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SUMMARY OF A SPECIAL EDUCATIONAL RESEARCH PROJECT WITH MILD AND BORDERLINE CASES OF MENTALLY RETARDED CHILDREN

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SUMMARY OF A SPECIAL EDUCATIONAL RESEARCH PROJECT WITH MILD AND BORDERLINE CASES OF MENTALLY RETARDED CHILDREN.

An approach in terms of learning psychology.

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I RESEARCH PRECEDING THE PRESENTLY REPORTED EXPERIMENT.

The experiment referred to in the heading (LYNGSTAD, T. & NYBORG, M., 1977), represents - at least for the time being - the concluding phase of a research project which has been going on for a period of approximately twelve years.

I.1 Theoretical Studies

It started with 1) a study of theories of *learning deficits* in *mental retardation* (NYBORG, 1969), and 2) *task analyses* and *evaluation of theories* of concept learning (NYBORG, 1970); the latter because *concept learning* (CL) was considered central and important for general development, and shortcomings in CL regarded as central in developmental retardation.

I.2 Laboratory experiments

Based upon such studies, a set of "laboratory" or well-controlled learning experiments were designed and performed individually with mildly mentally retarded children attending special schools.

a) Pre-training

In each experiment, three groups, randomly drawn among children aged 94 to 178 months (separated into two or three age intervals), and within the IQ-interval 50 - 70, were given three different *pretraining* conditions, all of which took place within the *same non-verbal* learning situation, however (NYBORG, 1971).

The learning situations can be classified as *delayed matching-to-sample discrimination learning* situations, arranged to involve also *concept acquisition* tasks (H.H. KENDLER, 1964).

The three learning conditions differed in all experiments according to the *amount* and *kind* of *verbal activity* which accompanied non-verbal stimuli and responses.

Verbalizing conditions

That is, in *one* condition, the *non-verbalizing* one, the subjects were not taught and challenged to utilize verbal "integrators and organizers" in order to learn the task.

In a *second* condition, subjects were required to *describe*, thereby *identifying* and *analyzing* stimuli in terms of *coordinating* (blue, green, red; squared, triangular, round; large, small; etc.) and *superordinate* (colour, shape, size, etc.) *class names* of stimulus *attributes*,relations, etc.

The descriptions were given shortly *after* the presentation, when stimuli had been removed.

This was supposed to facilitate the "*analysis*, *integration* and *organization*" of separate non-verbal experiences into *class concepts* and *conceptual systems*, *in* the subjects, thus reflecting the role of *adequate language* as a mediator of analysis, integration, organization, and storing-in learning.

In a *third* condition, the subjects were required, in addition, to compare two simultaneously presented stimuli in order to describe partial similarity and dissimilarity among them; it goes, "similar in colour, dissimilar in shape; similar in substance (metallic, wooden), dissimilar in size; similar in pattern (checked, dotted, or striped), dissimilar in colour and size; etc.

These verbal units (similar in .. /dissimilar in ..) were supposed, while frequently used, to facilitate analysis, class-integration and organization into superordinate and sub-classes of non-verbal experiences.

b) Test-training

During the following test-learning,i.e., in a set of concept identification or concept utilization tasks, identical for all subjects in an experiment, the condition three subjects regularly (in four experiments) and significantly surmounted the condition two subjects, and the condition two subjects excelled the condition one ss; that is, in terms of both 1) the proportion of learners to non-learners, and 2) number of trial series to the learning criterion.

c) Results and explanations

In other words: As predicted, the condition two, and, especially, the condition three subjects, were better able to adequately remember and transfer their pretraining learning, relevant for test-learning, into concept identification tasks, constituting the test-learning situations (NYBORG, 1971, chapt. IV.2).

It has been assumed that these subjects, by means of verbal "organizers" and "mediators", had learned in a qualitatively better way, during pretraining; that is, in a conceptually better organized, and thus, a better rememberable and transferable way; thus, the amount and kinds of verbal concommitants of non-verbal perceptions and behavioural choices, are inferred to be the main cause of group differences (NYBORG, 1971; 1976,and chapter II in this paper).

The experiments so far described can be considered performed within the areas of learning psychology and mental retardation.

I.3
Teaching programs.

Pre-training condition three, which proved to be the best one with regard to transfer, was transformed into a set of teaching-learning programs, covering a larger set of coordinated concepts, organized into a smaller set of fundamental conceptual systems (i.e., colour, shape, size, pattern, taste, smell, use or function, localization, etc.).

Each single concept (e.g., circular or round SHAPE) was designed to be taught - learned within a context or program, based 1) upon the laboratory experimental findings with regard to verbalizations; 2) upon an elaboration of sub-processes, derived from a thorough CL task analysis; and 3) upon several other learning-psychological and motivational considerations (NYBORG 1971 and 1976; chapt. II in this paper).

I.4
A short term, educational field experiment

A short term field experiment (of approximately 3 months' duration) was designed and performed in order to find out whether the programs could function satisfactorily in the small group teaching common to and "normal" in special schools for mentally retarded children. A control group (16 ss) was included in order to evaluate if the more complete conceptual functions could be obtained by mentally retarded children a) by "normal special educational methods", and/or b) by "maturation";

that is, without a specifically designed, theoretically founded "treatment".

16 experimental subjects sampled within the IQ-limits (Stanford-Binet) 60 - 69 and from two CA-intervals, were given the formerly described conceptual and language "training", one hour a day in each of five days a week for approx. 12 weeks.

They were taught in groups of four children, one group in each of four schools.

The control group had also been sampled from four, comparable schools, and within the same IQ- and CA-intervals.

A test (LYNGSTAD, 1973), designed to reveal the completeness of verbal and non-verbal processes in CL (including selective identifications, discriminations and generalizations) was given to all of the 32 subjects.

The results of a post-test-only, control group design can be summarized as follows (NYBORG, 1971, chapt. IV.3):

1) All differences between experimental and control groups were statistically significant on high levels of confidence.

2) In verbal scores, reflecting the correctness and completeness of verbal identifications, including identification of partial similarity, no overlap existed between experimental and control groups. The same holds good for the combined verbal and non-verbal responses.

3) A significant difference, existing between CA-levels in the control group, was "eliminated", in the experimental group.

I.5 Studies and experiments performed by others within our theoretical framework.

In the years following the short term field experiment, 1) a long term, uncontrolled educational pilot study was performed with mentally retarded children by a special school teacher (R.H. NYBORG, reported in LYNGSTAD & NYBORG, 1977); and 2) a series of better controlled, but more limited investigations - including controlled experiments - were performed by several of my students in the areas of concept and language learning, transfer, and partly, learning deficits (T. LYNGSTAD, 1973; E.-M. SÅSTAD, 1975; K. & L. STEMRE, 1975; K. ÅMLID & P.O. HAARTVEIT, 1973; A. SKODVIN, 1975, A.B. AMUNDSEN, 1975).

Long term pilot study

The long term pilot study was by far the most extended test of our theoretical model of a learning person (NYBORG, 1976, chapt. II, III, and IV, to be outlined also in this paper, chapt. II.3 and II.4), and principles of teaching derived from that model (NYBORG, 1976, chapt. V, VI, VII).

During this test, pupils were taught, not only a set of basic or fundamental class-concepts, "integrated and organized" by language units into basic conceptual systems; but the conceptual systems, tied to exact language use, were also utilized in or transferred to the learning of several aspects and kinds of language; that is, to the learning of class concept meanings of single words, making up sentences; to the learning of mathematical language; to the learning of reading and writing skills (FITTS, 1964: The cognition phase); and to different kinds of subject languages.

The results, daily observed by the teacher, by parents, and, indirectly, by a psychiatrist and myself, were as predicted from the model and very promising.

Since this pilot study was performed on a small scale (with few subjects; only one teacher, who had the unusual opportunity of discussing the work with me),without control group and without systematic test observations, it was decided to perform a better controlled long term experiment, involving a greater number of subjects, new and more teachers, several schools, and a testing program; this was done in order to see if the pilot study results could be replicated with new subjects and with less experienced teachers.

That is, the experiment to be reported in chapter III was started, financially supported (as had been my previous research) by the Norwegian Research Council for Science and the Humanities (NAVF).

It took place in the period from November, 1973, to May/June, 1976, and included 36 pupils and several schools and teachers, distributed between one experimental and two control groups.

Before we describe treatment conditions and results, however, it is necessary to examine theoretical considerations that governed our counselling to the experiment group teachers and their work with the children.

II THEORETICAL ANALYSES AND CONSIDERATIONS, CONSTITUTING THE BASES FOR TREATMENTS GIVEN.

II.1 Introduction: Development and learning

The superordinate point of view that has governed our reserach, is that *learning* is the main and more significant component in *human* development, as compared with animal development.

Accordingly, we reject a set of theories of human development whose *main* constructs are of biological, instinctual or maturational nature, though they may be adequate for explaining the development of traits common to many species.

It is accepted, of course, that a large set of genetically determined, inborn capacities, developed also by maturation and growth, are necessary for becoming a human. But they are made adequate *human* capacities only through the process of learning; that is, by *a large* and varied set of *experiences*, made in an *active* encounter with a *favourable* physical and social environment.

Learning inhibitions in retarded development

In accordance with this view upon the place of learning in development, the main emphasis is placed, not upon a defect nervous system or otherwise limited, inborn abilities, but upon *learning difficulties* or disturbances, in retarded development.

It is felt necessary to express, at this point, that too much research has been aimed at revealing brain defects, low ability and developmental peculiarities in the mentally retarded. Quite small amounts of research have been aimed, not only at detecting restrictions in learning, but also at showing how a better teaching-learning can reduce learning difficulties. As educators, we can not change abilities; nor can we heal an injured nervous system; even a knowledge of learning restrictions in retarded development is of little help, if suggestions as to how better learning can be arranged for, are not given accordingly.

Mental retardation, as a general phenomenon, probably has multiple causes, including also emotionally, motivationally, and socially conditioned learning restrictions.

Accordingly, a richly nuanced *teaching-learning approach*, including also conditions for favourable emotional and motivational learning, should be made to mentally retarded *individuals*, not as to a homogeneous group.

This, and not a classificatory and labelling task, is in our view the main challenge to teachers and other educators, including those whose task it is to counsel teachers and guide treatments.

Analyses of many *developmental tasks*, however, have revealed the necessity of concentrating upon some "central" aspects of all development and of developmental retardations.

Such analyses have led us to believe that an integrated conceptual and language skill learning, the former constituting the *socially* divisible meaning components of words and other signs of languages, must be especially concentrated upon when preparing "treatment-learning" sequences for mentally retarded persons, probably also for "language-deprived lower class" children.

This can be deduced from the mere fact that general tests of intellectual capacities, used to assess intellectual or "mental" retardation, to a large extent test a person's capacity to utilize concepts in order to solve problems (being problems only if the situation involves something not yet learned or previously solved).

II.2 Component theories of learning restrictions in mental retardation

Several research workers have concentrated upon components in retardate learning difficulties; that is, upon perceptual deficits, further specified as distractibility and perseveration (STRAUSS & LEHTINEN, 1947, and others); upon attentional deficits (ZEAMAN & HOUSE, 1963), later extended to attention-retention deficits (FISHER & ZEAMAN, 1973); upon "disequilibrium between exitatory and inhibitory processes" and "immobility between systems" (LURIA, & AL., 1961, 1963); upon incomplete short term memory processes, later including incomplete "rehearsal strategies" (ELLIS, 1963, 1970); upon inadequate motivational systems (CROMWELL, 1963).

Most of this research, as it is reported, constitutes descriptions of learning deficits and usually describes limited components of retardate learning;some of the research (e.g., ELLIS, 1970; FISHER & ZEAMAN,1973), has been performed within theoretical frameworks, whose aims are to explain shortcomings in a general way, however, rather than to predict outcomes of specified, compensatory treatment-learning.

Approaches to the latter aim have been made by BENOIT (1957, 1959), utilizing HEBBIAN constructs, and by LURIA (1961, 1963), who proposed in a general, not specified way that language could be used in compensatory fashion - by "cerebro-asthenics" - to control perception and "regulate behavior".

HEBB (1949, 1955) argues, in an acceptable way, that the content and organization of long-term memory (LTM) constitutes the structural base for both perceptual and motivational functions and disfunctions. He does not, however, seem to notice the possible role of LTM-organization for different "chunk-sizes" (MILLER, 1956), affecting also the "rehearsal strategies" and short term memory capacity.

This seems to be related to the fact that he overlooks the importance of language units as possible organizing factors in LTM; thus he fails to include in his neuro-psychological theory essential parts of human perception, conceptual learning and memory.

Though he treats the learning of verbal skills (i.e., reading skills) in terms of increasing integration of structures, he fails to include the role of language skills in the necessary development of "a conceptually organized nervous system" (HEBB, 1955).

The capacity for learning conceptually "loaded" language skills appears to be specific to human development (CASSIRER: animal symbolicum), and is probably the main cause of man's high levels of learning, thinking, and problem-solving.

In section II.4, a theoretical model of a learning person (NYBORG, 1976) will be presented in order

1) to interrelate and further differentiate constructs of human psychic functions, excellently, but more componently theoretically treated by different research workers;
2) in order to make assumptions on and explain both optimal functions and disfunctions; and
3) most importantly, in order to predict possible learning outcomes of intensified and well organized treatment-learning, in the mentally retarded.

But first (section II.3), an outlined analysis of CL tasks, of sub-processes in CL, and of inter-relationships between conceptual and language learning, will be given.

II.3
CL-tasks and sub-processes in CL.

At least four sub-processes in CL, i.e., skill learning, selective associations (later being the bases for selective identifications), selective generalizations, and selective discrimination-learning, can be operationally defined by considering similarities among CL tasks.

Similarities between CL tasks

There seems to exist agreement among several research workers (i.e., GOSS, 1961; GARNER, 1962; and others) that CL tasks, as an immensely large class of developmental tasks, can be operationally defined by following criteria:

> Two or more subsets or sub-classes of dissimilar stimuli (i.e., objects, object parts, events, components of events, including relations, attributes, functions, numbers in groups, etc. (NYBORG, 1976, chapt. II)), each subset containing two or more units, should be associated with a corresponding number of distinct response alternatives, some of which may constitute the withholding of a response, however.

These criteria should be considered the "minimum of common multiples" for CL tasks, however. It is possible - and in most concept teaching probably necessary - to add several criteria to those just given. That is, which kinds of similarity within subsets can give rise to the common response to members of a subset.

In figure II.1, the defined minimum criteria have been transformed into a simple model or paradigma.

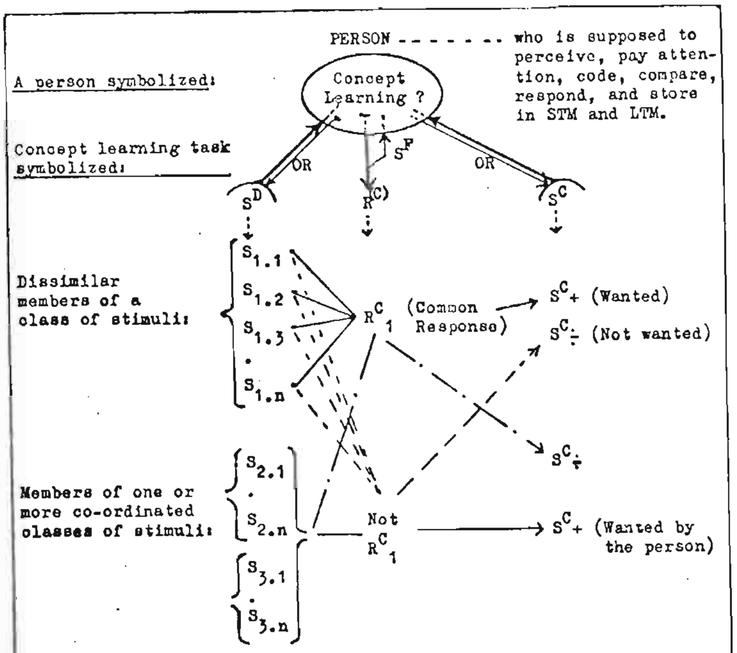
Sub-processes in CL

From this paradigma can be deduced a set of operationally definable sub-processes in CL, each of which has been extensively treated in the literature.

Skills involved in responding

First, in order to be able to "emit" a "common response to dissimilar stimuli" (T.S. KENDLER, 1961), the person usually must have learned a set of skills (here defined as pairedly and sequentially organized experiences, stored in LTM), thus making the observable responses or acts possible.

This does not hold good for unlearned responses; i.e., responses belonging to the inborn and matured capacities of a person, and frequently utilized in classical conditioning.



Explanations:

OR - orienting or observing responses, which can bring the person into some perceptual contact with S.
S^D - discriminative stimuli, preceding and giving the occasions for making - usually - an instrumental response.
R^C - common response, to be made to a class of dissimilar stimuli.
S^F - feedbacks from the person's own responses.
S^C - Stimuli which can be perceived by the person and others as the consequences of his acts.
$S_{1.1}$- $S_{1.n}$- subset or subclass of dissimilar stimuli, to be denoted by or associated with the common response, termed R^C_1.

Fig. II.1: Similarities among dissimilar CL tasks symbolized.

Further on, in "observational" learning, i.e., when a person learns by observing other persons during their learning or performance (as pupils often do in the classroom and in daily life), CL probably can take place without the "emittance" of an observable response. An "internal imitation" is possible, however.

But if this kind of learning, which can only be theoretically defined, is to be detected by others (e.g., by teachers, parents, etc.), the person must have in his "response repertoire" - and use - that skilled response or act which is agreed upon by social convention to be the correct identifiying response for members of a given class.

The response can be a verbal one (spoken, written), or can be given in some other kind of sign language.

Class membership can also be identified, and communicated, by using an object in a specific way, by acting in a situation in a specific way, by showing fear of, displaying avoidance of or being attracted to an object or event.

In the latter cases, emotional and motivationally conditioned responses can be said to involve in the identification and communication of class memberships. Though emotional responses frequently are "elicited" by specific classes of stimuli, they have proved to generalize to "substituting" classes of stimuli.

Paired association--learning

Secondly, one or more operationally defined associations (in the person theoretically defined as integrations) must be established between S^D and R^c_1 , and - sometimes - between S^D-R^c and S^c (see fig. II.1).

They may be conceived of as S-S -associations (e.g. S^D-S_R seen or heard) or as S-R -associations.

Stimulus generalization (SG)

Thirdly, if only one or a few class members have been associated to the response, spontaneous responding to new members can take place by the process of primary stimulus generalization. (Theoretically, the process of generalization shall be defined, within the model, as a class integration, in the learning person.)

This will most likely occur when "dissimilar" members of a class are approximately alike or nearly identical.

Secondary SG

When stimuli are more dissimilar, only partially similar, or entirely different (i.e., without systematic similarity, as in words denoting subclasses of a super-ordinate class or category) primary SG is not likely to occur, but secondary SG more probable.

In such cases generalizations can seldom take place after one association. It must be based upon previous or more learning (e.g., semantic generalization) and must usually be selective in nature.

Selective associations and generalizations

That is, if the person does not learn "paired-associates" between each stimulus class member ($S^D_{1.1}$ - $S^D_{1.n}$ in fig. II.1) and the common response (R^c), he must selectively pay attention to class criteria or relevant stimulus "dimensions", and "disregard" dissimilarities and irrelevant similarities.

The former kind of learning, operationalized by poor transferability and the person's "inability" to specify class criteria, should probably be denoted PAL rather than CL, because it lacks the transferability, constituting the gains of "genuine" concept learning.

Such learned "paired-associates" serve well to identify known members of a class, but probably fail when new and very different class members are to be identified.

In "genuine" and more complex CL, both associations and generalizations must be selective; i.e., the person must be able to analyze stimuli (see chapt. II.4) - in parts or components, in terms of relations, attributes, functions, number, word or sign meanings, etc. - in order to be capable of selecting the kinds of similarity that defines the actual and whole class.

Selective discrimination learning (DL)

Fourth, selectivity must be involved also in the discriminations, necessary when coordinated class-concepts are to be established by detecting and responding according to relevant dissimilarities (in fig. II.1: Class S_1, as different from classes S_2 and S_3).

Concept learning theoretically and operationally defined

When both selective associations (theoretically denoted as integration of paired events), selective generalizations (class-integrations), and selective discriminations (the third sub-process in conceptual organization) have taken place, and experiences[1] thus organized are permanently stored in the person's LTM, concept learning can be said to have occurred. The products of CL are class concepts or systems of class concepts. Thus, concepts, conceptual systems or structures, and conceptual organizations, are used here to denote "something" stored in the person, "representing" and corresponding to the classes or categories of environmental stimuli, established and named by social conventions, and to be re-constructed by each new person.

They can be manifested in, and inferred from the behaviour of a person as a regular and long-term use of "common responses to classes of dissimilar stimuli"; that is, when the person has a motive for doing those class-identifying responses or acts.

Consequences for teaching programs and for the model

By means of a CL-task analysis it has been inferred which sub-processes must be involved in an optimal CL. The sub-processes have been operationally defined, in order to provide bases for constructing teaching programs, intended to facilitate the learning of sub-processes as components of more complete, conceptual organizations.

In this way, task analyses have served practical purposes, in our psychological and educational research projects.

Task analyses have in part provided the bases, also, for inferring which psychic structures and functions, in the learning person, can aid the optimal learning of concepts and conceptual systems.

This will be treated in terms of a "theoretical model of a learning person", used to explain and predict outcomes of teaching-programs, when given as "treatments" to mentally retarded children.

As can be seen in section II.4, the model represents an elaboration and integration of theoretical and empirical notions, made by several research workers.

II.4 Theoretical model of a learning person

It has been pointed out that selective associations (integration of paired events - in the person), selective generalizations (class-integrations), and selective discriminations (providing complete conceptual organizations), are necessary in more complex CL, and that this has to be taken into consideration while organizing teaching programs for CL.

Some questions

It remains to answer a set of questions, also important for constructing teaching programs; that is, questions which cannot be answered on the basis of operational analyses, but which must be derived from a theoretical analysis:

1. What should persons/pupils learn - or what should they be taught - in

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[1] Here defined as stimuli/situations, originating outside or within the person, as perceived or coded by him, frequently in terms of previously learned concepts and skills.

order to obtain the analytic capacity necessary for selecting task-relevant and "rejecting" task-irrelevant stimulus criteria?

The conditions for a flexible analysis and selection seldom reside in stimuli. Though some stimuli or stimulus "attributes" can be more "attention-demanding" than others (e.g., change, colour, brightness, loudness, etc.), provisions for self-governed analysis must be in the person, and must usually be founded in learned capacities.

The question of which capacities should be taught-learned, cannot be answered until another set of questions are raised and answered, however.

2. How are - or should be - the relationships between 1) an analytic and selective perception and 2) the contents of the person's long term memory (LTM), which denotes his previously stored experiences or knowledge? That is, what should be stored - and how should experiences be stored - in LTM, in order for the person to govern his analysis and selection, and thus avoid being "under control of external" stimuli or internal "impulses"?

3. What role do language skills (also parts of LTM-content), or more precisely, specific units and attributes of language play for 1) analytic and selective perceptions, necessary for the person when he - as he must in daily life - continuously has to construct new "wholes" or classes? 2) for the integration, organization and storing of experiences in short term memory (STM), important in many kinds of learning tasks? 3) For the organization of non-verbal experiences in LTM?

The reader should note that points 1 - 3 focus upon several themes, previously (chapt. II.2) related to learning deficits in mentally retarded persons.

4. Our question is now: How could different kinds of disfunctions - in perception, memory, language, and motivation - constitute and explain learning "deficits" in the mentally retarded - probably also in language-deprived, lower class children? And - which is the more important question for advisors/counsellors and teachers: How may learning "deficits" be reduced by means of intensified and theoretically well founded teaching-learning?

II.41
The model outlined.
(NYBORG, 1976)

It has been argued that the question of adequate teaching-learning can only partially be answered on the bases of operational analyses of task characteristica and sub-processes.

In the general model of a possible learning situation, including at least one person as part of that situation (fig. II.2 - II.5), attempts have been made to provide bases, both for describing and explaining learning and learning "deficits", as well as for predicting outcomes of adequate compensatory teaching-learning.

The model represents an integration and further development of many theories and models (e.g., HEBB, 1949, 1955; LAWRENCE, 1963; BOWER & TRABASSO, 1964; BOWER, 1967; ELLIS, 1970, and others), but draws also upon more limited sources (BRUNER, 1957; SPERLING, 1960, and others).

It consists of a "structure" (fig. II.2) which remains fairly constant, but whose contents (fig. II.3 - II.6: in handwritings) can differ considerably according to the nature of the learning task.

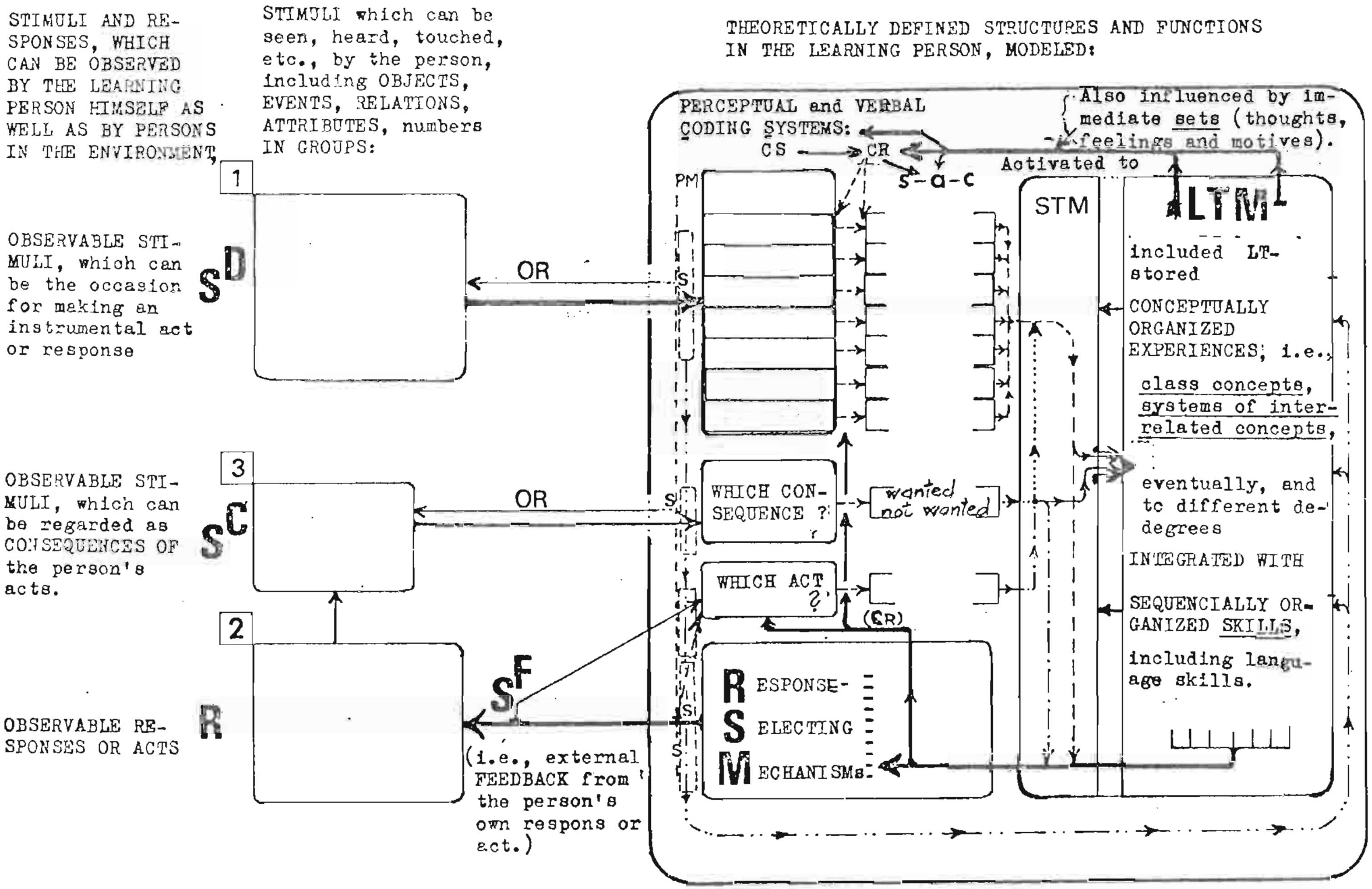


FIG. II.2

Explanations and extentions: CS - coding systems ; CR - coding responses ; s-a-c - stimuli-as-coded by the person ; PM - primary or physiological memory ; STM - short term memory ; LTM - lomg term memory (note the arrows from both the upper and lower part of LTM to CS and CR). Ad LTM : Involved in the conceptual organizations of LTM are also supposed to emotional and motivational components, previously integrated with cognitive components, thus providing the latter with incentive values.

"Learning situation" defined

It should be pointed out that the learning situation, in which the depicted person always, but to different degrees, is an active person, (otherwise it should not be denoted a learning situation - for him), frequently includes other persons, thus constituting the social environment in which most human learning must take place.

The situation constitutes a learning situation, only if it is not in all respects learned or known by the person.

The external, generally defined components, observable also for (but not necessarily observed by) other persons in the same situation - thus giving occasion for inter-subject agreement on what has been observed - have been suggested in fig. II.1 as S^D, R, S^C, S^F, and only partially observable, ORs.

What the person brings with him into the learning situation

In the symbolized person, LTM-contents, more or less activated and available, and a large set of "receptor" and "effector" mechanisms (only suggested in the model) are what the person brings with him into the learning situation.

LTM

Long term memory (LTM), including also the LTM-bases for experiencing emotions and motives in a situation, is supposed to be an important source of 1) perception (i.e., sensing and coding in terms of coding systems, coding responses (CR), and stimuli-as-coded by the person (s-a-c)), presumptively founded, mainly, in conceptual organizations and skills; 2) for choices and performance of responses or acts (RSM); for 3) short term memory (STM), and 4) for the evaluation of incentives and their value for the person (S^c more or less wanted/not wanted).

A set of arrows indicates these interrelationships.

A rich and important source of experiences, are stimuli or impulses, evoked in muscles and tendons during the person's own activity (small s's).

Coding: LTM →CS/CR

When stimuli, both kinesthetic and others, are coded (recognized or identified by means of coding systems, coding responses, whose consequences are s-a-c), they can readily be stored in STM for possible comparisons with preceding or succeeding coded events; or they can be transferred to and permanently stored in LTM.

Coding presupposes an activation through sense organs (s — ..— ..— .. → LTM) of LTM-stored experiences; thus activated, LTM-stored experiences can participate in the perceptual act, denoted coding in the present model (LTM ⟼ CS/CR).

Primary memory (PM)

If the stimulus-event is too short to be coded when present, a physiological or primary memory - PM - can make coding possible "post presentation" (SPERLING, 1960). This kind of storing may contribute to building up a representation of entirely new stimuli (HEBB, 1949) by activating "reverberatory circuits". They are readily broken down, or interfered with, however, by new stimuli in the "flow of stimulus events" usually meeting a person (AVERBACH & CORIELL, 1961).

Immediate, "discontinuous" and slow, "continuous" learning

Coding, in terms of previously stored experiences (LTM), is supposed to make immediate and quick integrations and LTM-storing possible.

If experiences are "entirely" or mostly new for the person - that is, do not activate LTM-stored experiences for coding - a long time involving many repetitions may be necessary to build up the representations in LTM which later can serve the coding. In such cases, PM may be thought to extend the CNS growth processes which probably follow a "stimulation" (HEBB, 1949).

Situations are frequently new or mostly new for a person in early periods of life. They are seldom entirely new in later periods of life.

Therefore, as pointed out by HEBB (1949), slow and "continuous" learning is more likely in early childhood; immediate, "discontinuous" learning more likely in later childhood and thereafter.

It is probably worth noticeing that in early childhood, a person cannot, or can only in a very restricted sense code his experiences in terms of language units. This should be related to the fact that most people have almost completely forgotten what happened to them in the earliest years of childhood, though psycho-analysts maintain that subconscious and preconscious memory from that time probably plays a dominating role also in later periods of life.

This should direct our attention to language as an instrument for organized memorization, as well as for making experiences conscious in a person. Both these lines of thought will be followed up in later sections of this paper.

STM

Short term memory (STM) is thought to depend upon LTM in two ways: It can store previously coded information, "taken out" of LTM as in thinking; and it can store coded events, having passed the perceptual system.

The coding or "chunk" units, dependent on LTM-organizations, and the form of coding (verbal-motor, non-verbal) will determine how much can be stored within a limit of 7 ± 2 (MILLER, 1956), and how long it can be stored (availability of appropriate rehearsal mechanisms).

The limits 7 ± 2 coding and rehearsal units probably apply only to relatively undisturbed memorization of verbally coded units, as in measures of memory span. When ST-memorization is interfered with, even three units are quickly forgotten (e.g., PETERSON & PETERSON, 1959, and others).

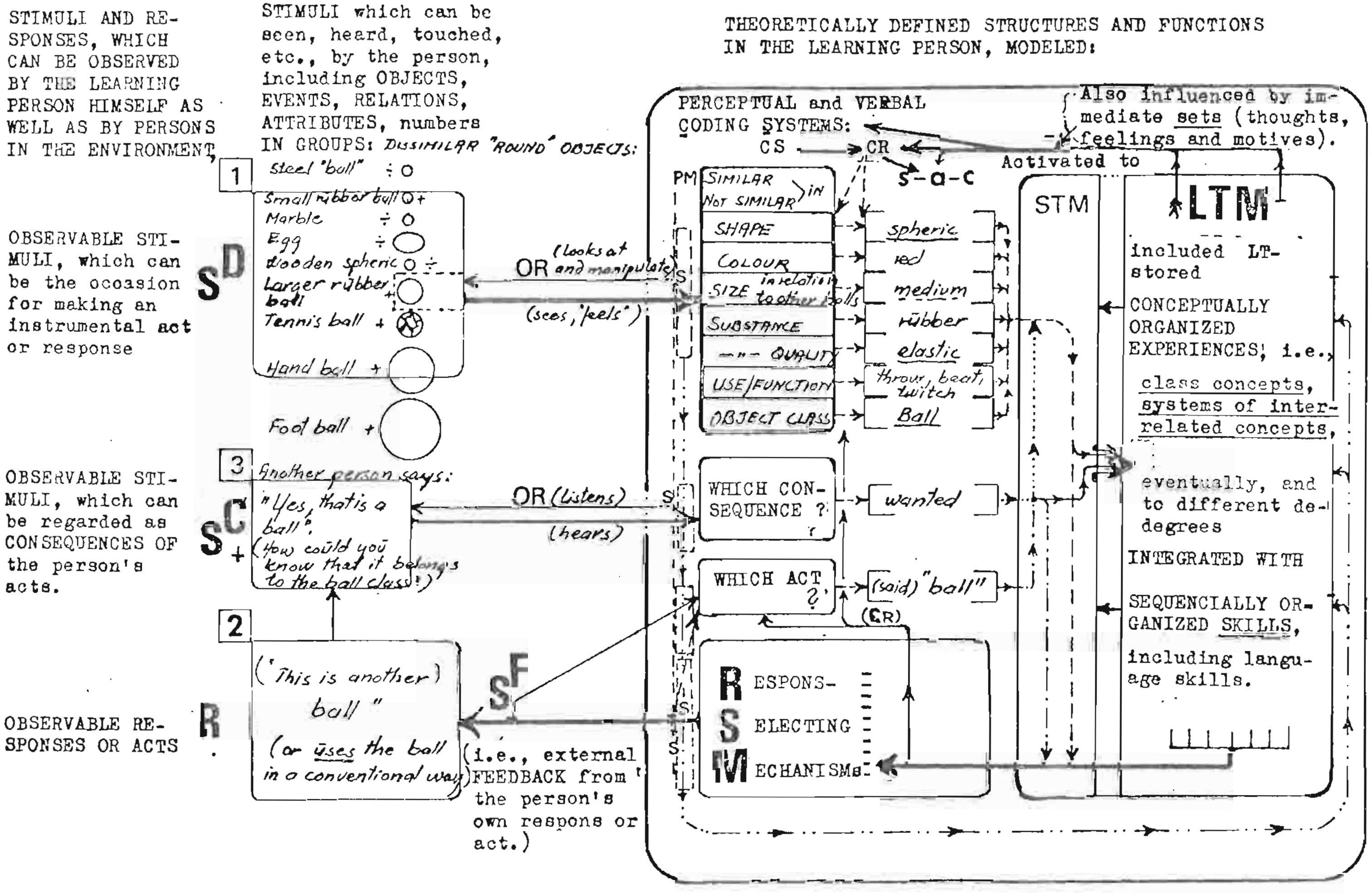
We shall return to the role of coding unit size and the verbal code as a convenient way of rehearsal in later sections.

II.42
The model applied to CL and other tasks

In order to make possible an evaluation of which organized units of experience, in LTM, can be thought to facilitate analyses and selective integrations and organizations, three representative tasks and parts of their solutions will be noted by drawings and hand-writings in the model (fig. II.3 - II.5).

First, a task including members of the object-class BALL is presented

Fig. II.3


STIMULI AND RESPONSES, WHICH CAN BE OBSERVED BY THE LEARNING PERSON HIMSELF AS WELL AS BY PERSONS IN THE ENVIRONMENT,
STIMULI which can be seen, heard, touched, etc., by the person, including OBJECTS, EVENTS, RELATIONS, ATTRIBUTES, numbers IN GROUPS: DISSIMILAR "ROUND" OBJECTS:
THEORETICALLY DEFINED STRUCTURES AND FUNCTIONS IN THE LEARNING PERSON, MODELED:
1
Steel "ball" ÷
Small rubber ball +
Marble ÷
Egg ÷
Wooden spheric ÷
Larger rubber ball +
Tennis ball +
Hand ball +
Foot ball +
OBSERVABLE STIMULI, which can be the occasion for making an instrumental act or response
S^D
OR (looks at and manipulate)
(sees, "feels")
3
Another person says:
"Yes, that is a ball".
(How could you know that it belongs to the ball class!)
OBSERVABLE STIMULI, which can be regarded as CONSEQUENCES OF the person's acts.
S^C_+
OR (listens)
(hears)
2
("This is another) ball"
(or uses the ball in a conventional way)
OBSERVABLE RESPONSES OR ACTS
R
S^F
(i.e., external FEEDBACK from the person's own respons or act.)
PERCEPTUAL and VERBAL CODING SYSTEMS:
CS
CR
S-a-c
Also influenced by immediate sets (thoughts, feelings and motives).
Activated to
PM
S
SIMILAR
NOT SIMILAR
IN
SHAPE
COLOUR
SIZE in relation to other balls
SUBSTANCE
— " — QUALITY
USE/FUNCTION
OBJECT CLASS
spheric
red
medium
rubber
elastic
throw, beat, twitch
Ball
WHICH CONSEQUENCE ?
wanted
WHICH ACT ?
(said) "ball"
(CR)
RESPONS-
SELECTING
MECHANISMS
STM
LTM
included LT-stored
CONCEPTUALLY ORGANIZED EXPERIENCES; i.e.,
class concepts,
systems of interrelated concepts,
eventually, and to different de- degrees
INTEGRATED WITH
SEQUENCIALLY ORGANIZED SKILLS,
including language skills.

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(fig. II.3). This class is chosen for simplicity to exemplify a class easily reviewed by the reader, and probably learned, though not completely conceptualized by most children in early years.

Next, a letter identification and discrimination task will be analysed in terms of the model (fig. II.4).

Lastly, a task including members of subclasses of animal names, in which semantic analyses and selections - i.e., analyses of and selection among word meanings - can aid semantic integration and organization (fig. II.5).

II.421 The object class BALL

The kinds of coding systems and coding responses which may be necessary to optimally analyze objects, either belonging or not belonging to the BALL class, is depicted in fig. II.3.

Object-analyses

It seems justifiable to deduce that object shapes, sizes, substances, colours, functions, etc., must be detected or attended to if a more complete analysis is to take place.

Shapes, sizes, substances, etc., are - at this point - defined as perceptual and verbal coding systems, within which a decision can be made by the person as to which specific shape, size, substance, function, etc. - i.e., as to which more specific coding "responses" - define each object (or event).

Thus, if the object attended to, in fig. II.3, is a small, red, rubber ball, the object-relevant coding systems and coding responses might be the following:

CS	CR
SHAPE	round or spheric
COLOUR	red
SIZE (in relation to footballs)	small
SUBSTANCE (STUFF)	rubber
STUFF QUALITY	elastic
USE (FUNCTION)	usually used to throw, beat, twitch (invented additional uses).

Analysis, preliminarily defined

Preliminarily, analysis should be defined as the multiple "use" of task-relevant coding systems and coding responses, giving for each object, event, attribute, relation, group, etc., a greater or lesser set of s-a-c's, depending upon the person's momentary or permanent capacity for analysis.

Analysis, in this sense, can be operationalized if the person is able to communicate it by some kind of language. It can be said to be 1) more or less varied (many or few CS's activated) and 2) more or less flexible (easiness of shift from one CS to another).

A flexible and nuanced analysis, in turn, will be considered favourable to a selection of the task-relevant set of coding systems.

Selection of task-relevant CS's

If the task is to sample the object-class BALL by responding with the spoken class name "BALL", a *selection* of *task-relevant* coding systems and coding responses has to take place. That is, *select shape* (round), *substance* (elastic), and partly *size* (within certain limits) and *use*, and *"reject"* the remaining, *task-irrelevant* coding systems and coding responses.

Such selection can be guided by *coded* consequences ($S^c\pm$) of responding; that is, the person may code "Yes" as a *wanted* consequence (S^c+), "No" as a *not-wanted* consequence ($S^c\div$) of his acts ("This is a ball").

If only one of the relevant CS's or some irrelevant CS is selected, alternations between S^c+ and S^c- will occur. If all and only *task-relevant* CS's are selected (after possible wrong selections and *re-selections*), only S^c+ will follow choices of BALL as a response.

Selection defined

An adequate selection process can now be defined as a sampling, among a larger set of CS's and CR's, of a set of *task-relevant* coding systems and coding responses; that is, coding systems and coding responses which result in the socially or otherwise defined correct choice of a "common response to a class of dissimilar stimuli".

The selection process constitutes an important part of task solution. As has been shown, task solution can be guided by consequent stimuli (S^cs), when the task is given in the form of "discovery learning", starting with "trial-and error".

The "selection" can also be *communicated* or instructed, however, if the particular language units necessary, can be meaningfully coded by the person. This can be a necessary and short-cut way to task solutions, in teaching, provided that the words making up instructions, convey socially defined, conceptual meanings to the learning person.

Class integration

Provided that the selected s-a-c's have been *integrated* with the s-a-c's originated in hearing and saying "BALL" (S^F), a *class integration* of dissimilar balls is supposed to be facilitated by an additional coding system, "similar in", denoting "partial similarity": "Similar in shape, in substance quality, and, in part, in functions." (see fig.II.3).

Organization of subclasses to a conceptual system

If the task also includes the distinctions or discriminations between sub-classes of balls, i.e., hand-balls, footballs, tennis balls, etc., the reselection of a new set of coding systems, *size*, *substance*, and partly, *use*, coded now additionally in terms of *dissimilarity* - dissimilar in size, in substance, in use - can aid the organization of the super-ordinate ball class into a *conceptual system*.

In this case, the direction Ball———> coordinated sub-classes of balls, is the most likely developmental course. In other cases, sub- and coordinated, first-learned classes may be thought organized into more super-ordinate classes. The organization, in the person, of subordinate, coordinate and super-ordinate classes into *conceptual systems*, probably depends wholly on appropriate experiences with interrelated units of language, including - according to our experiences in the research - the person's self-use as the most important experience.

STM in task solution

If the stimuli of a task are presented in close succession, short term memory probably plays an important role in task solution. Preceding s-a-c's (originating in $S^D - R - S^c$ sequences) have to be stored and thereby made comparable to new sequences, thus making an adequate selection possible.

LTM-storing

The final "link" in the learning process consists of an LTM store of organized experiences, in this case a storing, either of a super-ordinate class concept or of a conceptual object class *system*.

Thus, if learning occurs, it terminates with a long term store. We shall return now to the notion that learning probably - or frequently - *starts* with the *activation* of LTM-contents.

II.422
Perception, STM capacity and performed acts, dependent on LTM *organizations*

It should be noticed, that the labels' *shape*, *colour*, *size*, *function* or use, *substance*, etc., formerly used to denote coding systems, participating in the perceptual acts, also denote *conceptual systems* and constitute units of *language skills*, in a person who has learned them.

Conceptual system is used here to denote an interrelated system of class concepts, *in* a person, whose organization can be termed subordinate, coordinate and *different* levels of super- and sub-ordination. It corresponds to an interrelated set of units of language, whose interrelations can be defined by "principles" of language (circles, squares, triangles, etc., are all shapes).

It is an essential presumption of the present model, that more complex class concepts and conceptual systems cannot be learned except within the frame of some kind of language; further on, that superordinate names or signs contribute to integrate and organize subordinated class concepts into "tightly organized" conceptual systems.

Thus organized, a superordinate name or sign, while used in coding and analyses, can give rise to the "divergent production" of a set of coding responses, necessary in the analysis of objects, object parts, events, attributes of objects and events, relations between objects and events in the person's environment. (Which shape? Which colour? Which size in relation to what? etc.)

This, of course, depends upon it having previously been *learned* in a "convergent" manner.

A person who is repeatedly able to perform analyses in terms of such coding systems and coding responses, and is able to communicate them to an observer having the same social1) or cultural "reference" must, of necessity, have learned the conceptual systems and language skills, to which immediately functioning coding systems and coding responses correspond.

The most important bases for analytic and selective coding of "information" have been depicted in the person's LTM, therefore; that is, LTM-stored experiences, organized to class concepts, conceptual systems, and

---

1) It should be noticed, that *conceptual* meanings of words are those shared by most persons in a society or culture. Those who have not learned these meanings, including premature persons and language-deprived groups, are deemed to be outside society in these respects.

integrated with sequentially organized skills. Skills make the choice between and performance of responses or acts possible.

Among skills, language skills are probably the most important mediators of class integrations and organization of experiences into conceptual systems; they are probably the only possible media for organizing concepts and conceptual systems into "principles". The key-word for the understanding of language-mediated perception, motivation, learning, and thinking, etc., is integration; that is, integration between language skills and their conceptually organized meaning components (e.g., PFAFFLIN, 1960).

Thus, we agree with the notion launched by HEBB (1949, 1955), that only a conceptually organized nervous system is an effective one. But we seriously doubt that it can become so organized except by means of some kind of easily communicated language.

The heard, spoken, read and written "natural" languages can constitute immensely rich and nuanced instruments for human high level organizations, if they are so utilized.

Units of spoken language can conveniently be repeated or "rehearsed" as a means to prolong STM. Other attributes of language units can determine the amount of experiences kept in short term memory by each unit rehearsed.

II.423
Some of the roles assigned to language in the present model

It should be in place, therefore, to summarize and state more explicitly which roles language has been assigned in the present model.

Language skills regarded as important response repetoires

First, language skills constitute LTM-bases for performing verbal acts (speech, writing, manual signs, etc.), and for coding heard and written language.

Words as conceptual responses

Thus word forms may constitute a numerous and important category of "common responses" to dissimilar stimuli, most of which must become class names during a person's lifelong concept learning, if they are to function satisfactorily in communication.

Words and larger units of language as organizing agents in LTM

It seems a likely assumption, therefore, that they become "points of convergence" - or "mechanisms" for LTM-integrations and organizations of numerous experiences (i.e., CL), since they can be heard, spoken, etc., temporarily close to numerous and varied verbal and non-verbal experiences.

Thus, using or otherwise experiencing the same "name" for different class members, may be thought to facilitate selective generalizations or class integrations. On the other hand, experiences with different, but conceptually interrelated class "names", are supposed to facilitate the conceptual organization of more super-ordinate classes into subordinate class concepts.

Language as a vehicle for analytic and selective perception

While conceptually "loaded", language units can be thought to serve analytic and selective coding, involved in many kinds of learning, including higher level CL.

It has been deduced from task analyses and the model, however, that well organized conceptual systems - and their verbal denotations - rather than separately learned concepts or associative "word chains", will serve this function optimally. It has been an important goal for our research, therefore, to find out whether frequent self-use, not only of commonly used separate class names, but also their superordinate, integrating names (e.g., red colour, curved shape, greater size (than), rubber substance, place above/besides/beneath, etc.) may facilitate the learning of conceptual systems and - in turn - analytic capacity.

Thus, conceptually loaded language units, while used in a "divergent" manner during analyses, are supposed 1) to facilitate a persistent steering of attention, and 2) to make experiences more conscious in the person ("I'm going to look for (similar/different) numbers of elements in sets").

STM extension by means of greater rehearsal units

It has been shown that the "chunk size" (MILLER, 1956; COHEN, 1963) or possible rehearsal unit decides the amount of "information" to be stored in persons' STM.

Superordinate class names, while representing numerous experiences, conceptually organized into sub- and co-ordinated class concepts, involved in conceptual systems, can make possible more reconstructed information than subordinate class names.

The use of superordinate class names, corresponding to conceptual systems, as units for rehearsal, makes possible an extension of STM, which can otherwise be prolonged by active rehearsal. These "strategies" have to be detected or learned by a person.

Conceptually loaded language as a core of sociability

Finally, it should be emphasized that the conceptually organized meanings of word forms constitute those shared by most people (NYBORG, 1977, not yet reported). Private, associative word chains, however, are usually involved in the individual meaning contents given by written responses to separate stimulus words.

Thus, conceptual meanings of word forms, making up sentences and larger units of languages, seem to be an important core of communication, and thus of sociability.

II.424

A letter identification and discrimination task analysed

In figure II.4, page 21, a letter identification and discrimination task, including letters d, b, p, has been similarly analysed in terms of the model.

The person is thought to be one who is in a transition from the "cognition" to the "fixation" phase of learning to read and write (FITTS, 1964).

As compared to fig. II.3, additional conceptual and coding systems, relevant for learning many object class concepts, however, are in this task necessary in order to solve processes of analyzing, thereby identifying and discriminating the letters.

Thus, parts and several relations between similar parts have to be

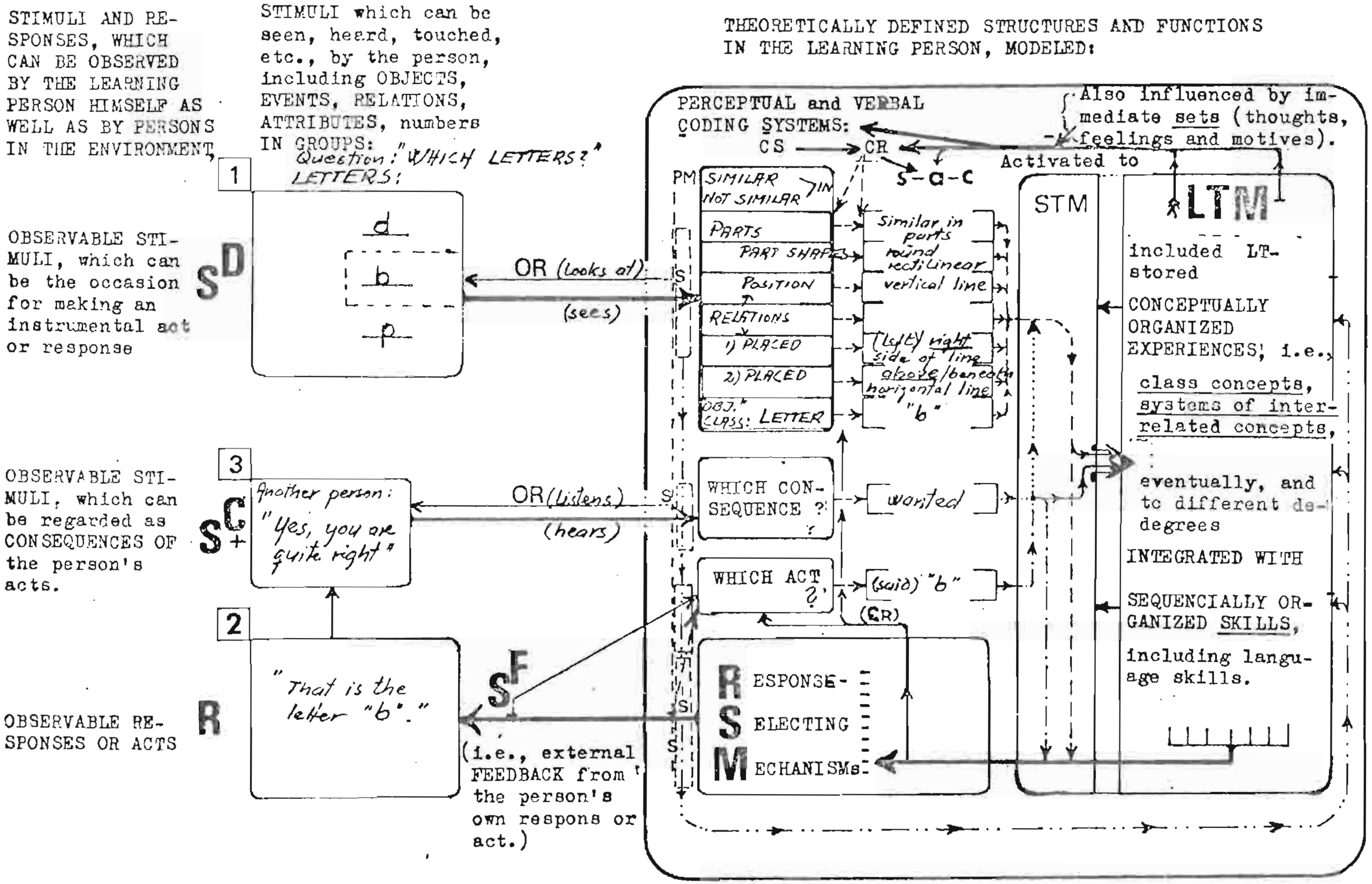
STIMULI AND RESPONSES, WHICH CAN BE OBSERVED BY THE LEARNING PERSON HIMSELF AS WELL AS BY PERSONS IN THE ENVIRONMENT,
STIMULI which can be seen, heard, touched, etc., by the person, including OBJECTS, EVENTS, RELATIONS, ATTRIBUTES, numbers IN GROUPS:
Question: "WHICH LETTERS?"
LETTERS:
THEORETICALLY DEFINED STRUCTURES AND FUNCTIONS IN THE LEARNING PERSON, MODELED:
1
d
b
p
OBSERVABLE STIMULI, which can be the occasion for making an instrumental act or response
S^D
OR (looks at)
(sees)
PERCEPTUAL and VERBAL CODING SYSTEMS:
CS
CR
S-a-c
Also influenced by immediate sets (thoughts, feelings and motives).
Activated to
PM
SIMILAR
NOT SIMILAR
IN
PARTS
PART SHAPES
POSITION
RELATIONS
1) PLACED
2) PLACED
OBJ. CLASS: LETTER
Similar in parts
round
rectilinear
vertical line
(left) right side of line
above/beneath horizontal line
"b"
STM
LTM
included LT-stored
CONCEPTUALLY ORGANIZED EXPERIENCES; i.e.,
class concepts,
systems of inter-related concepts,
eventually, and to different degrees
INTEGRATED WITH
SEQUENCIALLY ORGANIZED SKILLS,
including language skills.
3
OBSERVABLE STIMULI, which can be regarded as CONSEQUENCES OF the person's acts.
S^C +
another person:
"Yes, you are quite right"
OR (listens)
(hears)
S
WHICH CONSEQUENCE ?
wanted
WHICH ACT ?
(said) "b"
(CR)
2
OBSERVABLE RESPONSES OR ACTS
R
"That is the letter "b"."
S^F
(i.e., external FEEDBACK from the person's own respons or act.)
S
RESPONSE-SELECTING MECHANISMs

Fig. II.4

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analyzed, in order to select the relevant bases for identification. Discrimination is particularly dependent upon the selection of relations between parts, when letters take the depicted form.

Analysis and selection in PAL and DL

It should be noticed that both analysis and, in part, selection are involved in the paired-associates learning (making identifications possible) and discrimination learning, included in the present task.

(Besides, analysis enters the process of "segmenting" spoken words into phonemes, thus making letter-phoneme-integrations possible.)

Paired associates learning (PAL) - that is, the integration of 1) a set of S^D -originated with 2) a set of response-originated s-a-c's - can possibly be characterized by more integrations than in the learning of class concepts.

Thus, in the present task, both parts, their shapes and spatial interrelationships must be analyzed and learned, in order for the person to identify the letter b and discriminate it from letters d and p.

PAL in contrast to concept learning, therefore, requires more learning and more storing capacity than CL, which can take place in a selective way. That is, only the selected class criteria need to be stored in CL.

If learning classes takes the form of non-selective PAL, the learning should probably take longer time, require more storing capacity and be less transferable. We suspect that this may be the case in much of retardate learning and thus constitute components in their learning deficits.

II.425
A semantic concept identification task

In the final task to be analyzed in terms of the model, a set of written animal names, some of which denote domestic animals, constitutes the S^D's.

It should be meaningless to present this task to a person who has not yet learned to read and/or has not learned the conceptual meanings of the read words.

The coding of letters, letter sequences (direction: from left to right) or words, depends wholly upon language skills, depicted in the lower part of LTM.

Supposed that the required language skills are learned to an automatized level (but perhaps only then), this coding can probably take place without requiring much of the person's attention.

His attention can be saved for the semantic analyses, selections, and integrations of word meanings, making the subclass "name" domestic animals a possible response.

Associative links between words, within the person's LTM, can probably be sufficient to solve this task. But if the task includes a requirement to define similarities and dissimilarities among the subset of domestic animals, both the animal conceptual system, the concepts of domestic functions, and others, must be in the person (fig. II.5).

The latter task, i.e., to specify the class criteria to another person,1)

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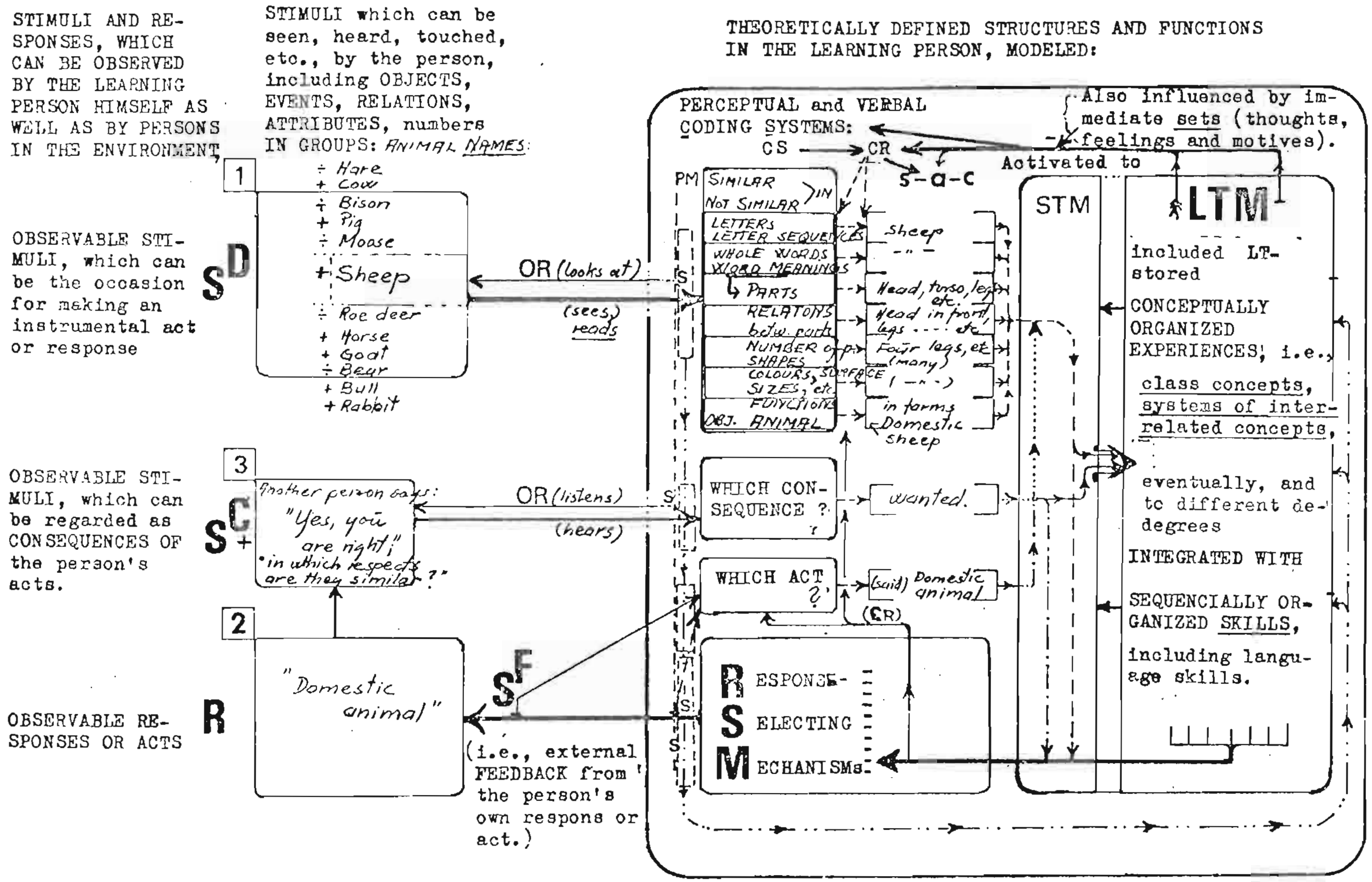
1)Thus communicating the conceptual meaning referred to by a class "name".

Fig. II.5


STIMULI AND RESPONSES, WHICH CAN BE OBSERVED BY THE LEARNING PERSON HIMSELF AS WELL AS BY PERSONS IN THE ENVIRONMENT,
STIMULI which can be seen, heard, touched, etc., by the person, including OBJECTS, EVENTS, RELATIONS, ATTRIBUTES, numbers IN GROUPS: ANIMAL NAMES:
THEORETICALLY DEFINED STRUCTURES AND FUNCTIONS IN THE LEARNING PERSON, MODELED:
OBSERVABLE STIMULI, which can be the occasion for making an instrumental act or response
S^D
1
÷ Hare
+ Cow
÷ Bison
+ Pig
÷ Moose
+ Sheep
÷ Roe deer
+ Horse
+ Goat
÷ Bear
+ Bull
+ Rabbit
OR (looks at)
(sees, reads)
OBSERVABLE STIMULI, which can be regarded as CONSEQUENCES OF the person's acts.
S^C+
3
Another person says:
"Yes, you are right;"
"in which respects are they similar?"
OR (listens)
(hears)
OBSERVABLE RESPONSES OR ACTS
R
2
"Domestic animal"
S^F
(i.e., external FEEDBACK from the person's own respons or act.)
PERCEPTUAL and VERBAL CODING SYSTEMS:
CS
CR
s-a-c
Activated to
Also influenced by immediate sets (thoughts, feelings and motives).
PM
S
SIMILAR
NOT SIMILAR
IN
LETTERS
LETTER SEQUENCES
WHOLE WORDS
WORD MEANINGS
PARTS
RELATIONS btw. parts
NUMBER of p.
SHAPES
COLOURS, SURFACE
SIZES, etc.
FUNCTIONS
OBJ. ANIMAL
Sheep
-"-
Head, torso, legs etc.
Head in front, legs ... etc.
Four legs, etc (many)
(-"-)
in farms
Domestic sheep
WHICH CONSEQUENCE ?
wanted.
WHICH ACT ?
(said) Domestic animal
(CR)
RESPONSE-SELECTING MECHANISMS
STM
LTM
included LT-stored
CONCEPTUALLY ORGANIZED EXPERIENCES, i.e.,
class concepts, systems of inter-related concepts,
eventually, and to different degrees
INTEGRATED WITH
SEQUENCIALLY ORGANIZED SKILLS, including language skills.

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represents the final level of concept learning (e.g. HUNT, 1962). Within the present context, it has been termed "to make experiences verbally conscious in the person", and comes close to the meaning of the word "understanding".

II.426
Summary and conclusions

It can be deduced, from the preceding task analyses, that many kinds of coding systems and their LTM counterparts, are necessary in solving tasks.

Basic to many kinds of analyses and selective integrations and organizations, however, seem to be a limited set of conceptual systems which can be denoted object parts (or components of events), relations between parts, attributes of parts and wholes, functions or use, number,etc., all in terms of super-ordinate names.

Some of these conceptual systems,e.g.part of a whole,(or elements of events) shape, colour, substance, functions, different kinds of relations (including sequential, size, localizational, positional relations), number, etc., and the concepts of partial similarity and dissimilarity, are probably fundamental in the sense of being necessary early in a person's life and in solving a large sample of tasks.

This has been taken into consideration while preparing educational treatments for mentally retarded children - and other young children.

II.43
Some final statements concerning the model

It is probably necessary to re-state, at this point, that many details of the model are originally derived from task-analyses and presumed optimal solutions of learning tasks. (In other respects, it represents further elaborations and integrations of many theories and models, thus representing also much empirical research.)

It does not intend to describe what really happens or what is in everyone who solves those tasks, therefore, but rather what could be thought to happen or be in a person if he, through adequate "treatments"-learning, had been given the optimal conditions for solving a set of specific tasks.

It has repeatedly been used to predict outcomes of learning, however, when children have received pretrainings (i.e., concept and language training), intended to provide - in them - the presumed optimal conditions for solving different kinds of tasks.

As has been indicated in chapt. I, and will be reported in chapt. III of this paper, the model has in this way received substantial, empirical support; thus it has proved to be a useful instrument for prediction.

By being diagnostic - that is, by describing what might be necessary "readiness" for solving tasks, it has also been used to evaluate and explain why children fall short in solving different kinds of tasks. Thus, it has been used to give answers to questions like these: What has this pupil previously failed to learn - or learned insufficiently - since he fails to learn a given specific, new task? And what might help him learn the necessary "readiness"?(i.e., not: what maturation must be waited for?)

By such "substracting" from optimal "readiness" - operationalized by means of diagnostic observations (e.g., LYNGSTAD, 1973) - it has been possible to detect and "treat" individual learning difficulties, along with the more general deficiencies, common to a class of "exceptional children". Young normal children have also profited from similar treatments (e.g., SKODVIN, 1975).

This strategy is probably advisable with all children who display some kind of "learning disabilities"; it is even more necessary when children belonging to the heterogeneously caused "mentally retarded" category are to be treated.

II.5 The model used to explain learning "deficits" in mentally retarded persons

We shall now turn to an application of the model to describe and explain some general learning deficits, assigned to persons belonging to the mentally retarded group and subgroups.

II.51 Negatively deviating intelligence test scores interpreted

It should be appropriate, then, to start with negatively deviating intelligence test scores, frequently used to assess membership of the mentally retarded groups, since they constitute the most general indications of learning deficits in such persons.

Several cut-off scores, most of which stay within the interval 70 - 85 (- 1SD to - 2 SD) have been used to define mental retardation, usually combined with some specified measures of learning, however (HEBER, 1961).

Intelligence test scores have been interpreted to express the person's capacity for transfer of previous learning to relatively new test tasks (CRONBACH, 1963).

More specifically, such transfer may be thought to take place by means of conceptual organizations, since several intelligence tests have been regarded as tests of a person's capacity for utilizing his concepts in solving tasks (INHELDER & PIAGET, 1964: concerning Raven's Matrices; LENNEBERG, 1967, concerning Leiter International Performance Scale; A. JENSEN, 1966, concerning Columbia Mental Maturity Scale; L. TERMAN (THORPE, 1964) concerning the Stanford-Binet tests).

Low test scores, therefore, probably indicate smaller amounts of transfer by means of conceptual organizations, and this corresponds or correlates, in general, with poorer language skills, in the mentally retarded (SPREEN, 1965, 1966).

In terms of the presented model, low intelligence test scores, indicating poor transfer by means of conceptual organizations, should not occur independently of poor language skills. On the contrary, language skills are supposed to influence concept learning in many ways, and conceptual organizations are supposed to provide bases for the understanding and use of language.

This point of view could probably be applied also to "language-deprived" lower-class children (B. BERNSTEIN, 1971).

This corresponds, in some respects, with the notions launched by JENSEN (1970) that the mildly and borderline, "familially and culturally" retarded essentially fall short in learning conceptual organizations, while the moderately and severely retarded probably display "deficits" also in more fundamental, associative processes.

In the present model, conceptual organizations and the corresponding language skills are presumed to constitute the most important organizations of LTM, "serving" several psychic functions, besides the social communication.

II.52 Perceptual disturbances

Thus, inefficient CL and resulting poor conceptual organization of LTM, should disfavourly affect analytic and selective coding of stimulus events, necessary in most complex learning.

This corresponds well with the combined conceptual and perceptual disturbances, i.e., distractibility and perseverations, observed in the "exogene" mentally retarded (e.g., STRAUSS & LEHTINEN, 1947), though probably not more characteristic for "exogenes" than for "endogenes" (GALLAGHER, 1957).

Limitations in analytic and selective capacity have been observed in moderately retarded persons by ZEAMAN & HOUSE (e.g., 1963: attentional deficits) and in mildly retarded children by NYBORG (1971).

Otherwise termed (as limited "cognitive differentiation" and rigidity of "boundaries between regions") they have been observed by LEWIN (1935) and KOUNIN (1941).

Finally, it should be noticed that several research workers have devised the notion that analytic and selective processes are the more difficult processes in concept learning (e.g., BOWER & TRABASSO, 1964; ZEAMAN & HOUSE, 1963; NYBORG, 1971, 1976, 1977 (not reported)) and probably in discrimination learning (HARLOW, 1949).

The former, at least, holds good for retarded persons, in relatively simple tasks;for normal children, and for students in more complex tasks.

The present model is in agreement with HEBB's notions, that "attention" is essentially determined by conceptual organizations of LTM. But notions concerning language functions have been added, in our model; and the construct of "conceptual organization" has been elaborated in order to meet requirements from several kinds of tasks.

(Thus language makes possible an extension of the limits of primary stimulus generalization and simple discriminations in class integration and organization).

Limitations of analyses and selections can be predicted on different bases, in the present model. Thus, 1) insufficient conceptual organizations, combined with poor language skills, should restrict a person's capacity for being analytic. This seems to be one appropriate explanation of distractibility, perseverations, rigidity, etc. all of which denote deviations from adequate, nuanced and flexible analyses.

II.53
Negative emotional and motivational concomitants of perceptual and learning deficits.

It has been noticed, however, that 2) strong negative emotions, originating in incapability for solving tasks, and inappropriate motivation, can have a similar restricting effect upon analytic capacity (e.g., MAIER, 1949; ZIGLER, 1966).

a) Negative emotions, previously evoked in learning situations and integrated with failures of learning, and b) expectancies of new failures, accompanied by lowered performance levels, are most likely in the mentally retarded (CROMWELL, 1963), since they usually learn slowly and frequently forget much of what they have learned.

Thus, poorly organized, learned "material" has proved to be quickly forgotten (DEESE & HULSE, 1967, p. 383), probably leaving the forgetting person in a state of frustration and insecurity, even hopelessness.

If the latter restrictions add to the conceptual and language skill shortcomings, a strong frustration of "motives for development through learning", should additionally retard their development.

Finally, it should be noticed, that insufficient "motivational systems" have been related, also, to poor conceptual organizations, as a causal factor, in the mentally retarded (e.g., BIALER, reported by CROMWELL, 1963; ZIGLER, 1966).

By "subtractions", in the present model, all these effects can be accounted for.

II.54
STM-limitations in the mentally retarded.

It has been shown that short term memory, except, perhaps, the ST-memorization of poorly organized material, probably depends upon LTM-organizations in two ways:

Skills available for rehearsal.

First, STM-capacity can be thought to depend upon skills, appropriate for the rehearsal of coded information, being learned to a high level of automatization, thus being easily available for the person and requiring only "small amounts" of his attention.

Language skills constitute, perhaps, the most convenient mode of coding and rehearsal. Even the rote memorization of letters and digits, utilized in ELLIS's (1963, 1970) experiments, depends heavily upon the subjects' language skills.

Language skills, in turn, are frequently insufficiently learned, in the mentally retarded (SPREEN, 1965, 1966).

Coding or rehearsal units.

Even more important, in the present model, is the coding (or "chunk) unit, to be rehearsed, when the material can be organized into differently "sized" units. The larger units, storing more information, will extend the capacity of STM, though the number of units that can be rehearsed under given circumstances, may be fixed.

Superordinate "names", while "labeling" encompassing, tightly inter-related and well organized conceptual systems, should meet such criteria of favourable rehearsal units. Even more information can be kept in STM, if principles, involving sequentially organized conceptual systems, constitute the coding and rehearsal units.

If LTM language skills are insufficiently learned, and "represent" conceptually poorly organized experiences, in the mentally retarded, STM-deficits should be expected in terms of the presented model.

They have been observed by ELLIS (ibid.), and have been ascribed to insufficient "rehearsal strategies", by him.

It is possible to accept that term, because "rehearsal strategies" can be further interpreted in many ways, including those used in our model.

However, the present writer has been led to reject the general notion, also made by ELLIS (1963, 1970), that long term memory is "normal" in the mentally retarded. At least, this notion can be accepted only in one sense; that is, if the material to be memorized 1) can be organized equally well by retarded and normal persons, and 2) has been learned to the same criterion - not by the same number of trials or time units - it should probably be kept as long in LTM by mentally retarded as by normal persons.

In other respects, that is, in the organization of LTM-content, they can scarcely be considered equal.

STM-shortcomings - in turn - should seriously affect many kinds of task solutions, when events, separated by short time intervals have to be compared and/or integrated.

Within the present model, STM-deficits should, among other things, disfavourably affect the process of selecting relevant coding systems, when stimuli to be coded are presented in close temporary succession.

The STM-deficit is mainly traced back to retardate LTM-shortcomings, however, as have been their perceptual deficits, language shortcomings and some disfavourable components of "motivational systems".

Other components of motivation (i.e. general expectancies of failure) and emotional disturbances, both of which constitute inhibitors of learning and may depress the level of performance, however) are considered secondary to those deficits pointed out formerly. If learning difficulties, in the former sense, are reduced, negative emotions and expectancies of failure should be reduced accordingly.

But even the learned bases for "elicited", negative, emotional reactions (e.g., anxiety and fear), must be considered components of LTM-organizations; the latter, or fear at least, may be considered integrated in the conceptual and language organizations of LTM ("Dogs are dangerous"; "I'm angry"; "father is angry with me", etc.). The possibility of preconscious or unconscious activation of negative emotion are more likely however, if they are early conditioned and thus not available for analysis in terms of a conceptually loaded language.

Help to clarify or make conscious emotions/motives is involved in many therapies, therefore; if language is to be used in therapy, language capacities, including conceptual organizations, may be necessary.

II.55 Conclusion

Thus, the model, while applied to an analysis of mental retardation, indicates that even though mental retardation may be differentially manifested and heterogeneously caused - i.e., by deprivations (including poor language "models"), by an injured or otherwise ineffective CNS, by disfavourable emotional and motivational conditions, etc. - the mentally retarded should, in many respects, be homogeneously treated, that is, in terms of a combined language and conceptual training.

Their learning difficulties - and the possible and numerous "channels" for treating them - rather than low original abilities or "powers", should probably be in the focus of teachers and those who advise teachers and parents, therefore.

The "ability" point of view is a static one, while the teaching-learning one is dynamic and intends to produce changes in the present state of a person.

And we feel - and have experienced - that it is possible to produce important and favourable changes in mentally retarded children. The means by which changes have been produced, will be returned to in following sections.

II.6 Conclusions for educational treatments

The conclusion, to be drawn from the present analyses, is that the prognosis for educational treatments of mentally retarded children is good, supposed that they can be taught - learned not only appropriate language skills, but also such skills integrated with conceptual systems of increasing complexity, thus constituting the "meaningful" components of language learning.

(This statement probably holds good, in some respects, also for "language-deprived", lower-class children, having a "restricted language code" as models for imitation and other kinds of learning.)

Such conclusions have actually governed our research with the mentally retarded, and our treatments of their learning difficulties.

Derivations from task analyses and the model.

From the model and from analyses of many kinds of tasks, the importance of a combined language skill- and conceptual learning has been derived; thus the goals for teaching-learning could be defined: Not to teach concepts and language skills in a random way; but in such a systematized way that they could really be LTM-stored and transferred and thus serve several functions in the pupils; that is, analytical and selective coding, rehearsal "strategies" in STM, class integrations and organizations, making an effective communication with himself as well as with other persons possible.

Derivations from the identification of sub-processes in CL

From our additional identification and analyses of subprocesses of CL, a model or strategy for the teaching of single concepts, has been derived.

Model for teaching "single" concepts.

A general model, not of a fully developed teaching program for single concept-teachings, is presented on the following page. That is, the main categories of tasks, providing conditions for learning selective associations, selective discriminations and selective generalizations, have been depicted; not all possible and necessary tasks.

Numerous and varied experiences

In the model it cannot be depicted how many different experiences should be provided for; neither can it be shown in how many ways pupils can be made active, and challenged to utilize or transfer the learned concepts within and outside classromms; how the teacher must continually give an exact language model and challenge pupils to use those verbal expressions.

Finally it can not be displayed, in the model, how pupils should gradually receive the responsibility for giving the tasks, to the teacher, to visiting persons, and to other members of the class.

Conceptual systems

Following the learning of a single concept, other concepts belonging to the same conceptual system would be taught-learned; in the present case, further learning should probably include PLACE on the left and right side, Place first, in the middle of, last in a ROW, etc.

When the teaching-learning of a conceptual system, or important parts of it, has been ended, it should not be considered sufficiently learned, until it has been used in conjunction with previously and subsequently learned conceptual systems, thus making mutual organizations of conceptual systems, and flexible utilization of conceptual systems possible; that is, flexibility in the analysis of environmental objects and events.

Verbally mediated integrations and organizations.

As has been pointed out, it had previously proved necessary to start with single, "fundamental" concepts, and systematically aid the organization of such concepts (and other concepts) into conceptual systems by means of super-ordinate class names.

In order to be agents for integration and organization, they should be heard and frequently used, by the pupil, in conjunction with subordinated class names and a rich variety of relevant non verbal experiences.

The selective generalizations - or class integrations - are thought to be facilitated by verbal expressions, denoting partial similarity or dissimilarity; that is, "similar in - -", "not similar in" parts, relations, attributes, numbers, functions, etc.

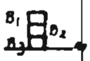
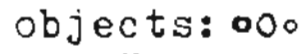
Instruments for teaching

Thus, both the theoretical model and the concept teaching model are thought to become instruments for independent thinking on the part of the teacher, and for planning and constructing teaching programs.

They provide inter-related principles, within which a well-educated (educated or provided nuanced insight also in learning psychology) teacher or leader of treatment can use his own resources and fantasy to construct effective teaching programs.

SA = Selective Associations
SD = Selective Discriminations
SG=Selective Generalizations

CONCEPT: Between CONCEPTUAL SYSTEM: PLACE(D)

SUB-PROCESS, and items	STIMULI (C+ = S^C+= positive concequences of R)		RESPONSES, gradually expected from pupils (ACTS)	
	Nonverbal	Verbal ("instructions")	Nonverbal	Verbal
Preceding teaching-learning:	Several conceptual systems are supposed to be taugt-learned in a similar way previous to the presently taught concept and system (i.e., things similar/dis-similar in SHAPE, COLOUR, USE or FUNCTION, SIZE (not yet differentiated into differentially dimensionalized sizes), NUMBERs of SETS, etc.). The task structures and some of the verbal expressions, common to many CL-tasks, have been learned and become "natural" for the pupils, therefore. The rela-tional principle,"PLACE in relation to --" has repeatedly been used and learned (probably only incompletely learned, however) in tasks concerning PLACEd above, beneath, and upon, and in learning SIZE-relations and NUMBER-relations.NUMBER concepts up to three are taught in such a way that they probably can meaningfully understand two and three.			
SA + SD:				
12.1	Boxes: 			
12.2		Conversation on similarities and dissimilarities between the boxes.		
12.3		Point at that box, which is placed between the other two.		
12.4			P. points at B_2	
12.5		Now, you thougt and acted correct again (C+). HOw is that box placed in relation to the remaining two boxes?		
12.6				It is placed between the other two boxes.
12.7		That did you say correct and exact.(C+).		
13.1	Sheet with pictured birds. 			
13.2		Put blue colour upon that bird which is placed between the remaining two.		
13.3			P. follows the instruction	
13.4		You were right again (C+). Why did you choose just that bird?		
13.5				Because it is placed between the other two.
13.6		Now you again gave a correct and exact description (and cause - causal relations).(C+)		
	MANY tasks of similar kinds could precede and follow the presented tasks, all examplifying the relational class"PLACE between" two other members of a set of three objects: ; SA and SD is combined, in this case, since"PLACE between"denotes a relational class.			
SG: 1.1	The sets of three objects, used earlier, assembled again.	(T. points out things"placed between":)		
1.2		In which respect is that car, that animal, that letter, that box, that bird, and that round shape, similar ?		
1.3				They are similar in being placed between two other things.
1.4		Now you were thinking and acting excellently (C+)		

Utilizations of fundamental conceptual systems.

"Fundamental" conceptual systems, thus learned, should provide the "readiness" conditions for being more flexibly analytic and selective, necessary in solving many developmental tasks, included CL tasks at increasing levels of complexity.

The kinds of tasks, to whose solution fundamental conceptual systems probably have contributed, in our three-year special educational "field" experiment, will be returned to in chapter III of the present paper.

III. A THREE YEAR, SPECIAL EDUCATIONAL "FIELD" EXPERIMENT, SUMMARIZED

(Previously more completely reported by
T. LYNGSTAD and M. NYBORG, 1977).

III.1 Recapitulations

It has been argued (chapt. II) that numerous and richly varied experiences, while stored in a person's LTM in terms of concepts, conceptual systems, and principles - previously organized by means of units of language and, thereby, integrated with language skills - should

i) better resist forgetting;

ii) should provide bases for transfer of learning
  - a) by facilitating a more nuanced and flexible analysis,
  - b) by facilitating selective coding, integration, and organization, and thereby, also,
  - c) should extend a person's STM-capacities;

iii) further, should provide bases for a person's capacity for communication by means of language skills, thus increasing also his possibility for social participation.

Finally,

iv) by providing bases for emotional security and confidence in being able to learn - or solve problems also in the future - involved in self-reliance and independence (in retardates probably reducing amounts of frustrations experienced and expectancies of failure, previously connected with learning situations), better learning could be thought to influence emotional and motivational states of a person so as to favour further learning.

(That is, in retarded persons, a motive to learn may be thought to gradually replace a motive to avoid learning situations).

II.2 Expected results of experimental treatments given to mentally retarded

Based, both upon the theoretical considerations recently presented (chapt. II and references made there), and upon previously reported, empirical research (references made in chapt.I,in this paper), it had been expected that mentally retarded children, in our three year "field" experiment

1) should fairly completely learn single "basic" concepts, organized - by means of and, thereby, integrated with language skills - into "fundamental" conceptual systems; this learning should be facilitated by the modelled concept teaching programs, involving systematic elaborations of subprocess and the recommended specific uses of language units.[1]

2) These kinds of learning were supposed to provide - in subjects given the experimental treatments - some important conditions for being analytic in the encounter with environmental objects and events, and selective in learning; that is, analytic during the integration of "paired events"; selective in discriminations also involved in "paired-associates" learning; and, even more, in the further learning of new and more complexly structured conceptual systems (i.e., concerning classes of objects and events, and the relations, attributes, functions, etc. involved in such learning).

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1) Probably corresponding to a more "elaborated code" in terms of B. BERNSTEIN's constructs.

3) Thus, they were presumed to provide facilitating conditions for the "cognition phases" of learning skills, involved in many kinds of language (e.g., reading and writing skills, mathematical language, also involving skills, and several subject matters or "professional" languages).

And concepts and conceptual systems would constitute important meaning components of verbal receptions and expressions (i.e., those shared by most people in a culture) thus representing a desirable "meaningful learning" of language.

4) Learning, while taking place in a more meaningful way, was expected to better resist forgetting and to transfer to new learning; thus, learning should gradually become faster or take place immediately, in experimental subjects.

More meaningful and faster learning, and less forgetting should, in turn, be expected to evoke favourable emotions and raise the motivation for new learning. Inversely, amounts of negative emotions and "expectancies of failure", should be reduced.

III.3
Testing and other observational methods

In order to permit a test of our main expectancies (points 1-4, section III.2), several observational methods had to be used, the most significant of which, perhaps, were the teachers' reports on their own daily teaching and on the pupils' learning and motivation.

In addition, several "test instruments" had to be used, designed either within the frame of our project in order to assess learning specific to the project and diagnose failures to learn; or constructed by others, i.e., in the form of standardized achievement tests of reading, writing, and mathematical skills.

Testing related to our first, main expectancy

The previously mentioned, diagnostic concept test model (T. LYNGSTAD, 1973), designed to test sub-processes involved in concept learning, and the completeness of verbalized, selective identifications, discriminations, and generalizations, was repeatedly used to design tests of the presumptions, outlined under point one in chapter III.2 (i.e., after first, second, and third year).

Testing related to our second main expectancy

In order to permit an observation of how - and to what degree - conceptual and language capacities would transfer to the multiple analyses (and selections) of objects (point 2), a "flexibility" test - intended to test the availability of and ease of shifts between conceptual systems, activated by test stimuli to coding systems and responses - was used after the first and second year.

Time restrictions and the great number of tests used after the third year of the experiment, permitted only a limited test of analytic flexibility.

Testing related to our third expectancy

After the second year of treatment, diagnostic tests of the learning of elementary reading and mathematical skills were used (point 3); in the latter subject, mainly mathematical concepts and principles, expressed by spoken language, were tested, however.

After the third year of our experiment, a large set of tests, covering numerous concepts and conceptual systems, as applied in several areas of teaching - learning, was used to test possible differences between experimental and control groups.

In addition, standardized achievement tests, designed to test reading, spelling, writing, and mathematical *skills* in first and second grade, normal children, were included in our test program.

A more general language test, the Norwegian adaptation of the "Illinois Test of Psycholinguistic Abilities" (ITPA) - i.e., the subtests covering "representational processes" had also, by "face validity", been deemed useful and were used.

Observations related to our fourth main expectancy

Finally, teachers in both experimental and control groups had been asked to rate subjects on a scale, denoting different levels of *emotional* stability/instability, *motivation* for learning and for being in school, and (social) *behaviour towards class mates*, teachers and other pupils in their respective schools.

III.4
Sampling and sampling procedures.

Through *all* years, *twelve* children in each of two groups served as an experimental and a control group, respectively.

The problem of representativeness of E-group and C_1-group for their common population

They attended *five* special schools for "children with learning deficits", and with few exceptions they belonged in the mildly retarded or *debile* sub-category (50-70) of mentally retarded, as evaluated by means of "general tests of intellectual functioning" (mostly a Stanford-Binet Revision).

The main sampling criteria, however, were 1) that in the autumn of 1973 they attended first grade ("maturational level") of the chosen category of schools, and 2) that they had not too severe speech handicaps.

A sampling according to random sampling rules could not be performed and was not even aimed at. Random sampling had been considered impossible, since we wanted to enter and involve in teaching as it had been established by the respective schools, thus approaching "situations in and sampling of pupils" common to and usual in such schools.

We have no *statistical means* of evaluating how representative the groups are for their common "parent" population, therefore. The number of schools 1) and children, belonging to the given populations of day schools and children, are rather small, however, and our (my assistant's and my own) experiences with children attending such schools, by far exceed the five (later *nine*) schools involved in our experiment.

Though based upon such extended experiences, it is not possible to define or state whether or in which respects experimental schools and subject groups should deviate from what could be considered *representative* or "normal" for those populations. On the contrary, we feel confident in saying that all learning difficulties or inhibitions to be found in the category of children in question, were represented in our samples.

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1) Approximately 30 day schools.

Regarding schools, their organizations, localities and teachers, it is similarly impossible to point out deviations from the "population norms" of special day schools for "children with learning difficulties".

An approximated representativeness of our samples has been accepted, therefore, even though this statement cannot be supported by means of statistical probabilities. A minor randomness could be said to enter our sampling procedure, however, by our sampling of five special schools among a larger set of schools.

E and C_1 compared: Equality of representativeness

While comparing the experimental with the control (C_1) group - that is, in terms of 1) mean IQ level, 2) mean CA level, 3) amount of previous "organized learning experiences", and 4) additional, more specific, individual difficulties of learning - the two groups proved to approach an equality in these respects, except, perhaps, in CA and amounts of "organized learning experiences".

In the latter respects, the E-group excelled the C_1 group (i.e., 3-4 months).

However, the fact that individuals producing the higher E-group CA-mean, despite a higher age and somewhat larger amounts of organized learning experiences received in kindergartens, preschools and schools, still remained in the first "grade" or "maturational level" of special schools, does not indicate a more favourable development prior to experimental treatments.

It is defensible, therefore, to consider the E- and C_1-group equally representative for the population from which they are drawn.

A control group 2 (C_2) sampled

In order to reduce uncertainty regarding this question, a second control group (C_2, N=12) was sampled at the end of the third school year (in the spring of 1976).

Another sampling procedure, more vulnerable to sampling errors, had to be used, however; and we suspect, for several reasons, that the new control group (C_2) had become less representative for the population than that followed up through three years; and for several reasons we obtained a limited set of observations, in the C_2 group.

However, larger samples of pupils (12+12+12), teachers, classes, and schools (9), could now provide our bases for evaluating group differences, presumed to be produced by specific treatment conditions given to the experimental group. This can probably be considered the gains of sampling an additional control group.

III.5 Experimental treatments and design.

Experimental treatments could be divided into two components: that is, 1) into one component common to all groups and originating in a) a) homogeneous teacher education, b) homogeneities of generally accepted teaching methods, progressions and sequences, and c) homogeneity of school organization, etc.

The second component constitutes the specific, theoretically and empirically derived treatment conditions, given only to E-subjects (chapters II and III.6).

The latter component was supposed to produce a superior experimental group; that is, superior in some previously described ways.

If the experimental group after treatments could be considered superior and thus not any longer representative for the population, while the control groups "still" remain representative for the parent population, this change could essentially be ascribed to the treatment conditions specific to the project; that is, presumed that group differences be reliable, valid, and "considerable" in size.

Thus, differences in representativeness, post treatments, could only be derived 1) from comparisons with control groups, and from the assumptions that control groups "still" remained representative for the parent population and 2) from an assumption that all groups (E_1, C_1, C_2) originally represented that population equally well.

As has been pointed out, this holds good most reliably for groups E and C_1.

Treatment effects were observed within a design which probably can be denoted a "post-test-only", control group design, but with "repeated measurements" constituting the post-tests, however.

That is, the "repeated measurements" constitute the test observations made after second and third year.

III.6 Project-specific treatment conditions, outlined

In the autumn (October/November) of 1973, our experimental teachers1) were presented with a set of CL teaching programs and the report from a "pioneering study" (R.H. NYBORG, 1973), previously mentioned.

They were asked to use those programs in their teaching for some time, in order to become able to decide whether they would participate in our long term experiment, in many respects modelled on the "pioneering study".

Except for a few of them, the teachers who participated in our experiment either in the first year or in the second and third year, had been involved in the "normal" teaching of mentally retarded children for several years.

They had been considered able, therefore, to judge whether results produced during the first months of participation - and later - were of such value as to be followed up in further teaching.

III.61 1973-74: The first 3/4 of a school year

In December 1973 they decided2) to become involved in our long term experiment; on several occasions and by means of several channels, e.g. courses, our visits to schools, studying our literature (NYBORG, 1976 and notes on teaching, LYNGSTAD & NYBORG 1977), they received information regarding our theoretical bases for teaching and practical details of teaching concepts.

For some months they relied almost entirely upon the concept teaching programs and teaching devices previously worked out by my assistants and myself.

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1) Except for one, preschool teachers this year.

2) Thus, it can be said that they "sampled" us, as much as we "sampled" them.

Later, they became increasingly able to use the model for concept teaching to construct teaching programs and select teaching materials independently.

Teaching - learning devices

Some CL teaching devices ((mostly picture cards) to be used on "door learning panels" and previously used in the short-term field experiment, were at their disposal.

A "door learning panel"

A "door learning panel" has been depicted in figure III.1. It had been equipped with five small doors, at which a corresponding number of stimulus cards could be presented, and to which subjects could respond by opening one or more of the doors, the "correct" one of which would hide small rewards ($S^{C}+$).

Fig.III.1 Sample S or instruction: "Point out, to me, those lines which are similar in having horizontal position". Afterwards: "In which respects are they similar ?" Finally: "Now you may open the doors pointed out".

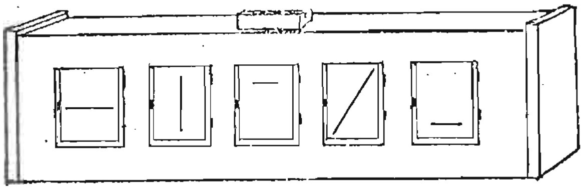


Fig.III.1: Door panel, to which a generalization task, to do with the concept of horizontality and the system of positions, has been applied.

This learning panel was especially useful while elaborating the selective discrimination and selective generalization sub-processes. It was particularly necessary while teaching important tasks, which probably should have been avoided - for the sake of "expectancies or fears of failure" - by several pupils, unless they could anticipate small rewards as positive incentives, while responding correctly.

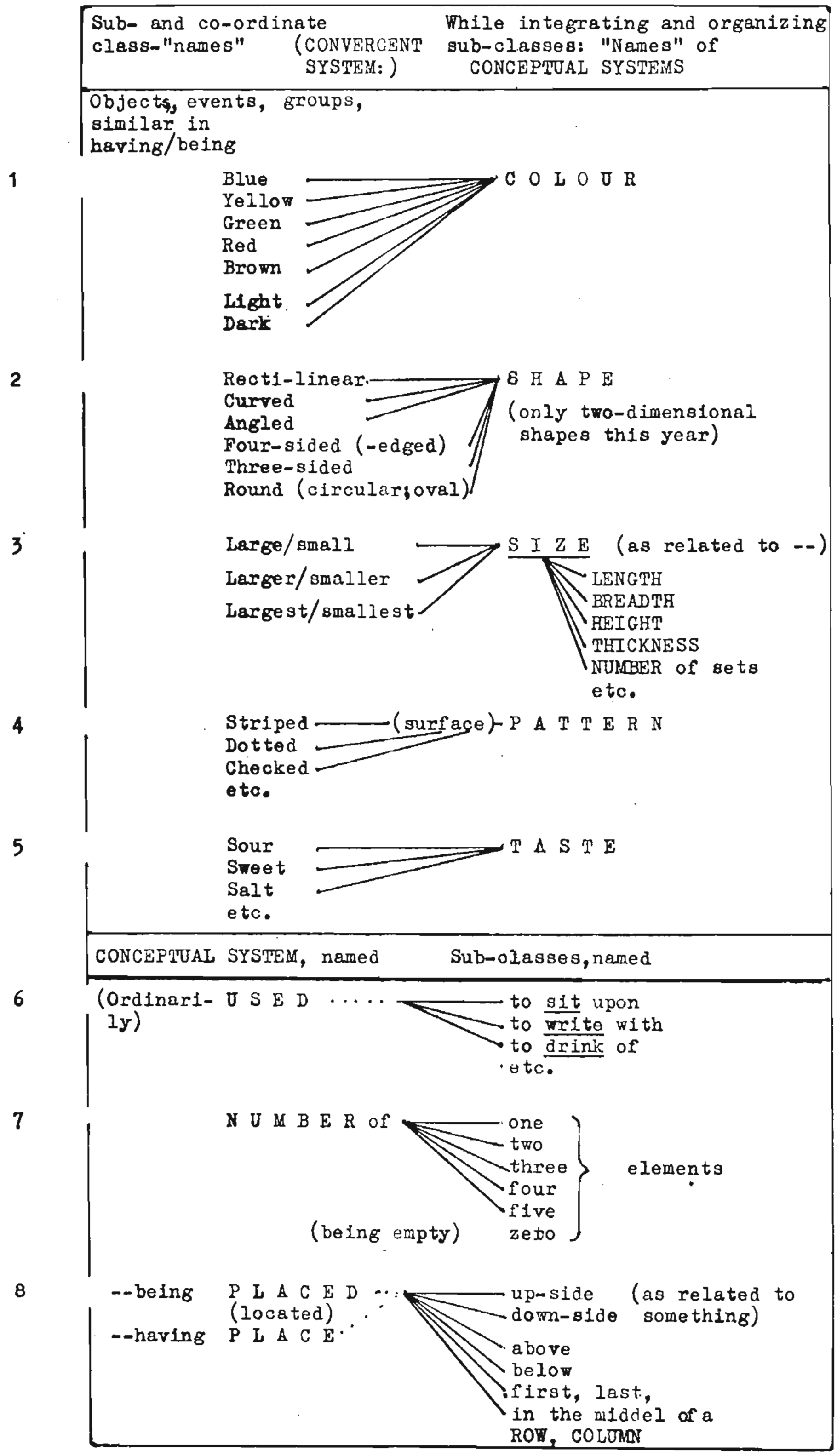
Thus it served to overcome developmentally unfavourable motivational states, in the pupils. But it also provided appropriate situations in which pupils could instruct each other, thus taking the responsibilty for giving - not only receiving and solving - tasks.

Finally, while assembled in front of the learning panel, they had an opportunity to learn favourable "rules" of social interactions and participation; that is, to show respect for each other by leaving each pupil to solve his problem; to help one another, if wanted and necessary; to positively evaluate a correct solution or an appropriate part of a solution, etc.; all this should probably be given as a "model" by the teacher.

Conceptual systems taught

During the time interval between late autumn, 1973, and May/June 1974, the following "fundamental" concepts and conceptual systems were taught and in many important respects learned by most of the experimental subjects (fig. III.2).

Fig. III.2 Conceptual systems, taught-learned in the first year.



Interrelating conceptual systems

Each new conceptual system taught had to be used in conjunction or combination with those previously learned, thus providing important conditions - in pupils - for double and multiple classifications.

Analyses

In terms of the presented model such conceptual systems, integrated with and by means of units of language skills, had been considered favourable to a flexibility of analyses. Thus, we intended by these means to increase the pupils' capacities for nuanced, non-verbal and verbal analysis and selective learning; and, inversely, to reduce their rigidity, perseveration or "immobility between systems" (LURIA, 1961, 1963), and distractability.

These goals were actually reached by most of our experimental subjects; but only after "long-term", systematical and persistent teaching - learning work on the part of both teachers and their pupils.

Object analyses

Concepts and conceptual systems, integrated with verbal skills, were repeatedly and frequently applied - in a "divergent manner" - to analyse objects and to reconstruct new classes of "daily life" objects and events.

Letter analyses

Some of the "fundamental" conceptual systems, e.g., shape, location or place, sizes, etc., lent themselves to the analyses and descriptions of letters (and digits), later to be integrated with and identified by phonemes.

In fig. III.3, it can be seen how the "door panel" could be used in a task involving the detection of similarities among shapes and dissimilarities of positional relations between shapes of letters.

Fig.III.3 Sample S or instruction: "Point at those letters which are similar in having both a round shape and a rectilinear shape as parts." Afterwards: "1) "In which respects are they similar ?" 2) "In which respects are they not similar?" Finally: "Now you may open the door pointed at."

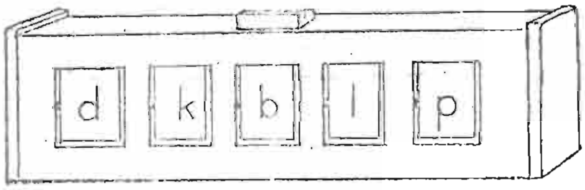


Fig.III.3:
The "door panel" used to present a combined selective generalization and discrimination task.

In similar ways, the analysis of phonemes out of the phone-sequences of spoken words, was prepared through a combined conceptual and language skill learning.

Mathematical concepts

Finally, the teaching - learning of concepts and conceptual systems, including *numbers of sets* (of *categorized* objects and events) and different kinds of *sizes*, only preliminarily organized into *relational principles*, however, prepared the later learning of a more complete mathematical language, involving also formalized mathematical skills.

Observation of classroom learning

1) The frequent hearing and self-use - on the part of our subjects - of language units denoting conceptual systems as well as their subclasses, and 2) the frequently used verbal expressions for "partial" similarities and dissimilarities, appeared to convey an increasingly better organized learning, as observed in the classrooms by our experimental teachers (and other teachers), by my assistant, T. LYNGSTAD, and myself.

Accompanying the more favourably organized learning, in E-subjects, an increased resistance against forgetting, extensions of speech skills and higher motivation for learning, were reported by our experimental teachers.

Test observations

These observations received support when, in May/June, 1974, both experimental and control subjects were tested and compared by means of test results, obtained in conceptual tests and tests of the "multiple use of and flexible shifts among conceptually based coding systems".

The differences between E and C_1 group means were "considerable", and were accompanied by only small amounts of overlap, especially 1) with respect to the completeness of verbal expressions and 2) in the flexibility test.

Scores of verbal and non-verbal conceptual responses corresponded fairly well, in E-subjects, however, while they did not in C_1 subjects.

III.62 The second school year (1974/75)

While in the first year, the teaching - learning of a set of "fundamental" conceptual systems and the corresponding language skills was started and had been the main theme, the treatment specific to the project in the second year constituted a *repetition*, *extension* and, increasingly, an *application* of basic conceptual systems; e.g., to the learning of new language skills and new or extended conceptual meanings.

Thus *language*, as used within the present context, denotes all aspects of language, including both the *meaning* and *skilled* aspects of heard and spoken, read and written language; including "mother tongue", mathematical and several other "subject matter" languages, etc.

Teaching subjects

Though organized into three broad, commonly used categories of tasks (i.e., 1) learning to read and write; 2) learning mathematics; 3) orientation towards persons, objects and events in the close environments), the application of a common set of "fundamental" conceptual systems, and a common model for teaching - learning concepts, provided *integrating* links between knowledge, obtained in differently named "lessons".

Teacher shifts: a problem

In two of three experimental groups, kindergarten or preschool teachers were replaced this year by "ordinary" teachers, according to a practice common to most special schools for retarded children.

In the third of our groups, an "ordinary" teacher had participated from the very beginning.

In a project utilizing theories and strategies of teaching not ordinarily used and not taught in teacher education, this shift of teachers represented an extraordinary problem, since new groups of teachers had to be repeatedly theoretically and practically "trained".

Thus, a similar, though more limited shift of teachers occurred - for several reasons - also after the second year, thus extending our problems in these respects.

A "low gear" performance of our experimental intentions could be expected, therefore. Thus, it has been shown, by limited replications of experimental teaching, made in new subject groups by the same teachers, that the teachers probably gain considerably from being experienced and further theoretically "trained". (LYNGSTAD & NYBORG, 1977, p.154). This should be expected when teaching is heavily dependent upon theoretical insights, on the part of the teachers.

A previously not reported, small replication by a widely experienced teacher, will be dealt with in section III.7.

Orientation toward daily life classes of objects and events

As has been previously indicated, only a minor set of entirely new, "fundamental" conceptual systems - and their "names" were introduced into the second year of teaching - learning.

Included in that set were the conceptual systems of substances (e.g., wooden, metallic, rubber, plastic, glass, etc.), substance qualities (weight, elasticity, the hard/soft distinction, etc.) and substance functions or use.

The learning and further spontaneous applications of such conceptual systems, as communicated by E-subjects, seemed to provide joyful discoveries or analyses concerning objects, object classes and their use in daily life.

The "cognition phase" of learning to read and write

Concepts of interrelated positions or places, including position in a sequence of events, could now be applied to articulatory and acoustic analyses of phonemes, involved in spoken words.

Similarly, letters, initially used to exemplify shapes, places - or positional relations, size relations,etc., and later used in the "whole word reading" of small words or morphemes (including also the subjects' own names), could now be systematically analyzed in terms of the mentioned coding and conceptual systems and subsequently, could be pairedly integrated with their corresponding phonemes.

Thus, the multiply "paired" integrations, between each phoneme and its analyzed, seen and written letter symbol, could constitute the bases for organizing letters into the letter sequences of whole words, previously learned only as units of spoken language.

The minor set of small words, initially learned as "unanalyzed wholes", could now be used to supply the "synthetically" read words while reading small sentences.

Focus upon conceptual meanings of language.

Thus reading and writing could be made meaningful, and made both maximally meaningful and motivating while including their own names, experiences, and real acting.

The conceptual meaning aspects of read and written language were focussed upon by teaching - learning as many words as possible as symbols[1] for or "names" of classes.

That is, by using the concept teaching model, involving the elaboration of sub-processes of CL, read and written words were taught-learned as names of class concepts and conceptual systems, in experimental subjects.

A mean number of 16 out of 24 test letters could be identified by phonemes by members of the E-group, at the end of this year. (A similar mean number of letters had been achieved by the C_1-group.) They had probably been learned in terms of a systematically elaborated "cognition" and a "fixation" level, however, while a high level "automation" still constituted a future goal.

That the letters had been more transferably learned by E-subjects, was manifested in test results obtained at the end of the second year; not so much in the identification by phonemes of single letters, as in the reading and conceptual coding of words and small sentences, to be paired with pictured stimuli.

A far better "cognition" of letters was revealed in E-subjects in a test of letter analysis providing occasion for a multiple coding of letters in terms of parts, part shapes and spatial relations among parts.

Similarly, a better "cognition" of letters was manifested in written letters and words; that is, they had been more conventionally or spatially organized by E-subjects, thus being more easily interpreted or read by observers.

Mathematical language

Teaching - learning the conceptual system of numbers of sets, involving also concepts of relations between and operations upon numbers of sets, had started in the first year.

Main emphasis had been placed upon the teaching - learning of cardinal number concepts and the counting of sets up to five or six, however. Only number words, not digits as symbols for numbers of sets, had been used so far.

In the second year, ordinal number relations (that is, relations among and operations upon numbers of sets (additions, subtractions)) became increasingly focussed upon. Thus, more completely organized number concepts up to nine/ten, and the corresponding symbols (digits, =, ≠ , >, <, +, -) had been learned by most E-subjects at the end of the second year.

When tested in May/June 1975, with tests of cardinal as well as ordinal aspects of number concepts; with tests of understanding as well as skilled aspects of mathematical language, the following results were observed:

It was in the understanding of number words, digits and mathematical

---

[1] The expression "symbol for" was actually used by teachers and gradually picked up in a manner indicating real understanding, by E-subjects.

signs as symbols for mathematical concepts and principles that E-subjects far excelled the C_1 subjects when evaluated in terms of differences between means and by SD's.

This superiority of E-groups transferred to the performance of mathematical skills, however; but fully "automatized" skills had not been expected - and were not revealed - in either of the groups at this time.

A new set of learning panels

In the middle of the second year, a new set of learning panels had been adopted.

Though similar in principle to the "door panels", the press-on buttons replaced door opening in the new panels, and a green and red lamp, signaling correct (+) and wrong (-) S^C's replaced reward - nonreward in the former panels.

The panel, including one of its many possible uses, has been depicted in figure III.4. (see p. 45.)

Pictorial stimuli (S^D's and sample S's), appropriate for the dimensions of this learning panel, and to be used in the teaching of reading and mathematics, were drawn, copied and distributed to E-classes in the second and third year. Additional stimuli (i.e., pictures and small objects/models) were designed or collected by the E-teachers.

III.63
The third school year (1975/76)

Continued learning to read/write as components of language learning

In the third year of our experiment, "fundamental" conceptual systems became further repeated and extended; this was done, mainly, in their application to the learning of language skills, to the multiple analyses of objects, events and sets, and to the learning of higher order concepts, conceptual systems and principles.

Though only small amounts of forgetting had been "observed", several basic conceptual systems still proved necessary in order to analyze and learn the remaining (i.e., the previously not taught-learned) letters and to govern writing acts; further on, in order to analyze objects and events and thereby establish new class concepts, "named" in conversation, in reading and by writing.

(In addition, several aspects of Norwegian grammar could be analyzed and taught-learned in terms of "similarities among..." and "dissimilarities between" verbal experiences.)

"Daily life" experiences conceptually organized

In this way, several "conceptual systems", regarding houses, rooms of houses, their furniture and use, regarding trees and flower plants, farms (and their houses, domestic animals, tools), Norwegian wild animals, etc., were taught-learned in an analytic and selective ordering and "naming" of - mostly - self-experienced objects.

Though emerging toward a separation into more formal teaching subjects, integration among separately treated subjects could be obtained by analyses and organization in terms of a common set of "fundamental" conceptual systems.

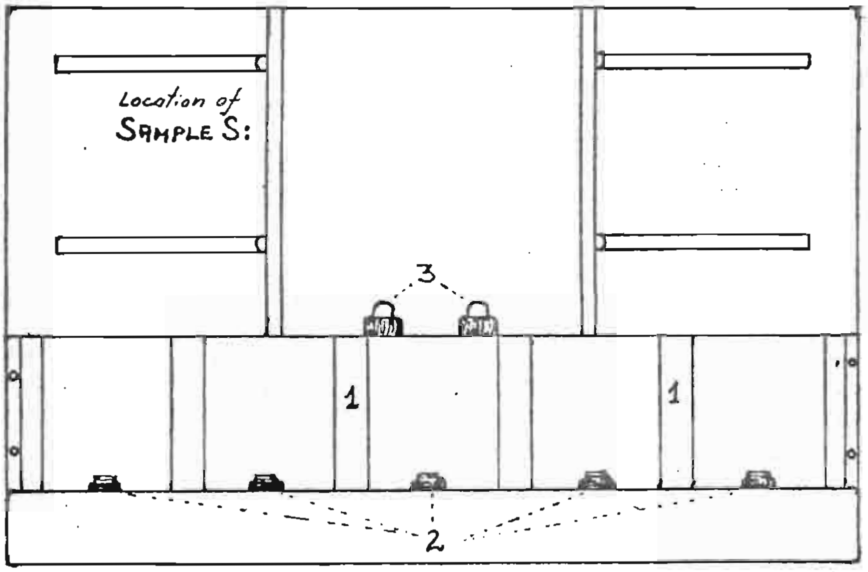
The conceptual systems of time and temperature

New kinds of analyses could be performed this year, in terms of the more fundamental conceptual systems of temperature and time.

Basic to the understanding of both temperature and time is an additional

Fig.III.41

A matching-to-sample, discrimination learning panel:



1 Card to which five discriminative stimuli (S^D) can be attached.

2 A corresponding number of press buttons, by means of which subjects can manifest their choices (among five) of a sub-set of S^Ds.

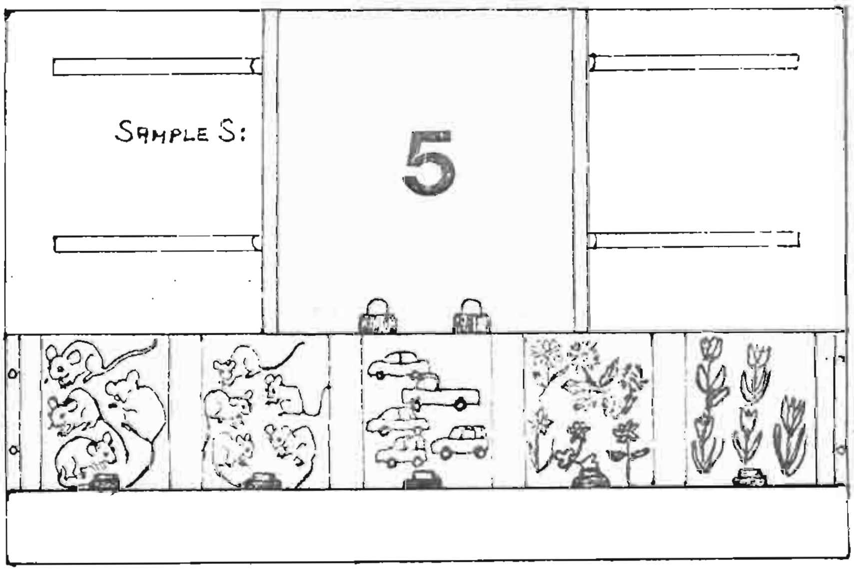
3 Lamps illuminated when buttons are pressed. Thus, accompanying a correct press, a green light (S^C+) appears; similarly, a red light (S^C-) accompanies an incorrect press. (Programmed from behind the panel by the teacher.)

Fig.III.42

The learning panel, utilized to present one part of a CL task:

Question: What does this digit symbolize ?
(---the number of five)

Instruction: Press the buttons, located beneath sets (groups), similar in having the number of five elements.



conceptual system - i.e., change.

The word change was frequently used, therefore, to integrate changes - produced by pupils and teachers or "taking place" - in shape, in colour, in size, in location and position (movement), in temperature, in substance quality, in taste and smell, in functions, etc., previously learned as separate fundamental conceptual systems.

Thus, the dynamics of regular and irregular events had been introduced and made fundamental to the learning of past, present and future time.

Standard units of measurement

Though the more elaborated conceptual systems of temperature and time could not be obtained by "our" pupils this year, they could be used to learn "standard units of measurement" and classes of instruments used in measuring time and temperature.

Already in the first part of the second year, standard units of length (dm and m) had been introduced by means of dm-sticks, used to measure lengths and breadths; in order to measure heights and vertical depths, our E-subjects had experienced that different kinds of folding rulers proved to be more suitable.

In the third year,standard units of area, (dm^2, m^2), of space (dl, l), of weight (hg, kg), and of value (i.e., real money), were systematically learned and used.

Mathematical language

These units, and especially "value units" or money, lent themselves to demonstrate and learn ones (elements/wholes similar in being taken or counted one at a time) as related to tens (sets, similar in being taken or counted ten at a time), and to learn the decadic system, upon which many standard units have been built.

Many teaching devices, including standard units of measurement , were used to demonstrate similarities and dissimilarities among ones and the corresponding tens.

When tens and ones should be signified by digits in numbers, the conceptual system of place could readily be used to state the symbol value of digit places in a number.

At the end of the third school year, it could be observed that most of the E-subjects had learned to adequately operate upon and relate both "concrete" and numbered sets in the "area" 0-100, though without passing tens.

Thus, the mathematical principles involved in operations upon and relating numbers of sets, could be fairly completely expressed by words or in terms or numbers and corresponding mathematical signs.

"Simple" fractions had been introduced via the concepts (or principle) "parts of a whole", useful - and actually used in our "treatment" - within many contexts (e.g., dissimilar parts of an object, as the "whole" analyzed); while applied to fractions, "parts of the same whole and similar in size" could define the denominators, though being of different size when different parts/wholes were compared.

As has been indicated, "parts of wholes" had been used also in analyses of objects and events, in order to selectively learn class concepts and conceptual systems of objects and events.

(In this sense, "partial similarity" and "partial dissimilarity" could be literally defined. Only in a more figurative sense can they be used to define similar and dissimilar attributes, relations, functions, numbers, etc.)

III.64
Additional information given to E-teachers

It has previously been mentioned that a main source of the information given to our experimental teachers was a copied manuscript on "Learning, Concept learning, Concept teaching", originally written in 1973, but further elaborated in 1974 and made available for students of education in 1976 (NYBORG, 1976).

Through three years, additional information regarding theoretical foundations and practical details of teaching - learning had been provided in ten papers (LYNGSTAD & NYBORG, 1977, parts of Appendix).

They provided analyses of problems involved in teaching - learning reading and other language skills, mathematical language (including standard units of measurement), the conceptual systems concerning time and object classes, etc. These papers constituted "documents" discussed at our meetings. They probably influenced the teachers' thinking about and planning for teaching in several ways, as can be seen in their daily reports.

III.65
Some final remarks

It can probably be inferred by readers of this paper that the summary of a nearly three-year educational treatment recently presented, only represents some main aspects of the project-specific treatment conditions. The many important and complexly related details had to be omitted.

A more complete, though still limited summary is available in the report previously referred to (LYNGSTAD & NYBORG, 1977).

Similarly, the experimental results, to be outlined in section III.7, will lack the many statistical analyses, discussions and conclusions made in the original report.

III.7
Final observations and summary of results.

At the end of the third school year, a large set of tests, both diagnostic and achievement tests, not standardized as well as standardized tests, were used to compare the E-group with control groups one (C_1) and two (C_2).

In addition, the teachers were asked to rate their pupils on a seven-step scale of emotional stability, motivation for learning and their social interactions in school life; i.e., the development through three years in these respects.

As a more general test of "psycholinguistic abilities", some ITPA subtests had been included in the test battery. In terms of "face validity", it had been considered an appropriate test of "representational" processes. While analyzed in terms of "theoretical validity", manifested in item selections and evaluational strategies, it appeared to be a more limited test of representational processes than had been previously assumed.

Only minor emphasis could therefore be placed upon the mean differences in "auditory receptions" and "verbal expressions", which particularly favoured the E-group.

Statistical methods

Since we had no quantitative means to evaluate the representativeness of our samples (E, C_1, D_2) for their common parent population, it was not considered advisable to test group differences with the parametric tests (e.g., analyses of variance, t-tests, etc.) which under different circumstances could be conveniently applied to our design.

Our data have been reported, therefore, in terms of graphic distribution of raw scores, by group means, standard deviations and differences between means $(\overline{X}_E - \overline{X}_{C_1} ; \overline{X}_E - \overline{X}_{C_2})$.

In the present summary, only a simplified method, utilized in the original report to summarize and compare data for three years, will be used. That is. group mean differences, expressed by proportions (P),

$$P = \overline{X}_E/\overline{X}_C : P_1 = \overline{X}_E/\overline{X}_{C_1} \text{ and } P_2 = \overline{X}_E/\overline{X}_{C_2}$$

have been used (Table III.1).

A proportion, $P<1$, accordingly, means that the E-group has a lower mean score than the C-group; $P=1$ indicates equal means; while P's = 1.5 or 2.0, etc., signifies that C-group means should be multiplied by 1.5 or 2.0, respectively, in order to obtain the corresponding E-group means.

In table III.1, proportions marked by * are accompanied by somewhat larger differences in SD^s from the means, involved in the computation of P. When proportions indicate only minor deviations from 1, an *-marked proportion should be cautiously interpreted, therefore. (See p. 49.)

It seems warranted to interpret proportions amounting to 1.5 or higher, as indicating significant differences; the word "significant" should not be interpreted in terms of statistical tests and confidence intervals, however, since such tests have not been performed.

In this "looser" sense, 39 out of 51 differences may be considered significant. If a proportion near 2.0 is chosen as a lower limit, 33 out of 51 differences remain significant.

With only two exceptions, differences favour the E-group. Differences between E-group and C_1-group means are usually greater than the corresponding differences between E-group and C_2-group means. A possible reason for this has been discussed on page 36.

But even the latter differences (P_2) appear to be "significant" in cases where also P_1 indicates "significant" proportions.

What is probably more important, is that the greater and smaller differences distribute to different teaching - learning and testing topics according to our expectations (chapter III.1).

Thus, the most definitely expected differences (i.e., in conceptually "loaded" tests) can be considered highly significant (points 1-3 and 8.1-8.5 in table III.1).

The smaller differences in skilled aspects of reading/writing and mathematics (points 4-7) had been expected, since neither of the groups had been supposed to reach a high level of "fixation" and "automation" at the times tested.

Table III.1

Proportions between mean scores, based upon test observations made at the end of each of three school years in experimental and control groups:

$$P_1 = \bar{X}_E/\bar{X}_{C_1} \quad ; \quad P_2 = \bar{X}_E/\bar{X}_{C_2}$$

TOPICS OF TEACHING AND TESTING		TEST AFTER		
		1.year (P_1)	2.year (P_1)	3.year(P_1,P_2)
1.1	Diagnostic concept test, verbal responses	4.55*	3.96*	
1.2	Concept test, nonverbal R	1.27	1.76	
1.3	Concept test, selective identifications	2.35*	2.27	
1.4	Concept test, selective discriminations	1.11*	1.52	
1.5	Concept test, selective generalizations	2.87	3.46	
1.6	Concept test, total scores	2.05*	2.54	
2	Concept utilizations in more complex tasks[1]		4.17*	P_1 = 2.05* P_2 = 2.03
3	Test of analytic FLEXIBILITY	4.83*	4.75*	
4	Letter identifications by phon.	.70	.96	P_1 = 1.17* P_2 = 1.07
5.1	Reading, diagnostic test		1.49*	P_1 = 1.57* P_2 = 1.45
5.2	Reading, standardized test			P_1 = 1.55
6	Dictation, letters, words and small sentences		2.00	P_1 = 1.43 P_2 = 1.25
7	Numbers, symbolized by digits, identified, dictated, and used in additions and subtractions		1.32*	P_1 = 1.39* P_2 = 1.26
8.1	Concepts of numbers of elements in sets		1.99	P_1 = 2.45 P_2 = 2.03
8.2	Concepts and principles concerning relations between numbers/sets		2.40*	P_1 = 2.70 P_2 = 2.01
8.3	Operations upon numbers (additions, subtractions)		2.60	P_1 = 2.85* P_2 = 3.14*
8.4	Standard units of measurements; Ones and tens[2]		3.36	P_1 = 3.10* P_2 = 2.32
8.5	Sum of scores 8.1 - 8.4		2.45	P_1 = 2.89* P_2 = 2.43*
9	Sum of scores, mathematical language		1.95	P_1 = 2.11* P_2 = 1.84*
10.1	Test of mathematical skills; standardized (middel of 1.gr.)			P_1 = 2.32
10.2	Test of mathematical skills; standardized (end of 1.grade)			P_1 = 2.33*

Explanations and notes: * means that the corresponding group means are accompanied by greater deviations of SDs.

1) (Ad point 2): tests after 2. and 3. year are not comparable.
2) (Ad point 8.4): Ones and tens only after third year.

A better learning of the elementary "cognition" phases - in E-subjects, seemed to transfer - after the 2nd. and 3rd. year to more complex components of reading, writing and mathematical skills (points 5, 6, and 10), some of which involved additional "multiple concept identification tasks", however.

Our main expectations reconsidered

Chapt.III.2, pts.1 and 2.

Thus, our main expectancies one and two (chapt. III.2) have received substantial support from data obtained in the diagnostic concept test and in the flexibility tests (points 1-3, table III.1). The selective, but non-verbal discrimination tasks (1.4) had been considered the easier parts of the concept test. They had not been expected to produce significant differences, therefore.

In a small replication, a highly experienced teacher obtained - in a comparable, but smaller group of five children - the following proportions after one whole school year of teaching (table III.2):

Table III.2 Results obtained on concept test and flexibility test after the first year of a minor replication, compared to the corresponding "field" experimental data :

TEST, referred to by numbers in table III.1	First year of field experiment: $N_E = 12$; $N_{C_1} = 12$ $P_1 = \bar{X}_E/\bar{X}_{C_1}$	Small replication made by extensively experienced teacher (after 1.year): $N_{E'} = 5$; $P_1' = \bar{X}_{E'}/\bar{X}_{C_1}$
1.1	4.55	8.00
1.2	1.27	1.85
1.3	2.35	3.80
1.4	1.11	1.37
1.5	2.87	5.02
1.6	2.05	3.26
3.0	4.83	12.27

(R. & M. NYBORG, 1977, not yet reported)

Though these results were obtained after a whole school year of teaching (for 3 of 5 subjects) - in contrast to 3/4 of a year in the previously described E-group - the data presented in Table III.2 are highly impressive in several respects; but most, perhaps, the data concerning analytic flexibility (point 3).

It seems warranted, therefore, to interpret the data to be a result - mainly - of the teaching given by a person 1) whose insight into our theoretical frame of reference is profound, and 2) whose experience with the use of our concept teaching model has been obtained through several years of application.

While related to this replication, our field experimental data (Table III.1) should be considered obtained by teachers who still remain in the first phases of a learning process, which can proceed only (and has actually proceeded) through continued theoretical studies and additional amounts of experience with the use of the teaching model.

It may therefore be defensible to conclude that our field experimental data reflect a "low gear" realization of the project-specific treatment intentions.

Chapt.III.2, point 3

In spite of this, the remaining expectations also receive support in our data (Table III.1).

Thus, the conceptual and language LTM-readiness - in E-subjects - for being <u>analytic</u> and <u>selective</u>, seem to transfer to the learning of elementary and more complex components of reading and writing skills; also to the learning of an elementary mathematical language and the skills involved in that language.

This is manifested, not only in diagnostic test results (points 2, 4, 5.1, 6, 7, and 8 in Table III.2), but also in results obtained by means of standardized tests (points 5.2, 10.1, and 10.2), which match fairly well with the corresponding diagnostic test data.

Chapt.III.2, point 4

Our fourth, main expectancy received support in the answers given by experimental and control group teachers to a questionnaire, previously mentioned (chapt. III.3). The answers revealed expected and significant group-mean differences in <u>emotional</u> and <u>motivational</u> development, both of which favoured the E-group.

These expectations received additional support when E-teachers, as they had been asked to do, evaluated - in a written essay - their own participation in the project. They were highly impressed while comparing the present groups with classes previously taught; not only by the E-subjects' learning, remembering and transfer, but also by the increased curiosity manifested in several ways, and by the favourable emotional and motivational changes taking place in most of them.

And they considered the latter changes produced, in many respects, by a better organized teaching - learning in E-groups.

IV FINAL DISCUSSIONS AND CONCLUSIONS

IV.1 Reliability and validity of "measurements"

The problems of reliability and validity of our experimental observations and results have beem extensively discussed in the more complete, original report (LYNGSTAD & NYBORG, 1977).

Though they have been implicitly expressed in preceding chapters of this paper, they should probably be explicitly reviewed in the present chapter.

IV.11 Reliability

Formal computations of "reliability of measurements" have not been performed, since it can readily be inspected as an "inner consistency" between repeated, comparable measurements in Table III.1.

Thus reliability, considered as an inner consistency, is manifest in the high degree of stability of mean differences, observed through three years. In some important aspects, differences even increase from one year to another.

Our data matrices reveal an inner consistency, also, between different test-items and tests within each year of testing.

Though the time-consuming and necessarily extensive formal computations of "measured reliability" could not - within reason - be undertaken, we feel confident in concluding that the reliability of measurements and differences is satisfactory and probably high.

IV.12 Validity

A high degree of "reliability of measurements" cannot be considered sufficient, unless it is accompanied by an estimated validity, including estimates of to which degrees experimental results can be"generalized" to a population.

"Sampling validity"

Since "sampling validity" (or the capacity of our experimental results to be generalized to the parent population - in terms of the representativeness of our samples for that population) could not be quantitatively estimated, we have to rely essentially upon other kinds of validity.

The theoretical, empirical, content, and "consumer" validity of our results will be discussed in subsequent sections, therefore.

Before leaving the topic of "sampling validity" it should be restated, however, that we have no particular reason to believe that our samples (especially E and C_1) are not representative for the parent populations from which they have been drawn. We cannot, for such reasons, reject a satisfactory sampling validity, therefore.

Theory validity

It has been argued, in chapter III.7, that differences between E-group and C-group means distribute among topics of teaching - learning and testing according to expectations derived from a theoretical"model of learning persons" (chapters II and III.2).

For these reasons we feel confident in rejecting the notion that might be developed, that the differences could have occurred by randomness.

Neither can different kinds of "halo effects" account for the sizes and distributions of mean differences between E- and C-groups. Though "halo effects" cannot be disregarded, they can probably be attributed to only minor amounts of the group-mean differences presented in Tables III.1 and III.2.

If the preceding conclusions can be accepted by the reader, a satisfactory "theory validity" of our results - or a predictive capacity of our models - should be accepted accordingly.

That is, the theoretical model and the concept teaching model could possibly be used to predict similar effects or learning outcomes, if comparable (or better) treatments were provided for the whole subpopulation sampled from in our experiment.

Empirical validity

The latter statement can be based, also, upon other kinds of considerations. Thus, it can be shown that the present data "match" or replicate data obtained in previous investigations performed within the same theoretical "frame of reference" (chapt. I in this paper).

Since the present data appear to be in accordance with several previously reported, empirical data, a high degree of "empirical validity" can be attributed to them (though this kind of validity can also be considered a reliability of or inner consistency between several predicted outcomes of common theoretically derived treatment conditions).

Content validity

Parts of the "content validity" - i.e., our sampling from a large population of possible teaching and testing subjects - reside in the validity attributed to our models. That is, parts of our diagnostic tests are derived from the models outlined in chapt. II of this paper.

Other parts of our teaching/testing are commonly accepted as valid "contents" to be taught and tested.

Thus teaching-testing contents, derived from our models as well as sampled among commonly accepted contents, contribute to one - in our view - defendable content validity.

It should be noticed, however, that a considerable consistence or correspondence exists between 1) results obtained in our diagnostic concept test and flexibility tests, and 2) results obtained in more formally designed tests.

This may, in part, be considered some of the transfer effects predicted in chapters II and III.2.

"Consumer" validity.

Finally we wish to discuss a kind of empirical validity which can be denoted "consumer" validity, since it originates in the "consumers'" evaluation of our treatment conditions and their consequences for E-subjects.

Thus, our experimental teachers could be considered "consumers" of our theoretical notions and practical teaching models.

Most of them were, prior to their project participation, well trained and experienced teachers in the area of special education given to "mentally retarded" children.

Their comparison of 1) previous teaching, based upon the ordinary and in most respects common training given to special teachers, with 2) their teaching performed within our project, should be given considerable weight, therefore.

At the end of the experiment, the teachers were asked to evaluate objectively their experimental teaching and the subjects' learning. All of the teachers seemed to agree upon the following themes, taken from their essays:

Their studies of the theoretical model used - and its implications for teaching - and their numerous applications of the derived concept teaching model, had provided a more profound insight into and a more independent thinking about the intricate problems to be dealt with in their work with mentally retarded children.

They felt that they had become better able than before to analyze individual learning difficulties and to help pupils learn in a more effective and meaningful way.

The secondary effects of such learning had been observed in terms of increased interest and curiosity, increased emotional stability, and reduced disorganized behaviour.

These outlines of "verbal reports" are in accordance with our observations and data; they have later been supported by the fact that both teachers and schools, in their teaching of "old" and new pupils and by training new teachers, have continued the work started within our project.

Though this kind of validation probably is an unusual one, it has been considered an important supplement to other kinds of validation by the present writer.

In conclusion By reconsidering the different kinds of validity evaluated in preceding sections, it seems justifiable to conclude that the validity of our experimental data may be considered satisfactory or even of high-degree.

IV.2 Final comments.

This notion underlies our final conclusion regarding the possible consequences - for teacher training and educational practices - to be drawn from our twelve year research project. (LYNGSTAD & NYBORG, 1977, chapt. VI.5).

Analyses performed and experiences gathered through those years have led me to believe that it probably should have such consequences, starting with changes in teacher training.

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