and the PPS member was presented on the left half of the panel as viewed from the subject's side of the panel.

The pairs of stimuli exemplified the same stimulus variables, sometimes represented by the same values, sometimes represented by different values along variables.

The simultaneous presentation provided the subject with an opportunity to compare stimuli and to name the dimensions and values of similarity or dissimilarity in two independently presented stimuli.

This constitutes another point significantly related to the treatment differentiation and to the hypotheses lying at the base of the treatment differences.

Treatments and Responses

In the pretraining period, different treatments were given to three treatment groups, one of which constituted the control group (Appendix, pp. 232-242).

Treatment differences were primarily related to response differences, the non-verbal stimulus conditions being equal to all groups in an experiment.

Treatment A_1 (the control condition)

Stimuli were presented to the subject in presentation intervals of 8 seconds. At the end of this interval, stimuli were removed and a row of press buttons was uncovered. Then the subject was instructed to press the button thought to be the correct one.

Each button was located beneath a minor example of the CPS. Thus the subject, after having seen a CPS-member, was presented with the entire CPS-series, represented by small copies of the series (fig. IV. 3, p. 97). He was expected to choose the one which immediately before had been presented in the central window, and then press the button located beneath this small replica of the stimulus.

While pressing the correct button, a green light signal appeared in front of the subject, and while pressing an incorrect one, a red light signal appeared.

This procedure secured the reinforcement of a response being dependent upon several processes including a correct observation, discrimination and recognition of stimuli, and is similar to the procedure utilized by ELLIS et al. (1963) to observe manifestations of short-term memory in mentally retarded persons.

Prior to the proper pretraining series, during which differential treatments were given, all subjects, regardless of treatment group membership, received a common experience with the training apparatus and the training procedure to be used (Appendix, p. 233).

During the first of two series, both of which resembled the control (or A_1) condition, only CPS-stimuli were presented (fig. IV. 2, p. 97), thus providing the training of an observing response to CPS-stimuli as the proper occasions for emitting motor press responses.

During the second training series, during which the subject was supposed to adapt to PPS-stimuli, both CPS- and PPS-stimuli were simultaneously presented. The subject was instructed to pay attention to CPS-stimuli, however, in order to be able to respond with a delayed press to the correct Operation Panel stimulus (fig. IV. 3, p. 97).

Treatment A_2

Treatment A_2 was exactly like A_1 except for one important extention. After each stimulus presentation and press response, the subject had to answer one or several questions concerning the stimulus previously being exposed to him.

The questions asked by the experimenter were intended to elicit verbal labels adequate for the stimulus variables and values represented in the CPS just seen, and would have the following form: "Which shape did this figure exhibit?" "Which pattern?" "Which color?" "What orientation?" etc.

The subject had to include verbal labels characterizing both stimulus variable and value (e.g., "red color") in his response in order to be deemed correct.

Again a correct and an incorrect response received a green and a red feedback signal, respectively.

Regardless of the subject's response, i.e., whether it was right or wrong, the feedback signal was immediately followed by the correct answer verbalized by the experimenter.

Treatment A_3

Treatment A_3 represented a further extention of A_1, being equal to A_2 but including questions regarding similarity between two simultaneously presented stimuli.

The questions would be of the following kind: "You could see two figures at the same time. Were they similar in shape?... in color?... in pattern?", etc.

The subject was required to apply verbal labels for similarity or dissimilarity as well as for the stimulus variable (and sometimes for the values) in question (e.g., "similar shape", "not similar shape", "similar color", "not similar color", "similar substance", "not similar substance", etc.).

The responses thus emitted received the same kind of feedback as that described for A_2.

From a learning point of view, A_2 and A_3 subjects would probably have benefited from emitting the verbal responses in the presence of non-verbal stimuli, thus avoiding the delay interval between the non-verbal stimulus presentation and the verbal responses (BLUE, 1962; NYBORG, 1969, p. 104).

As it were, the time interval between stimulus removal and the verbal responses amounted to several seconds depending upon the order of the experimenter's questions, sometimes reaching far beyond the level which proved damaging to the paired-associates learning in BLUE's subjects.

Being fully aware of the probably unfortunate effect of the delay interval, the experimenter nevertheless decided upon this procedure for the benefit of the control group.

If the experimenter decided to ask the necessary questions and the A_2 and A_3 subjects were allowed to respond to them while still observing non-verbal stimuli, the presentation interval should become considerably extended. This prolongation, the experimenter reasoned, would have a damaging effect upon attention in the control subjects rendering portions of their observing time ineffective.

The experimenter had the opportunity to observe this effect because, at the first presentation of a new pretraining series, he used an extended presentation interval in order to ask the required questions and allowing A_2 and A_3 subjects to respond to them in the presence of non-verbal stimuli.

During these single series, the experimenter observed an increased fluctuation of observing responses in the control subjects, indicating that they were only partially affected by experimenter-defined stimuli.

For these reasons we have retained the procedure formerly described, making an exception only for the first or the first two pretraining series.

The Relation of Pretraining Task to Test-Training Task

The reader's attention is now turned to the nature of the treatments and their probable effect on test-learning.

During pretraining all treatment groups received the same amount of non-verbal experience with stimulus variables and values to be represented later in test-training stimuli.

Only A_2 and A_3 subjects were explicitly required to make a verbal analysis of pretraining stimuli in terms of verbal labels adequately related to the to-become-relevant stimulus variable and values along this variable (in exp. I and II, an irrelevant stimulus variable was also verbalized).

According to the mediated learning hypothesis, the labels thus acquired would play the role of verbal mediators during test-training, thus facilitating the stimulus selection part of the concept learning process.

In the A_3 subject we would expect that verbal labels for partial similarity would enable him to obey a verbally formulated instruction containing a rule for applying responses.

Actually such a rule (or a simple definition of concept learning) was offered to all subjects previous to the presentation of a test-training series: "Figures having the same name are similar in some respect."

In one experiment (exp. IV), instructions were extended to include the dimensions of similarity: "Figures having the same name contain lines being similar in orientation."

One would expect that this "definition" would mediate in the A_3 subject an active and direct search for similarity among individual members of a sub-group of stimuli.

In terms of H. H. KENDLER's (1964) distinction the A_3 subject's task would be a concept identification rather than a concept acquisition task.

The question remains, however, whether the control subjects implicitly utilized verbal labels in their analysis of stimuli. This question has to remain unanswered because only a few of the control subjects manifested a verbal analysis of stimuli.

Sometimes, especially during pretraining periods, the experimenter noticed that control subjects emitted "verbal analyzers" while observing a stimulus item, usually utilizing a verbal label representing a value in the stimulus presented.

The labeling was not stable, however, repeatedly shifting from one dimension to another and frequently being an incorrect one as related to the test-training task.

In experimental subjects, in contrast, the experimenter observed an increased verbal control over pretraining stimuli (as revealed in our data), obviously being retained for intervals of several seconds after the removal of stimuli.

It seems reasonable, therefore, to assume that the probability of a verbally mediated and systematic (though not necessarily a conscious) stimulus selection process was more likely in experimental than in control subjects.

Training Administration

Pretraining as well as test-training stimuli were presented in an a priori randomized order.

The questions coordinated to pretraining stimuli had been recorded verbatim, thus securing equality of treatmens within each treatment group.

So were the critical elements required in the respondent's answer, thus reducing the evaluational record to a 1-0 record for a correct and for an incorrect response, respectively.

The entire pretraining program was assembled in a booklet form, one for each of the subjects. An example of such a pretraining program is presented in abbreviated form in the appendix.

The number of pretraining series varied somewhat according to the difficulty of the task, while the number of test-training series remained constant through all laboratory experiments, thus rendering possible a comparison between experiments as well as within experiments.

Training and Learning Criteria

In pretraining, a within experiment equal number of presented series constituted the training criterion. Otherwise termed: the subjects were not trained to a definite learning criterion, but instead received a certain amount of training.

This point possibly represents a weakness of the design, because some of the subjects obviously needed more training than others. The design was chosen, however, in order to equalize the subjects' experiences with the non-verbal stimuli, while the shortcomings were related primarily to the verbal training.

The equal-amount of pretraining, if favorizing any of the groups, probably favorized the control groups, since these groups were required to learn a simpler task than the experimental groups.

The control groups were probably favorized in test-training as well. This point needs a further explanation.

As has already been pointed out, test-training included twelve series in each experiment. The learning subjects, that is, subjects reaching the learning criterion within 12 series, received a score according to their individual number of series to criterion. The non-learning subjects, who were unsuccessful in reaching the learning criterion within 12 series, nevertheless received a score of 12.

Since non-learners all over proved to be in the majority in the control groups and constituted a minor part of the experimental groups, it seems reasonable to assume that this scoring method favorized control groups.

It remains to be explained why test-training was terminated after twelve series.

First, a considerable proportion of subjects seemed to be genuine non-learners while confronted with a specific task at the actual time, that is, they were presumed not to reach the learning criterion even if the number of series was considerably increased.

This assumption was partially confirmed in one of our experiments (exp. IV), tentatively extended to embrace 15 test-training series. In this experiment only one subject belonging to an experimental group reached the learning criterion between series 12 and 15.

A prolonged training in non-learning subjects would possibly reinforce a generalized expectancy of failure and a failure-avoiding tendency, thus leaving a harmful effect on postexperimental classroom learning (GARDNER, 1958; MOSS, 1958; in NYBORG, 1969, p. 142.).

Second, even while including only 12 test-training series, the experiments became rather time-absorbing. Each experiment required a training period (pretraining plus test-training) of 6-8 weeks, this period being excessively extended by the preceding testing and sampling of subjects.

The training, of course, interfered with teacher and pupil routines, thus placing a considerable amount of load upon teachers and pupils.

Third, the first experiment was, for practical purposes (including those already exposed), performed within the limits of 12 test-training series. In order to permit a between-concepts estimate of treatment effects, we had to stay within these limits through all laboratory experiments.

For these reasons it was decided to keep the test-training phase of the experiments within the limits of 12 series, these limits constituting the costs paid for adapting research to a natural school and teaching setting.

IV. 2. 1. 2 Training Apparatus

Pretraining and test-training were given by means of the same training apparatus (figures IV. 2, IV. 3, and IV. 4).

The apparatus consisted of a table, 42 1/4 x 32 x 27 inches, the top of which was partitioned into two approximately equal parts by a vertical presentation panel, 42 1/4 x 13 5/16 inches (1).

The Subject's Side of the Panel

As has been pointed out, the subject's side of the panel allowed a simultaneous presentation of two separate stimulus patterns, one in front of the subject (CPS (2)) and one on his left front side (PPS(3)). The latter possibility was utilized only during pretraining.

The CPS were presented through a centrally located window (2), 8 3/4 x 6 1/8 inches, behind which was fastened a wooden screen (13) preventing the subject's view into the experimenter's part of the apparatus.

The screen was attached to a wooden frame on the experimenter's side of the panel, the frame simul-

Fig. IV. 2

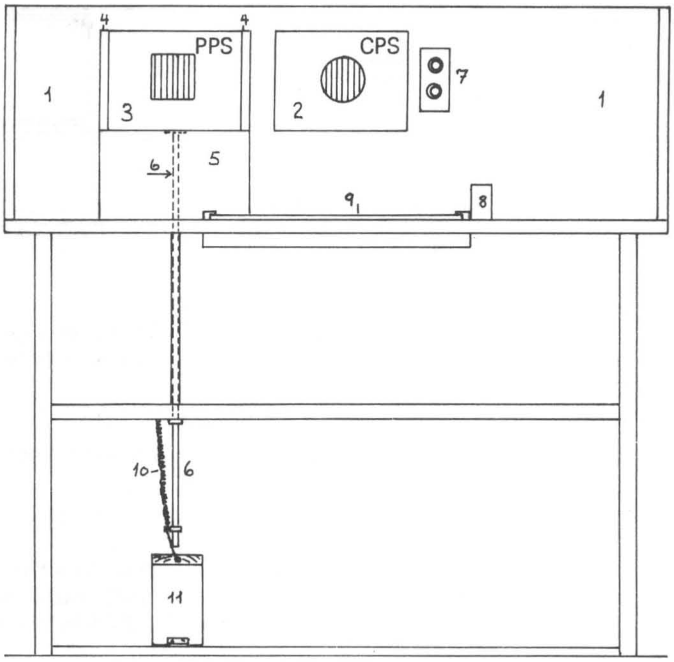


Fig. IV. 2. Training Apparatus as seen from the Subject's Side of the Panel. Scale: 1 : 10.

Fig. IV. 3

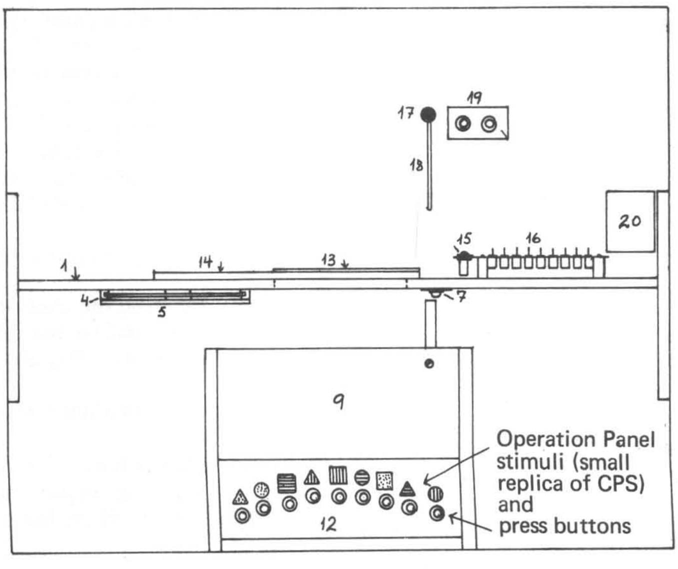


Fig. IV. 3. Training Apparatus as seen from above. Scale: 1 : 10.

Fig. IV.4

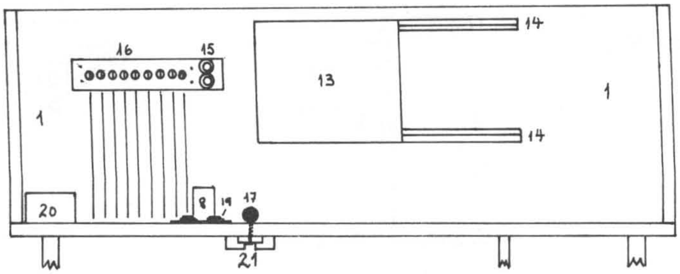


Fig. IV.4. The Training Apparatus as seen from the Experimenter's Side of the Panel. Scale: 1 : 10.

Figures IV. 2-4: Explanations.

1 Presentation panel
2 CPS presentation window
3 PPS
4 Extensions of box (5) walls, containing tracks which steered PPS while lowered and raised
5 Box concealing PPS between two presentations
6 PPS lifting bar
7 Signal lamps on the subject's side of the panel
8 Hole for saving box
9 Sliding sheet covering the subject's operation panel
10 Spiral spring which, while contracting, lifts the PPS lifting bar
11 Pedal used to raise and lower the PPS
12 Subject's operation panel with press buttons and small copies of the CPS
13 Wooden screen preventing the subject's view into the experimenter's part of the table
14 Sliding tracks steering the CPS while slid into the presentation window
15 Control signal lamps located on the experimenter's side of the panel
16 Switch panel
17 Knob utilized to manipulate the operation panel cover
18 Track cut through the table top
19 Press buttons used by the experimenter to manipulate feedback signals to verbal responses
20 Transformer providing electric power supply to signal lamps
21 Slide mechanism beneath table top connecting the knob (17) on the experimenter's side to the sliding cover (9) on the subject's side of the panel

taneously constituting the tracks (14) along which a stimulus card (wearing the stimulus pattern) could be slid to the presentation window.

The CPS would be slid to the presentation window in a left-to-right direction as viewed by the subject.

The PPS could be raised - in a vertical direction - from a box (5) located on the subject's side of the panel.

In this box, utilized to conceal the PPS during the interval between two presentations, two of the walls (4) extended beyond the top of the box and contained tracks permitting the stimulus card to be slid up and down.

The PPS card visible to the subject possessed the same dimensions as the CPS (8 3/8 x 6 1/8 inches), and was presented at an equal height.

The signal lamps (7) providing feedback information to the subject were located on the right hand side of the CPS presentation window, the green one being the upper, the red one being the lower of the two lamps.

Below the signal lamps at the base of the panel, a rectangular hole (8) had been cut out of the wooden panel permitting the saving box (a yellow and transparent Kodak slide container) to be located with one part at the experimenter's side and the remaining part at the subject's side of the panel. This location allowed the experimenter to drop coins through an opening in the cover, simultaneously allowing the subject to see the coin falling into the box.

Finally, on the subject's part of the table top, a sliding wooden plate (9) was located, covering an operation panel equipped with a curvilinear row of press buttons and a corresponding number of small copies of the CPS series, all of which had been mounted on an aluminium plate (12).

The Experimenter's Side of the Panel

The sliding cover could be manipulated from the experimenter's side of the table, thus permitting him to uncover the operation panel while the subject was instructed to make his motor press response.

This was made possible by a knob (17) fastened by means of a vertical iron screw to a wooden slide mechanism (21) located beneath the table top and transforming the knob movement to the cover (9) on the subject's side of the panel.

Each press button, while pressed, would close an electric circuit including the red <u>or</u> the green signal lamp, respectively, depending upon the connection previously established by the experimenter.

In order to establish the correct connection between the press button and the signal lamps, the experimenter had a row of switches (16), each of which corresponded to a press button on the subject's operation panel.

While turning one switch upwards, letting all the others stay in a down position, the press button corresponding to the "up" switch position, while pressed, would light the green lamp, the remaining buttons being able to light the red signal lamp only.

Otherwise termed: the feedback signal to a press response could be manually regulated from the experimenter's side of the panel.

The feedback signal to a <u>verbal</u> response was given by means of one of two press buttons (19) located on the experimenter's side of the table top. One of the buttons would close the green lamp circuit, the remaining one if pressed, would close the red lamp circuit.

The switches, two press buttons, a stop watch, and the sliding cover could be manually operated by means of the experimenter's left hand.

By means of his right hand he could slide the CPS into and out of the correct window position and mark the subject's response in the training booklet.

Finally, by means of his right foot on a pedal, he could lift and lower the PPS.

The pedal movement would be transformed to the PPS by means of a vertical sliding bar (6). This bar, sliding in a metal tube, would be pulled by a contracting spring (19) while the pedal became released, thus causing the upwards movement of the PPS. The upwards movement would be terminated by a stop mechanism when reaching the correct height.

In order to lower the PPS, the experimenter had to press the pedal, thus stretching the spiral spring (10) and allowing the bar (and the PPS) to slide down by its own weight.

It should be obvious that a PPS could not be easily replaced by a new one prior to each presentation. The PPS, therefore, was replaced by a new one only prior to each new pretraining series.

IV. 2. 1. 3
Subjects and Sampling Criteria

As has been pointed out in section IV. 1, our subjects have been sampled from a moron or debile sub-population of mentally retarded children.

The term "moron" is closely related to the concept of psychometric intelligence, that is, general intelligence as evaluated by means of a qualified test instrument.

Psychometric Intelligence

Subject intelligence, as evaluated by means of The Norwegian Standard of The 1937 Stanford-Binet Revision Test, therefore, became the principal sampling criterion.

In terms of scores on this test, only persons who scored within the IQ-limits of 50 and 70 were se-

Fig. IV. 5.a

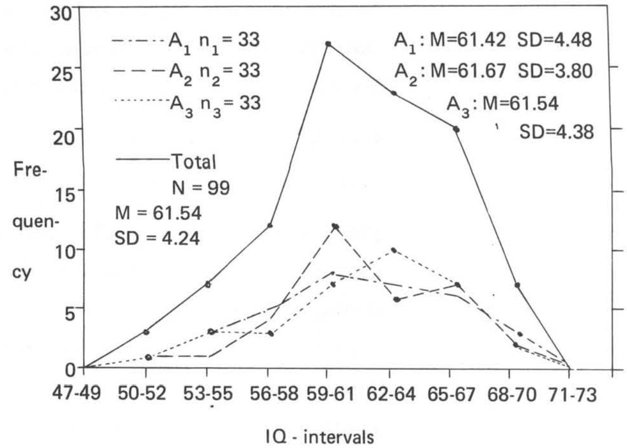


Fig. IV. 5. a. Mean, SD, and a Graphic Representation of IQ-Scores for the Total Sample of 99 Subjects and for each of the Treatment Groups.

Fig. IV. 5.b

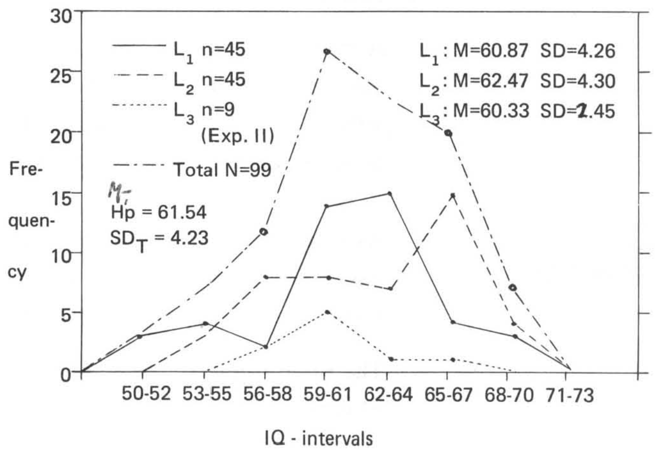


Fig. IV. 5. b. Mean, SD, and a Graphic Representation of IQ-Scores for the Total Sample of 99 Subjects and for each of the CA-Levels.

lected as subjects for our laboratory experiments (Fig. IV. 5).

Test observations performed more than $1\frac{1}{2}$-2 years prior to the actual experiment were not accepted as valid. In such cases the pupil was retested before being selected or rejected as a subject.

In figure IV. 5. _a_ and _b_, mean, SD, and a graphic distribution of IQ-scores for the total sample of 99 laboratory experiment subjects and for each of the treatment groups (described in section IV. 2. 1. 1) are given.

The mean difference between treatment groups as evaluated by means of a one-way analysis of variance proved to be non-significant.

Other Sampling Criteria

Four additional sampling criteria were applied in conjunction with the psychometric data.

Special School Attendance

First, subjects were sampled from a special school population, that is, the population of children attending special schools for mentally retarded, "evneveike" children.

This criterion, of course, was applied for practical purposes, in order to facilitate the sampling procedure. Persons belonging to the special school population are assembled in large numbers in the same schools, thus being conveniently available for the experimenter.

They constitute a homogeneous group so far as they have usually failed in the "normal" primary school (HEBER, 1959; Impaired adaptive behavior.).

The "treatment" received in different special schools, however, could not be regarded as homogeneous at the time of experimentation.

No special school curriculum had been deveoped at that time, and the teachers had been differently educated for their work in special schools.

Being a special school pupil, therefore, would not secure a "homogeneous treatment" or special education.

The only homogeneous "treatment" received would be organizational in nature. Thus a special school class would never exceed the number of twelve pupils.

Exclusion of Extreme Specific Handicaps.

Second, our subjects should not be extremely specifically handicapped.

That is, children displaying severe emotional or social disturbances, children displaying severe specific speech and language deficits, children having extremely impaired vision or hearing, etc., were excluded from our samples.

Sampling according to CA- and Grade Level

Finally, for each of the laboratory experiments, subjects were sampled from two relatively distinct levels of chronological age (CA), nine subjects from each of the levels (Fig. IV. 6; Table IV. 1).

Fig. IV. 6

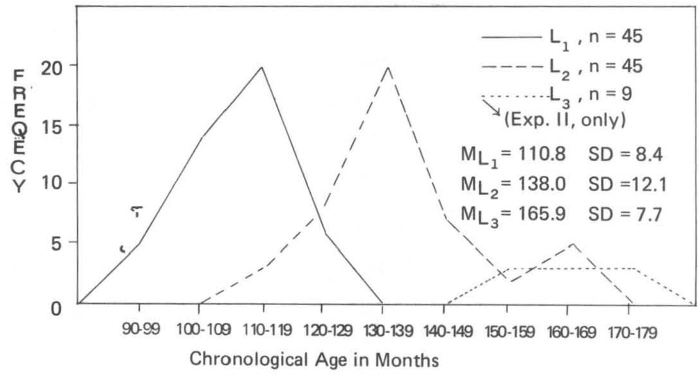


Fig. IV. 6. Graphic Representation of the CA-Distribution for each of Three CA-Levels.

The CA-level sampling criterion is an essential one as related to our hypothese. It bears upon hypothesis II, which concerns the regulating function of speech at different levels of CA.

The CA-levels (or the comparable MA-levels) are utilized in the design for two purposes.

First, it is applied as a classifying variable permitting a levelling or blocking of subjects for the purpose of controlling error variance due to individual differences (LINDQUIST, 1954, p. 121).

Second, the classification was performed in order to permit a comparison between CA-levels.

The over-all CA-meanfor level I subjects was 110.8 months, for level II subjects, 138.0 months, and the corresponding SDs amounted to 8.4 and 12.1, respectively (fig. IV.6).

Grade Levels

The high numerical values of the SDs indicate a great amount of variability within levels.

As a matter of fact, the CA-levels limits used varied to some extent over experiments, thus causing a certain amount of overlap between CA-level distributions (fig. IV.6).

Within each experiment, however, the overlap was rather trivial and limited to experiments I.a and IV (table IV.1).

Table IV.1

CA-Range for each of the Experiments and for the Total Sample of Subjects.

EXPERIMENT	CA-range and Number of Subjects						
	n_1	L_1	n_2	L_2	n_3	L_3	N
I.a	9	94-129	9	127-161			18
I.b	9	95-116	9	136-161			18
II	9	109-123	9	125-165	9	156-178	27
III	9	95-128	9	129-149			18
IV	9	95-117	9	116-136			18
I - IV	45	94-129	45	116-165	9	156-178	99

The overlap was accepted, however, because during levelling or blocking both CA-level and school grade were taken into consideration.

Table IV. 2

The Total Sample of Laboratory Experiment Subjects, classified according to CA, Experimental Levels, and Grade Levels.

Grade level	CA - INTERVALS (in months) and EXPERIMENTAL Ls.																		SUMS			
	90-99		100-109		110-119		120-129		130-139		140-149		150-159		160-169		170-179					
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	L_2	L_3	L_2	L_3	L_2	L_3	L_1	L_2	L_3	Total
0	1		1																2	0	0	2
1	4		10		14		4			2^x		1^x							32	3	0	35
2			3		6		1	1^x		4^x		1^x							10	6	0	16
3						3^x	1^x	7^x		14		4	2		2^x				1	32	0	33
4												1			3^x				0	4	0	4
5																						
6														3^x		3		3	0	0	9	9
SUMS	5	0	14	0	20	3	6	8	0	20	0	7	2	3	5	3	0	3	45	45	9	99

In table IV. 2, subjects are classified according to three variables, including (1) several CA-intervals, (2) several grade levels, and (3) three experimentally applied CA-levels, the third of which constitutes a combined CA- and grade levelling.

The CA-interval of 120-129 constitutes the cut-off zone between levels I and II. Another cut-off line is drawn between grade levels 2 and 3.

In a comparable way, the separation of experimental levels II and III was performed as a combined CA- and grade levelling.

A more correct sampling distribution would be one containing zero frequencies in cells marked x in table IV. 2.

Sampling problems, however, forced the experimenter to dispense with an ideal sampling. Instead, he had to make his best choice between the subjects available.

The dispense was not done without rationale, however, Two principal lines of thought have been followed while deviating from the main principle of sampling.

First, we would argue on the basis of the generally accepted notion that development accompanies and is positively correlated with an increase in CA. This notion, of course, became the rationale for including, in experimental level II groups, high-CA low-grade subjects.

In some cases, this choice proved to be an unfortunate one. The developmental point of view would not always be valid while applied to this particular sub-group of mentally retarded children. The detrimental effect of this choice, however, seemed to be randomized over treatments.

The second line of thought, which proved to be a sounder one, concerned the teacher-selection of pupils to a higher grade level. In general, transferring a pupil from a lower to a higher grade seemed to be based upon an evaluation of his specific achievements and general adjustment in school.

Though grouping in a special school need not be executed according to any level criterion, level grouping after all seemed to influence practice in most of the schools involved in our investigations.

However, it is not a strict CA-level grouping, as would be common in "normal" schools, but rather a grouping and transferring from a lower to a higher grade according to a general level of "adaptive behavior" (HEBER, 1959, 1961).

According to this point of view, the third and fourth grade pupil is assumed to have reached a higher level of specific and general adaption than the first and second grade pupil, belonging to approximately the same CA-interval.

This argument provides the rationale for including high grade, low CA-level subjects in the experimental levels II and III (table IV. 2).

Classification according to Sex and Etiology

Classification according to subject sex or etiology has not been undertaken.

Etiological classification was not undertaken because of the difficulties associated with making a valid etiological diagnosis. The reports available were only tentative on this point and did not justify a classification of subjects according to etiology.

In addition, as has been pointed out elsewhere (NYBORG, 1969, pp. 38-46), an etiological classification rather seldomly contributes to define exactly the behavioral characteristica in persons belonging to an etiological class of mentally retarded children.

Finally, even if it were possible to utilize an etiological classification, it would be impossible to perform it because of sampling difficulties.

The latter point of views holds for sex grouping as well.

Summary

It should be obvious to the reader that the sampling and classification of subjects have been performed according to two criteria, widely applied to define the mentally retarded person.

On the one hand, a below normal general intellectual status, as evaluated by means of a well-accepted test instrument, has served the purpose of a principal selection criterion.

On the other hand, below normal status, when evaluated in terms of levels of "adaptive behavior", has served the combined purpose of selecting and levelling.

In the latter case, three criteria have been used. First, being a special school pupil is taken as a general indication of extreme shortcoming (as validated against a normal school curriculum). Second, the developmental and adaptional level is evaluated by means of a combined CA- and grade level score.

IV. 2. 1. 4 Design

We are now in a position to describe the general design applied to all of our laboratory experiments.

Except for one experiment, all of the experiments conformed to a 3 x 2 treatment by levels design with cell frequencies equal to 3 (table IV. 3).

Table IV. 3

The Standard Design applied to most of our Laboratory Experiments.

Combined CA- and Grade Levels:	Treatments			Sums
	A_1	A_2	A_3	
L_1	3	3	3	9
L_2	3	3	3	9
Sums	6	6	6	18

Experiment I was composed of two experiments, each of which conformed to the design outlined in table IV. 3.

Experiment II was extended to include three CA-levels, thus constituting a 3 x 3 treatment by levels design.

The term "Treatment by Levels Design" has been applied, though our use of this design does not fully justify being so designated (LINDQUIST, 1954, pp. 121-155).

According to LINDQUIST the term is reserved for an experiment to which levels are introduced in order to control individual differences between treatment groups.

This of course, has been one of our intentions. In addition, however, our interest has been directed towards a comparison of treatment effects in different levels of CA (or mental development).

In the latter situation, LINDQUIST would apply the term "factorial or block design", thus indicating that the investigator wished to observe the combined effect of two separate experimental variables.

For convenient reasons, however, we have retained the former term, correctly describing several aspects of the design.

IV. 2. 2
Experiment I

As has been pointed out, experiment I was made up of two equal experiments, the first of which was performed during the last months of 1965 at TORSHOV off. skole, Oslo, the second during the last half of 1966 at Drammen off. spesialskole.

The experiment was divided into two for two reasons, both of which were practical in nature.

First, the experimenter would not be capable of administrating training to a number of subjects reaching beyond 27 (exp. II).

Second, the sample of pupils attending a special school at a particular time would not allow him to sample 18 subjects from each of the two levels described, at least not at the same time. The experimenter had to await the arrival of new pupils at the school or wait until pupils had reached the required levels of CA and grade.

Subjects

In the way described in section IV. 2. 1, 36 subjects were sampled from one IQ-population and from two CA-populations.

Within each level of CA, subjects were randomly assigned to three treatment groups, thus providing a 3 x 2 treatment-by-levels design with cell frequencies equal to six.

IQ-Data

In table IV. 4, IQ frequency distributions, means and SDs are presented for the total sample and for all sub-samples of subjects.

The IQ-differences between treatment groups and experimental levels, as evaluated by means of a two-way analysis of variance, did not reach a significant level (F: $p_A > .20$; $p_L > .20$).

Table IV. 4 IQ-Data describing the Entire Sample and all the Sub-Samples of Experiment I Subjects.

IQ-Inter-- vals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
50-52			1		1		2		2
53-55	1				1	1	2	1	3
56-58		2		2		1		5	5
59-61	2	1	4	1	2	1	8	3	11
62-64	2		1		1	2	4	2	6
65-67	1	2		3		1	1	6	7
68-70		1			1		1	1	2
N	6	6	6	6	6	6	18	18	36
M	61.0	62.3	59.0	61.7	59.7	60.2	59.9	61.4	60.6
SD	3.5	4.5	3.3	3.4	6.6	4.4	4.5	4.2	4.2
N_A	12		12		12				
M_A	61.7		60.3		59.9				
SD_A	4.0		3.6		5.3				

CA-Data The comparable CA distributions, means and SDs are presented in table IV. 5.

Table IV. 5 CA-Data (in months) describing the Entire Sample and all the Sub-Samples of Experiment I Subjects.

CA-Inter- vals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
90-99			1		1		2		2
100-109	3		2		2		7		7
110-119	2		3		3		8		8
120-129	1			2		1	1	3	4
130-139				1		4		5	5
140-149		2		1		1		4	4
150-159		2						2	2
160-169		2		2				4	4
N	6	6	6	6	6	6	18	18	36
M	111.8	154.2	109.0	141.8	106.5	136.5	109.1	144.2	126.6
SD	10.0	6.8	7.0	13.8	6.6	4.6	8.3	11.9	20.3
N_A	12		12		12				
M_A	133.0		125.4		121.5				
SD_A	22.9		19.7		16.0				

As may be evident in table IV. 5, treatment group means (A_1, A_2, A_3) differ considerably, and a test revealed that the difference was significant (F:. 025 p . 01).

Since CA-means differ significantly while IQ-means do not, it should be possible to conclude that the corresponding MA-means vary in much the same way as do the CA-means.

If this conclusion is sound, the following relations between treatment group means would exist: mean $MA_{A1} >$ mean $MA_{A2} >$ means MA_{A3}, that is, in favor of the control group as compared to experimental groups, and in favor of A_2 as compared with A_3.

Pretraining

Stimuli

During pretraining, three series of stimuli were used, each of which conformed to the two-way classification scheme displayed in table IV. 6.

Table IV. 6

Exp. I Pretraining Stimuli, classified according to Values along each of Two Stimulus Variables (Shape and Color) (left), and Delayed Verbalization in Experimental Groups (right):

SHAPE	COLOR			VERBALIZATION
	Blue 1	Red 1	Green 1	
Tri-angle	S=4 3/16 inch 1 S=1 1/16 inch	4	7	A_2 and A_3: "Three-sided", "four-sided", "round" SHAPE; Blue, red, green COLOR. A_3: "Similar SHAPE", "not similar SHAPE", "similar COLOR", "not similar COLOR".
Square	S=3 3/16 inch 2 S=1 3/16 inch	5	8	
Circle	D=3 5/16 inch 3 D=1 3/16 inch	6	9	

Upper numbers: Sizes of CPS and PPS Series.
Lower numbers, in italics: Subject operation panel stimulus sizes.
Green_1-Shamrock Green, Red_1-Auburn, Blue_1-Italian Blue
Color source: Webster's New International Dictionary (2nd ed.).

The patterns in a stimulus series were composed of one of three values along each of two stimulus variables or dimensions, orthogonally combined to nine different stimulus patterns.

As may be evident in table IV. 6, shape and color constituted the stimulus variables involved, triangle, square, circle, and green, red, blue the corresponding values, respectively.

CPS and PPS series were similar in every respect, but had been mounted on differently sized cards. To the subject, however, they appeared completely similar, because the presentation windows were equal in size.

Only seven out of nine PPS were used, one for each series of nine CPS. The sample of PPS used, the order of presentation of PPS, and the corresponding CPS series are given below (table IV.7).

Table IV.7

CPS-series:	I	II	III	IV	V	VI	VII	
PPS-items:	1	5	9	7	2	6	4	(cf. table IV.6

In order to counteract a possible position effect, each CPS series had become randomized with respect to order of presentation.

The third series of stimuli, located on the subject's operation panel (12, fig. IV.3), were minor in size. The sizes, in inches, are given in table IV.6. The upper number in each cell corresponds to the CPS and PPS series, the lower number (in italics) corresponds to the operation panel series.

All of the pretraining (and test-training) stimulus patterns had been cut out of cardboard, colored by means of placard paint, and had finally been glued to the white stimulus card or to the aluminium operation panel.

Verbal Training

The training procedure and the different kinds of responses have been extensively described in section IV.2.1 (cf. also table IV.6, Verbalization).

It is necessary, however, to make a comment on the verbal labels utilized by A_2 and A_3 subjects during pretraining.

In the case of a red and squared stimulus pattern, A_2 and A_3 subjects would be required to respond to the pattern in terms of a chain of verbal responses, including "four-sided shape" and "red color".

These labels, if emitted implicitly during test-training, would adequately describe a rectangular stimulus pattern, colored in a new shade of red (table IV. 8).

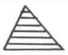
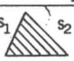
Correspondingly, an equilateral triangle and a circle would be responded to in terms of "three-sided shape" and "round shape", respectively, thus correctly describing a test-training skewed triangle and an ellipse.

Test-Training

Test-training stimuli and the a priori nonsense three-letter responses corresponding to each of three sub-groups of stimuli are represented in table IV. 8. Below the table, essential parts of the instruction are presented.

Table IV. 8

Exp. I. Test-Training Stimulus and Response Variation. Shape Relevant Stimulus Variable. Essential Parts of Instruction.

STIMULUS VARIATION				RESPONSE VARIATION
SHAPE	COLOR (irrelevant)			
	Blue $_2$	Red $_2$	Green $_2$	
Tri-angle			s_1  s_2	KEV
Rect-angle			 s	VUK
Ellipse			 d D	HOB

$s_1 = 3^{11}/_{16}$ inch
$s_2 = 4^{1}/_{16}$ "
$s_3 = 4^{3}/_{16}$ "
$S = 3^{6}/_{16}$ inch
$s = 2^{5}/_{8}$ "
$D = 3^{13}/_{16}$ inch
$d = 3$ "

$Blue_2$ - Ultramarine, Red_2 - Carmine, $Green_2$ - Moss Green

Abstract from instruction: "Today I'll show you some new pictures (figures), and you shall learn to name them correctly. (Later sessions: "We shall continue to learn the names..."). Some of them may be called KEV (can you say KEV?), some VUK, and some HOB. The pictures which have a common name are similar in some respect."

Color source: Webster's New International Dictionary (2nd. ed.).

Again the series of nine stimuli were composed of values along each of two variables, color and shape, the latter of which constitutes the relevant stimulus variable, providing the cues for associating the nonsense "names" to each sub-group of stimuli.

The color and shape values, however, were different, as compared with pretraining stimuli (tables IV.6 and IV.8).

Obviously, the value changes required the A_2 or A_3 subject to generalize his verbal responses from pretraining to test-training stimuli.

The changes in values, however, were not extreme. This kind of primary stimulus generalization, therefore, was assumed to take place without too great efforts.

The more significant point, as related to our first hypothesis, is that A_2 and A_3 subjects, through pretraining had acquired or reactivated "verbal coding systems" which could, if sufficiently integrated with other segments of experience, serve as analyzers capable of facilitating the stimulus analysis and selection processes of test-training concept learning.

The facilitating effect of utilizing verbal labels, signifying stimulus variables and values along variables, as a means of analyzing and coding stimuli, should become evident in the results in terms of a more effective stimulus selection phase of test learning - in A_2 and A_3 subjects.

A facilitating effect would not inevitably be the consequence of a pretraining verbalization, however.

According to our hypothesis, verbal facilitation would depend upon the integration of verbal with non-verbal coding systems (a process which is not available for evaluation during pretraining) as well as upon learning the adequate labels or words.

First, since an equal number of pretraining trials were given to all subjects (see below), individual differences in learning the adequate labels may produce individual differences in verbal facilitation during test-learning.

Second, in subjects whose verbalization appeared to be successful, during pretraining, the integration of verbal with non-verbal coding systems may, for some reason, have been incomplete.

Therefore, we should not expect that, without exception, pretraining verbalization would lead to a successful test-training concept learning.

Training and Learning Criteria

As has been pointed out, an *a priori* defined number of presented series of trials constituted the pretraining criterion.

In experiment I, seven pretraining series were given to each of the subjects.

In contrast, test-training included twelve training series (or 108 trials), during which 16 subjects solved the concept learning task. The remaining 20 non-learning subjects received a score of 12 each.

The distinction between Learners (L) and Non-Learners (NL) had been based upon a learning criterion, requiring the subject to respond correctly (1) to an entire series of nine stimuli, or (2) to 16 out of 18 stimuli in two subsequent series.

Each learning subject received a score according to the number of series used to reach the criterion.

The non-learner who might have solved the problem during one of the series subsequent to the last (or twelfth) series received a score of 12, as has been pointed out.

Results

Sub-samples of subjects have been compared along three different variables, (1) in terms of the learner-non-learner dichotomy formerly described, (2) in terms of scores representing the individual number of series to solution (in NLs, the score of 12), and (3) in terms of scores representing individual number of correct responses in 108 trials.

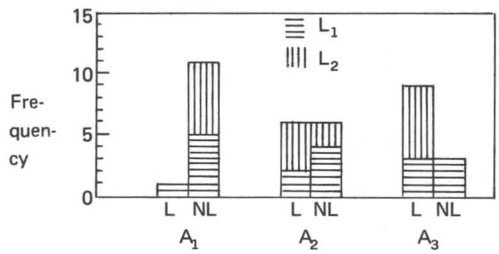
Before proceeding to the specific analyses, it seems necessary to state that one of our subjects belonging to the A_3-L_2 sub-group was deemed experimentally mortal. That is, during test-training she appeared to be emotionally blocked and obviously not capable of emitting any response at all.

Statistically, however, she received a score according to the mean performance of that sub-group (LINDQUIST, 1954, p.148). That score has been applied to the chi-square as well as to the analysis-of-variance calculations.

X^2 applied to the L-NL Dichotomy

The sample distributions of L and NL subjects to treatment sub-groups and CA-levels 1 and 2 are graphically represented in figure IV.7.

Fig. IV.7



X^2_A = 10.92
2 df, $p < .01$
A_1-A_2-difference:
Close to the .05 limit of rejection.
A_1-A_3-difference:
$p < .01$

Fig. IV.7: Experiment I Subjects distributed to Treatment Groups (A_1-A_3), to CA-Levels (L_1-L_2), and according to the Learner-Non-Learner Distinction (L-NL). To the right: Chi-Squares, df's and the corresponding Levels of p.

Evidently, contingenciew differ considerably among treatment groups, and an over-all chi-square evaluation of differences (fig. IV. 7) confidently permits one to reject H_O ($p < .01$). From a table of cell frequencies required to achieve significant chi squares, we may read that the A_1-A_2 difference approximates the .05 area of rejection, and that the A_1-A_3 difference is significant on a high level of confidence ($p < .01$).

Two-way Analysis of Variance of individual Number of Series to Criterion

Before proceeding to the analyses of variance, it is necessary to describe the sample distributions of scores, thus stating the conditions to which the analyses, and particularly, the F-tests have been applied.

The cut-off score of twelve, of course, produced a markedly skewed, J-shaped distribution, as has been demonstrated in figures IV. 8 and IV. 9. More correct, perhaps, would be to say that it reveals the presence of two samples, each of which probably represents a different parent population, thus supporting the Learner-Non-Learner distinction applied to the X^2-test.

Fig. IV. 8

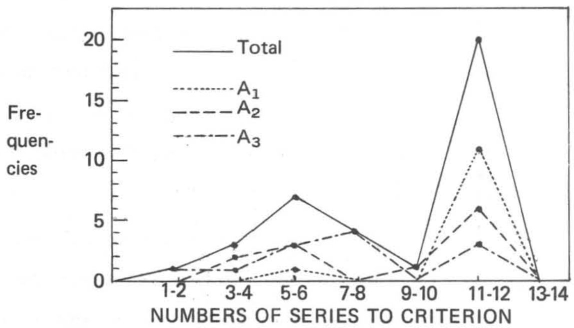


Fig. IV. 8: Experiment I. Number of Series to Criterion in Test-Training. Frequency Distribution for the Total Sample and for each of the Treatment Sub-Samples.

The non-normality of the total sample distribution can be assessed by a mere inspection of the distribution curves in figures IV. 8 and IV. 9. The same holds true for the sub-sample distributions.

We may assume, however, that these distributions approximately mirror the populations from which the samples have been drawn (LINDQUIST, 1954, p. 133, point 1).

Fig. IV. 9

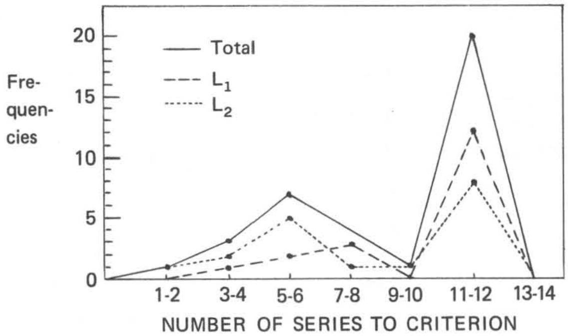


Fig. IV. 9. Experiment I: Number of Series to Criterion in Test-Training. Frequency Distribution for the Total Sample and for each of the CA-Levels.

A normal distribution of criterion scores in the parent populations, therefore, is most unlikely (LINDQUIST, ibid., point 2, p. 133).

As has been demonstrated in the NORTON study, however, the F-distribution "is amazingly insensitive to the form of the distribution of criterion measures in the parent population, granting that the same form is common to all treatment populations" (LINDQUIST, 1954, p. 81).

The more critical point as related to F-test validity is the homogeneity of form and variance of sub-distributions. However, as has been stated by LINDQUIST,

In general, unless the heterogeneity of either form or variance is so extreme as to be readily apparent upon inspection of the data, the effect upon the F-distribution will probably be negligible. In general, when the heterogeneity in form or variance is "marked" but not "extreme", allowance may be made for this fact by setting a higher "apparent" level of significance for these tests of treatment effects than would otherwise be employed (LINDQUIST, 1954, p. 86).

The question remains unanswered, however, what exactly constitutes the contents of the terms "markedly" and "extreme" heterogeneity, and what constitutes the limit separating them.

Returning now to figures IV. 8 and IV. 9, they obviouslys display a considerable homogeneity among subsample distributions.

The heterogeneity of <u>form</u> of distributions does not reach an "extreme" level, as evaluated by the present writer.

The heterogeneity of variance, in contrast, appears to be more "extreme". The value obtained in a COCHRAN test for homogeneity of variance, though approaching the critical value, does not permit a rejection of the homogeneity hypothesis, however ($F_{max.\,95}(3,11) = .5967$; observed value = .56).

Yet the heterogeneity of variance is considered so extreme, by the present writer, that it may complicate the interpretation of an F-test following the analysis of variance.

In order to meet this problem, an alpha-level of .01 will be employed instead of a level of .05 which would be accepted under different conditions.

With these cautions in mind, we are ready to evaluate the data displayed in table IV. 9.

Table IV. 9

Experiment I: Analysis of Variance of Test-Training Scores. (Number of Series to Criterion).

Source of Variance	df	ss	ms	F	p
Treatments (A)	2	121.97	60.78	7.32	$.005 > p > .001$
Levels (L)	1	34.02	34.02	4.08	$p > .05$
A x L	2	57.49	28.75	3.45	$.5 > p > .025$
Within Cells	29*	241.49	8.33		
Total	34*	454.97			

* One df subtracted because of the missing subject.

Evaluation

Main Effects

When compared, the Chi-Square analysis applied to the L-NL dichotomy and the analysis of variance applied to individual number of series to criterion, confidently permits one to reject H_{OA}. That is, so far as the criterion scores are concerned, the control group and the experimental groups should no longer be considered representative of a common parent population.

Evidently, the main effect of level grouping, though being considerable in A_3 (table IV. 10), does not reach the accepted level of confidence.

The interaction effect, though failing to reach the accepted alpha-level, after all amounts to a considerable size. Obviously, the interaction may be primarily be attributed the simple effect of A_1 on L (table IV. 10).

Comparing Treatment Means

The magnitude of sub-sample means and the nature and size of differences between means are indicated in table IV. 10. For the sake of comparison, a third measure, that is, mean numbers of trials to criterion, has been introduced (the lower number in each cell).

Table IV. 10

Experiment I: Sub-Sample Means and Differences between Sub-Sample Means. The Upper Number in each Cell corresponds to Number of Series to Criterion, the Lower Number to Mean Number of Trials to Criterion (yielding a Higher Value).

	Means				Diff. between Means		
	A_1	A_2	A_3	$A_1+A_2+A_3$	A_1-A_2	A_1-A_3	A_2-A_3
L_1	11.0 99.0	9.3 83.7	9.7 87.3	10.0 90.0	1.7 15.3	1.3 11.7	-.4 -3.6
L_2	12.0 108.0	7.7 69.3	4.5 40.5	8.1 72.9	4.3 38.7	7.5 67.5	3.2 28.8
L_1-L_2	-1.0 -9.0	1.6 14.4	5.2 46.8	1.9 17.1			
L_1+L_2	11.5 103.5	8.5 76.5	7.1 63.9	9.0 81.0	3.0 27.0	4.4 39.6	1.4 12.6

Since the level effect failed to produce a significant difference, we shall concentrate further analyses on differences between treatment means which concern our first and main hypothesis.

The A_1-A_3 difference, i.e., between the control group and A_3, appeared to be significant while evaluated in terms of the Learner-Non-Learner dichotomy ($p < .01$). In the case of a Chi-Square, an alpha-level of .05 would be accepted.

The A_1-A_2 difference approached, but did not reach the latter level of rejection.

The analysis of variance has been followed by a t-test of the difference between A_1 and A_3 means, in terms of series to criterion equal to 4.4. This test (WINER, 1962, pp. 89-92, 207-211) revealed that the difference is significant on a high level of confidence ($t = 3.73$, 29 df, $p < .005$).

The difference between A_1 and A_2 means (3.0) also reached the accepted level of alpha ($t = .2.54$, 29 df, $p < .01$).

Number of Correct Responses

Since one difference between A_1 and A_2 appeared to be significant, the other did not, it is necessary to make a third comparison, that is, in terms of individual number of correct responses in all (or 108) trials, which is a more sensitive measure (H-I-3).

The form and variance of distributions of scores appeared to justify the utilization of a t-test and an alpha-level of .05.

The t-test, while applied to the following data, revealed that the difference was significant on an even higher level of confidence ($p < .005$).

$M_{A2} = 64.7$ $\qquad M_{A2} - M_{A1} = 24.1$

$M_{A1} = 40.6$

$t = 3.44$ $\qquad$ 22 df (one-tailed test)

$p < .005$

IV. 2. 3
Experiment II

The main trends revealed in experiment I, that is, a superiority of experimental groups as compared with control groups, and partly, the superiority of higher level compared with lower level groups, have been manifested in the remaining three laboratory experiments.

The trends, however, frequently failed to reach a significant level of confidence in the latter experiments, probably because of the low cell frequencies used in the design.

Yet they will be reported in order to elucidate the specific training conditions and learning criteria utilized.

Experiment II was performed at TORSHOV off. skole during the first half of 1967.

Subjects

In tables IV. 11 and IV. 12, the total sample and all the sub-samples of experiment II subjects are represented in terms of IQ- and CA-data.

Table IV. 11

Experiment II Subjects represented in Terms of IQ-Scores. Distribution of Scores to Different Sub-Samples.

IQ-Intervals	Treatment and Level Groups									L_1	L_2	L_3	Total
	A_1			A_2			A_3						
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3				
53-55		1								0	1	0	1
56-58		1	1	1		1		1		1	2	2	5
59-61	2		2	1	2	1	1		2	4	2	5	11
62-64	1			1		1	1	1		3	1	1	5
65-67		1			1		1	1	1	1	3	1	5
N	3	3	3	3	3	3	3	3	3	9	9	9	27
M	60.3	59.7	58.7	60.0	62.3	60.7	63.0	62.0	61.7	61.1	61.3	60.3	60.9
SD	1.25	5.3	1.3	2.2	3.3	2.5	1.6	3.3	2.4	2.2	4.2	2.5	3.1
N_A	9			9			9						
M_A	59.6			61.0			62.2						
SD_A	3.3			2.9			2.6						

The IQ-differences between sub-samples, when evaluated by means of a two-way analysis of variance, failed to reach a significant level of confidence.

Table IV. 12

Experiment II Subjects represented in Terms of CA-Data (in months). Frequency Distribution of Scores to all Sub-Samples. Mean and SD calculated for each Sub-Group.

CA-Inter--vals in months	Treatment and CA-Level Groups									L_1	L_2	L_3	Total
	A_1			A_2			A_3						
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3				
100-109				1						1	0	0	1
110-119	2			1			2			5	0	0	5
120-129	1			1	1		1			3	1	0	4
130-139		2			2			2		0	6	0	6
140-149		1								0	1	0	1
150-159						2			1	0	0	3	3
160-169			1			1		1	1	0	1	3	4
170-179			2						1	0	0	3	3
N	3	3	3	3	3	3	3	3	3	9	9	9	27
M	116.0	138.3	171.0	113.7	132.3	159.0	117.0	145.3	167.7	115.6	138.7	165.9	140.0
SD	5.1	2.9	5.4	5.3	5.2	2.9	4.1	13.9	7.9	5.0	10.2	7.7	22.0
N_A	9			9			9						
M_A	141.8			135.0			143.3						
SD_A	23.0			19.2			22.8						

As has been pointed out, the experiment II sample included three levels of CA, the third of which had been drawn from a sixth grade population of pupils.

Pretraining Conditions

Stimuli

Again pretraining stimuli consisted of three series, each of which conformed to the classification of patterns displayed in the four-contingency table presented below (table IV. 13). Each series included four stimulus patterns.

It may be evident in table IV. 13 (p. 126) that experiment II pretraining stimuli could be classified according to three variables, two of which were redundant variables (COLOR and SUBSTANCE).

Each variable was represented by two values (SIZE: Large, Small; SUBSTANCE: Wood, Metal; COLOR: Light Yellow Brown, Gray).

Table IV. 13

Experiment II Pretraining Stimuli classified according to Three Binary Variables, Size, Substance, and Color. Verbalization in A_2 and A_3 Subjects.

STIMULUS VARIATION				VERBALIZATION in A_2 and A_3
SUBSTANCE	COLOR	SIZE Large	SIZE Small	
Wood 1 (Birch)	Light Yellow Brown 1	S = $3\frac{7}{16}$ inch 1 s = $\frac{3}{4}$ inch	S = $1\frac{7}{8}$ inch 2 s = $\frac{7}{16}$ inch	A_2 and A_3: "Wooden" anc tallic SUBSTA "Large, small SIZE"
Metal 1 (Aluminum)	Gray 1	3	4	A_3: "Similar, r similar SUBST AND SIZE"

Upper Numbers: Size of CPS and PPS.
Lower Numbers (in italics): Operation Panel Stimuli. Size.

In the CPS and PPS series, Large and Small corresponded to 3 7/16 inches and 1 7/8 inches squares, respectively. The corresponding sizes for the operation panel series were 3/4 inch and 7/16 inch, respectively (table IV. 13: numbers in italics).

Stimulus patterns had been cut out of thin (1/32 inch) aluminium or wooden plates and had been glued to cardboard cards or to the operation panel.

Order of Presentation

The order of CPS-presentation had been randomized within each block of four series. The order of presentation of CPS and the corresponding PPS are given below (table IV. 14).

Table IV. 14

Order of Presentation of Experiment II Pretraining Stimuli, within each block of Four Series.

Series No.	Kind of stimulus	Order of Presentation 1	2	3	4
I. 1	CPS	3	4	1	2
	PPS	1	1	1	1
I. 2	CPS	2	4	1	3
	PPS	2	2	2	2
I. 3	CPS	3	1	4	2
	PPS	3	3	3	3
I. 4	CPS	2	1	3	4
	PPS	4	4	4	4

Cell Nu refer t Stimuli Numbe Table I

Verbal Pre-Training

During pretraining series, A_2 and A_3 subjects were required to respond verbally to questions concerning stimulus substance and size and, in A_3 subjects only, to questions concerning stimulus similarity and dissimilarity (table IV. 13).

In order to be correct, the subject had to respond in terms of variable names and value labels, e.g., Large or Small Size, and in terms of similarity, e.g., similar ot nor similar Substance.

Amount of Training

Responses including the labels formerly described would be emitted during twenty pretraining series, each of which consisted of four trials.

Test-Training

Stimulus and response variation involved in the test-training task has been presented in table IV. 15.

Table IV. 15

Experiment II Test-Training Task.

<table>
<tr><th colspan="5">STIMULUS VARIATION</th><th rowspan="3">RE–SPONSE Variation</th></tr>
<tr><th rowspan="2">SUBSTANCE (relevant)</th><th rowspan="2">COLOR</th><th rowspan="2">SHAPE</th><th colspan="2">SIZE</th></tr>
<tr><th>Large</th><th>Small</th></tr>
<tr><td>Wood - 2 (Balsam)</td><td>Light Yellow Brown - 2</td><td>Tri-angle</td><td>1</td><td>3</td><td rowspan="2">KIB</td></tr>
<tr><td>Wood - 1 (Birch)</td><td>Light Yellow Brown - 1</td><td>Square</td><td>2</td><td>4</td></tr>
<tr><td>Metal - 2 (Aluminum)</td><td>Gray - 2</td><td>Tri-angle</td><td>5</td><td>7</td><td rowspan="2">FOK</td></tr>
<tr><td>Metal - 1 (Tin)</td><td>Gray - 1</td><td>Square</td><td>6</td><td>8</td></tr>
</table>

Test-training stimuli varied along four variables, two of which constituted redundant relevant variables (SUBSTANCE and COLOR). Thus stimulus patterns containing wooden substance and wearing a light yellow-brown color, should be associated to "KIB" as a verbal response. Similarly, in the presence of a pattern wearing a gray color and being made of metal, the problem solving subject was expected to emit "FOK" as a response.

During the first six test-training series, only four-stimuli series were used (stimulus nos. 1,3,5,7, table IV.15).

This part of the task appeared to be rather easy to solve, at least to the higher level subjects in all treatment groups.

This fact can probably be attributed several contributing factors: (1) Values along relevant stimulus variables were only slightly changed from pretraining, to test-training stimuli, rendering a primary stimulus generalization highly probable and the importance of verbalization a minor one. (2) Stimulus redundancy provided the "occasion" for emitting responses. (3) The proportion of relevant to irrelevant stimulus variables amounted to a ratio of 2 : 1, thus offering a high probability of selecting the correct cues. (4) The number of stimuli in a series was low, permitting the non-selective subject to learn in a paired-associates rather than in a concept learning fashion.

Pretraining stimuli (2-4-6-8 in table IV.15), therefore, were included in the remaining six training series, thus (1) increasing the sub-category size from two to four instances, and (2) doubling the number of irrelevant stimulus variables (simultaneously changing the ratio of relevant to irrelevant variables from 2 : 1 into 2 : 2).

Learning Criteria

According to the distinction between two categories of test-training series, two levels of learning criteria were established:

(1) Four-trial series: Four subsequent series had to be correctly solved.

(2) Eight-trial series: One perfect series, or seven correct out of eight trials in two subsequent series.

Results

Four categories of scores will be applied to the analyses, (1) the L-NL dichotomy, (2) number of series to solution, (3) number of trials to criterion, and (4) individual number of correct responses in all trials.

The L-NL Dichotomy

The L-NL dichotomy produced 18 Learners and 9 Non-Learners. Even while disregarding the L_3-group (cf. fig. IV. 10), this distribution of scores indicates that the experiment II criterion task was easier to solve than the corresponding experiment I task.

Learners and Non-Learners appeared to be equally distributed among treatment groups (fig. IV. 10).

Figure IV. 10

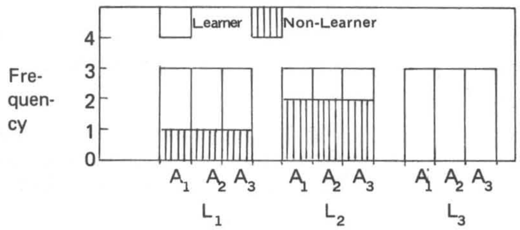


Fig. IV. 10. Experiment II: Distribution of Learners and Non-Learners to Treatment Groups (A) and CA-Levels (L_{1-3}).

They were not, however, equally distributed among levels, as has been demonstrated in figure IV. 10.

Contrary to our expectation, the L_2 group contained a higher frequency of Non-Learners than did the L_1 group. That outcome is contrary, also, to results obtained in the remaining experiments.

It is likely to assume, therefore, that the specific distribution of L-NL scores revealed in experiment II is a mere chance occurrence.

Number of Series to Criterion

The distribution of scores for the total experiment II sample, and for separate treatment groups and CA-levels are represented in figures IV. 11 and IV. 12.

Figure IV. 11

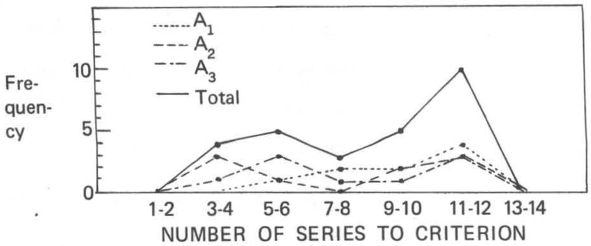


Fig. IV. 11. Experiment II: Number of Series to Criterion. Frequency Distribution for the Total Sample and for each of the Treatment Groups.

Figure IV. 12

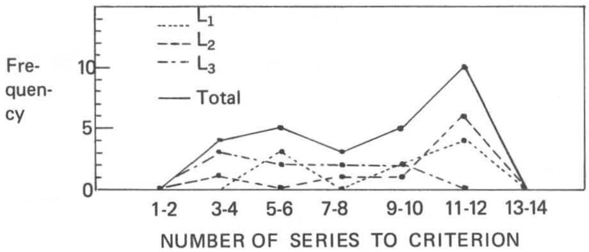


Fig. IV. 12. Experiment II: Number of Series to Criterion. Frequency Distribution for the Total Sample and for each CA-Level.

The main trends revealed in experiment I distributions, though less extremely lefthand skewed, are apparent in the present distributions.

The arguments for utilizing a two-way analysis of variance with experiment I data, therefore, seems to apply to the present conditions, as well.

Again, the heterogeneity of variance appeared to constitute the main problem. A COCHRAN test, though failing to permit a rejection of the homogeneity hypothesis, revealed a considerable heterogeneity among treatment subgroups ($F_{max.95}(3,8) = .6333$; observed value = .52).

For reasons formerly discussed, therefore, an alpha-level of .01 would be employed.

F-tests of the AL-interaction and main effects of treatments and levels are displayed in table IV. 16.

Table IV. 16 — Experiment II: Sum of Squares, Mean Squares, and F-Tests, all of which concern Individual Number of Series to Criterion.

Source of Var.	Df	ss	ms	F	p
Treatments (A)	2	19.19	9.59	1.02* 3.87**	$p > .2$
Levels (L)	2	79.41	39.70	4.21* 16.00**	$.05 > p > .025$ $.25 > p > .01$
A x L	4	9.92	2.48	.26	
Within Cells	18	170.00	9.44		
Total	26	278.52			

$*ms_W$ respective $**ms_{AL}$ used as an error term.

Neither the interaction nor the main effects of treatments and levels happened to reach the accepted level of significance. The between-levels effect, however, achieved a value close to the accepted level of confidence.

The simple effects of levels and treatments have been further elucidated in table IV. 17.

Table IV. 17 — Experiment II. Sub-Sample Means and Differences between Sub-Sample Means.

		Means				Diff. between Means		
		A_1	A_2	A_3	A_{1-3}	A_1-A_2	A_1-A_3	A_2-A_3
Means	L_1	11.0	9.3	7.7	9.3	1.7	3.3	1.6
	L_2	11.3	9.0	10.3	10.2	2.3	1.0	-1.3
	L_3	7.3	5.3	6.3	6.2	1.7	.7	-1.0
Diff. betw. means	L_1-L_2	-.3	.3	-2.7	-.9			
	L_1-L_3	4.0	4.0	1.3	4.0			
	L_2-L_3	4.3	3.7	4.3	3.1			
Means	L_{1-3}	9.8	7.9	8.1		1.9	1.7	-.2

The trends revealed in differences between L_1 treatment means conform to the predictions contained in our first hypothesis.

The results obtained in L_3 subjects are in accordance with our predictions as well. Thus, according to hypothesis II, higher MA-level subjects may be assumed to stay on a more advanced level of conceptual comprehension and verbal skills, both of which may be presumed to facilitate an adequate analysis of stimulus conditions involved in a new concept learning task.

In addition, the specific stimulus variable and values made relevant to task solution, that is, Wooden and Metallic SUBSTANCE, had probably been frequently experienced and verbalized by L_3 subjects during carpentry lessons, thus constituting a considerable amount of pre-experimental training.

A_2 and A_3 subjects within L_3, therefore, should not be expected to profit very much from a further training in experimental settings.

In general, and contrary to our preconditions, L_2 groups proved to be inferior to L_1 groups, and, within L_2, the A_2 group exceeded the A_3 group. These specific effects, none of which reached a significant level, however, could not readily be explained in terms of the measures utilized in this section (cf. section V. 1).

Apparently, the main effects of levels may be attributed the differences between L_1 and L_2, on the one hand, and L_3, on the other. Thus, a comparison of L_2 with L_3, in terms of a t-test between means, revealed a high, but insignificant difference between means ($t = 1.90$, 18 df, $p < .05$).

The former conclusion is relevant, at least, to A_1 and A_2 treatment groups. In the A_3 group, all levels of CA contribute more evenly to the main effect of levels.

Number of Trials to Criterion

The introduction of a third measure, that is, the individual number of trials to criterion, did not radically change the picture already drawn.

Minor differences, however, became apparent in the analysis of main effects and the subsequent analyses of simple effects (table IV. 18, fig. IV. 13).

Table IV. 18

Experiment II. Analysis of Variance of Number of Trials to Criterion.

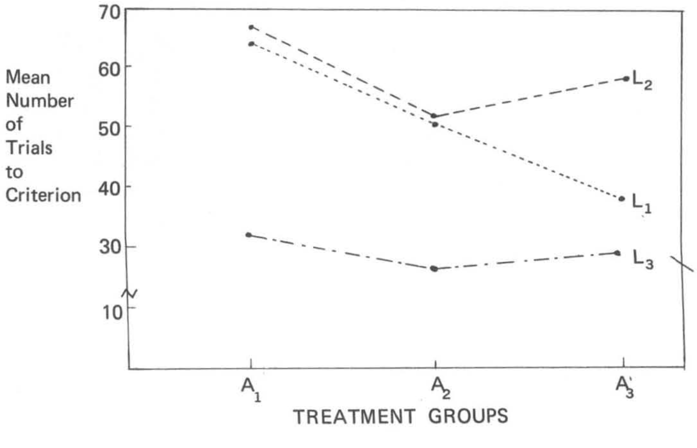
Source of Variance	Df	ss	ms	F	p
Treatments (A)	2	804.74	402.37	4.05**	.05 > p > .025
Levels (L)	2	4274.96	2137.48	4.41* 21.54**	.05 > p > .025 p < .01
A x L	4	397.37	99.34		
Within Cells	18	8735.67	485.31		
Total	26	14212.74			

$^{*}ms_{W}$ resp. $^{**}ms_{AL}$ used as an error term.

Thus the main effect of levels appeared to reach the accepted level of confidence while evaluated in terms of number of trials to criterion (ms_{AL} used as an error term), and the main effect of treatments reached a level close to the established alpha-level.

Figure IV. 13

Experiment II. Sub-Sample Mean Number of Trials to Criterion.



The simple effect of treatments upon L_2 changed slightly rendering L_2 groups completely inferior to L_1 groups (fig. IV. 13).

A test of differences between sub-samples within L revealed that the mean L_1-L_3 difference approached the area of rejection ($t=2.1$, 18 df, $p < .025$), and that the L_2-L_3 difference moved into that area ($t=2.86$, 18 df, $p < .01$)

Number of Correct Responses

Since the effect of treatments appeared to be considerable in the preceding analysis, a comparison of each experimental sub-sample with the control group (A_1) in terms of individual number of correct responses, may be in order.

The effect of pretraining verbalization was predicted for L_1 and L_2 sub-groups, while a zero-effect was expected for higher levels of CA (cf. the preceding discussion of L_3-data).

For this reason, and since the analyses may be utilized as parts of an over-all comparison of treatment groups restricted to the L_1 and L_2 sub-groups (section IV. 2. 6), the present analysis will be carried out within those levels (i. e., L_1 and L_2).

A t-test has been applied producing the data displayed in table IV. 19.

Table IV. 19

Experiment II: T-Test of Differences between Treatment Groups in L_1 and L_2.

M_{A1}(control) = 35.0, M_{A2}=45.7, M_{A3}=49.8

	D	t	df	p
M_{A2}- M_{A1}	10.7	1.76	10	$.1 > p > .05$
M_{A3}-M_{A1}	14.8	3.44	10	$p < .005$

An alpha-level of .05 has been accepted for the present kind of scores. In terms of the accepted alpha-limit, we may state that the A_2-A_1 difference approached the area of rejection (the critical value for 10 df is 1.81), and that the A_3-A_1 difference appeared to be highly significant.

Thus a considerable effect of treatments A_2 and A_3 has been revealed by the present analyses of correct responses.

IV. 2. 4
Experiment III

Experiment III was performed during the last half of 1967.

Subjects

18 subjects, sampled in the manner formerly described, were randomly assigned to three treatment groups, each of which consisted of a high and a low CA-level group.

The samples thus established, are statistically represented in tables IV. 20 and IV. 21, in terms of IQ- and CA-intervals, respectively.

Table IV. 20

Experiment III: The Total Sample and each Sub-Sample represented in Terms of IQ-Data.

IQ-Intervals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
50-52									
53-55	1					1	1	1	2
56-58		1						1	1
59-61		1	1	1		1	1	3	4
62-64	2		1	1	2		5	1	6
65-67		1		1	1	1	1	3	4
68-70			1				1		1
N	3	3	3	3	3	3	9	9	18
M	60.7	61.7	64.0	63.3	63.3	60.7	62.6	61.9	62.3
SD	4.0	3.3	2.9	1.7	1.9	4.9	3.4	3.7	3.6
N_A	6		6		6				
M_A	61.2		63.7		62.0				
SD_A	3.7		2.4		4.0				

Table IV. 21

Exp. III: The Total Sample and each Sub-Sample represented in Terms of CA-Data (in months).

CA-Intervals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
90-99			1		1		2		2
100-109	1		1				2		2
110-119	2				1		3		3
120-129			1	1	1		2	1	3
130-139		3		1		2		6	6
140-149				1		1		2	2
N	3	3	3	3	3	3	9	9	18
M	113.3	133.0	110.0	138.0	110.3	140.7	111.2	137.2	124.2
SD	6.0	2.9	13.6	7.3	11.9	5.9	11.1	6.5	15.9
N_A	6		6		6				
M_A	123.17		124.0		125.5				
SD_A	10.9		17.8		17.8				

Pretraining

As will become evident, experiment III criterion task appeared to be the most difficult one used in our series of experiments.

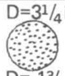
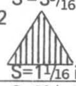
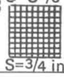
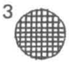
This specific result may be attributed several experimental conditions, some of which may be apparent in pretraining conditions and in differences between pretraining and test-training stimuli.

Stimuli

According to the general training procedure adopted, three pretraining series were used, each of which, however, included only three members (table IV. 22).

Table IV. 22

Stimuli and Responses involved in Exp. III Pretraining Task. The Size of Operation Panel Stimuli in Italics.

STIMULUS variables	CPS-VALUES	PPS-VALUES	CPS- and OPERATION Panel series	PPS-SERIES	VERBALIZATION in A_2 and A_3 SUBJECTS
Shape Color Pattern*	Circle Yellow Dotted*	Triangle Brown Striped*	1 D=3¼ inch  D= 1 3/16 inch	1 	A_2 and A_3: "Dotted, striped, squared PATTERN".
Shape Color Pattern*	Triangle Black Striped*	Square Yellow Striped*	2 S = 3 9/16 inch  S=1 1/16 inch	2 	
Shape Color Pattern*	Square Brown Squared*	Circle Black Squared*	3 S=3 1/8 inch  S=3/4 inch	3 	A_3: "Similar, not similar PATTERN"

* The to-be relevant Stimulus Variable and Values.

Experiment III pretraining series differed in several respects from those applied to previous experiments.

First, contrary to previous tasks, two separate categories of pretraining series were used.

CPS and operation panel stimuli were similar in every respect, except in size. That is, they constituted identical combinations of three values along each of three stimulus variables (table IV. 22, fourth column).

In PPS, the same variables and values were utilized, but they had been differently combined to stimulus patterns, as has been demonstrated in table IV. 22, fifth column.

Second, contrary to previous pretraining series, also, each value appeared only once in a series, thus producing a series containing three entirely different stimulus members.

Verbalization

The verbal labels emitted by A_2 and A_3 subjects subsequent to the presentation of a stimulus pair, are indicated in table IV. 22 in the right-hand column.

Disregarding for a moment the PPS series and the A_3 responses to stimulus similarity, it may be evident from table IV. 22 that the pretraining task provided a list of paired-associates in which no physical similarity existed among individual members of the stimulus part of the list.

In figure IV. 14, the one-to-one correspondence between stimuli and responses is obvious when value labels (i. e., Dotted, Striped, and Squared) are considered apart from the variable name.

Figure IV. 14

CPS	VERBAL RESPONSES	
(Numbers enclosed within parentheses refer to table IV. 22)	Value Label	Variable Name
(1) $S_{x1,y1,z1}$ ——	R_{x1} (Dotted)	
(2) $S_{x2,y2,z2}$ ——	R_{x2} (Striped)	R_X (Pattern)
(3) $S_{x3,y3,z3}$ ——	R_{x3} (Squared)	

Fig. IV. 14: Stimulus-Response Relationships in Exp. III Pretraining Task.

The inclusion of a variable name (i. e., PATTERN), however, changes the nature of the task towards a concept learning task.

The task still does not meet the criterion proposed by GOSS (1961), requiring the stimulus set of a concept learning task to contain two or more sub-sets, each of which would be associated to a different overt response.

This criterion was met in previous pretraining tasks, providing, in each case, a complete concept learning task and offering to A_2 and A_3 subjects the opportunity to apply a chain of verbal responses (e.g., Red COLOR) to different members of a sub-set (abstracted primary Stimulus Generalization).

The opportunity to generalize along a stimulus variable was provided in experiment III pretraining task, as well, because CPS and PPS were simultaneously presented.

This opportunity was available primarily to A_3 subjects, however, because their attention, through the questions asked by the experimenter, had been positively drawn to the PPS and to an eventual similarity among PPS and CPS.

Third, both pretraining and test-training stimulus patterns had been sketched with ink color pencils on the stimulus card itself. In other words, stimulus patterns (that is, stimulus shape or contours) would not stand out from the stimulus card as was the case in previous series.

The latter point, however, is probably of minor importance as related to task difficulty.

Order of Presentation and Training Criteria

Pretraining (CPS) stimuli were presented according to a Latin Square order within each block of three subsequent series.

The standard order of presentation of CPS and PPS within a block is represented in table IV.23 (p. 140).

Table IV. 23

Exp. III: Order of Presentation of a Standard Block of Three Pretraining Stimulus Series.

Series Number	Series Nature	Order of Presentation 1	2	3
I. 1	CPS	1	3	2
	PPS	1	1	1
I. 2	CPS	3	2	1
	PPS	2	2	2
I. 3	CPS	2	1	3
	PPS	3	3	3

Cell Numbers refer to Stimulus Nos. in Table IV. 22

In the manner described, each subject received a training using the criterion of 21 series (L_2 Ss) or 24 series (L_1 Ss), the training being distributed over a period of $3\frac{1}{2}$ weeks.

Test-Training

The main components of the experiment III test-training (or criterion) task are represented in table IV. 24.

Table IV. 24

Exp. III. Stimulus and Response Variation included in the Test-Training Task.

STIMULUS VARIATION Shape	Pattern size	PATTERN (relevant) Dotted	Striped	Squared
Triangle	Small	1 Red C	4 Blue C	7 Green C
Circle	Medium	2 Blue C D=3 1/4	5 Green C	8 Red C
Square	Large	3 Green C S=3 1/8	6 Red C	9 Blue C
Response Variation		TUK	MÆF	FÅB

Stimulus Variation

Test-training stimuli constituted combinations of three values along each of four stimulus variables (SHAPE, COLOR, PATTERN, and PATTERN-SIZE), two pairs of which had been orthogonally combined (SHAPE-PATTERN, PATTERN-SIZE-PATTERN).

"PATTERN" constituted the relevant stimulus variable, the remaining three variables being irrelevant to task solution.

Thus, the ratio of relevant to irrelevant variables equalled 1 : 3.

Two irrevelant stimulus variables, that is, SHAPE and PATTERN-SIZE, correlated completely, thus providing irrelevant stimulus redundancy.

The low ratio of relevant to irrelevant stimulus variables, and to some extent, the irrelevant stimulus redundancy, probably contributed significantly to task difficulty (BOURNE & RESTLE, 1959; NYBORG, 1970a, p. 139).

Differences between Pretraining and Test-Training Stimuli

The low effect of verbal pretraining upon experiment III criterion task problem solving (to-be revealed in our data) may, at least in part, be attributed differences between PATTERN values in the two sets of training stimuli.

Those differences, if great enough, would be expected to interfere with an abstracted Stimulus Generalization or even prevent a generalization of verbal responses occurring between the two sets of stimuli.

That is, A_2 and A_3 subjects, though being trained to verbalize during pretraining, should not be capable of emitting implicit verbal labels (denoting values along the PATTERN stimulus variable) nor utilize them as analyzers or coding systems, capable of facilitating the stimulus selection part of the criterion learning task.

Returning now to stimuli represented in tables IV. 22 and IV. 24, "Dotted" values obviously varied less than "Striped" and "Squared" values, from pretraining to test-training. The dots, though being larger and located more distant to each other, after all remain dots.

The stripes, in contrast, have changed orientation (from vertical to horizontal orientation), and have lost the character of evenly distributed stripes.

The latter point holds true for "Squares" as well.

The different relations existing between values in test-training stimuli, on the one hand, and pretraining stimuli, on the other, would be expected to reflect in test-training probabilities of correct responses to Dotted, Striped, and Squared PATTERNS, respectively.

These expectations appear to be verified in the data given in table IV. 25.

Table IV. 25

Probability of Correct Responses to Dotted, Striped, and Squared PATTERNS during Exp. III Test-Training.

Value	Series Nos		Responses
	I-XV	VI-XV	
Dotted	$\frac{397}{810} = .490$	$\frac{333}{540} = .617$	TUK
Striped	$\frac{261}{810} = .322$	$\frac{206}{540} = .381$	MÆF
Squared	$\frac{264}{810} = .326$	$\frac{220}{540} = .407$	FÅB

Responses and Learning Criterion

Experiment III test-training responses, as in previous experiments, consisted of a priori nonsense trigrams.

Each response would be associated in learning subjects to a sub-group of stimuli according to the scheme displayed in tables IV. 24 and IV. 25.

Because of the obvious severeness of the task, a lower learning criterion, that is, 8 correct in a series of 9 trials was chosen.

Results

Since only five subjects happened to reach the learning criterion within twelve test-training series, the number of series was tentatively extended to fifteen.

The L-NL Dichotomy

At the end of fifteen series, another subject had solved the task according to the criterion selected, thus producing a distribution of 6 Learners and 12 Non-Learners.

The proportion of Learning to Non-Learning subjects is rather small, as compared with results obtained in the remaining three laboratory experiments. This results, it may be assumed, can be attributed - at least to a large extent - to the specific experiment III training conditions already described.

A further distribution of Learners and Non-Learners to each of six sub-samples has been provided in table IV. 26.

Table IV. 26

Experiment III Subjects distributed according to the L-NL Dichotomy, Treatment Groups and Levels.

L-NL Dichotomy	Treatment Groups and CA-Levels						Total
	A_1		A_2		A_2		
	L_1	L_2	L_1	L_2	L_1	L_2	
L	0	1	2	1	1	1	6
NL	3	2	1	2	2	2	12
Sums	6		6		6		18

The trends predicted in our hypothesis I are apparent in the present table, but they fail to reach a significant level of confidence.

Number of Series to Criterion

This, to be sure, holds true for scores according to the individual number of series to criterion as well.

In figure IV. 15, a and b, frequencies of scores have been distributed to treatment groups (A) and CA-levels (L), respectively.

Figure IV. 15

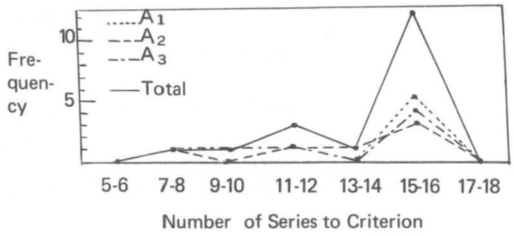


Fig. IV. 15, a. Experiment III: Number of Series to Criterion. Distribution of Scores in the Total Sample and to each Treatment Group.

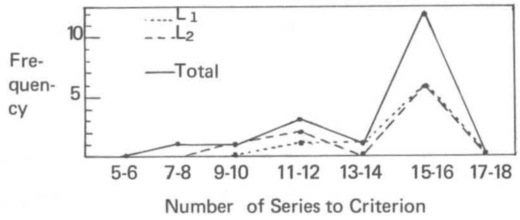


Fig. IV. 15, b. Experiment III: Number of Series to Criterion. Distribution of Scores for the Total Sample and to each CA-Level.

The form of distributions, though moved to higher score intervals, resembles that met in previous sample distributions (Exps. I and II), and the heterogeneity of variance is probably less extreme than in earlier cases.

The premises for utilizing a two-way analysis of variance to previous experiments, therefore, seem valid to the present conditions as well (table IV. 27).

Table IV. 27

Analysis of Variance of Experiment III Scores (Number of Series to Criterion).

Source of Var.	df	ss	ms	F	p
Treatments (A)	2	8.45	4.23	.56	
Levels (L)	1	.00			
A x L	2	9.33	4.67	.62	
Within Cells	12	90.67	7.55		
Total	17	108.45			

The analyses made available in table IV. 27 do not strongly support our hypotheses. On the contrary, only slight trends appear in favor of predictions concerning differences between treatment groups.

A further analysis of simple effects, therefore, would probably generate no new and important information.

The scores obtained within twelve test-training series, however, will be applied to the final analysis of an over-all effect of treatments and levels (section IV. 2. 6).

Number of Correct Responses

A clearer trend in favor of our main hypotehsis may be detected in an analysis of individual number of correct responses emitted in all series, which is a more sensitive measure.

In table IV. 28, a set of data, relevant to the present analysis, has been made available to the reader.

Table IV. 28

Experiment III: T-Test of Differences between Treatment Groups. Number of Correct Responses-Data. M_{A1} (control) = 41.0 M_{A2} = 57.5 M_{A3} = 55.2

	D	t	df	p
$M_{A2} - M_{A1}$	16.5	1.19	10	$.1 < p < .2$
$M_{A3} - M_{A1}$	14.2	1.28	10	$.1 < p < .2$

The t-values failed to reach the accepted level of alpha. They will be utilized in section IV. 2. 6, however, in order to evaluate an over-all effect of pretraining treatments involving laboratory experiments I-IV.

IV. 2. 5
Experiment IV

Experiment IV was performed during the last half of 1968 at TORSHOV off. skole, Oslo.

Subjects

The standard design, including three treatments and two CA-levels, was employed.

Again, 18 subjects were sampled from one IQ population and from each of two CA (and grade level) populations.

Within each experimental level, subjects were randomly assigned to treatment groups, the outcome of which is displayed in tables IV. 29 and IV. 30.

Table IV. 29

Experiment IV. The Total Sample and each Sub-Sample of Subjects represented in Terms of IQ-Data.

IQ--Intervals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
50-52	1						1		1
53-55			1				1		1
56-58					1		1		1
59-61			1				1		1
62-64	1	1		1	2	1	3	3	6
65-67		1	1	1		1	1	3	4
68-70	1	1		1		1	1	3	4
N	3	3	3	3	3	3	9	9	18
M	61.3	66.7	60.3	66.3	60.7	66.0	60.8	66.3	63.6
SD	7.4	2.1	5.0	2.6	2.6	2.9	5.4	2.6	5.0
N_A	6		6		6				
M_A	64.0		63.3		63.3				
SD_A	6.0		5.0		3.9				

In table IV. 29, the total sample, each of six sub-samples and five higher-order sub-samples have been represented in terms of IQ-intervals.

Treatment group means, it may be seen, differ only slightly. Level means, in contrast, differ to a considerable extent, rendering the main effect of levels in a two-way analysis of variance on a comparably high level of confidence ($.05 > p > .025$).

The IQ-differences thus revealed, may be presumed to affect the distribution of criterion scores. This point, however, will be further discussed in a later section.

Table IV. 30

Experiment IV. The Total Sample and each Sub--Sample of Subjects represented in Terms of CA--Data (in months).

CA--Inter-vals	A_1		A_2		A_3		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	Total
90-99			1				1		1
100-109	2		1		1		4		4
110-119	1	1	1	1	2	1	4	3	7
120-129		1		1		1		3	3
130-139		1		1		1		3	3
N	3	3	3	3	3	3	9	9	18
M	108.7	126.7	104.3	124.3	112.0	125.3	108.3	125.4	117.0
SD	3.7	6.3	7.0	8.5	4.1	6.6	6.0	7.3	8.6
N_A	6		6		6				
M_A	117.7		114.3		118.7				
SD_A	10.4		12.7		8.6				

Pretraining Task

The main aspects of the pretraining task have been made available in table IV. 31.

Table IV. 31

Experiment IV. Stimulus and Response Variation included in the Pretraining Task. Length of Operation Panel Lines in Italics.

STIMULUS VARIATION					A_2 and A_3 Subj. Verbal Responses
*ORIEN-TATION	LENGTH (SIZE)	COLOR	CPS and Operation Panel Series	PPS	
*Vertical	Long (Large)	Red	1 *5 1/2 inch* 15/16 inch	1 Green *4 5/8 inch*	A_2 A_2 and A_3 "Vertical ORIENTATION" A_3 : (Lines having) "Similar ORIENTATION", "not similar —„— ".
	Short (Small)	Green	2 *2 7/8 inch* 7/16 inch		
*Oblique	Long (Large)	Green	3 *6 1/2 inch* 1 1/8 inch		A_2 and A_3: "Oblique ORIENTATION", A_3: (Lines having) "Similar ORIENTATION", "not similar —„— ".
	Short (Small)	Red	4 *3 1/4 inch* 1/2 inch	2 *2 3/5 inch*	

* The to-become relevant Stimulus Variable and Values

Stimuli

Ten pretraining stimuli could be grouped into three individual series, two of which (CPS and Operation Panel stimuli) were equal in every respect except in size.

The CPS and the Operation Panel Series each contained four different members constituting lines systematically varied along three binary stimulus variables (LENGTH, Short and Long; COLOR, Red and Green; ORIENTATION, Vertical and Oblique).

The PPS series contained only two stimulus members, the letters X and L, varied in SIZE or Length of component lines (Short, Long) in COLOR (Red, Green), and in ORIENTATION of one or more component lines (Vertical, Oblique).

Verbalization

A_2 and A_3 subjects were required to respond verbally to stimuli in terms of orientation of lines (in letters X and L: component lines), A_3 subjects only, in terms of similarity and dissimilarity of line orientation.

This variable, it may be evident, became the relevant variable in test-training stimuli.

The task, this time, constituted a complete concept learning task in the sense of containing two or more sub-sets, each of which was represented by two or more members, and each of which would be associated with a different terminating response.

Order of Presentation and Training Criterion

The order of presentation of CPS had been arranged into a 4 x 4 Latin Square within each block of four series.

The standard order of presentation of CPS and PPS within each block is represented in table IV. 32.

In the way formerly described, each subject received a training to the criterion of twenty series.

Table IV. 32

Experiment IV. Standard Order of Presentation in a Block of Four Pretraining Stimulus Series.

Series		Order of Presentation			
Number	Nature	1.	2.	3.	4.
I. 1	CPS	1	2	3	4
	PPS	1	1	1	1
I. 2	CPS	2	3	4	1
	PPS	2	2	2	2
I. 3	CPS	3	4	1	2
	PPS	1	1	1	1
I. 4	CPS	4	1	2	3
	PPS	2	2	2	2

Cell Numbers refer to Stimulus Numbers in Table IV. 31.

Test-Training Task

The essential features of the experiment IV test-training task have been made available in table IV. 33.

Table IV. 33

Experiment IV: Stimulus and Response Variation included in the Test-Training Task.

STIMULUS VARIATION							RESPONSE VARIATION
Orientation of One or More Component Line	COLOR						
	Green			Red			
Vertical	1 L* B	2 S F	3 S T	4 L P	5 L E	6 S H	"ONE"
Oblique	7 L A	8 S Z	9 S Y	10 L A	11 L Ø	12 S V	"TWO"

L* = Large Size (4 1/8 inch.) S** = Small Size (2 5/16 inch.)

As may be evident from the present table, twelve Roman capital letters constituted the test-training series of stimuli, the letters being systematically varied along three binary variables (SIZE, COLOR, and ORIENTATION of one or more component lines), and unsystematically varied along a fourth variable, that is, compound letter SHAPE:

Thus the SHAPE variable contained a number of unique values corresponding to the number of different stimulus members in the series.

Orientation of component lines in the letters constituted the relevant stimulus variable. Thus letters containing a vertical line had to be associated to "ONE" as a terminating response, and letters containing an oblique line would be associated in learning subjects with "TWO" as a verbal response.

Like the experiment III test-training stimuli, the present task involved the ratio of 1:3 of relevant to irrelevant variables.

Contrary to the former task, however, the experiment IV irrelevant stimulus variation involved no redundancy.

Responses

Contrary to all the previous criterion tasks, responses presumed to belong to the response repertoire of our subjects were utilized.

Originally the experiment had been designed and started with motor press responses instead of verbal terminating responses.

For reasons to be explained in the following paragraphs, however, the task had to be changed on this point.

As has been pointed out in section IV. 2. 1, feedback signals to a motor response, in pretraining, had been made dependent upon the subject's pressing on a button as well as upon the experimenter's turning over of a switch on the switch panel (fig. IV. 4, 16).

The switch, when being turned over, emitted an audible click preceding each presentation of a new stimulus pair. A new CPS, in turn, required the subject to shift his response from one button to a new one.

The shifting of response, it became apparent in the first series of the test-training task, had become conditioned to the click as a signal, the signal function being particularly evident in insecure or anxious subjects.

This detrimental artifact was detected because, during test-training, a click was produced prior to each new stimulus presentation (regardless of its relevance for a change of light signal) in order to prevent the subject's utilization of a click-no-click sequence as a cue to correct responding.

In order to avoid this artifact, therefore, two well-learned responses (that is, ONE and TWO) were substituted for the motor press responses producing a rapid transition in some of the subjects from a non-learned guessing state to a learned state.

Learning Criterion

The distinction between Learners and Non-Learners in experiment IV was based upon the criterion of 10 of more correct trials in a series of twelve.

Results

According to this criterion, 8 subjects solved the task within twelve test-training series.

L-NL-Dichotomy

The distribution of Learners and Non-Learners to several sub-samples has been presented in table IV. 34.

Table IV. 34

Experiment IV Subjects distributed according to the L-NL Dichotomy, Treatments and Levels.

L-NL Dicho-tomy	Treatments Groups and CA-Levels						Sums		
	A_1		A_2		A_3				
	L_1	L_2	L_1	L_2	L_1	L_2	L_1	L_2	T
L	1	0	0	3	2	2	3	5	8
NL	2	3	3	0	1	1	6	4	10
Sums	6		6		6		9	9	18

The trends revealed in table IV. 32 conform to the predictions contained in our hypotheses. The trends, however, failed to reach a significant level of confidence ($X^2_A = 3.04$, 2 df, $.3 > p > .2$), probably because of a small sample size.

The presumed effect of an uneven distribution of IQ-scores, if affecting the criterion score distribution at all, may have contributed to the marked A_2L_1-A_2L_2 difference. In the remaining levels of treatment, no such effect is discernable.

The A_2L_1-A_2L_2 difference may be attributed several kinds of individual differences, however, leaving the assumption proposed to be a mere assumption.

Number of Series to Criterion

Frequency distributions of criterion scores (that is, individual number of series to task solution) for the total experiment IV sample, and for treatment groups and CA-levels, are displayed in figures IV. 16, a and b, respectively.

Figure IV. 16, a

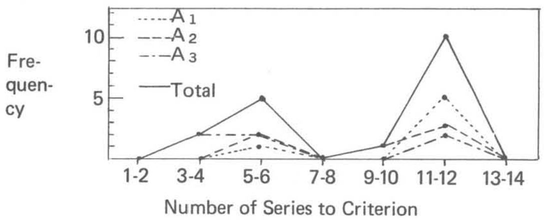


Fig. IV. 16, a: Experiment IV. Number of Series to Criterion. Distribution of Scores for the Total Sample and to each Treatment Group.

The frequency polygones demonstrate the trends apparent in earlier criterion score distributions.

An analysis of variance, therefore, will be used according to the premises applied to previous analyses (table IV. 35).

Fig. IV. 16.b

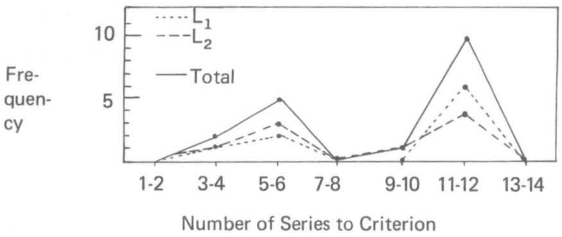


Fig. IV. 16. b: Experiment IV: Number of Series to Criterion. Distribution of Scores for the Total Sample and for each CA-Level.

Table IV. 35

Analysis of Variance of Experiment IV Criterion Scores (Number of Series to Task Solution):

Source of Var.	Df	ss	ms	F	p
Treatments (A)	2	40.78	20.39	2.29	$.2 > p > .1$
Levels (L)	1	4.49	4.49	.50	
A x L	2	39.00	19.50	2.19	$.2 > p > .1$
Within Cells	12	107.34	8.89		
Total	17	191.61			

Evaluation

In figure IV. 16. b, no trend clearly indicates the presence of an IQ-difference effect upon criterion scores for level sub-groups.

The same holds true for the analysis of variance data made available in table IV. 35. The main effect of levels, if substantially affected by the sampling differences revealed in table IV. 29, would be expected to reach a higher level than the value apparent in the present table.

The main effect of treatments, in contrast, though failing to reach the area of rejection of H_{OA}, after all reveals a clear trend in favor of our predictions.

This, of course, happens to be true only when treatment effects are our main concern. If treatments and levels are simultaneously taken into consideration, treatment effects, at least in part, are confounded with level effects, this fact being manifested in the comparably high F-value provided by the A x L-interaction.

A further analysis of simple effects (table IV. 36) reveals that four out of six cells (marked * in the table) contribute to the main effect of treatments, the four cells being evenly distributed among levels.

Table IV. 36

Experiment IV: Sub-Sample Means, and Several Comparisons between Sub-Sample Means. + - Number of Series to Criterion. ++ Number of Trials to Criterion.

		Means				Diff. between Means		
		A_1	A_2	A_3	A_{1-3}	A_1-A_2	A_1-A_3	A_2-A_3
Means	L_1	10.0+ 120.0++	12.0 144.0	7.3 87.6	9.8 117.6	- 2.0 -24.0	2.7* 32.4	4.7* 56.4
	L_2	12.0 144.0	7.0 84.0	7.3 87.6	8.8 105.6	5.0* 60.0	4.7* 56.4	-.3 -3.6
Diff.betw. Means	L_1-L_2	-2.0 -24.0	5.0 60.0	0.0 0.0	1.0 12.0			
Means	L_{1-3}	11.0 132.0	9.5 114.0	7.3 87.6		1.5 18.0	3.7 44.4	2.2 26.4

In table IV. 36, the higher value in each cell represents number of trials per criterion (marked ++), the lower value represents number of series per criterion (marked + in the table). The former kind of scores has been introduced in order to permit a comparison between subsamples in terms of a more sensitive category of scores, the distribution of which, however, prevented an analysis of variance.

A set of t-test comparisons of treatment groups, following the analysis of variance, revealed that only the A_1-A_3 difference approached the area of rejection ($t=2.15$, 12 df, $p < .05$).

Number of Correct Responses

A third comparison of treatment means, therefore, should be made in terms of individual number of correct responses, which may be considered an even more sensitive category of scores.

The distribution of scores within each treatment group indicated that a t-test and an alpha-level of .05 may be in order.

Individual comparisons of experimental groups (A_2 and A_3) with the control group (A_1) mean has been provided in table IV.37.

Table IV.37

Experiment IV: T-Tests of Differences between Treatment Groups. Number of Correct Responses-Data. M_{A1}(control) = 74.5, M_{A2}= 82.7, M_{A3}=94.7

	D	t	df	p
$M_{A2} - M_{A1}$	8.2	1.14	10	$.2 > p > .1$
$M_{A3} - M_{A1}$	20.2	2.24	10	$p < .025$

The tests revealed that the A_2-A_1 difference remained insignificant, while the A_3-A_1 difference entered the area of rejection.

The former t-value will be utilized, however, in an over-all estimate of A_2-A_1 differences (section IV.2.6).

IV. 2. 6
An Over-all Evaluation of Main Effects

The experiments so far described (sections IV. 2. 1-IV. 2. 5), though being individually different in certain respects, contain many aspects in common.

Introduction

The similarity between experiments has been extensively described in section IV. 2. 1 and need not be repeated here.

It seems correct to ascertain, however, that similarities between experiments by far exceed dissimilarities.

In this section, however, it is necessary to pay attention to dissimilarities among experiments, in order to examine the probability of being wrong while making a comparison between experiments.

Three main differences between experiments, two of which can be attributed to pretraining conditions, may threaten the validity of making a comparison between experimental results in the way to be described.

First, the number of pretraining trials were not equal in all experiments (table IV. 38).

Table IV. 38

The Number of Pretraining Trials in Experiments I-IV.

Experiment	I	II	III	IV
Number of Pre-training Trials	63	80	72	80

This difference, of course, does not prevent a between-treatment or a between-levels comparison of experiments.

It does, however, interfere with a between-experiments comparison of test-training scores. This point, it is supposed, needs to be further explained.

As will become evident in a later section, it is desirable to investigate the effect of differentially calibrated test-training tasks upon criterion scores. That is (1) the effect of different ratios of relevant to irrelevant stimulus variables (1/1, 1/3), and (2) the effect of different numbers of sub-categories contained in the stimulus set, each being associated to a different verbal response (2-choice and 3-choice problems compared; cf. table IV. 40).

The higher and lower numbers of pretraining trials (80 on the one hand, and 72 or 63 on the other), it appeared, happened to coincide with the distinction between two- and three-choice test-training problems, respectively.

A risk exists, therefore, that the effect of different numbers of choices to be learned, may be confounded with the effect of different amounts of pretraining.

This possibility, of course, has to be considered while evaluating the results.

Second, pretraining tasks have been differentially related to test-training tasks.

These differences, which may not be expressed in terms of numerical values, essentially concern the facility with which pretraining verbalization may be transferred or generalized to test-training stimulus values.

Drawing upon earlier investigations (e.g., MEDNICK & FREEDMAN, 1960), we may presume that the generalizability of a response principally depends upon the amount of similarity (or dissimilarity) between the stimulus to which the response had originally been associated, and stimuli to which the response is expected to generalize.

In our tasks, stimulus similarity (or dissimilarity) may be attributed values along specific stimulus variables.

Utilizing different amounts of similarity between pretraining and test-training stimuli as a criterion, a distinction may be drawn between experiments I and II on the one hand, and experiments III and IV on the other.

Thus in experiments I and II, the difference between relevant values in pretraining and test-training stimulus sets, respectively, is rather small.

In experiment III, relevant values differ considerably from pretraining to test-training stimuli, and in experiment IV, values verbalized during pretraining became concealed in intricately shaped test-training stimuli patterns, previously probably experienced by subjects as letters of the alphabet (and therefore, perhaps, possessed a character of "object"-wholeness which had to be broken down during analysis of component lines).

The latter distinction, it will become evident from table IV.40, coincides with the distinction made between a high and a low ratio of relevant to irrelevant stimulus variables.

Thus another risk of confounding causalities has to be considered.

Third, experiment IV test-training responses consisted of words probably well acquainted to subjects and frequently emitted by subjects to natural-environmental experiences.

Otherwise termed experiment IV subjects, contrary to previous subjects, did not have to learn the responses "from scratch" in experimental settings (though had to learn a new "meaning" of the words), this fact probably constituting a facilitation of task solution.

As will be demonstrated in a later chapter (section V. 2), subjects in the remaining experiments usually needed several test-training series to discriminate and correctly pronounce the nonsense trigrams utilized in experiments I-III.

On the other hand, experiment IV test-training started with motor terminating responses, thus delaying, with a comparable number of series, the conditioning of verbal responses to sub-categories of stimuli (p. 151).

It seems reasonable to assume, therefore, that the two counteracting effects described mutually neutralized each other.

Conclusion

It seems safe to conclude that the differences between experiments pointed out in the preceding paragraphs do not at all affect an over-all comparison of treatment groups and CA-levels.

This kind of comparison, of course, is our main concern.

They may, however, at least partly affect a between-experiment comparison of test-training task difficulty, if the ratio of relevant to irrelevant stimulus variables and the distinction between two- and three-choice tasks be applied as additional factors in a four-dimensional factorial design.

Yet the comparison will be made, however, the possible confounding of causalities being taken into consideration.

L-NL Dichotomy

As has been pointed out in section IV. 2. 1, the total sample of subjects participating in our laboratory experiments involved 99 children, nine of whom belonged to CA-level 3 (fig. IV. 6, p. 104; table IV. 2, p. 106).

Since L_3 appeared in experiment II only, it would be necessary to exclude L_3 subjects while making an over-all evaluation of main effects.

This exclusion does not affect the L-NL main effect of treatments, however, since L_3 subjects, regardless of treatment group membership, all belonged to the Learner sub-category.

In table IV. 39, the remaining 90 subjects have been distributed according to the Learner-Non--Learner distinction, treatment group membership, and CA-levels.

Table IV. 39

Distribution of 90 Learners and Non-Learners to each of Three Treatment Groups and each of Two CA-Levels.

L-NL	A x L						Treatments			Levels		Total
Dicho-tomy	A_1		A_2		A_3							
	L_1	L_2	L_1	L_2	L_1	L_2	A_1	A_2	A_3	L_1	L_2	
L	4	2	5	9	8	10	6	14	18	17	21	38
NL	11	13	10	6	7	5	24	16	12	28	24	52
Sums	15	15	15	15	15	15	30	30	30	45	45	90

$X^2_A = 10.19$ $X^2_L = .73$

2 df   1 df

$p < .01$ $.2 > p > .1$

The trends predicted, it may be seen, are evident in the present frequency distributions.

Only treatment group differences, however, happened to reach a significant level of confidence ($p < .01$).

A closer inspection of cell frequencies reveals that all treatment groups contribute to the significant Chi-Square, but that the differences between control groups (A_1), on the one hand, and experimental groups (A_2 and A_3), on the other, provide the higher values.

From a table of cell frequencies required to achieve significant Chi-Squares, we may read that the A_1-A_2 difference closely approached the .05 level and that A_1-A_3 differences reached beyond the .01 level of rejection of H_{OA}.

The A_2-A_3 difference, in contrast, failed to reach a significant level of confidence.

These results conform to our first and main hypothesis, including H-I-1 and H-I-4. H-1-2 concerns the criterion of series to task solution, and will be evaluated in the next section.

The failure of CA-level differences to reach a significant level of confidence, contradicts H-II-1, but may be considered a support for H-II-2.

Number of Series to Criterion

In the introduction to the present chapter, a description of the higher-order design to be applied to the final analysis of number of series to criterion was anticipated.

An A x B x C x L design will be used, in which A signifies three levels of treatment, L two levels of CA, B two separate ratios of relevant to irrelevant test-training stimulus variables, and D two distinct numbers of terminating responses, thus constituting a 3 x 2 x 2 x 2 analysis of variance design with cell frequencies equal to 3.

Subjects

In order to obtain equal cell frequencies, one half of experiment I subjects, that is 18 Ss, had to be excluded from the sample of 90 (cf. the preceding sect.).

This could easily be done, since, it may be remembered experiment I had been composed of two equivalent experiments performed at two different schools.

Experiment I. a became selected, since that part of the experiment had been performed at the same school as the remaining three laboratory experiments.

Thus 72 subjects constituted the total sample utilized in the final analysis (experiment II L_3 subjects, of course, being excluded from this sample as well).

Test-Training Task Variation

The experimental variables to-be applied in the higher-order experiment perhaps need a further elucidation.

In each of the two-way analyses formerly described, one subject classification variable (L) and one treatment (or pretraining) variable (A) was used.

Two additional treatment variables have been introduced, producing a higher-order experimental design involving four variables or factors.

The new treatment variables, it may be evident from table IV.40 (p.163), both constitute test-training task variables, one being a stimulus variable and the remaining one, a response variable.

An extensive description of the latter variables and values (B and C) has been provided in table IV.40.

The assembly of several specific data, displayed in table IV.40, clearly demonstrates the interrelationships among single experimental test-training tasks.

Distribution of Criterion

The problems of heterogeneity of form and variance of criterion score sample distributions, of course, are relevant to the present analysis of variance, as were they to earlier analyses.

However, an inspection of total sample distributions through-out experiments reveals homogeneity rather than heterogeneity of form and variance among experiments.

Table IV. 40

Interrelationships among Test–Training Tasks in Experiments I–IV:

B Ratio of R/I	C Number of respon.	EXPERIMENTS	STIMULUS VARIATION: N. of Stimulus Items in a Series	STIMULUS VARIATION: STIMULUS VARIABLES	Relevant (R)	Irrelev. (I)	R/I	VALUES	RESPONSE VARIATION: Number of R	Nature of R	Positively reinforced CUE–R connections
B_1 (1/1)	C_1 (2)	II	8	Shape Color 4 Substance Size	Color 2 Substance (Redundant)	Shape 2 Size	2/2 =1/1	2 □ △ 2 Gray, Light Yellow-Brown 2 Wood, Metal 2 Large, Small	2	Verbal: "KIB" "FOK"	Wood, Light Yellow-Br. ⇒ KIB Metal, Gray ⇒ FOK
	C_2 (3)	I.a	9	Shape 2 Color	Shape 1	Color 1	1/1	3 △ □ ⬭ 3 Blue, Green, Red	3	Verbal: "KEV" "VUK" "HOB"	Triangles ⇒ KEV Rectangles ⇒ VUK Ellipses ⇒ HOB
B_2 (1/3)	C_1 (2)	IV	12	Shape Color 4 Size Component line Orientation	1 Component line Orientation	Shape Color Size 3	1/3	12 Letters 2 Green, Red 2 Large, Small 2 Vertikal, Oblique	2	Verbal: "ONE" "TWO"	Vertical Lines ⇒ ONE Oblique Lines ⇒ TWO
	C_2 (3)	III	9	Shape Color 4 Pattern Pattern size	1 Pattern	Shape Color 3 Pattern size	1/3	3 △ □ ○ 3 Blue, Green, Red 3 Dotted, Striped, Squared 3 Large, Med., Small	3	Verbal: "TUK" "MÆF" "FÅB"	Dotted ⇒ TUK Striped ⇒ MÆF Squared ⇒ FÅB

It seems safe to assume, therefore, that the arguments advanced in section IV. 2. 2 apply to the present comparison of experiments.

Evaluation

In table IV. 41, the higher-order analysis of variance and the corresponding F-tests have been presented.

Since none of the interactions appeared to reach a significant level of confidence, the within-cells mean square has been used as an error term in order to compute F (LINDQUIST, 1954, p. 243).

Table IV. 41

Over-all Evaluation of Treatment Effects in which Four Laboratory Experiments are involved. N=72.

Source of Variance	Df	ss	ms	F	p
Treatments (A)	2	77.50	38.75	5.52	$.01 > p > .005$
Ratio of I/R (B)	1	8.70	8.70	1.24	
N. of Responses (C)	1	15.10	15.10	2.15	
CA-Levels (L)	1	0.00	0.00		
AB	2	2.80	1.40	.20	
AC	2	3.30	1.65	.23	
AL	2	9.00	4.50	.64	
BC	1	25.70	25.70	3.66	$.10 > p > .05$
BL	1	4.00	4.00	.57	
CL	1	.10	.10		
ABC	2	27.10	13.50	1.92	$p > .10$
ABL	2	4.50	2.25	.32	
ACL	2	39.20	19.60	2.79	$.10 > p > .05$
BCL	1	4.10	4.10	.50	
ABCL	2	18.90	9.45	1.35	
Within Cells	48	337.00	7.02		
Total	71	577.00			

Main Effects

Only one of the main effects, that is, the experimental treatment effect (A), happened to reach the accepted level of confidence, while a zero effect of CA-levels has been revealed in the present analysis.

The two remaining main effects indicate trends, none of which, however, approached the area of rejection.

The distinction between two- and three-choice tasks produced the more pronounced trend, as compared with the distinction between ratios of relevant to irrelevant stimulus variables (1/1 and 1/3, respectively).

Interactions

Two interactions approached, but failed to reach the accepted area of rejection, that is, the BC and the ACL interactions.

Since neither the main effects involved (except for A) nor the interactions were significant, however, it would be superfluous to make further analyses of the data producing those interactions.

Comparing Treatment Means

A comparison of treatment means and differences between treatment means (table IV.42), displays a pattern of relations which conforms to the predictions involved in our first hypothesis.

Table IV.42

Mean Number of Series to Criterion in Experiments I-IV. Differences between Treatment Means. N=72.

Treatment Means			Diff. between Means		
A_1	A_2	A_3	A_1-A_2	A_1-A_3	A_2-A_3
11.25	10.00	8.71	1.25	2.54	1.29

The numerical differences between treatment means may seem small. It should be remembered, however, that they represent series of trials, and that non-learning subjects who failed to reach the learning criterion nonetheless received a score of 12.

Non-Learners, in turn, were by far the most frequent in the A_1 sub-groups (table IV.39, p. 160).

A set of t-tests following the analysis of variance, revealed that both the A_1-A_2 and the A_2-A_3 differences approached, but failed to reach the area of rejection, while the A_1-A_3 difference appeared to be highly significant ($t=3.32$, $df=24$, $p<.005$).

In general, the present analyses strongly support the predictions involved in hypotheses I-2 and partly, I-4:

1 The over-all evaluation of treatment differences in terms of number of series to criterion is highly significant (table IV.41).

2 Predictions concerning the A_1-A_3 difference (N-I-4) have received significant support in the present analyses.

3 Predictions concerning the A_1-A_2 difference received support, but the difference failed to reach the accepted level of confidence while evaluated by means of a t-test.

4 The A_2-A_3 difference was not expected to reach a high level. It was expected, however, to obtain a value numerically lower than the A_1-A_2 and the A_1-A_3 differences.

In the present analysis (table IV.42), the A_1-A_3 difference exceeds the A_2-A_3 difference, while the A_1-A_2 difference does not.

In previous analyses (except for exp. IV), however, a clear trend has been manifested in favor of our predictions concerning the A_1-A_2 and A_2-A_3 differences (e.g., table IV.39, p. 160).

Number of Correct Responses

The more interesting prediction (as compared with the A_2-A_3 difference) concerns the difference between A_1 and A_2 sub-groups.

The prediction that A_2 excels A_1 has received support in all experiments. The difference reached a significant level of confidence only in experiment I, however.

For this reason it is desirable to make an over-all comparison of A_1 with A_2 groups in terms of number of correct responses emitted in all series of an experiment which, it has been argued, constitute a more sensitive measure than the remaining ones.

The statistic used is one prescribed by WINER (1962, pp. 43 - 45), when it is desired to combine several independent tests on the same hypothesis.

According to this method, the probabilities of independent t-tests of differences may be tested by means of a Chi-Square, utilizing the formula

$$X^2 = 2\sum u_i,$$

where $u_i = -\ln P_i$.

The X^2 statistic under these conditions may be assumed to have a sampling distribution "which is approximated by the Chi-Square distribution having 2k degrees of freedom" (k = number of independent t-tests).

In table IV.43, natural logarithms of P_{I-IV} (with signs changed) have been utilized in order to compute Chi-Square.

Table IV.43

An Over-all Estimate of Differences between Control Groups (A_1) and A_2 Groups in Terms of Number of Correct Responses.

Experiment	t_{obs}	Probability	-ln (probability)
I	3.44	.005	5.30
II	1.75	.1	2.31
III	1.19	.2	1.61
IV	1.14	.2	1.61
			10.83

$$X^2 = 2(10.83) = 21.66$$

$$X^2_{.99}(8) = 20.1;\ X^2_{.995} = 22.0$$

From table IV.43 we may read that the A_2-A_1 differences when combined, reach beyond the .01 area of rejection of H_O-I-3.

It is not necessary to make a comparable computation involving A_3-A_1 differences, since the confidence levels obtained in the corresponding t-tests (experiments II-IV) are more favorable than those applied to the present analysis.

In terms of the present over-all evaluation we may confidently reject H_O-I-3, therefore, and enter the rival hypotheses contained in our hypothesis I-3.

IV. 2. 7 Hypotheses I and II Reconsidered

We are now in a position to review our hypotheses I and II in terms of the evidence reported in sections IV. 2. 1 to IV. 2. 6.

An alpha level of .01 has, for reasons formerly discussed, been accepted as the lower limit of the area of rejection of H_O when analyses of variance are involved. In the remaining analyses, an alpha level of .05 has been accepted.

H_O, of course, predicts that experimental sub-samples may be considered drawn from a common parent population, so far our criterion scores are concerned.

The opposite prediction is contained in our hypotheses, that experimental sub-groups, while evaluated in terms of criterion measures, may be considered drawn from different parent populations.

The criterion scores in our laboratory experiments contain the distinction between Learners and Non-Learners in criterion concept learning tasks, in the first place, and the rate of learning theses tasks, in the second.

A third measure, that is, the individual number of correct responses emitted during test-learning, has been introduced in order to permit more accurate comparisons between treatment sub-samples.

As has been pointed out, these measures may be considered indicative of the subjects' capability of solving the stimulus selection sub-processes in concept learning. (This point will be further discussed in chapters V and VI.)

Two main variables, one of which constitutes an experimental or treatment variable, and one a classification or developmental variables, have been introduced in order to predict differential effects of treatments upon retardate concept learning.

Treatment Effects (Main Hypothesis)

The treatment variable includes three levels of treatment, one of which (i. e., A_1) constitutes the control condition.

The remaining two experimental conditions represent, in part, different kinds of verbalization during pretraining concept acquisition.

The verbal pretraining included verbal labels for the to-become-relevant stimulus variables and values (A_2 and A_3 subjects), and in A_3 subjects only, verbal labels for abstracted similarity and dissimilarity (e.g., "similar SHAPE", "not similar SHAPE", "similar COLOR", "not similar COLOR", etc.) among simultaneously presented stimulus items.

It has been predicted that the learning (or reactivation) of such verbal labels and the integration of verbal with non-verbal experiences may facilitate stimulus selection in retardate concept test-training.

Hypothesis I

This, it may be recognized, constitutes the main content of our first and main hypothesis (sect. III. 4).

The hypotheses will not be reproduced here, only the evidence for and against them.

H-I-1

H-I-1 has been tested by means of the Chi-Square test applied to the Learner-Non-Learner dichotomy.

H-I-1 received support in all except one (i. e., exp. II) of our laboratory experiments. H_O-I-1 may be considered rejected by data obtained in experiment I (fig. IV. 7, p. 118), and by the over-all estimate of treatment effects (table IV. 39, p. 160).

The A_1-A_2 difference approached the area of rejection in experiment I and in the over-all test of treatment effects, while the A_1-A_3 difference appeared to be highly significant when tested in the same sets of data.

In the remaining single experiments, low cell frequencies probably contributes to the non-significant results.

H-I-2

In very much the same way H-I-2 received support throughout our experiments in analyses of variance of individual number of series to task solution.

Thus H_O-I-2 may be considered rejected by evidence obtained in experiment I and in the over-all evaluation of treatment effects (sections IV. 2. 2 and IV. 2. 6).

The A_1-A_2 difference reached a significant level of confidence in experiment I, but failed to reach the area of rejection in the final (over-all) estimate of treatment effects.

The A_1-A_3 difference approached the area of rejection in experiment IV, and appeared to be highly significant in experiment I and in the over-all evaluation of treatment effects.

H-I-3

H-I-3 involved predictions concerning treatment group differences in number of correct responses emitted during criterion learning. The treatment group differences have been tested by means of t-tests, and an alpha level of . 05 was accepted for those test.

H-I-3 received clear support in all experiments, but H_O-I-3 may be considered rejected only by data obtained in experiment I, and partly, by data obtained in experiments II and IV.

H_O-I-3 may be considered rejected, also, by the over-all estimate of treatment group differences.

Thus the A_2-A_1 difference reached a high level of confidence in experiment I and in the combined evaluation of t-test probabilities (section IV. 2. 6).

The A_3-A_1 difference appeared highly significant in all except one experiment (exp. III).

H-I-4

H-I-4 predicted a trend in differences rather than testable presumptions concerning differences.

According to this prediction, A_1-A_2 and A_1-A_3 differences were expected to exceed A_2-A_3 differences.

In general, this prediction received support in our data. It was contradicted by the experiment IV data, however, and the trend did not become evident in the over-all analysis of variance data.

H-I

In the light of evidence reconsidered in terms of our main hypothesis, it seems justified to reject H_O-I, and enter the rival hypothesis, which constitutes the content of our first hypothesis.

That is, in terms of criterion scores, control groups and experimental groups may be considered drawn from two separate populations, the latter of which contain more concept learners and more effective concept learners.

The experimental subjects may be considered transformed from the former to the latter population in the course of pretraining treatments, given in order to facilitate test-training stimulus selection and therefore, test-training concept learning.

Effects of Incidental Learning and Maturation (Secondary Hypothesis)

Another variable, that is, the classification of a comparably homogeneous IQ-group into two CA-levels (M_{L1} = 110.8 months, M_{L2} = 138 months), has been introduced in order to evaluate the effect of increased MA (i.e., a mean time of 2 1/4 years of incidental learning and maturation), upon the utilization of implicit verbal labels in retardate concept learning.

H-II-1

Several trends have appeared in our data in favor of H-II-1. No trend reached the area of rejection, however.

The results obtained when introducing a third and higher level of MA in experiment II, indicate that an extended period of development may be necessary in order for an adequate verbal learning and integration to occur in mentally retarded children.

In experiment II, the L_3 sub-sample (mean CA= 165.9 months), significantly excelled the L_2 group (mean CA = 138.7 months), while the L_1-L_3 difference failed to reach the accepted level of alpha.

Experimental verbal pretraining in L_3 subjects proved to have no facilitating effect upon test-training concept learning, that is, experimental groups did not excel the control group.

The latter fact may be taken to indicate that verbal labels, adequate to the task in question, had been acquired and had become adequately integrated with other chains of behavior prior to experimental pre-training in L_3 subjects.

With respect to the L_1-L_2 difference, however, H_O-II-1 may not be rejected.

H-II-2 A partial rival hypothesis, that is, H-II-2, will be tentatively accepted, therefore, and will be held as a working hypothesis for further investigation.

The notions involved in hypotheses I and II have been further elaborated in hypothesis III, which shall be evaluated in the face of evidence obtained in a field experiment to be dealt with in the next section.

IV.3 THE FIELD EXPERIMENT

The field experiment has been devised and performed for two main purposes, (1) in order to test our third hypothesis, and (2) in order to evaluate the possibility of adapting the methodological aspects inherent in our laboratory procedure to a special school education of mentally retarded children.

IV.3.1 Sampling of Subjects and Teachers

32 subjects were sampled in the field experiment, from eight special schools, from two levels of CA, and from one interval of IQ (60-69).

The total sample and several sub-samples (i.e., treatment and CA sub-samples) of subjects have been represented in terms of the two sampling criteria in tables IV.44 and IV.45.

Table IV.44 The Field Experiment. The Total Sample of 32 Subjects represented in Terms of IQ-Data.

IQ-- Inter-vals	A_1		A_2		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	Total
60-61	1	1	1	1	2	2	4
62-63	2	2	1	2	4	3	7
64-65	1	2	2	1	3	3	6
66-67	2	1	1	1	3	2	5
68-69	2	2	3	3	4	6	10
N	8	8	8	8	16	16	32
M	65.4	64.8	65.6	65.1	65.5	64.9	65.2
SD	2.8	2.9	2.7	3.2	2.8	3.0	2.9
N_A	16			16			
M_A	65.1			65.4			
SD_A	2.9			3.0			

Schools

Two schools were residential institutions. The remaining six were day schools.

Residential and day school pupils had been equally distributed to the experimental and to the control conditions.

Table IV. 5

The Field Experiment. The Total Sample of 32 Subjects represented in Terms of CA-Intervals (in months).

CA--Inter-vals	A_1		A_2		Sums		
	L_1	L_2	L_1	L_2	L_1	L_2	Total
100-104	2				2		2
105-109	3		2		5		5
110-114	2		3		5		5
115-119	1		3		4		4
120-124		1		3		4	4
125-129		4		1		5	5
130-134		1		2		3	3
135-139		2		1		3	3
140-144				1		1	1
N	8	8	8	8	16	16	32
M	108.4	129.9	112.1	129.5	110.3	129.7	120.0
SD	4.5	5.2	4.0	5.7	5.0	5.5	11.0
N_A	16		16				
M_A	119.1		120.8				
SD_A	11.9		10.0				

The experimental subjects (A_2) were trained in four groups of 4 (i.e., 16 Ss), each group being sampled from a different school and trained by a different teacher.

The control or A_1 subjects (except for two) had been sampled from the remaining four schools, and received no specific training beyond the training given in calssrooms and by speech therapists.

Teachers

The experimental teachers, of course,had been sampled from experimental schools, and included one qualified special teacher, one speech therapist, and two kindergarten teachers.

The teachers thus selected, who may be considered a representative sample of the teacher population in special schools for mentally retarded, debile children (at least at the CA-levels selected), received a one-week training course in the procedures to-be utilized in experimental conditions.

During teacher training, the procedures were taught by means of a specifically written booklet, in which the rationale for training procedures, as well as the training procedures themselves had been sketched (FYRILEIV,HOPE,FOLLERÅS & NYBORG,1967).

IV.3.2
Experimental Conditions

The experiment was performed during the last three-and-a-half months of 1968.

During these months, experimental subjects received one training lesson (45 minutes) a day, five days a week.

67 concepts were taught, all which may be considered belonging to GOSS category I concept learning tasks. The concepts involved in the training tasks have been recorded in the appendix, pp. 244-245.

Training Procedure

Three steps were included in the teaching of each concept.

In the first, or selective association phase, an attempt was made to establish associations between several and different non-verbal stimuli and labels for a stimulus value and the corresponding variable.

Through many and different instances, the subjects were trained to identify a particular value and the corresponding variable by means of adequate verbal labels.

In the second, or selective discrimination phase, which, of course, also included many and different instances, the subject was trained to abstract and discriminate the relevant value from a set of values belonging to the relevant stimulus variable (e.g., squared shape from triangular or circle shapes).

Each discrimination had to be followed, in the subject, by a verbal response to the value discriminated and the stimulus variable selected.

Finally, in a third group of tasks, i.e., the selective generalization phase, the subject was required to identify two or several "objects" (from a larger sample of "objects"), all of which had a common value along the relevant stimulus variable.

Again, the following motor identification, the subject had to identify by verbal labels, both the stimulus variable, the value in consideration and labels for partial similarity (e.g., "they are similar in shape").

It may be noted that the experimental training thus described represents an adaptation of treatment A_3, in our laboratory experiments, to the classroom teaching of a small group.

The classroom teaching of a small group of children is probably more favorable to the learning in retarded children, however, since it puts less restrictions upon the experimental leader.

The results, in turn, may be generalized to other classroom situations, which, of course, constitute the ultimate goal of educational research.

In the generalization and discrimination phases, a "door" panel proved particularly favorable in the training of experimental subjects.

A vertical panel equipped with five small doors prevented the subject's view into the teacher's side when he placed reinforcing incentives behind each "correct" door.

On the subject's side of the doors, cards showing stimulus patterns could be fastened by means of sliding tracks.

When opening the "correct" door (discrimination) or the sub-set of correct doors (discriminated generalization), the subject would find an incentive behind it.

He would not receive the incentive, however, until he had verbalized the relevant stimulus variable and value, and, in generalization, the similarity of values along the relevant stimulus variable.

Training Program Recorded

The training procedure, including non-verbal and verbal stimuli (i.e., instructions), the motor and verbal responses expected from the subject, and different kinds of information feedback or reinforcement had been described in detail and recorded verbatim for each of the concepts trained.

Thus a booklet covering 200-250 pages was provided for each of the experimental teachers, containing a "programmed instruction", derived from the principles of learning psychology previously described.

Further, a large supply of stimulus material, to be used individually or in groups, was provided for the teachers.

This was done (1) in order to prevent a mis-understanding on the part of the experimental teachers, and (2) in order to homogenize treatments throughout groups.

Examples of the training procedure utilized (none of which are identical with those used in the experiment, however) are available in the work previously referred to (FYRILEIV, HOPE, FOLLERÅS, NYBORG, 1967, pp. 49-51, pp. 68-105).

Examples drawn from the actual training program have been provided in the appendix, pp. 246-256.

IV. 3. 3
Control Condition

The control "training" may be inferred from curricula and from reports given by teachers whose classes included one or several control subjects.

Concepts, according to these sources, would be trained in control subjects as well, but without the rationale and procedures provided to experiment-tal teachers.

That is, the control teaching would not be systematic to the same extent as the experimental teaching. It would not be based upon learning psychology and upon an evaluation of the specific retardate concept learning deficits. It probably constituted paired-associates learning, rather than concept learning.

IV. 3.4
Criterion Test

14 concepts, randomly sampled from the population of 67 concepts taught, constituted the content of the concept test utilized to test the effect of differential trainings upon two CA-levels.

Each of the 14 concepts thus selected were tested in a separate sub-test involving 8 items.

A sub-test was designed to test selective identification (association) (2 items), selective discrimination (2 items), and selective generalization (4 items), all of which may be considered fundamental to an adequate concept utilization.

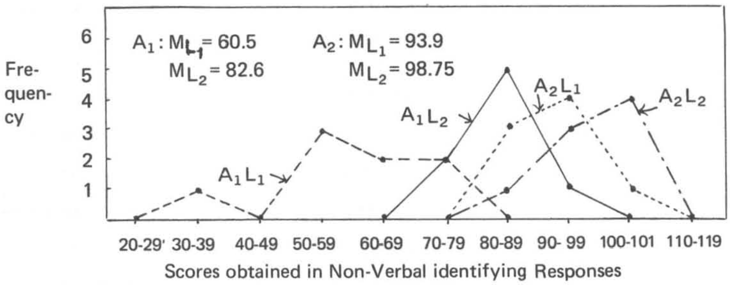
Responses to test items were either motor or verbal identifying responses. In the latter case, labels denoting stimulus variables, values, and similarity along variables, had to be emitted in order for a response to be deemed correct.

The test had been constructed by one of our co-workers, TURID LYNGSTAD, who also administered the test to individual control and experimental subjects at the end of the training period.

IV.3.5 Results

The distribution of scores obtained by the subjects in non-verbal and verbal responses to test items are represented in figures IV.7, a, b and c.

Fig. IV.7.a



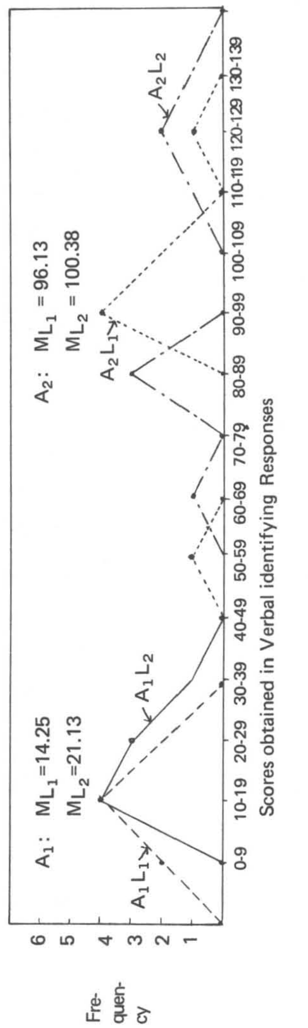
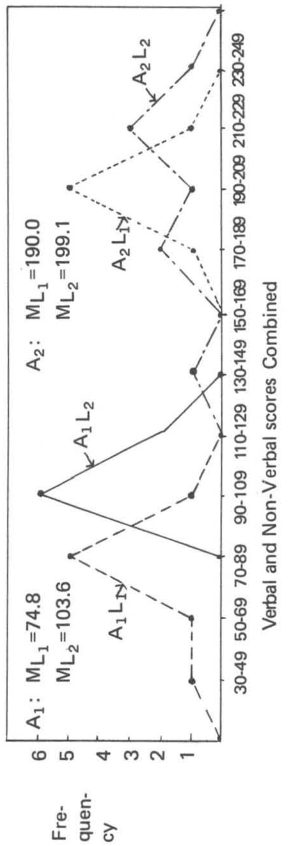


Fig. IV.7: Scores representing Correct Motor Responses (a) Verbal Responses (b) and Combined Verbal and Motor Identifying Responses (c) to Criterion test Items.



Two-Way Analysis of Variance	Neither form nor variance of sub-sample distributions seem to be extremely heterogene.
	A higher level of alpha (i.e., a .05 lower level of rejection) is accepted, therefore, while testing main effects and simple effects of experimental variables.
Main Effects	The main effects of treatments reached a high level of confidence regardless of the measure considered (i.e., non-verbal, verbal, or combined verbal and non-verbal ($p < .001$)).
	The main effect of CA-levels upon criterion scores differed somewhat according to the type of score considered.
Combined Scores	The effect of CA upon the combined verbal and non-verbal scores reached beyond the .05 level of rejection (F-test: $.025 > p > .01$). No interaction was manifested.
Motor Responses	A comparable effect of CA-levels upon the motor responses reached a significant level as well ($p < .001$). An interaction effect disturbed the latter picture, however ($.025 > p > .01$), indicating that the effect of A_2 is not essentially different for the two CA-groups (fig. IV. 7. a).
	This point will be further elucidated in the analyses of simple effects.
Verbal Responses	In verbal responses, the CA-level effect did not even approach the area of rejection of H_O, and no interaction effect was manifested.
Simple Effects	Analyses of simple effects have been performed in terms of t-tests, by which the following levels of confidence were obtained (table IV. 46):

Table IV.46 Field Experiment. T-Test of Simple Effects.

Difference	Direction		Combined Scores	Motor Responses	Verbal Responses
$A_1:L_2-L_1$	+	M_D	28.8	22.1	6.75
		t	3.84	4.03	1.87
		p	$p < .005$	$p < .005$	$p < .05$
$A_2:L_2-L_1$	+	M_D	9.1	4.9	4.25
		t	.64	1.29	.35
		p	-	-	-
$L_1:A_2-A_1$	+	M_d	115.2	33.4	81.9
		t	10.8	6.21	10.23
		p	$p < .0005$	$p < .0005$	$p < .0005$
$L_2:A_2-A_1$	+	M_d	95.5	16.2	79.4
		t	7.96	4.08	8.1
		p	$p < .0005$	$p < .005$	$p < .0005$

All comparisons: One-Tailed Test, 14 df.

IV.3.6 Hypothesis III Reconsidered

The predictions contained in our third hypothesis have received a rather strong support in the present data and tests.

H-III-1

Thus H-III-1 received convincing support in the treatment (A_2-A_1) differences manifested in verbal responses to test items.

H-III-2

The treatment differences (A_2-A_1) predicted in H-III-2 are manifested in motor response as well as in combined score differences between treatment groups.

H-III-3

Finally, the failure in experimental groups of L_2 subjects to exceed L_1 subjects was predicted in H-III-3.

H_O-III may confidently be rejected, therefore, and the rival hypothesis (H-III) is entered and will be held as a future working hypothesis.

It holds (1) that the treatment groups, subsequent to the training period, may be considered drawn from two separate parent populations, so far as our criterion scores are concerned, and (2) that the CA (L_2-L_1) difference has become indistinct in experimental groups while remaining distinct in control groups (i.e., may be considered drawn from one and two parent populations, respectively).

More specifically, it seems possible, through adequate training procedures, to considerably improve the concept learning and raise the level of conceptual achievement in mentally retarded children.

IV.3.7
Evaluation

The results obtained in our field experiment clearly belong within the area of special education. It may be in order, therefore, to relate our data to results obtained by other investigators within the same area of special educational research.

Reviews of special educational research (e.g., S.A.KIRK, 1965, pp. 57-99) provide no information that may serve the purpose of a relevant comparison, however.

While related to the experience frequently reported by special school teachers that mentally retarded children manifest a low level of conceptual achievement and only slowly proceed to higher levels, our results appear to be highly promising.

They conform remarkably well to the prognosis made by M.RAY DENNY (1965), after reviewing learning studies in the ares of mental retardation:

> The outlook for the mentally retarded is surprisingly optimistic - at least theoretically. It should be possible to develop motivational procedures and special training techniques to overcome an appreciable portion of the retardates' difficulties, at least to the extent that they relate to the closely connected deficits in incidental learning, attention, and verbal control. These defects might be amenable to correction by (1) long-term training to attend or orient to stimuli, especially verbal stimuli, and (2)

motivating the retarded children sufficiently and building in what they failed to learn incidentally during the early years, as, for example, with speically designed programmed teaching machines.

(M. RAY DENNY, 1965, p. 136).

V A SET OF DATA WHICH IS ONLY PERIPHERICALLY RELATED TO THE HYPOTHESES

In this chapter a set of laboratory experimental data more loosely related to our hypotheses will be dealt with and discussed.

Thus in section V. 1, an analysis of test-learning errors will provide the basis for a discussion of possible multiple causation of retardate concept learning deficit.

In section V. 2, a set of learning curves will be presented and related to the continuity-discontinuity controversy in learning theory.

V. 1 ANALYSIS OF ERRORS

Three separate kinds of test-training errors have been observed and recorded throughout the laboratory experiments: (1) "Intrusions" (i. e., "correct" responses used to wrong stimuli), which constitute the major part of all errors, (2) "No-Responses", and (3) "Invented" or wrong responses, both of which prevail in the initiating series of trials.

V. 1. 1 "Intrusions"

The labels "Intrusions" and "Invented Responses" have been used in accordance with BAUM's (1954) terminology (NYBORG, 1970a, pp. 120-133).

Thus "Intrusion" error has been used to denote an incorrect choice of a terminating response from the sample of task-relevant responses.

Making "Intrusion" errors, according to BOWER & TRABASSO (1964), may be considered parts of the stimulus-analysis and -selection processes, in which the subject, in a trial-and-error fashion, samples stimulus elements (e. g. ,values along stimulus variables) and (in the learning subject) selects the relevant stimulus elements according to a schedule of information feedback.

Figures V. 1-V. 3 demonstrate that "Intrusion" errors prevail in all except the first 2-4 series of trials, depending, in part, upon how many "new" verbal and terminating responses had to be learned prior to the stimulus-analysis and -selection.

Fig. V. 1

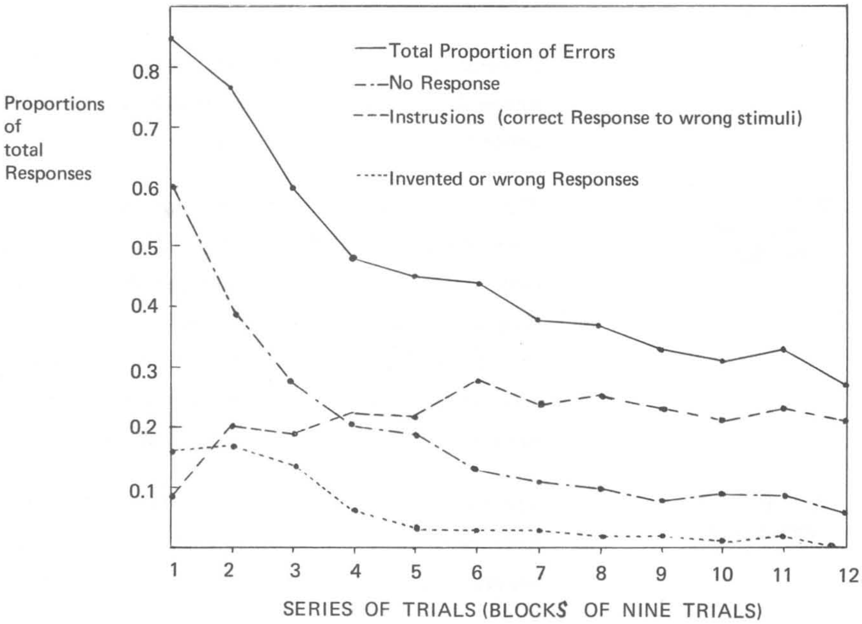


Fig. V. 1: Exp. I Total Proportion of Errors Distributed to Three Sub-categories of Errors and to Twelve Blocks of Nine Trials.

Fig. V. 2: Exp. II Total Proportion of Errors distributed to Three Sub-categories of Errors and to Twelve Blocks of Trials.

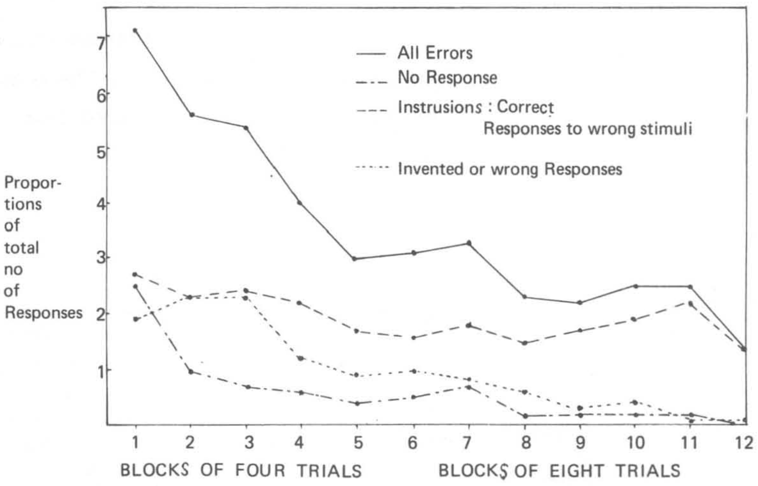


Fig. V. 3: Exp. III Total Proportion of Errors distributed to Three Sub-categories of Errors and to Fifteen Blocks of Nine Trials.

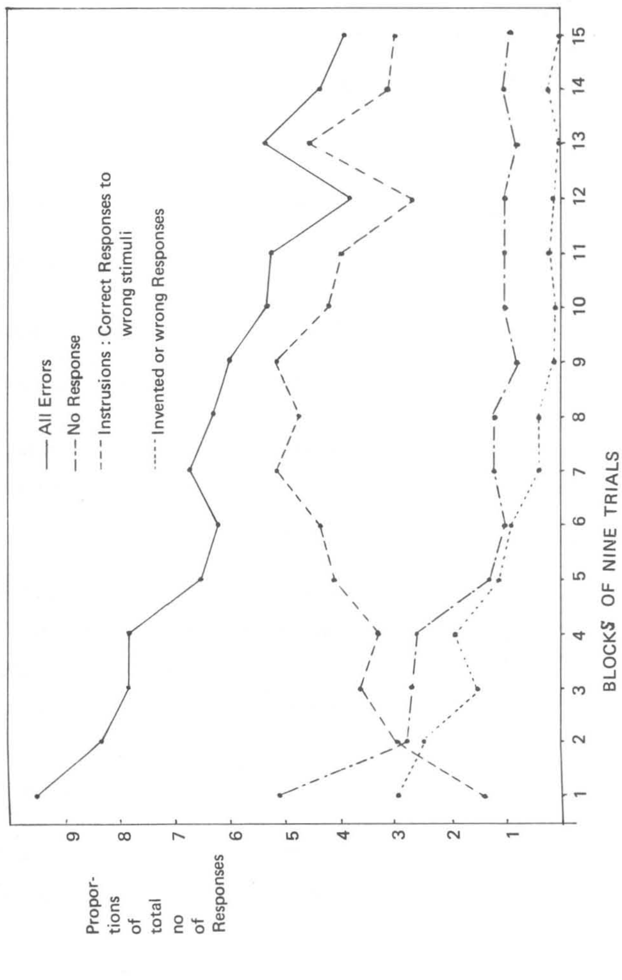


Figure V.4 displays the pattern of errors when no new responses had to be learned (Exp. IV), that is, the terminating responses had been sampled from the subject's repertoire of well-learned verbal or motor responses.

Fig. V.4

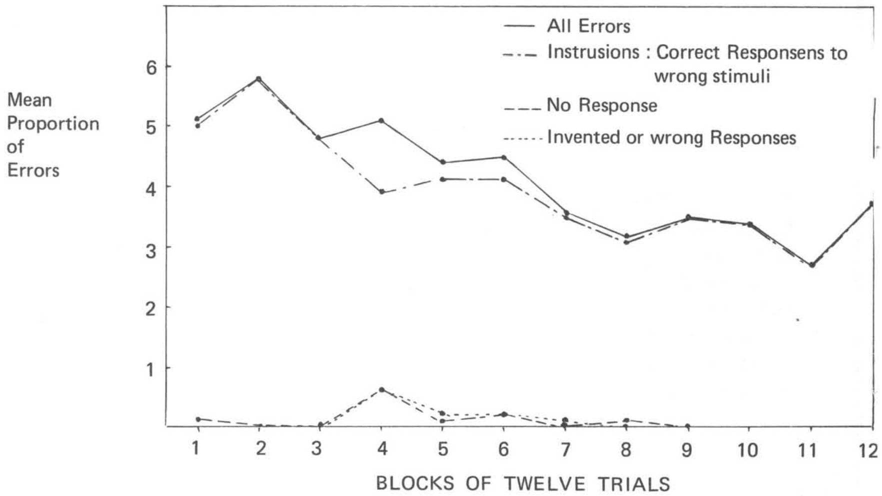


Fig. V.4. Exp. IV Total Proportion of Errors distributed to Three Sub-categories of Errors and Twelve Blocks of Twelve Trials.

In the latter case (i.e., Exp. IV, fig. V.4), "Intrusion" errors prevail throughout the entire test-training period.

The pronounced discrepancy between figures V.1-3, on the one hand, and figure V.4, on the other, may be interpreted in the following way: the stimulus-analysis and -selection processes may not adequately take place in the subject until the "new" responses have been discriminated and correctly articulated.

In the period of learning to discriminate and differentially articulate the responses, "No-Responses" and "Invented Responses" constitute the major parts of the error pattern.

It may be noted, however, that the latter categories of errors persist in minor proportions throughout most of the series.

This fact may be indicative of specific learning deficits on the part of a minor sample of subjects.

In the following sections this hypothesis will be further investigated and evaluated.

V.1.2 Interpretation of "No-Response" as an Error Alternative

Prior to the discrimination of verbal stimuli repeatedly presented by the experimenter, and the differentiation of the subject's own speech responses in experiment I-III test-trainings, "No-Responses" and "Invented" responses constituted considerable proportions of the total number of errors.

Usually these errors tended to be reduced or even disappeared in most of our laboratory subjects.

In some of the subjects, however, these errors appeared in a greater proportion or persisted in considerable proportions beyond the first two or three series of trials.

In table V.1, the frequency distribution of "No-Response" scores to three experiments (I-III) and to seven Standard score intervals has been presented.

It indicates that 15 subjects out of 81 received a score deviating $\mp$ .75 Standard Deviations or more from the group means.

It seems possible to interpret an extremely high or low "No-Response" score in terms of the LURIAn concept of "disequilibrium between excitatory and

Table V. 1: Frequency Distribution of "No-Response" Scores in Three Experiments and to Seven Standard Score Intervals.

Standard Score Intervals		Exp. I M_p=.195	Exp. II M_p=.049	Exp. III M_p=.164	Total
-1.49	-.75	5	0	1	6
- .74	.00	16	17	13	46
+ .01	+.75	11	8	1	20
+ .76	+1.50	1	1	1	3
+1.51	+2.25	2	0	0	2
+2.26	+3.00	0	0	2	2
+3.01		1	1	0	2
N		26	27	18	81
Raw Score Data		M=21.0 SD=20.4	M=3.5 SD=5.3	M=22.1 SD=29.4	

inhibitory higher nervous system processes".

According to LURIA (1963), the detrimental effect of a minor brain injury may be manifested in a strong domination of inhibitory over excitatory nervous processes, or vice versa.

Extremely High "No-Response" Scores

Thus an extremely high (positive) "No-Response" score may be coordinated to a disequilibrium in which inhibitory processes prevail.

One of our subjects, who displayed a pattern of errors including the proportion of .972 (z=4.12) of "No-Responses", became deemed experimentally mortal for these reasons (Exp. I. b).

Several other subjects, however, received a "No--Response" score reaching beyond +1 SD from the mean of their sub-sample. The patterns of errors of these subjects are presented in table V. 2.

It may be noted that all except one of the subjects represented by error scores in table V. 2 are Non-Learners in the sense previously defined.

Table V. 2: Individual Error Patterns for Subjects who received an Extremely High "No-Response" Score.

Subject No.	Exp. No.	Proportion of "No--Responses"	Corre-sponding Z	Total Pro-Portion of Errors	L	NL	Propor-tion of Intrusion	Corre-spond-ing Z	Propor-tion of In-vented Rs	Corre-spond-ing Z
35	I	.972	+ 4.12	.972		x	.000	-1.20	.000	-.85
69	III	.726	+ 2.58	.911		x	.178	-1.31	.007	-.81
64	III	.704	+ 2.48	.770		x	.015	-2.40	.052	-.34
9	I	.583	+ 2.06	.639		x	.028	-1.04	.028	-.42
7	I	.546	+ 1.86	.805		x	.250	+ .19	.009	-.70
73	III	.437	+ 1.26	.889		x	.348	- .17	.104	+.21
47	II	.389	+ 4.62	.556	x		.083	- .69	.083	+.04

A relatively high "No-Response" score is typically combined with a high total proportion of errors and with correspondingly low "Intrusion" and "Invented Response" scores.

In the remaining learning subject a comparatively high "No-Response" Standard score is combined with a relatively low proportion of "No-Response" errors and a low total proportion of errors.

The high Standard score, in this case, may be ascribed the low mean proportion of "No-Responses" specific to experiment II (table V. 1).

It has already been pointed out that the error pattern in these subjects may be interpreted to manifest a domination of inhibitory over excitatory "higher nervous system processes".

This interpretation, of course, does not constitute the only possible interpretation.

A high "No-Response"-score could as well be interpreted in terms of deviating motivational and emotional conditions in the subject.

Thus, according to the Social Learning Theory (SLT) concept of generalized expectancy of failure, we should expect that a retardate, in whose history failure experiences by far have exceeded success experiences in number, would display a low "potential of behavior", at least until a situationally determined expectancy of success replaces the generalized expectancy of failure (CROMWELL, 1963; NYBORG, 1969, pp. 138-158).

Further, according to AMSEL et al. (e.g., AMSEL & HANCOCK, 1957), a strong disposition for making mediational frustration responses (r_f) would interfere with a response which makes a new frustrating (and therefore, an emotionally negatively loaded) experience likely.

When no clear evidence of brain injury has been observed in the subject, the latter interpretations are more convincing.

Interpretation of a Low "No-Response" Score

When a subject received a low "No-Response" score, this observation may be even more difficult to interpret (table V. 3).

Table V. 3

Individual Error Patterns for Subjects who received a Low "No-Response" Score:

Subject No.	Exp. No.	Proportion of "No-responses"	Corresponding Z	Total Proportion of errors	L	NL	Proportion of "Intrusions"	Corresponding Z	Proportion of Invented Rs	Corresponding Z
70	III	.000	-.75	.593		x	.400	+.18	.193	+ 1.16
43	II	.000	-.66	.083	x		.083	-.69	.000	- .81
49	II	.000	-.66	.042	x		.014	-1.16	.027	- .53
50	II	.000	-.66	.458		x	.375	+1.27	.083	+ .04
52	II	.000	-.66	.042	x		.014	-1.16	.027	- .53
57	II	.000	-.66	.458		x	.431	+1.64	.027	- .53
60	II	.000	-.66	.431		x	.292	+ .71	.139	+ .61
63	II	.000	-.66	.236	x		.194	+ .06	.042	- .39
28	I	.009	-.98	.648		x	.407	+1.07	.231	+ 2.68
34	I	.018	-.93	.120	x		.018	-1.10	.083	+ .42
12	I	.028	-.88	.694		x	.620	+2.26	.046	- [illegible]
36	I	.028	-.88	.046	x		.009	-1.15	.009	- [illegible]
21	I	.037	-.83	.324	x		.241	+ .14	.046	- [illegible]

A low proportion of "No-Response"-errors may be combined with the status of being a Learner (L) or a Non-Learner.

In the former case (that is, in learning subjects), a low proportion of "No-Responses" is usually combined with a low total proportion of errors.

In Non-Learning subjects, a low proportion of "No-Responses" may be combined with (1) a comparably high proportion of "Intrusions" (Subjects no. 12, 50, and 57), (2) a high proportion of "Invented Responses" (S. no. 70), or (3) both (S. no. 28).

One of the subjects represented in table V. 3 does not conform to any of the classification patterns (S. no. 60).

Only when an extremely low proportion of "No-Responses sponses" is combined with a high proportion of "Intrusion" errors (Ss no. 12, 28, 50, 57, may it be considered indicative of an extreme and detrimental excitatory disequilibrium.

Such subjects, though numerically few, have actually been observed in our samples. The typical performance of those children was reflected in a rapid responding, that is, the response was emitted immediately subsequent to the stimulus presentation, the short interval between stimulus presentation and response emission rendering an intervening and mediating process unlikely.

It remains difficult to assess, however, whether this kind of performance may be ascribed a defective nervous system, as has been suggested by LURIA:

It obviously reveals a lack of "normal" inhibition, necessary in order for mediating processes to occur in the subject.

The lack of inhibition may be, but need not be attributed to a brain injury.

Again an interpretation in terms of detrimental emotional conditions in the subject may be more valid, particularly when the neurological findings are negative.

Even when valid indications of a brain injury have been observed, however, emotional disturbances which may be considered consequences of many failures due to an anomalous CNS, may contribute to a disinhibited pattern of behavior (e.g., K. GOLDSTEIN: catastrophic reactions).

According to GOLDSTEIN (1943), a "catastrophic reaction" (i.e., a strong and temporary emotional disturbance) may be manifested in an extremely inhibited (i.e., rigid) or in an extremely disinhibited pattern of behavior.

V.1.3 Interpretation of a High "Invented--Response" Score

The third and final category of errors observed, was "Invented-Response" errors, that is, the utilization in test-learning situations of responses which did not belong to the sample of task-relevant responses.

Most of our subjects made such errors, particularly at the beginning of a test-learning period (Exps. I-III).

Only a minor part of our subjects made a greater proportion of "Invented-Response" errors or persisted in making "Invented" responses throughout.

In table V.4 we may read that 11 subjects out of 81 received an "Invented-Response" score reaching beyond +1 SD.

Table V.4 Frequency Distribution of "Invented-Response" Scores in Three Experiments and in Five Standard Score Intervals.

Standard Score Intervals	Exp. I M_p=.056	Exp. II M_p=.079	Exp. III M_p=.084	Total
- .99 .00	24	17	12	53
+ .01 +1.00	7	7	3	17
+1.01 +2.00	3	1	2	6
+2.01 +3.00	1	1	0	2
+3.01 +4.00	1	1	1	3
N	36	27	18	81
Raw Score Data:	M=6.0 SD=7.1	M=5.7 SD=7.0	M=11.3 SD=12.7	

The "Invented" responses most frequently observed represent <u>distortions</u> of task-relevant nonsense syllables.

The distortions included <u>reversals</u> (e.g., VEK substituted for KEV), <u>substitution</u> of a sound belonging to another trigram, for the correct sound (e.g., V<u>E</u>K instead of V<u>U</u>K), or replacing a correct sound with a similar sound (e.g., VU<u>G</u> substituted for VU<u>K</u>).

When a subject displayed an extreme articulatory disturbance (e.g., caused by a cleft palate), his response would be accepted as a correct one in spite of an articulatory distortion, but only when the distortion could be ascribed the articulatory defect.

Another, though less frequent error, was the <u>substitution</u> of a well-learned meaningful word for a task-relevant nonsense syllable (e.g., HOBBY for HOB).

A high score of "Invented" responses has been interpreted as indicating a <u>specific speech defect</u> on the part of a subject.

It is not possible on the basis of our data to assess which speech function had been disturbed in each case.

The defect may be localized in the subject's discrimination of verbal sound stimuli, in the elaboration and storing of afferent cochlear impulses in the brain, or in the decoding processes which may be considered fundamental to a correct vocalization.

It is possible, however, at least to some extent, to evaluate the effect of a high "Invented-Response" score upon concept learning (table V.5).

Table V.5 Individual Patterns of Errors in Subjects who received a High "Invented-Response" Score.

Subject No.	Exp. No.	Proportion of "Invented" Response	Corresponding Z	Total Proportion of Errors	L	NL	Proportion of "Intrusions"	Corresponding Z	Proportion of "No" Responses	Corresponding Z
41	II	.403	+ 3.33	.542	x		.083	- .69	.056	+ .09
75	III	.370	+ 3.05	.719		x	.333	- .27	.015	- .68
38	II	.292	+ 2.20	.375	x		.056	- .88	.027	- .28
20	I	.287	+ 3.52	.352		x	.009	-1.15	.056	- .74
51	II	.264	+ 1.90	.500		x	.194	+ .06	.042	- .09
68	III	.244	+ 1.71	.607	x		.333	- .27	.030	- .62
28	I	.231	+ 2.68	.648		x	.407	+1.07	.009	- .98
70	III	.193	+ 1.16	.593		x	.400	+ .18	.000	- .75
2	I	.148	+ 1.41	.741		x	.444	+1.28	.148	- .25
13	I	.148	+ 1.41	.713		x	.509	+1.64	.056	- .74
31	I	.148	+ 1.41	.259	x		.037	- .99	.074	- .64

From table V.5, which displays individual patterns of errors for 11 subjects each of whom received an "Invented-Response" score greater than +1 SD, we may conclude that a high "Invented-Response" score does not inevitably and completely interfere with concept learning. Thus four subjects out of eleven (i.e., subject no. 31, 38, 41, 68) did solve the actual concept learning problem.

Only when a high proportion of "Invented" responses is combined with a relatively low proportion of "Intrusions" in the <u>Non-Learning</u> subject, may we safely assume that speech disturbances have considerably interfered with concept learning (Ss no. 20, 51,70,75).

Concept learning is prevented also when a high "Invented-Response" score is combined with a high "Intrusion" error score (Ss no. 2, 13, 28).

We may not confidently infer, however, what kind of errors, "Intrusions" or "Invented-Response" errors, have caused the failure of learning in the latter subjects. Most likely the combined pattern of errors determined the unsuccessful learning.

In neither of the cases represented in table V. 5, "No-Responses" proved to constitute an essential part of the error pattern.

V. 1. 4 Conclusion

Three categories of errors, each of which constituted part of a total pattern of errors, have been interpreted in terms of psychological processes.

The main proportion of errors consisted of "Intrusion" errors, psychologically interpreted to constitute an essential and necessary part of stimulus-selection processes.

"Intrusions" prevailed in the last 8-10 series of trials in three experiments (Exps. I-III). In the initiating series of trials, "No-Response" and "Invented-Response" errors contributed considerably to the total pattern of errors.

This fact has been psychologically interpreted to manifest a learning period in which auditorily presented word stimuli are discriminated and stored, and the subjects' own speech responses become differentiated in (most of) the subjects.

A minor sub-sample of subjects deviated considerably from the mean proportion of "No-Response" and "Invented-Response" errors. In addition, they persisted to make such errors for a greater number of series.

An extremely high proportion of "No-Response" errors has been taken to indicate a large amount of inhibition on the part of a subject, while a low proportion of "No-Response" errors may, but need not, manifest a below normal amount of inhibition.

Inhibition and disinhibition may be further interpreted in terms of deviating conditions in the central nervous system (e.g., disequilibrium between excitatory and inhibitory "higher nervous system processes"), or in terms of deviating motivational and emotional conditions in the subject (e.g., generalized expectancy of failure and corresponding "frustration responses" and "catastrophic reactions").

Finally, an extremely high proportion of "Invented-Response" errors has been interpreted in terms of speech disturbances which extend the area of motor-articulatory functions.

V.2
DATA BEARING UPON THE CONTINUITY-DISCONTINUITY CONTROVERSY

The continuity of learning, reflected in continuously rising learning curves, has at length been emphasized by many investigators in the area of learning psychology (e.g., HULL, 1930, SPENCE, 1936, BURKE & ESTES, 1957).

In recent years, however, the discontinuous components of learning, previously emphasized mainly by Gestalt psychologists, have been considered by several S-R-psychologists (e.g., BOWER & TRABASSO, 1964).

In the present section, some implications of the BOWER & TRABASSO (1964) "All-or-None" mathematical model of concept identification will be reviewed and evaluated in terms of our laboratory data (NYBORG, 1970a, pp. 153-171).

In figures V.5-V.8 our laboratory-experimental data have been plotted according to a procedure, similar to the one used by BOWER & TRABASSO, that is, in terms of mean probabilities of correct responses (1) obtained in blocks of trials and (2) obtained prior to task solution (in the present report, pp. 28-33).

The curves, therefore, reflect mean probabilities obtained by a decreasing number of subjects, starting with the entire sample of subjects and terminating with the sub-sample of Non-Learning subjects.

Discontinuity

While so processed, the experiment IV data produced a learning curve (fig. V.5) similar to the one obtained by TRABASSO (NYBORG, 1970a, p. 156), and may be said to reflect an "All-or-None" performance.

As has been pointed out, the "-none" state of performance (characterized in Exp. IV by a mean proba-

Fig. V.5

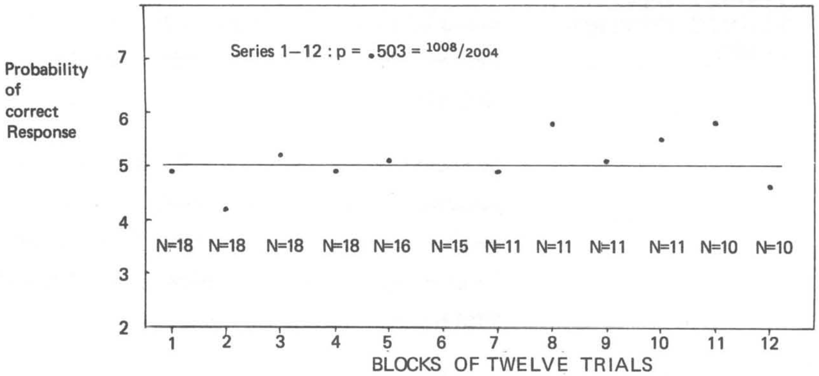


Fig. V.5: Exp. IV Mean Probability of Correct Responses Prior to solution in Twelve Blocks of Twelve Trials.

bility of .503 of being correct), may be coordinated with an unlearned, guessing state of performance, and may further be assumed to reflect a stimulus-analyzing and -selecting process in the subject who has still not learned or is not capable of learning the test-training task.

The learning subject, who at a given point of training leaves the unlearned state, manifests a quick transition from this state to a new and learned (All- or absorbing) state, characterized by a probability=1 of being correct in each trial or in each block of trials.

This description seems to be valid when the task-relevant responses have been previously acquired by the subjects.

Continuity

When an entirely new set of responses, i.e., a set of a priori nonsense syllables has to be learned in the course of training, the picture becomes more complex (figures V.6 - V.8).

In figure V.10, the curve manifesting the probability of using TUK correctly, departs from the remaining learning curves early in the training period, that is, it rises faster and to a higher terminating level.

Fig. V.10

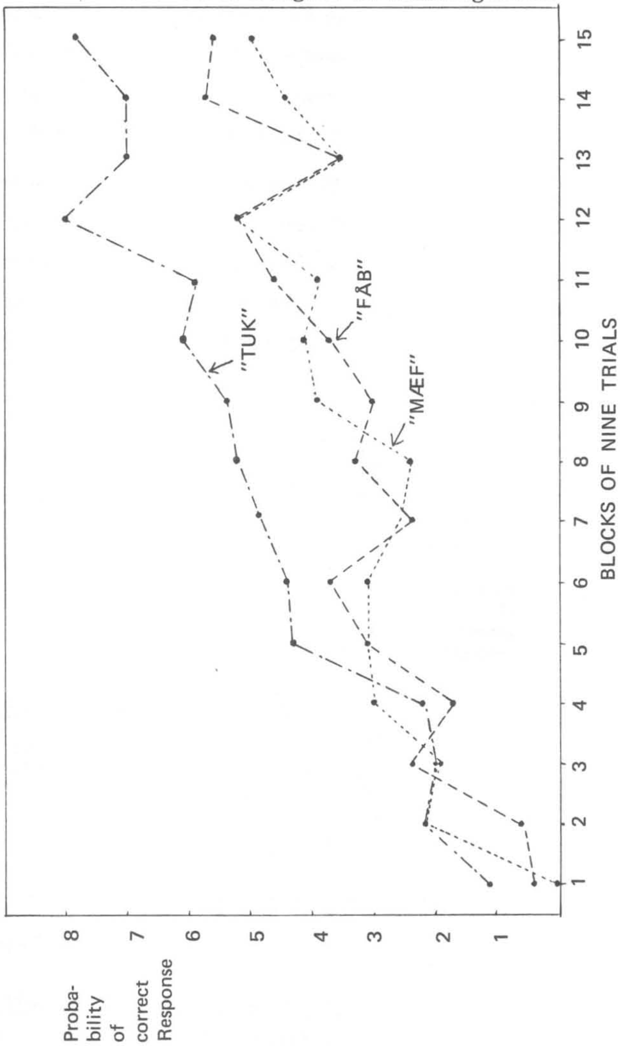


Fig. V.10: Exp. III Mean Probabilities of making Correct Differential Responses (TUK, FÅB, MÆF) in Fifteen Blocks of Nine Trials.

Particularly when the curves rise at different rates, this may be reflected in the mean total learning curve in terms of plateaus.

discontinuity prevails after all.

A further component of continuity may be added when three-choice rather than two-choice tasks be used.

In the former case, one sub-set of stimuli may be more easily discriminated (Exps. I and III), or one response may be more easily discriminated and differentiated than the remaining two (Exp. I).

This fact is reflected in the learning curves depicted in figures V. 9 and V. 10, both of which are plotted on the basis of three-choice data, when compared to the learning curves displayed in figures V. 11 and V. 12, which are based upon two-choice data.

Fig. V. 9

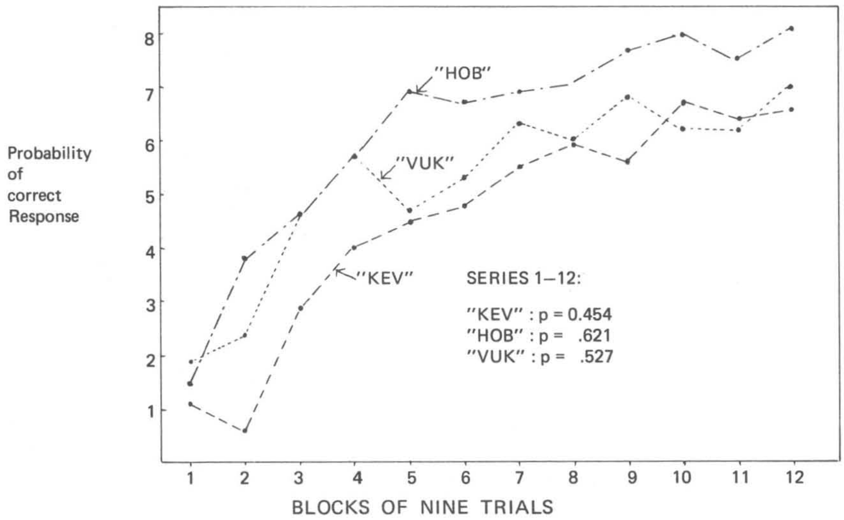


Fig. V. 9: Exp. I Mean Probabilities of making Correct Differential Responses (HOB, VUK, KEV) in Twelve Blocks of Nine Trials.

In figure V. 9, HOB may be seen to lie on a consistently higher probability than KEV, and, in most series, higher than VUK.

Thus in figures V.6 - V.8, the performance during the first three or four series displays a curvilinear rise from a low to a higher probability, the latter of which approximates a rectilinear curve running at a constant distance from the abscissa.

Fig. V.6

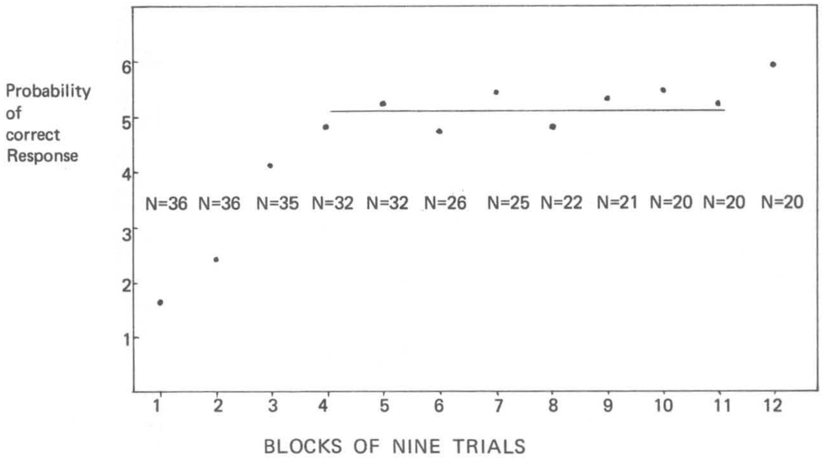


Fig. V.6: Exp. I Mean Probability of Correct Responses prior to solution in each Block of Nine Trials.

Fig. V.7

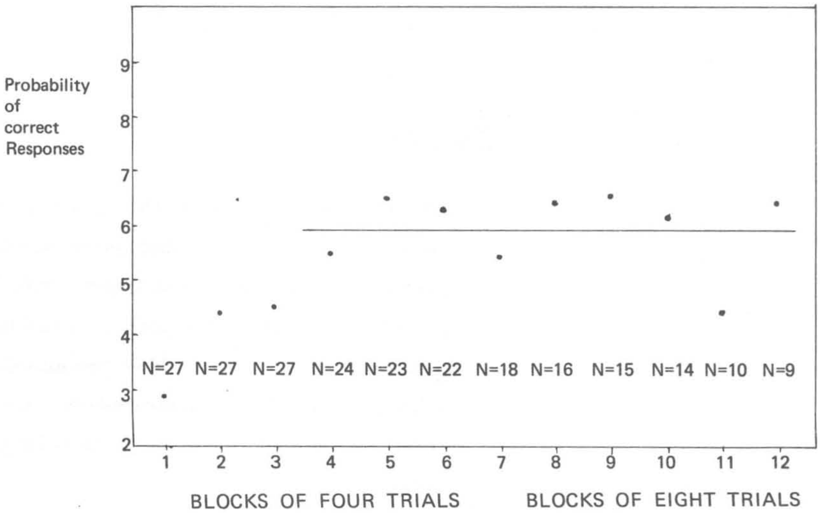


Fig. V.7: Exp. II Mean Probability of Correct Responses prior to solution in each of Twelve Blocks of Trials.

Fig. V. 8

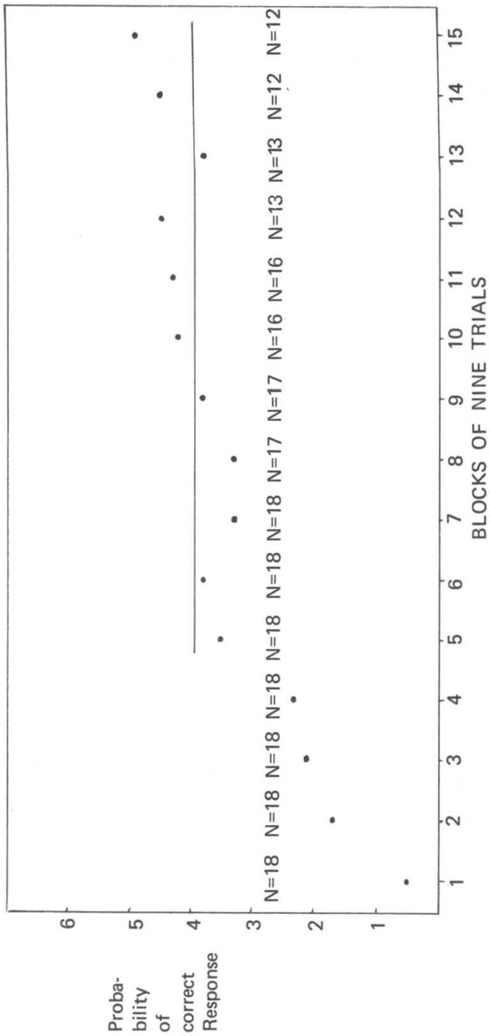


Fig. V. 8:
Exp. III Mean Probability of Correct Responses prior to Task Solution in each Block of Nine Trials.

As has been indicated by the analysis of errors, the rising curve describing the performance during initiating series of trials, may be interpreted as manifesting a period of learning in which the nonsense syllables become discriminated (as stimuli) and differentiated (as responses) in the major part of the subjects belonging to a sample.

It may be evident that this period adds a component of continuity to a picture in which, however,

Fig. V.11

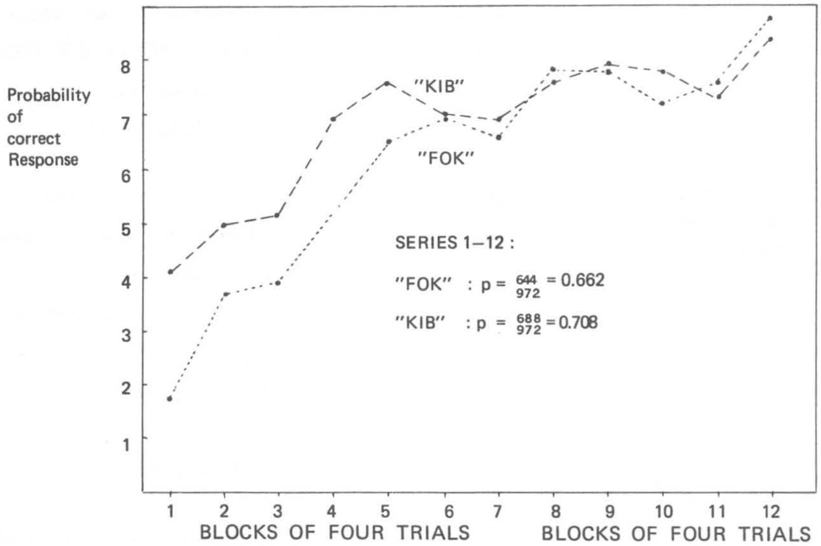


Fig. V.11: Exp. II Mean Probabilities of making Correct Differential Responses (KIB, FOK) in Twelve Blocks of Trials.

Fig. V.12

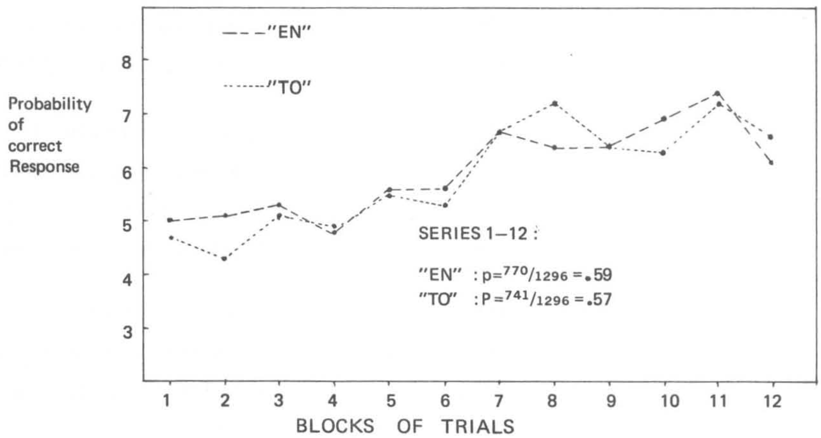


Fig. V.12: Exp. IV Mean Probabilities of making Correct Differential Responses (EN, TO) in Twelve Blocks of Twelve Trials.

Reminiscences of separate plateaus are clearly evident in the Exp. III mean learning curve (fig. V. 8: series 5-9 and series 10-14 may be interpreted to manifest two separate plateaus), but evidence of a temporary plateau may be detected in figure V. 6 as well (the marked rise at the right-hand end of the curve may manifest a transition to a new plateau).

Conclusion: Continuity and Discontinuity

If these conclusions are valid, i. e. , that a higher degree of continuity enters the "All-or-None" learning curve (1) when new terminating responses have to be learned, not only the correct utilization of responses previously learned, and (2) when two-choice tasks are replaced by multiple-choice tasks, a different interpretation of the continuity-discontinuity problem may be possible.

A learning curve which solely reflects discontinuity (e.g. , fig. V. 5), may be assumed to be <u>part</u> of a learning curve which <u>initiates prior</u> to experimental learning and, probably, continues beyond the training period.

This interpretation, it may be recognized, conforms to the view advanced by CULLER & GIRDEN (1951).

If this interpretation is valid, learning should not be considered <u>either</u> continuous <u>or</u> discontinuous, but both continuous <u>and</u> discontinuous, depending upon the <u>unit</u> and <u>kind</u> of learning investigated.

Obviously the tasks selected by BOWER & TRABASSO (like our Exp. IV task), represent a unit and kind of learning that may take place in a predominately discontinuous fashion.

The tasks utilized in our experiments I-III may be said to represent extended units in which a continuous response-learning adds to a discontinuous learning in correctly utilizing the responses in a concept learning problem.

VI SUMMARY AND FINAL DISCUSSION

VI. 1 SUMMARY

Mental retardation has been reviewed, in this report, in terms of a failure to develop an adequate "conceptual nervous system" (ch. III).

The conceptual deficit is supposed to reflect in below "normal" scores obtained in tests of general intelligence and in a poor adaptation to environment (impaired "maturation" and learning).

A "conceptual nervous system" may be thought to develop in the course of a period, starting at birth (or even before birth) and continuing until development terminates in a person.

The development may be considered dependent upon the number and nature of experiences made by the organism, as well as upon the conditions in and maturation of the organism's central nervous system.

It may further be conceptualized in terms of an increasing integration and organization of single cells of the nervous system (primarily of the CNS) into subordinated and superordinated structures, representing classes of interrelated environmental events. These structures of the CNS may later function as facilitators of adequate perceptions, learning, thinking, and behavior (ch. II).

The integration and organization of separate and partly dissimilar stimulus events into classes, represented in the organism in terms of CNS-structures, may be assumed to depend upon several processes, some of which, for several reasons, may be ineffective in the retarded organism.

Thus it has been argued (and partly, demonstrated) that when associations, generalizations, and discriminations have to be combined with complex stimulus-analysis and -selection in incidental concept formation and controlled concept learning, the integration and organization may not adequately take place in the retardate.

This kind of deficit may be ascribed several and different, environmental or organic causes.

The attention, in this report, has been drawn (1) to the probable importance of language as a mediator of abstractions (i.e., stimulus-analysis) and selective associations, generalizations, and discriminations, and (2) to the language deficits frequently observed in mentally retarded children.

The language deficit is most clearly manifested in a limited repertoire of observable verbal responses and in the failure of retardates to correctly articulate words.

It has been argued, however, that a more fundamental language deficit is manifested in the failure of the retardate to effectively utilize "verbal coding systems" (i.e., consisting of words or greater units of natural language and representing conceptual similarity and dissimilarity) as a means, by which he analyzes complex stimulus patterns and selects the relevant stimulus components, and thereby, as a means of regulating output behavior.

It has been suggested by the present writer, therefore, that an extended verbal training may facilitate stimulus-analysis and -selection, provided that the training includes verbal labels which may later function as verbal "analyzers" and "coders" in concept learning and incidental concept formation.

The effect of verbal training, however, may be assumed to depend heavily upon the integration of verbal with non-verbal coding systems.

The verbal training, therefore, may not be mere verbal. Verbal labels, including labels denoting partial similarity, have to be learned in the face of classes of non-verbal stimuli to which verbal responses, implicitly or explicitly emitted, are expected to generalize.

The training, also, must include verbal abstractions (i.e., analyses) and selections of relevant stimulus variables, along which later selective generalizations and discriminations may take place.

It has been suggested, in chapter IV, how this kind of training may be arranged in laboratory (treatments A_2 and A_3) and classroom settings (treatment A_2) so far as GOSS category I concept learning tasks are concerned.

It is considered a necessary condition and a specific achievement of our design that laboratory procedures (i.e., A_3) have been adapted to fit the classroom teaching of small groups of mentally retarded children.

This was done, primarily, in order to demonstrate that it would be possible to apply the laboratory pretraining procedures to a natural classroom setting which is not uncommon in special schools, and thus, in order to increase the generalizability of the laboratory experimental results.

Experimental treatments, developed along the lines previously described (i.e., A_2 and A_3), have proved (1) to positively affect test-training concept learnings (laboratory experiments) and (2) to positively transfer to the performance in a post-test, in which the subjects were required to identify (within a new context) concepts previously acquired (the field experiment).

The control condition, in the latter case, was introduced (1) in order to make possible the utilization of a post-test-only design, and (2) in order to control for the confounding impact of subject "history" and "maturation" upon experimental results (CAMPBELL & STANLEY, 1967).

VI. 2 ATTEMPTS TO REACH AN INTEGRATION

It remains, in the present chapter, to make more detailed assumptions of how and why experimental treatments positively affected test-learning and test performance in our subjects.

For this purpose a set of miniature models has been constructed.

The models and constructs utilized may not be considered an achievement specific to the present writer. They draw heavily upon models and constructs previously reported and discussed (ch. II) and may be considered extensions and adaptations of previous models of our spcific experimental conditions.

VI. 2. 1 Test Learning

In figure VI. 1, experiment I test-learning is represented in terms of initiating stimuli, presumed mediating responses and stimuli, terminating responses, and feedback given to terminating responses.

The model describes what may be thought to take place in the learning subject after the nonsense trigrams, utilized as terminating responses, had been acquired by the subject.

Emphasis has been placed, in the present model, upon the stimulus analyzing and selecting processes, presumed to precede the selection of terminating responses.

A response-selecting mechanism within the organism, rendering the reactivation of and choice from among a set of experimenter-defined "nonsense" syllables possible, has not been accounted for in the model, therefore, only the manifested choices of terminating responses.

What happened or may have happened during the "stimulus-analysis and -selection" parts of test-learning has been sub-divided into two main categories of events, i. e., observable events and presumed intervening events, the latter of which may be regarded - in part - as an impact upon test-learning of previous learning, including the pre-training conditions.

Fig. VI. 1

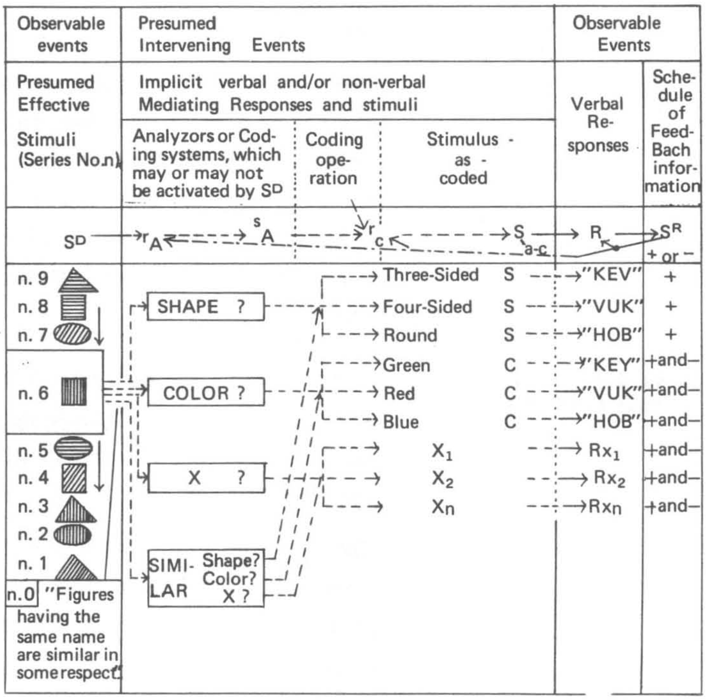


Fig. VI. 1: A Model describing what may be assumed to take place during Exp. I Test-Learning after the Acquisition of Terminating Responses. Verbal and Non-verbal mediating Responses probably acquired or reactivated during Pretraining: Non-verbal Analyzers and Coding Values: A_1, A_2, and A_3; Verbal Analyzers and Coding Values: A_2 and A_3; Partial Similarity verbalized: A_3 only.

The Observable events include (1) a set of experimenter-defined stimuli or discriminanda, which precede the possible intervening events, and (2) a set of terminating responses, which may be considered a consequence of stimulus reception and intervening events.

Depending upon the subject's terminating response, (3) a negatively (-) or positively (+) reinforcing signal is fed back to the subject, indicating an incorrect or a correct choice of terminating response, respectively.

Discriminative stimuli (lefthand column) include a randomly selected presentation (n) of the complete set of Exp. I test-training stimuli, in the first place, and a verbal instruction involving a simple definition of a concept, in the second.

The instruction (n. 0), presented prior to each new series of stimuli, was presumed to create a set or active search, in the subject, for abstracted similarity among sub-groups of stimuli.

Only one stimulus pattern, that is, no. n. 6, stays, at the moment of modelling, within the subject's field of perception. The remaining eight discriminanda have either been presented (n. 1-n. 5) or remain to be presented (n. 7-n. 9).

Responses

In each trial, the subject is supposed to emit one out of three (a priori nonsense) word responses.

Feedback Information

Only when each response is emitted in the face of a specific value along the relevant shape variable, that is, a "three-sided" shape (KEV), a "four-sided" shape (VUK), and a "round" shape (HOB), the subject consistently receives a positive feedback signal. When no systematic choices or incorrect systematic choices are manifested, the response would be either negatively or positively reinforced, depending upon the coincidence of a relevant value with the irrelevant cue selected by the subject.

Intervening Events

Reinforcing stimuli are supposed to feed back, not only to the choice of a terminating response, but also - and this may be considered more important - to the mediating events which may be thought to precede and are basic to the choice of a terminating response.

Intervening or mediating events may be further conceptualized in terms of a verbal and/or non-verbal "processing" in the organism, of stimuli, anteceding (S^D) and following (S^R) a response.

In complex concept learning, "processing" may include an analysis of discriminanda into two or several stimulus variables, and the selection of values along one or more variables as the occasion for emitting responses.

Stimulus Analysis or Abstraction

The analyzing process may be considered facilitated by and dependent upon the existence in the organism of a set of "analyzers" or "coding systems", each involving a set of "coding values", by means of which stimuli may be coded (s-a-c).

The "coding systems" may be considered ordered representations and integrations, in the organism, of many and dissimilar experiences, similar, however, in certain respects. They may be non-verbal and verbal representations in a human being.

A verbal coding system may be thought to consist of a set of interrelated words of the social language, one of which is the common reference for the remaining ones (e.g., color, shape, etc.). The words may be implicitly activated, as parts of an intervening process, or explicitly emitted, as an observable response or as parts of a verbal statement.

If sufficiently integrated with "non-verbal" experiences, the verbal coding system may be capable of mediating, in an organi sm, the conceptual similarities and dissimilarities represented in its environment.

Within the present formulation, the word "color", serving as a common reference for a set of color names, may exemplify a verbal coding system into which current experiences may be coded or "assimilated".

The corresponding "non-verbal" coding system may be thought to emerge from a large set of color experiences, somehow or the other ordered and stored within the organism.

Thus the term non-verbal is used to denote stimuli which are not mediated by any kind of social language and corresponds roughly to what PAVLOV and later Russian psychologists have termed "the first signal system" or "the direct signals of reality".

The latter or non-verbal systems may be considered the more fundamental, since they may be manifested in the behavior of infrahuman organisms and in human organisms lacking an ordinary language skill.

In contrast, verbal coding systems (or coding systems involving some kind of social language), whenever available, may be presumed to mediate the high level of "abstractions" proved possible in man. Thus, complex learning, problem solving, and "abstract thinking" may be considered facilitated by man's high level of language skills.

Pretraining Treatments: Generating or reactivating Verbal Coding Systems Systems

In the present research project, the effect of utilizing verbal "analyzers" or coding systems on test-training concept learning has been investigated. This was made possible, through pretraining procedures, by equalizing non-verbal stilulus presentation over treatments, and by varying the amount and nature of verbal pretraining.

Thus A_1 subjects received no verbal pretraining.

Exp. I A_2 and A_3 subjects were trained to describe pretraining stimuli in terms of color and shape and the corresponding color and shape values (green, red, blue; three-sided, four-sided, round).

In this way it was attempted to build up or reactivate, in A_2 subjects, a color and a shape coding system, being verbal in nature and adding to the non-verbal systems. The labels utilized constituted adequate verbal descriptions of pretraining as well as of test-training stimulus variation. They were expected to function during test-training concept identification as "analyzing" mechanisms, facilitating stimulus-analysis and -selection processes.

A_3 subjects, in addition, were trained to describe simultaneously presented stimuli in terms of partial similarity, i.e., similar shape, similar color, thus providing a third coding system with two possible coding values, that is "similar" and "not similar" shape or color.

In the model, each of the possible coding systems and their corresponding coding values (s-a-c's) are represented. All of the subjects are supposed to have available non-verbal coding systems. Only experimental subjects had learned or - more precisely - had been provided the opportunity to learn or reactivate the verbal components.

The X system represents one or several additional coding systems which may have been utilized by the subject, but had not been anticipated, and therefore, had not been defined by the experimenter.

X may represent one or several physical dimensions in the total learning situation, or it may represent a coding of task stimuli in terms of emotional or motivational mediating responses.

In the latter case, the task may be coded in terms of an expectancy of success or failure and corresponding satisfactory and frustrating emotional experiences.

If the task becomes coded in terms of a failure expectancy, this kind of coding should be expected to interfere with an adequate stimulus-analysis and -selection, and thereby, with a final task solution.

Stimulus-Selection

The selection process may be thought of as a choice of coding system, previously abstracted and later utilized as the basis for associating individual "s-a-c's" to different terminating responses.

The selection process, therefore, may be assumed to depend heavily upon an adequate stimulus-analysis, but not solely upon that process.

The choice of a coding system may be correct or incorrect. If the response, derived from the choice of a coding system, receives a consistently positive feedback, the subject may retain the coding system chosen and the associations established between individual coding responses (s-a-c's) and terminating responses.

If the response receives a negative feedback, the coding system chosen may be irrelevant, or the individual associations between implicit coding "operations" and terminating responses may be incorrectly paired.

In the latter cases, the subject has to re-select a coding system or change the "s-a-c"-R-pairings attempted.

In order to be able to select the "correct" or relevant coding system, the subject has to coordinate and integrate an adequate stimulus-analysis with a sequence of feedback signals given to his responses.

An adequate selection process, therefore, requires the subject to integrate several different events, some of which are separated by time intervals measured in seconds or even in minutes. Thus the integration of separate events has to take place within one trial as well as between separate trials.

Memory Processes

Stimulus selection, therefore, may be assumed to depend heavily upon processes previously referred to as "short term retention" (chs. II and III).

Thus the subject has to simulataneously "keep in memory" the coding system selected and coding responses (s-a-c's) made, the terminating responses concurrently and previously emitted, and the feedback information received to those responses.

If what has been argued in chapter III is correct (pp. 63 - 64), that short-term retention depends, in part upon the possession and utilization of adequate verbal and non-verbal coding systems, stimulus selection is determined, also, by what has previously become (or has not become) stored in long-term memory.

In very much the same way stimulus - analysis may be said to depend upon what has been stored in long-term memory and upon what is retained, within a limited time interval, in short-term memory.

Thus in order to carry through an adequate stimulus-analysis, that is, in order to re-establish or reactivate the coding systems representing immediate stimulus variance and invariance, the subject has to integrate a set of stimulus events separated by short time intervals (i.e., a sequence of stimulus presentations).

It is not necessary, however, in order for an adequate analysis to occur, that stimulus events be integrated with responses emitted and with feedback information received to those responses.

As has been pointed out, stimulus selection, on the contrary, depends upon a more encompassing immediate integration.

It seems safe to conclude, therefore, that stimulus-analysis is less dependent upon short-term memory and to a larger extent determined by what has previously been stored in long-term memory than the stimulus-selection process.

Both stimulus-analysis and -selection, however, since they are interrelated processes in concept learning, may be considered determined by the content of long-term store.

An adequate permanent representation in terms of coding systems in long-term store, in turn, may positively affect short-term retention, and thereby, the integration of many immediate and separately occurring events, necessary in order for a final task solution to occur.

Integration

When ELLIS (1963) suggests that mentally retarded persons, as a group, manifest a poor short-term memory, this defect may, at least partly, be attributed a lack of task-relevant coding systems in long-term store.

Since "coding systems" may be coordinated to class concepts, necessary in order for new concepts to be learned, a conceptual deficit rather than a short-term retention deficit may be the more relevant description of mentally retarded children.

Most readily observed is the lack of and poor utilization of verbal coding systems, and it seems justified, particularly in the light of our laboratory-experimental results, to utilize these observations and assumptions as a starting point for an intensive remedial training (ch. I).

Thus the verbal pretraining, including labels denoting stimulus variables, values along relevant variables, and partial similarity, produced more learners and faster learners in laboratory-experimental test-training.

We are now in a position to offer a final interpretation of those results:

The labels utilized during pretraining may be assumed to store in long-term memory in the form of verbal coding systems.

While sufficiently integrated with non-verbal systems, the verbal coding systems may function as additional analyzers during test-learning, extending the capacity of short-term memory and, thereby, facilitating both stimulus-analysis and -selection processes.

In control subjects who solved the test-training tasks (1) non-verbal coding systems may have sufficiently facilitated concept learning, or (2) verbal systems may have been acquired and stored prior to experimental training.

The latter interpretation is considered the more valid for Exp. II A_1-L_3 subjects.

In experimental subjects who did not solve test-training tasks, the verbal labels utilized during pretraining (1) may have become incompletely stored or (2) had not become sufficiently integrated with non-verbal systems.

When analyzing and selecting processes have been successfully carried through, a simple concept task, including associations of single "s-a-c's" to individual terminating responses, generalization of each terminating response to a sub-set of stimuli, and discriminations of two or more distinct coding "values", remains to be learned.

These parts of the task may probably be learned without too great efforts, provided that stimuli have become adequately analyzed and the relevant coding system has been selected. They may even - at least partly (i. e. , discriminations and generalizations) - be assumed to involve in or constitute a by-product of the analysis and selection processes.

Generalizability of the Model

The model constructed describes the processes assumed to take place during the "stimulus selection" part of experiment I test-training.

The model may, if extended to embrace additional coding systems, be generalized to learning in the remaining laboratory experiments, and probably to all concept learning in which GOSS, category I stimuli are involved.

It may not, however, at least not without considerable modifications, be used to model intervening events which may be assumed to take place when GOSS, categories II and III concept tasks be learned.

This fact obviously constitutes a limitation of the model, but probably constitutes a strength as well.

Thus the specificity of our model probably makes it an adequate description of the present kind of concept learning, but restricts the generalizability of the model to tasks, involving GOSS category I stimuli.

VI. 2. 2
Test Performance

A similar, but not identical model has been constructed in order to represent test performance following the field experiment (fig. VI. 2).

The test model deviates in several respects from the learning model: (1) Each stimulus item is

Fig. VI. 2

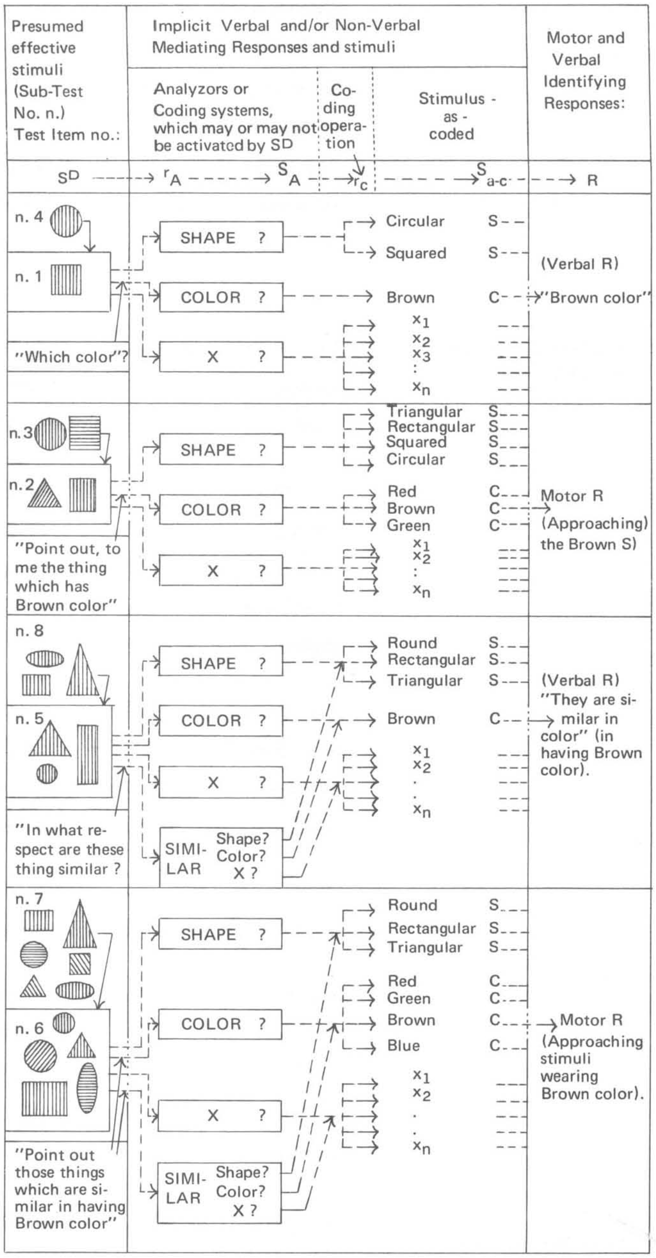


Fig. VI. 2: Model describing an Adequate Performance in one of the Sub-tests used to observe Treatment Effects at the End of the Field Experiment. The Sub-test, which constitutes a Simplified Version of the Color Sub-test, displayes the Principal Features common to the Fourteen Sub-tests used. For Further Explanation see Text.

presented only once to a subject. (2) Two or several stimulus patterns are simultaneously presented in items 2-8. (3) Responses may be either motor or verbal responses. (4) No information regarding the adequateness of the response is fed back to the subject. If feedback occurs, it is always positive, regardless of the correctness of the response.

In figure VI. 2, in the left-hand column, a simplified version of the color sub-test has been presented. It is simplified, since non-verbal stimuli are not multivaried to the same extent as were the original test-items. Thus the original items 3,4,7 and 8 constituted assemblies of presumptive well-known objects, exemplifying the color concept tested.

X in the model, therefore, may be considered a substitute for several possible coding systems activated by test-stimuli.

It may represent stimulus-substance, -size, -texture, -substance qualities, -functions, -object-class, -object-elements, etc., or it may represent emotional and motivational coding systems, activated by single stimuli or by the complete task conditions.

The sub-test, which may be considered a prototype for all the sub-tests used, has been divided into four sub-groups of items, each of which is designed to test a different process involved in complex concept identification, and each of which is initiated by a different auditorily presented verbal instruction.

Items 1 and 4 provide the subject an opportunity to make verbal identifications of the relevant color concept.

In items 2 and 3, non-verbal identifications and selective discriminations are tested. Emphasis is placed, in these items, upon the subject's "ability" to discriminate color values, involved in the stimulus variation, and choose the relevant one.

Items 5 and 8 are presumed to test verbal identification of the color value considered and the relevant color similarity represented by several test-stimuli. The latter fact (i.e., the weight placed upon the detection and formulation of partial similarity) reveals the main intention assigned this sub-group of items, that is, to test the subject's "ability" to selectively generalize his verbal response to several sub-values within the brown-color interval, involved in a set of multi-varied stimulus objects.

Finally, in items 6 and 7, a combined selective identification, selective discrimination and selective generalization is tested and may be manifested in motor identifying responses. The verbal instruction explicitly directs the attention towards a partial similarity and thus emphasizes the selective generalization of a motor response.

Different aspects of the concepts learned may be manifested in motor and verbal selective identifications, discriminations, and generalizations, all of which may be considered important and necessary sub-processes involved in concept acquisition and concept identification.

Two categories of verbal control may be manifested: (1) the subject's own control over non-verbal environmental events manifested in verbal identifying responses, and (2) the influence of auditorily received verbal instructions upon choice behavior manifested by the subject in his motor identifying responses.

Both kinds of verbal control may be assumed to indicate the existence of (or, when verbal control is incomplete or lacking: the absence of) adequate verbal analyzers (e.g., color) and verbal coding responses (e.g., brown).

It may be noted that the correct performance in a sub-test represents the upper limit of conceptual achievement, the goal towards which a teacher may direct his teaching.

Each sub-test, therefore, may be considered a diagnostic procedure, adequate to test the acquisition of many, perhaps all concepts involved in GOSS category I stimuli.

When used as a diagnostic procedure, a test consisting of 14 sub-tests, each of which had been designed according to the principles displayed in the model (fig. VI. 2, left-hand column), revealed a considerable difference between an experimental and a control group.

This difference may be considered the result of an intensive and prolonged concept training given to experimental subjects, arranged according to the training principles inherent in the A_3 laboratory treatments.

The difference has been interpreted to mean a considerable increase in field-experimental subjects in conceptual control over environmental events. The increased control was most markedly observed in verbal terminating responses.

As has formerly been pointed out, this fact may be taken to indicate a previous acquisition and present utilization, in experimental subjects, of adequate verbal mediating mechanisms, including verbal coding systems and verbal coding responses, which, in turn, are assumed to facilitate present stimulus-analysis and -selection.

It further indicates the validity of a training procedure designed in order to provide an optimal concept learning in the sense described by the models.

Since the training procedure and the diagnostic test-procedure are both designed according to the same constructs, i.e., according to comprehensive analyses of possible sub-processes involved in concept learning, the construct validity of the test may be said to reflect in the field-experimental discrepancies between treatment groups, in the first place, and partly, between CA-level groups, in the second.

The validity and reliability of the sub-test as a standard diagnostic procedure will be further investigated by one of our co-workers, who has also designed the test.

VI.3 CONSEQUENCES FOR TEACHING

We shall return in this final section to some of the notions involved in chapter I of the present report.

If one accepts, in the light of intervening chapters, what was argued in that chapter, i.e., (1) that concept learning and conceptual development constitute important aspects of general development, and (2) that mentally retarded children, as a group, display a retarded conceptual development and severe disturbances of concept learning, this acceptance should have consequences for the teaching of "normally" as well as of retardedly developed children.

The first point above concerns all children, including "normal" children and several kinds of retardedly developed children.

Let us consider first the concept of "normal" development:

"Normal" development should by no means be confused with optimal development. The former may be considered the product of an interaction of a fairly "normal" organism with an environment "common" to the group of persons by which normality is defined.

An optimal development, on the contrary, may be thought to take place if an organism, whether it is "normal" or "abnormal", is offered the (for him) best developmental conditions.

Returning now to conceptual development and learning in "normal" children, several questions may be asked concerning such development in a "normal" environment:

(a) Is it correct to assume that concept formation may adequately take place in the "normal" child, without the systematic aid provided by a mature person?

If this question has to be negatively answered, it automatically generates new questions:

(b) Do schools, institutions, and teachers produce optimal conditions in order for adequate concept learning to take place in their pupils? (c) Have teachers, in the course of their own teacher training, been provided with the psychological insight necessary in order to prepare optimal conditions for concept learning?

It will not be attempted to answer these questions because they lie beyond the scope of this work. It is necessary, however, that the questions should be seriously evaluated by teachers of all categories, including the preschool teacher and the university teacher.

If they have to be negatively answered, steps should be taken to improve present conditions in teaching.

When we pass from "normally" developed to mentally retarded children, it may be more readily accepted that their conceptual delveopment is retarded.

If it is simultaneously accepted that concept formation and concept learning constitute important determiners of incidental learning and general development, one essential starting point for remedial training is given.

Question (a) above may be negatively answered, that is, we may not expect that concept learning should adequately take place in mentally retarded children without the systematic aid of a mature person.

Questions (b) and (c), therefore, become highly valid and urgent questions to teachers employed in the special education of mentally retarded children.

The latter two questions may be answered only by means of assumptions, however.

It is preferred, therefore, to answer them, not in terms of what "treatment conditions" are offered to mentally retarded children in present-day special education, but rather in terms of what may be considered wanted aspects of special teaching for such children.

As has been suggested in chapter I and has received support in the intervening chapters, the concept learning deficit should be approached in terms of learning psychology, in the first place, in terms of a thorough psychological knowledge of mentally retarded children, in general and of the specific child taught, in the second place.

Two of the criteria suggested are met by the training methods utilized in our field experiment: they had been based (1) upon a thorough theoretical and empirical study of concept learning, and (2) upon a study of the general phenomenon of mental retardation.

Thus a general method has been suggested. The general method should be adapted to the individual child in terms of the specific concepts taught, the specific stimuli and incentives employed, the specific size of units selected for a teaching lesson, the specific rate of teaching, etc.

Systematic concept training should probably start early in mentally retarded children, debile category, in order to accelerate learning and development, and it should begin with a training of class concepts which might be expected to facilitate immediate orientation in the environment and facilitate later learning, including later concept learning.

When the mentally retarded child enters the first systematic training in special schools and special classes, he has probably acquired a set of object class concepts.

The criteria for ordering objects and events into classes, however, have probably not been detected, at least not at a "conscious" level of perception and thought.

He should probably profit, therefore, from learning GOSS category I concepts, which approximates the area of sensation and perception and may be utilized to detect the similarity present in many classes of objects and events. This kind of concepts may later function as "analyzers" or "coding systems", by means of which current experiences may be "coded" or "assimilated".

Concept training should not be restricted to GOSS category I concepts, however, nor to the first years of training in special schools.

Concept training, including GOSS categories I-III tasks, should be integrated with and constitute an essential part of all training given such a child.

Thus every word or number taught should be taught as a class concept as well as a heard, written, or spoken symbol. More precisely: several kinds of symbols dealt with in school teaching should not be considered effective symbols until they adequately represent selected features of classes of objects or events.

Concept learning, therefore, if adequately organized by the teacher, should introduce "meaning" into a learning which, to many retarded children is probably rather meaningless and, therefore, does not motivate them for further learning.

If organized in a systematic manner, at an optimal rate and into optimal units, concept training should result in successful learning.

This should be considered necessary and urgently important to children in whom unsuccessful learning has been a frequent experience and in whom expectancy of failure prevails.

APPENDIX

Laboratory Experiments:

1	A pretraining program exemplified (Exp. III, abbreviated).	pp. 232-242
2	Instruction given prior to test--training series	p. 243

Field Experiment:

3	The concepts taught in experimental groups	pp. 244-245
4	The training program exemplified. .	pp. 246-256

REAKSJONER UNDER FORTRENING: R=rette F=feil

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INSTRUKSJON UNDER ØVINGSSERIER

CPS

Øvingsserie I: Bare hovedstimuli (hS).

Ved dette rare bordet skal du og jeg arbeide sammen 2 eller 3 dager i uken en tid fremover. Hver gang du kommer, får du 50 øre i lønn; pengene skal du legge på ei sparebørse som du får utlevert når vi er helt ferdige.

- Under denne platen er det mange knapper. Når jeg har vist frem en figur her (fl. peker), skal du trykke på den knappen som du tror er riktig. Når du trykker på den rette knappen, lyser det slik (fl. gir grønt lys ved å trykke på en knapp på sin side av panelet). Trykker du på feil knapp, lyser det slik (rødt lys).

  CPS
  hS-sekvens: 2 - 1 - 3

- Operasjonell sekvens: 1 hS inn.
  2 5 sek.
  3 hS ut.
  4 Deksel tilbake.
  5 "Trykk på den rette knappen" Ev. "Forsøk en gang til".
  6 Deksel frem igjen.

PPS CPS

Øvingsserie II: Samtidig S (sS) + hS

- Nå skal vi gjøre det samme om igjen, bare med en liten forandring. Når jeg har vist frem en figur her (fl. peker), skal du trykke på den knappen som du tror er riktig. Når du trykker på den rette knappen, lyser det slik (grønt lys). Trykker du på feil knapp, lyser det slik (rødt lys).

  PPS CPS
- sS 1 og hS-sekvens 3 - 2 - 1

- Operasjonell sekvens: 1 hS og sS inn.
  2 5 sek.
  3 sS og hS ut.
  4 Deksel tilbake.
  5 "Trykk på den rette knappen". Ev. "Forsøk en gang til".
  6 Dekselet frem igjen.

SERIE 1 - 1

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3	A_1 0 / A_2 0 / A_3 0
1 Prik-ket	1 Prik-ket	S-presentasjon og motoriske R	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? ________: LIKE I MØNSTER	
1	3 Rutet	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? _________: IKKE LIKE I MØNSTER	
1	2 Stre-ket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? _________: IKKE LIKE I MØNSTER	

Antall riktige motoriske reaksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER	
STREKET MØNSTER	
RUTET MØNSTER	
Likhet/ulikhet	

SERIE 1 - 2

A_1 0
A_2 0
A_3 0

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
2 Stre- ket	3 Rutet	S-presenta- sjon og mo- toriske R	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
2	2 Stre- ket	D.s.	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER
2	1 Prik- ket	D.s.	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER

Antall riktige motoriske reaksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER
STREKET MØNSTER
RUTET MØNSTER

Likhet/ulikhet

SERIE 1 - 3

A_1 0
A_2 0
A_3 0

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
3 Rutet	2 Streket	S-presentasjon og motoriske R	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
3	1 Prikket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
3	3 Rutet	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER

Antall riktige motoriske reaksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER	
STREKET MØNSTER	
RUTET MØNSTER	
Likhet/ulikhet	

SERIE n - 1

A_1 0
A_2 0
A_3 0

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
1 Prik-ket	1 Prik-ket	S-presenta-sjon og mo-riske R	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER
1	3 Rutet	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
1	2 Stre-ket	D. s	Hva for et MØNSTER hadde denne figuren? ....___:STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER

Antall riktige motoriske re-aksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER	
STREKET MØNSTER	
RUTET MØNSTER	
Likhet/ulikhet	

SERIE n - 2

				A_1 0
				A_2 0
PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3	A_3 0
2 Stre-	3 Rutet	S-presentasjon og moriske R	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER	
2	2 Streket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER	
2	1 Prikket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? _________: IKKE LIKE I MØNSTER	

Antall riktige motoriske reaksjoner:___

Antall riktige verbaliseringer:

PRIKKET MØNSTER	
STREKET MØNSTER	
RUTET MØNSTER	
Likhet/ulikhet	

SERIE n - 3

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3	A_1 0 A_2 0 A_3 0
3 Rutet	2 Stre- ket	S-presenta- sjon og mo- toriske R	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER	
3	1 Prik- ket	D. s.	Hva for et MØNSTER hadde denne figuren* ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER	
3	3 Rutet	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER	

Antall riktige motoriske re- aksjoner: ___

Antall riktige verbaliseringer.

PRIKKET MØNSTER	☐
STREKET MØNSTER	☐
RUTET MØNSTER	☐
	☐
Likhet/ulikhet	☐

SERIE 8 - 1

A_1 0
A_2 0
A_3 0

PPS sD	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
1 Prik- ket	1 Prik- ket	S-presenta- sjon og moto- riske R	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER
1	3 Rutet	D.. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
1	2 Stre- ket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER

Antall riktige motoriske reaksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER
STREKET MØNSTER
RUTET MØNSTER

Likhet/ulikhet

SERIE 8 - 2

A_1 0
A_2 0
A_3 0

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
2 Stre-ket	3 Rutet	S-presenta-sjon og mo-toriske R	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
2	2 Stre-ket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER
2	1 Prik-ket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER

Antall riktige motoriske reaksjoner: ___

Antall riktige verbaliseringer:

PRIKKET MØNSTER
STREKET MØNSTER
RUTET MØNSTER

Likhet/ulikhet

SERIE 8 - 3

A_1 0
A_2 0
A_3 0

PPS sS	CPS hS	A_1, A_2, A_3	Bare A_2 og A_3
3 Rutet	2 Stre- ket	S-presenta- sjon og mo- toriske R	Hva for et MØNSTER hadde denne figuren? ....___: STREKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
3	1 Prik- ket	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: PRIKKET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: IKKE LIKE I MØNSTER
3	3 Rutet	D. s.	Hva for et MØNSTER hadde denne figuren? ....___: RUTET MØNSTER A_3: Du kunne se to figurer på en gang. Var de LIKE I MØNSTER? __________: LIKE I MØNSTER

Antall riktige motoriske re- aksjoner:___

Antall riktige verbaliseringer:

PRIKKET MØNSTER ☐
STREKET MØNSTER ☐
RUTET MØNSTER ☐

Likhet/ulikhet ☐

INSTRUCTION - presented prior to each exp. III test--training series. Except for the nonsense words, the present formulation was common to all laboratory experiments.

"I dag skal (du få se) jeg vise deg noen nye figurer.
De figurene skal du lære navn på.

(Senere: Vi skal fortsette å lære navn på de nye figurene.)

Hver figur har sitt navn, men noen av figurene har samme navn:

Noen heter TUK. Kan du si TUK?
Noen heter MÆF. Kan du si MÆF?
Noen heter FÅB. Kan du si FÅB?

De figurene som har samme navn, er like i noe.

Hver gang du sier det rette navnet før meg, lyser det slik (viser grønt lys), og da slipper jeg en 25-øre på spareborsa di.

Hvis du sier feil navn, eller glemmer å si navnet, lyser det slik (viser rødt lys), og da slipper jeg ikke noen 25-øre ned på børsa di.

Husk på at du skal si navnet før meg."

CONCEPTS INVOLVED IN THE TRAINING OF EXPERIMENTAL SUBJECTS IN THE FIELD EXPERIMENT

I Concepts denoting attributes of objects (and events):

FORM	(som) rett linje (Vannrette linjer, Loddrette linjer, Skrå linjer)	SHAPE	Straight Line (Horizontal lines, Vertical lines, Oblique lines).
	Bueformet linje med åpning vendt mot Høyre/Venstre, Oppover/Nedover.		Curved, Arched Lines Oriented to the Right/ to the Left, Upwards/Downwards.
	Vinkelformet linje med åpning vendt Oppover/Nedover		Angled Lines, oriented Upwards/Downwards
	Sirkel-(form)		Circular (shape)
	Firkantet (form)		"Four-sided" (shape)
	Trekantet (form)		Triangular (shape)
	Terning (-form)		Cubical (shape)
	Kule (-form)		Spherical (shape)
	Sylinder (-form)		Cylindrical (shape)
FARGE	Gule Grønn Blå Rød Brun	COLOR (HUE)	Yellow Green Blue Red Brown
STØRRELSER		SIZES	
STØRRELSE	Stor/Liten,	SIZE	Large/Small
LENGDE	Stor/Liten Lang/Kort	LENGTH	Long/Short
HØYDE	Stor/Liten Høy/Lav	HEIGHT	High/Low
BREDDE	Stor/Liten Brei/Smal	BREADTH	Broad/Narrow
TYKKELSE	Stor/Liten, Tykk/Tynn	THICK- NESS	Thick/Thin
VEKT	Tung/Lett	WEIGHT	Heavy/Light
MØNSTER	Rutet Stripet Prikket Blomstret	PATTERN	Squared Striped Dotted Flowery

STOFFART	(stoffet) Stein (- " -) Metall - " - Glass - " - Plast - " - Tre	SUBSTANCE	Stone Metallic Glass Plastic Wooden
STOFF-KVALITET	Tungt/Lett STOFF Hardt/Bløtt - " -	SUBSTANCE QUALITY	Heavy/Light SUBSTANCE Hard/Soft - " -
SMAK	Sur Søt Salt	TASTE	Sour Sweet Salt
OBJEKT-FUNKSJON	BRUKES TIL å sitte på - " - å spise med - " - å skrive med	OBJECT-FUNCTION	USED TO sit on " while eating " while writing

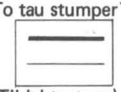
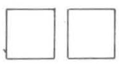
II <u>Concepts denoting spatial organization of objects and events.</u>

RETNING el. STILLING	Vannrett Loddrett Skrå	ORIENTATION	Horizontal Vertical Oblique
REKKEFØLGE (Posisjon i ei rekke)	Først Sist i ei rekke Midt	SEQUENCE	First in a row Last In the middle of a row
STED/PLASS	Har plass/er plassert Foran/Bak Over/Under Øverst/Nederst Ved siden av (på høyre/venstre siden av) Mellom	LOCATION	Is located In front of/Behind Above/Below At the top/bottom of At the left hand/ right hand side of Between

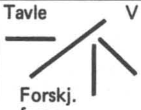
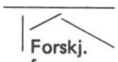
Begrep: Tykk/tynn/stor/liten tykkelse
Side 1

Begrep Tykkelse: Tykk/tynn	Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase	Ikke-verbale	Verbale	Motoriske o.a.	Verbale
I. Selektiv assosiasjon og 1.1	På tavla V			
II. Selektiv diskriminasjon 1.2		(Repetisjon:) Her er to linjer **som er like** i at de er **vannrette** og i at de **har samme lengde.**		
1.3		Men hva **er de forskjellige i ?**		Den ene **er tykk** og **den** andre **er tynn.**
1.4		Det greidde du fint (r). Kan du peke på den linjen som **er tykk** eller **har stor tykkelse ?**	o	
1.5			x	
1.6		Det gjorde du riktig (r). **Hva for en tykkelse** hadde den linjen du pekte på ?		
1.7				Den **hadde stor tykkelse.**
1.8		Flott ! (applaus) (r)		
2.1	På tavla V			
2.2		(Rep.) Hva **er** disse to linjene **like i ?**		
2.3				De **er like** i at **de er loddrette linjer.**
2.4		Helt rett ! Er det noe annet de **er like i ?**		
2.5				De **er like** i at **de har samme lengde.**
2.6		Det greidde du flott, enda det er vanskelig (r). Er de to linjene **forskjellige i noe ?**		
2.7				Den ene **er tykk** og den andre **er tynn.**
2.8		Det er helt rett (r). Kan du si det på en annen måte ?		
2.9				(Læreren hjelper til:) Den ene **har stor tykkelse** og den andre **har liten tykkelse.**
2.10		Flott ! (applaus) (r). Kan du peke på den linjen som har liten tykkelse.		
2.11			o x	

Begrep: Tykk/tynn/stor/liten tykkelse
Side 2

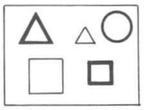
Begrep	Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase	Ikke-verbale	Verbale	Motoriske o.a.	Verbale
2.12		Fint (r). Hva for **en tykkelse hadde** den linjen du pekte på ?		
2.13				Den **hadde liten tykkelse.**
2.14		Det sa du flott ! (r)		
3.1	To tau stumper TK 		x (Gjentas med andre elever og med det tykke tauet som relevant verdi).	
3.2	(Tildekte øyne)	Her er to taustumper. Den ene **har stor tykkelse,** den andre **har liten tykkelse.** x Kjenn på dem, Kari, og gi Per den som **har liten tykkelse.**		
3.3			o	
3.4		Fint (r). Hva for **en tykkelse hadde** det tauet du ga Per, Kari.	x	
3.5				Det **hadde liten tykkelse.**
3.6		Det sa du flott ! Hva for **en tykkelse hadde** det tauet du fikk, Per ?		
3.7				Det **hadde liten tykkelse.**
3.8		Det sa du flott ! (r).		
4.	V/TK Den samme fremgangsmåten, med og uten tildekte øyne, benyttes med spiker, strikkepinner, stokker, streng, alle variert i verdiene stor og liten tykkelse.			
5.1	V/TK Tynn finer. Tykk trefiberplate, begge med samme form og areal.			
5.2		Kjenn på disse treplatene, Ole, og gi Liv **den** som **har liten tykkelse.**		
5.3				
5.4		Det greidde du fint (r). Hva for **en tykkelse hadde** den treplaten du ga Liv ?		
5.5				Den **hadde liten tykkelse.**
5.6		Det sa du fint, selv om det var vanskelig. (r).		

Begrep: Stor/liten tykkelse.

Begrep		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbale
	5.7		Hva for **en tykkelse hadde** den treplaten du fikk, Liv ?		
	5.8				**Den hadde liten tykkelse.**
	5.9		Det sa du også fint! (r)		
		(Det samme gjentas med andre elever og stor tykkelse som den relevante verdi)			
	6.1	Dør panel V			
	6.2	A M O (r)	Kan du finne den bokstaven som er laget av linjer som **har stor tykkelse ?**		
	6.3			o x o	
	6.4		Fint! (r) Hva for **en tykkelse hadde** linjene i den bokstaven ?		
	6.5				**De hadde stor tykkelse.**
	6.6		Det greidde du flott! (r) Nå kan du åpne døra og spise det du finner der.		
		(Alle elevene får prøve. Andre bokstaver benyttes som stimuli.)			
III. Selektiv generalisering	1.1	Tavle V  Forskj. farger			
	1.2		Hva **er** alle **disse linjene like i ?**		
	1.3				De **er like** i at de **har stor tykkelse.**
	1.4		Det sa du flott! (r)		
	2.1	Tavle V  Forskj. farger			
	2.2		Hva **er** alle **disse linjene like i ?**		
	2.3				De **er like i** at de **har liten tykkelse.**
	2.4		Det sa du fint, selv om dèt var ordentlig vanskelig.		

Begrep: Stor/liten tykkelse

Side 4

Begrep	Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase	Ikke-verbale	Verbale	Motoriske o.a.	Verbale
3.1	Dørpanel V 1 2 3 4 O R S F		(Alle elevene prøves).	
3.2	5 T (r)	Kan du finne de bokstavene **som er like i** at de er laget av linjer med **stor tykkelse ?**		
3.3			O S T	
3.4		Fint ! (r). Hva **var de** bokstavene du fant, **like i ?**		
3.5				De **er like i** at de har linjer **med stor tykkelse.**
3.6		Det sa du flott (r). Nå kan du spise det som ligger bak dørene (r).		
4.1	Ark V/TK 			
4.2		Legg farge på de figurene **som er like i** at de har linjer **med liten tykkelse.**		
4.3				
4.4		Fint (r). Hva **er disse** figurene **like i?**		
4.5				De **er like i** at de har linjer **med liten tykkelse.**
4.6		Det sa du veldig fint ! (r).		
5.1	V/TK Spiker, streng, tau, strikkepinner m.m., en tykk og en tynn av hver.		(Alterneres med liten tykkelse).	
5.2		Legg alle de tingene **som er like i at de har stor tykkelse** oppi denne esken.		
5.3	Eske		Elevene sorterer.	
5.4		Det gjorde du helt rett! (r). Hva var **de** tingene du fant, **like i ?**		
5.5				De **er like i** at **de har stor tykkelse.**
5.6		Det sa du svært fint ! (r).		

Begrep: Midt i/midt på en rekke
Side 1

Begrep Rekkefølge		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbale
I. Selektiv assosiasjon og II. Selektiv diskrimi-nasjon	1.1	V Tre lekebiler, stilt på rekke bak hverandre  Blå Rød Grønn		(Alle elevene prøves).	
	1.2		Her er tre biler **som står i rekke.** Hvor **i rekken** står den som **har blå farge ?**		
	1.3				Den står **først** i **rekken.**
	1.4		Det sa du flott ! (r). Hvor **i rekken** står **den som har grønn farge ?**		
	1.5				Den står **sist** i **rekken.**
	1.6		Flott igjen (r). kan du greie å si hvor **i rekken** denne bilen står ?		
	1.7		(Peker på den røde bilen).		Den står i **midten.**
	1.8		Ja, det er rett ! (r). Vi kan også si at den står **midt i rekken.** Kan du si det ?		
	1.9				Den står **midt** i **rekken.**
	1.10		Fint ! (applaus) (r).	(Oppgavene gjentas med bilene snudd motsatt)	
	2.1	V Tre av elevene tas frem Ole - Liv - Per			
	2.2		Kan dere stille dere **i rekke** slik at Ole står **først i rekken,** Per står **sist i rekken,** og Liv står **midt i rekken ?**		
	2.3			 (Læreren hjelper til)	
	2.4		Det greidde dere fint (r). Hvor **i rekken** står du, Ole?		
	2.5				Jeg står **først** i **rekken.**
	2.6		Rett (r). Hvor **i rekken står** du, Per?		
	2.7				Jeg står **sist i rekken.**
	2.8		Det er rett (r). Hvor **i rekken står** du, Liv?		
	2.9				Jeg står **midt** i **rekken.**
	2.10		Fint ! (r).. Nå kan du , Kari, komme og ta Liv's plass **i rekken.**		
	2.11			Kari gjør det.	

Begrep: Midt i rekken

Side 2

Begrep Rekkefølge	Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase	Ikke-verbale	Verbale	Motoriske o.a.	Verbale
2.12		Hva for en **plass har** du **i rekken,** Kari ?		
2.13				Jeg står **midt i rekken.**
2.14		Fint ! (r). Dere er jamen flinke.		
3.1	Elevene V/TK snus 180°			
3.2		Kan dere snu dere slik at alle ser hit. Hvor **i rekken står** du nå , Per ?		
3.3				Jeg står **først i rekken.**
3.4		Det sa du fint ! (r). Hvor **i rekken står** du, Ole?		
3.5				Jeg står **sist i rekken.**
3.6		Det sa du fint ! (r). Hvor **i rekken står** du, Kari ?		
3.7				Jeg står **midt i rekken.**
3.8		Fint ! (r). Kari **står** fremdeles **midt i rekken.** Hvor **i rekken står** Kari, Liv ?		
3.9				Hun står **midt i rekken.**
3.10		Det sa du fint (r).		
4.	Oppgaven gjentas slik at alle elevene får stå midt i rekken. 1 2 3 ← ← ← 1 2 3 ↓ ↓ ↓ 3 2 1 → → →			
5.1	Tre esker V/TK			
5.2	$\boxed{1}$ $\boxed{2}$ $\boxed{3}$	Her er tre (kubeformede) esker. Dersom du løfter den som **har plass midt i rekken,** vil du finne fem rosiner under den.		
5.3			Løftereaksjon o x o	
5.4		Det greidde du fint ! Hvor **i rekken sto** den du løftet ?		
5.5				Den sto **midt i rekken.**
5.6		Det sa du fint ! (r). Nå kan du spise rosinene.		
6.	Den samme oppgaven gjentas med fem i stedet for 3 esker. Alle elevene prøves.			

Begrep: Midt i rekken

Side 3

Begrep		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbale
	7.1	Flanello-graf V/TK			
	7.2	LIV	Her er tre bokstaver i **rekke.** Kan du ta bort den bokstaven som **er midt i rekken,** Liv ?		
	7.3			Liv tar bort. I	
	7.4		Det greidde du fint ! (r). Hvor **i rekken sto** den bokstaven som du tok bort ?		
	7.5				Den sto **midt i rekken.**
	7.6		Det sa du fint ! (r).		
	8.	Oppgaven gjentas med forskjellige tre- lyds- og fem-lyds-ord. Alle elevene prøves. Dørpanel i stedet for flanello-graf.			
III. Selektiv generalisering	1.1	Flanello-graf V/TK			
	1.2	MOR FAR PER OLE	Her kan du se fire rekker med bokstaver. Kan du ta bort de bokstavene **som er like i** at **de står midt i en rekke ?**		
	1.3			Eleven tar bort O, A, E, L	
	1.4		Fint ! (r). Hva **var** alle **de** fire bokstavene **like i ?**		
	1.5				De var **like i** at **de sto midt i en rekke.**
	1.6		Det sa du veldig fint (r).		
	2.	Oppgaven gjentas med andre tre–lyds–ord og med fem–lyds–ord. Alle elevene prøves.			
	3.1	▲ ▲ ▲ ▲ ▲ V/TK			
	3.2	■ ■ ■ ■ ■ ● ● ● ● ● 3 rekker med 5 like leke-gjenstander i hver.	Her er **en rekke** med hester, **en rekke** med biler og **en rekke** med trær. Kan du ta bort dem **som er like i at de står midt i en rekke ?**		
	3.3			Eleven forsøker å løse oppgaven.	

Begrep: Midt i en rekke

Side 4

Begrep	Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase	Ikke-verbale	Verbale	Motoriske o.a.	Verbale
3.4		Det gjorde du helt rett (r). Hva var **de tre tingene like i før** du tok dem bort ?		
3.5				De **var like** i at **de sto midt i en rekke.**
3.6		Det sa du flott (r).		
4.1	V/TK Ark til hver elev			
4.2		På dette arket er det tre **rekker** med hus. Kan du legge farge på **de** husene **som er like** i at **de står midt i en rekke ?**		
4.3			Eleven velger hus og farge. Læreren går rundt og rett-leder og spør hver elev.	
4.4		Fint (r). Hva **er de** tre husene du har farget **like i ?**		
4.5				De **er like** i at **de står midt i en rekke.**
4.6		Det sa du like fint som en voksen (r),		

Ting som kan brukes til å sitte på ← Begrep

Side 1

Begrep / Objekt-funksjon		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbale
I. Selektiv assosiasjon	1.1	En av stolene V i klasserommet			
	1.2		Hva er dette ?		
	1.3				Det er en stol
	1.4		Det er rett ! (r). Hva **pleier vi å bruke** en stol **til ?**		
	1.5				Vi **bruker den til å sitte på.**
	1.6		Det sa du fint (r).		
	2.1	En krakk V			
	2.2		Hva er dette ?		
	2.3				Det er en krakk.
	2.4		Fint ! (r). Hva **hva pleier vi å bruke** en krakk **til ?**		
	2.5				Vi **bruker den til å sitte på.**
	2.6		Det sa du fint. (r). Kan **den brukes til** noe annet enn **til å sitte på ?**		
	2.7				(Forslag:) Den **kan brukes til** å stå på, til å sette fra seg noe på etc.
	2.8		Nå var dere flinke (r).		
	2.9		Men hva **bruker vi den** mest **til ?**		Vi **bruker den mest til å sitte på.**
	2.10		Det sa du fint (r).		
	3.1	Sofa eller benk, V i rommet eller på tegning.			
	3.1		Hva er dette ?		
	3.2				Det er en sofa (benk).
	3.3		Fint ! (r).		
	3.4		Hva pleier vi å **bruke** en sofa (benk) **til ?**		Vi **bruker den til å sitte på.**
	3.5		Det sa du fint (r). Kan vi **bruke den til** noe annet enn **til å sitte på ?**		
	3.6				(Forslag:) Vi **kan bruke den til å ligge på.**
	3.7		Nå var dere flinke (r). Men hva **bruker vi den** helst **til ?**		

Begrep: Funksjon - til å sitte på

Side 2

Begrep		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbale
	3.8				Vi bruker den mest til å sitte på.
	3.9		Dere er flinke synes jeg (r).		
	4.	Den samme fremgangsmåten benyttes med forskjellige typer av stoler (tegnet eller virkelige), skammel, ulike typer av camping-stoler, hage-benk. I hvert tilfelle spør lærern frem både hovedfunksjon og mulige bifunksjoner.			
II. Selektiv diskriminasjon	1.1	Kjøkken-krakk, gardintrapp V/TK			
	1.2		Kan du sette deg på den tingen som vi pleier å bruke tilå sitte på ?		
	1.3			Eleven setter seg på krakken	
	1.4		Nå gjorde du rett (r). Hvorfor satte du deg på krakken ?		
	1.5				Fordi vi bruker den til å sitte på.
	1.6		Det sa du like fint som en voksen.		
	2.1	Dørpanel V			
	2.2		Kan du finne en tegning her av noe som vi bruker til å sitte på ?		
	2.3			Eleven peker på tegning av hage-benk	
	2.4		Det er helt rett (r). Hvorfor valgte du den ?		
	2.5				Fordi vi bruker en benk til å sitte på.
	2.6		Det sa du svært fint (r). Nå kan du åpne døra som bildet av benken står på.		
	2.7			Eleven finner en liten belønning (r)	
	2.8		Den har du fortjent.		

Begrep: Funksjon - til å sitte på

Side 3

Begrep		Stimuli r = reinforcement		Reaksjoner, forventet av elevene	
Læringsfase		Ikke-verbale	Verbale	Motoriske o.a.	Verbal
III. Selektiv generalisering	1.1	(Ark) V Tegning av forskjellige typer stoler, krakker, benker.			
	1.2		Hva **er alle** tingene på bildet **like i** ?		
	1.3				De er **like i** at vi **kan bruke** dem **til å sitte på.**
	1.4		Det sa du fint (r).		
	2.1	(Ark) Interiørbilde, som inneholder forskj. sitteredskaper, blandet opp med annet interiør.			
	2.2		Kan du sette kryss ved de tingene **som er like i** at vi **kan bruke** dem **til å sitte på** ?		
	2.3			Elevene krysser av	
	2.4		Fint ! (r). Hvorfor har du satt kryss ved disse tingene ?		
	2.5				Fordi **de er like i** at **vi kan bruke** dem **til å sitte på.**
	2.6		Det sa du svært fint (r).		
	3.1		Når dere kommer hjem, kan dere lete etter ting **som er like i** at vi **kan bruke** dem **til å sitte på.** I morgen kan dere fortelle om dem til meg.		

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