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ABSTRACT

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Technical Report No. 108

EFFECTS OF INSTRUCTIONAL INTERVENTION ON PERFORMANCE OF SECOND GRADE CHILDREN IN A CATEGORIZATION GAME

Report from the Project on
Situational Variables and Efficiency of
Concept Learning

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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This technical report is from the Situational Variables and Efficiency of Concept Learning Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Concept Learning Project has the following five objectives: to identify the conditions that facilitate concept learning in the school setting and to describe their management, to develop and validate a scheme for evaluating the student's level of concept understanding, to develop and validate a model of cognitive processes in concept learning, to generate knowledge concerning the semantic components of concept learning, and to identify conditions associated with motivation for school learning and to describe their management.

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ABSTRACT

Originating from an interest in the language-cognition relationship as reflected in the cognitive abilities of children, this study was planned to examine the differing theoretical implcations of Piaget and Vygotsky regarding categorization. Two types of instructional intervention were designed: Class Construction (CC) in which the Ss were instructed to sort the objects into groups and label them and Class Reception (CR) in which the Ss received the categories and lables from E. The instrument designed for this study, the Question Game, based on the game of Twenty Questions, was made up of a set of 32 objects, carefully selected on the basis of their potential for hierarchical classification. The task in each game was to identify the object E had in mind in as few questions as possible. A series of five games was played by each S, the instructional intervention following the second game. The scoring system was based on the proportion of objects eliminated with each question. The mean score in the three games following the treatment was one dependent variable on which statistical analysis was made. The responses of the Ss were recorded and four types of categories were identified: Nominal, Taxonomic, Functional, and Descriptive. The differences in the use of these categories were also analyzed. The sample was made up of 77 second grade children in public school in Madison, Wisconsin.

The results showed that the difference between the mean efficiency scores of CC and CR was non-significant. The post-instruction scores were significantly different from the pre-instruction scores ($p < .0001$). A multivariate analysis of variance of the differences in the types of categories used was found significant ($p < .03$). CC Ss used Functional categories and CR Ss used Taxonomic categories with significantly greater frequency. The conclusions drawn were that the interventions had a marked impact upon performance in terms of efficiency and the use of categories, but the difference between the two treatments were significant only in the types of categorization. The cognitive processes involved in the two experimental conditions were discussed and implications for education were drawn.

I

INTRODUCTION

In the last decade, the cognitive aspect of human development has become an increasingly important focus of research. Empirical studies of cognitive development have gained in number and in experimental rigor. This trend may be expected to continue, and as Wright and Kagan (1963) conclude,

> The use of verbal labels and mediators, the selection of dimensions and strategies for organizing experience, and the active information producing behavior of children appear to be phenomena that will play a central role in a continuing investigation of cognitive functioning (p. 196).

The "booming buzzing confusion" of the neonate's world is short-lived and early in life he learns to distinguish attributes that are relevant to his immediate needs from attributes that are not. Later organization of the child's cognitive experience involves both the reduction of uncertainty and the processing of information and is a function of his conceptual systems. Classification has been described as "the process most central to conceptual behavior (Furth & Milgram, 1965, p. 343)." The abilities related to the perception of pattern and regularity, the detection of higher order relations among objects, and superordinate relations between classes of objects develop with maturation and with education. The essence of categorization is in the recognition of criterial attributes of specific classes, the appreciation of similarities and differences, and the separation of relevant from irrelevant information within the given context. The more systematic and selective this process, the greater the efficiency in coping with complexity. The ability to categorize objects and events is sometimes equated with abstract thinking, although this seeming equivalence causes confusion. As Braine (1962) indicates,

> An account of the development of a concept of class must occupy a central position in any theory of the ontogeny of reasoning since so much of the verbal behavior often vaguely called "abstract thinking" appears to consist of reasoning about classes and class membership...(p. 48).

The exact nature of the relationship between language and cognition is much debated. Language has been described as a program for ordering and integrating experience, or as a system of categories of thought and culture (Brown, 1956). Words, in Brown's (1956) metaphoric expression constitute a lure to cognition, an invitation to form concepts. The role of language in classification behavior is preponderant; in fact, to separate verbal from non-verbal ability in categorization is a theoretical exercise, at best. The strategies of classification have been considered analogous to "the grammar of grouping what is alike and segregating it from the rest of the world (Bruner et.al., 1966, p. 84)." Bruner (1966) contends that linguistic experiences which enable the child to control and manipulate his perceptual input must precede certain cognitive operations.

A vigorous defense of the directive function of speech comes from the school of "materialist psychology" in the U.S.S.R. Luria (1959) views the role of the word in the formation of mental processes exceptionally important because it makes possible the "systematization of direct experience (p. 12)." He suggests that when the word is connected with the direct perception of the object, the essential properties of the object are isolated and the less essential inhibited, and that this aids in object permanence and generalization. In a brief review of Vygotsky's research contribution, Luria (1959) states that Vygotsky

> ...arrived at the fundamental conclusion that human mental development has its source in the verbal communications between child and adult (p. 16).

In contrast to the viewpoint emphasizing the primacy of language, Piaget (1964) warns that words are no short-cut to understanding. According to him,

> Mainly, language serves to translate what is already understood; or else language may even present a danger if it is used to introduce an idea which is not yet accessible (Duckworth, 1964, p. 5).

Language, from Piaget's epistemological perspective, is a medium for logical thought processes, not a determinant. Inhelder (1960) in a concluding statement on the performance of class inclusion problems of children says that operational behavior and activity make possible the eventual use of linguistic and other forms of symbolic manipulation.

Furth and Milgram (1965) demonstrated that objective verbal elements or the input and output sides of a conceptual task should not be confused with the conceptual operation itself, and they urge caution in inferring conceptual operations from verbal behavior alone.

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This theoretical controversy about the importance of language to other cognitive processes is reflected in practice, in a notable difference in emphasis. However, there is a large area of overlap between the two schools of thought and the contrast serves mainly the heuristic purpose of generating testable hypotheses. Whether language plays a necessary and/or sufficient part in conceptual development, and whether verbal mediation mechanisms are always facilitative in cognitive behavior are questions worth investigating. The implications of the answers for the practice of education could be far-reaching.

The second major issue in the development of classification skills concerns the effectiveness of the didactic process. The classical Piagetian contrast between spontaneous and non-spontaneous operations implies intrinsic factors controlled by a genetic time table. Vast numbers of empirical studies in the last decade have been undertaken to evaluate the pros and cons of this viewpoint. One of Piaget's early critics, Vygotsky (1962), felt that Piaget's exclusion of instruction as an agent of change was a serious omission and that the interaction of development and instruction was important. Piaget's (1962) response to this criticism was that interaction was complex, and that while in some cases, instruction would be an advantage, in other cases instruction may be presented "too soon or too late (p. 13)." Echoing the sentiments of many others, Carroll (1964, p. 79) criticized the Geneva School for its apparent indifference to the effects of training, especially in view of Piaget's theory that mental development occurs only through processes of learning, which need the dynamics of environmental interaction.

The didactic issue also represents a differential emphasis rather than a polarization of ideas. Ausubel (1968) stresses the efficacy of verbal didactic procedures in conjunction with concrete empirical props in accelerating the acquisition of cognitive skills. Inhelder and Piaget (1958) acknowledge the role of cultural and educational conditions in acceleration or retardation of potential, but point out that "the psychological facts allow us to reject this hypothesis of complete social determinism (p. 338)."

The relationship between categorization, language, and didactic intervention seems to be very complicated and from this perspective one must be willing to accept attempts at analyzing it as exploratory rather than definitive. However, as Bourne (1966) points out, it is increasingly accepted that "conceptual activity is accessible to experimental investigative procedures (p. 126)," and it is with this conviction that the following study is undertaken.

II

RELATED STUDIES

In the main, studies in the area of categorization can be allocated to two groups: those which test the efficacy of verbalization or verbal mediation on conceptual behavior, and those which test the developmental trends in categorizing ability and style. An added dimension entering both types of studies is that of didactic or training intervention leading to questions of transfer and generalization. The studies reported below cover a wide age range and a variety of methods.

A recent study emphasizing the role of verbalization in classification skills in middle and lower class preschool children was reported by Charlesworth (1968). A set of 24 objects, with potential for cross classification was selected so that function, shape, color, and generic class, could be used as criteria for grouping. Since the statistical analysis of the data on sorting responses was not reported, the interpretation of the statements that follow must be cautious. The author stated that when given a verbal clue, Ss "had less difficulty in sorting out appropriate objects than when given an object clue (p. 25)." A significant correlation (r = .41) between the language measures and classification performance was found and the author concluded that efficient object sorting was, to some extent, a function of linguistic skills.

In a learning set formation study by Crooks (1967) on third graders (N = 90) where the variables were degree of learning (number of practice trials), presence or absence of categorizing rule, and type of problem, she found that transfer in classification skills was facilitated by overtraining only when a categorization rule was learned.

Ervin (1960) came to a similar conclusion when she found that verbalization, while not significantly affecting performance on a motor-skill task, was facilitative in transfer to a related task in which the same principles operated.

Measuring the performance of 6- and 8-year olds on a double classification task (2 X 2 matrix of geometric shapes), Smedslund (1967) found that labelling was consistently superior to perceptual matching. Asking the child to describe the kind of object that should be in the empty cell seemed more conducive to a correct solution than asking him to point to it in a set of objects. Verbalization apparently helped him to orient his attention to the criterial attributes.

An analogous finding is reported by Wohlwill (1968) who concluded that verbally presented material was apparently more efficiently treated than pictorially presented material in a class-inclusion task, because the responses were strongly influenced by a perceptual set.

Carlson (1967) suggested that a verbal rule is used as a "cognitive organizer", in that those who were given a verbal rule seemed to use it as a framework. He tested 50 Ss (second graders) on a conservation task after instructional intervention. There were two levels of verbal instruction and two levels of overt activity. One scoring system (which allotted 1 for a correct response and 0 for an incorrect one) produced an interaction effect significant at the .05 level. A post hoc analysis of the data revealed High and Minimal Verbal Instruction (HVI and MVI) in interaction with the first level of overt activity--Demonstration--accounted for the variance. Contrary to the general Piagetian argument in favor of actually manipulating the substance to attain conservation, the Ss in this study evinced more successful task performance after watching the E manipulate the material. An alternate scoring system found that Ss in HVI scored significantly better than MVI ($.05 < p < .10$). Carlson felt that his data permitted him to conclude "that language training, supplying verbal rules and potential verbal mediators, can affect cognitive structures (p. 57)." He did not define "structures" and his findings seemed to support only that conservation performance can be learned.

In a training study on conservation of length with 170 kindergarten children, Beilin (1965) demonstrated that training facilitated conservation performance, but principally with the Verbal Rule Instruction method. This was a didactic method with feedback on incorrect responses, reinforcement, and verbalization. However, even those who learned to perform the task on which they were trained, did not transfer the training to an analogous task. Also, the ability to give correct verbal conservation responses was not sufficient to insure performance success. The author defends the efficacy of the didactic method, while conceding at the same time, that maturational factors cannot be overlooked.

The superiority of verbalization or verbal explanation as a treatment condition in cognitive task performance is not always substantiated. Sullivan (1967) studied 100 6-7 year olds on a conservation of water task, using two kinds of film mediated treatments. The Verbal Principal group watched the model perform a conservation task and give an explanation; the No Principle group saw the model perform without an explanation of the principle. The difference between the scores of the two experimental groups was non-significant. The only significant difference was between the control group and the experimental groups and this implied that any intervention was better than none. Sullivan felt that his data did not support the Piagetian theory that conservation required a radical reorganization of cognitive structure, but that a semantic explanation was more appropriate. The child's performance on conservation might, he felt, depend simply on his mastering the adult definitions of words like "same", "more", and "less".

Kohnstamm's (1967) recent research in testing specific aspects of the Piagetian theory of class inclusion resulted in his renewed support for effectiveness of training. According to the Geneva School about 75% of 7-8 year olds can allocate objects into classes. Kohnstamm found that 18 out of 20 five year olds were able to learn class inclusion through intensive training and then transfer to a purely verbal problem of the operation. He used the Piagetian class inclusion materials (for example, a picture of 10 flowers, 7 of which are poppies). He claimed that an active restructuring of the phenomenal field rapidly led to learning the principle, which in turn, provided a routine for solving certain sorts of problems. Kohnstamm also found that the exact question asked before the critical inclusion problem seemed to be important. This observation is supported in the finding of Bittner and Shinedling (1968) that instructional variables seem to be important in determining performance in a conservation task, especially in younger children.

Sigel and Olmsted (1967) who trained middle- and lower-class preschoolers on categorization found that training improved the ability to group objects, as well as increasing the variety of criteria used for grouping. They also observed that lower-class children learned to classify three-dimensional objects, but could not transfer this capacity to two-dimensional representations of the same objects i.e., pictures. They discussed this without arriving at any clear-cut explanation.

The developmental studies of classification are generally descriptive and indicate only the types of classification most frequently used at different age levels. Goldman and Levine (1963) selected a wide ranging sample, with Ss from kindergarten to the post-doctoral stage, and studied active and passive object sorting among them. (Passive object sorting refers to recognizing the categories set up by E, rather than constructing them.) The changes observed with increasing age in the object sorting task suggested a shift from the criteria of perceptual and immediate experiential links to conceptual ones.

Another categorization study was reported by Mosher and Hornsby (1965) who devised a version of the game of Twenty Questions to investigate the information-seeking strategies used by children. An array of 42 pictures of everyday objects was presented to the Ss (6, 8 and 11 year olds, N = 90), and they were instructed to find out which object E had in mind. The objects lent themselves to a variety of groupings, and the ability to form superordinate and subordinate categories was required for efficient performance. The two strategies for the game were identified as Constraint Seeking (CS) and Hypothesis Scanning (HS). CS implied grouping objects into domains and asking a question that would eliminate a group of objects at a time. HS was similar to guessing, where each question appeared to test the hypothesis about a specific object, with no relation to previous questions. CS was more efficient, as it guaranteed the solution with a minimal number of questions. HS, according to the authors, was less of a strain both in formulation and use, but required in general more questions to achieve solution. The results showed that 6 year olds used mainly HS, 8 year olds used HS for 25% of all questions and the 11 year olds guessed only to an inconsiderable degree. It is clear that the older children seemed willing to postpone specific hypotheses until the possibilities had been narrowed down beyond a first set of constraints. The authors pointed out that "...the development of strategies for seeking information is toward increasingly connected acts designed to locate relevance by more economical but less direct means (p. 96)." In this study, a predictable linear developmental trend toward more efficient information-processing strategies was thus supported.

Another developmental study of classification on four Piagetian tasks with kindergarten and second grade children by Wei (1966) reported a significant difference between grade levels as well as between social class levels, with the differences in the predicted direction.

Parker and Halbrook (1969) in a multiple classification study (Ss from kindergarten to grade 3, N = 80) tested a developmental hypothesis of conjunctive concept attainment. An incomplete matrix design was set up and the researchers identified three bases of classification: Concrete, Functional and Designative. The youngest children tended to combine concrete concepts using surface attributes, and the ability to use functional and designated attributes developed with age. Significant differences were found in the scores by grade and type of matrix. The analysis for errors made on functional and designative grades also revealed a significant between-grades difference.

A content-free logical task was designed by Neimark and Lewis (1967) to test for developmental differences. 96 Ss between 9 and 14 years of age participated in the experiment which was based on the paradigm of diagnostic problem solving or Twenty Questions. One of a number of patterns of binary elements was to be identified. A scoring system based on uncertainty reduction was set up i.e., the information gathering behavior was quantified in terms of expected informational outcome. They observed that younger Ss performed mostly at a random or non-logical level and there was increasing improvement with advancing mental age. MA rather than IQ appeared to be related to task efficiency. A product moment correlation of .52 was obtained between MA and strategy. All groups seemed to learn at the same rate and group differences were parallel throughout. The between-group difference was significant at the .001 level and a developmental argument was supported.

A recent study by Davey (1968) is especially interesting in view of the unusual history of the subjects. They were 37 children ranging from ages 6 to 13, who along with their families had been evacuated from the isolated island of Tristan da Cunhan following a volcanic eruption and brought into U.K. The Ss were presented with a set of 42 pictures and asked to sort them out. The author identified three types of grouping strategy that the children used: Superordinate Complexive and Thematic. The attributes on which the groupings were based were designated as Perceptible, Functional and Linguistic Convention. The early instances of grouping seemed to be based on attributes which were sensorily most readily available. With increasing age, there was a preference for grouping the pictures on the basis of function or class. Maturation thus seemed to enable a gradual independence from surface quality as a basis for equivalence. This finding is in accord with most developmental studies of the cognitive processes.

Finally, a study by Kofsky (1966) intended to validate some aspects of Piaget's theory of the development of classification in children must be reviewed. She tested a sample of 122 children ranging from ages 4 to 9 on clearly delineated logical tasks that in Piagetian theory are treated as invariant in the sequence of development. Eleven experimental tasks were devised to test the order of acquisition of classificatory ability ranging from "resemblance sorting" to "hierarchical classification" by a scalogram analysis. An analysis of variance of age effects and correlation of age with score were both significant. The rank order correlation of the predicted logical sequence with the obtained sequence of difficulty of the tasks was .87 ($p < .01$). Although the results supported the theoretical premises, the author felt that individual differences on specific tasks were an important source of variance. It was also suggested that children's performance on cognitive tasks may be susceptible to subtle variations in instruction and material.

III

DESIGN OF THE STUDY

Purpose

The general purpose of this study was to examine the differing theoretical implications of Piaget and Vygotsky regarding the acquisition and use of hierarchial classification by children. Specifically, the aim was to evaluate the effects of two types of instructional intervention derived from the above theories upon performance in a categorization game devised for this study. The two intervention treatments were Category Construction and Category Reception. The major dependent variable was the score obtained in a series of three games following the instructional treatments. Differences in the types of categories formed by the two groups were evaluated.

Theoretical Relevance

Classification or categorization behavior is a salient aspect of adaptation to the environment. It is a cognitive process that becomes increasingly useful as information gets more complex and varied. To categorize is to have some knowledge of the characteristics and attributes of the objects under consideration prior to the classifying act. Similarities have to be found even in the face of apparent differences and differences to be identified even in the face of apparent similarities. In considering objects in terms of their function or class, conceptual categories go beyond the surface quality of objects, employing the ability to move away from the perceptual pull of given stimulus objects, which in Piagetian terminology, is perceptual decentering. The recognition of class membership in terms of relevant attributes enhances the efficiency in the task of classifying objects.

A fundamental aspect of classification is the reduction of the informational load. An analogy from memory research is pertinent here. To group diverse stimuli into categories is to code the information from them in simpler form, enabling better storing and recall. Miller (1956) suggests that "by organizing the stimulus input simultaneously into general dimensions and successively into a sequence of chunks, we manage to break...(the) informational bottleneck (p. 95)."

Categorizing the same objects in various ways necessitates the use of different grouping rules. Reclassification would thus be equivalent to recoding the information, either through a substitution of the relevant attribute for grouping or through a change in grouping rules. In Piagetian terms, it would be described as performing combinatorial operations (Bruner, 1963, p. 134). Since every natural environment has a multitude of stimulus objects, the ability to classify develops almost spontaneously, as a coping response. As the child matures, he acquires more efficient methods to deal with complexity of input materials and organizes his classes into an interrelated structure. Thus, hierarchical categorization implies the ordering of classes on the basis of relevant attributes at each level and a progressive coordination of ascending and descending categories. The same object is recognized as a member of a sub-class as well as a member of the larger class to which other sub-classes belong. To say that two objects come from the same level of a hierarchy is equivalent to saying that they are categorized according to a specific criterion. And to return to the earlier analogy, in clustering of words in a memory task, input is recoded into chunks, and at the next level of organization, first-order chunks are recoded into "superchunks" (Mandler, 1967, p. 332). A hierarchical system of organization is thus implicit in many cognitive tasks, because it defines structure.

In learning categorization, the child does not proceed logically from subordinate to superordinate, or vice versa. In fact, he does not always effectively discriminate between general and specific terms. As Vygotsky (1962) points out, sometimes young children use a superordinate label to refer to a specific subordinate category and their use of a general term may not imply the comprehension of a more general concept. So statements about the directionality in learning hierarchical categorizations appear to be unsubstantiated, even undefended. Nevertheless, it is interesting to note that Church (1961) for instance says,

> ...upward categorization of perceptually dissimilar objects is necessarily a symbolic operation while downward categorization can take place at the perceptual level (p. 177).

This suggests that moving down the hierarchy may be a simpler process.

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Piaget, on the other hand, has argued that class addition is a simpler logical fact than class subdivision as observed in the cognitive activities of younger children. Kohnstamm (1967) in support of this view says that inclusion reasoning, the Piagetian term for understanding the subordinate-superordinate relationship, involves the ability to arrive at $A + A' = B$ as well as its inverse $B - A' = A$, and that in general, the inverse which requires the process of subtraction is learned later. Combination and subtraction have to be seen as operations upon the same material and young children are often confused about the identity of objects remaining constant through various groupings. Downward categorization may be comprehended but may not be simple for the young child to initiate when faced with a variety of objects.

Traditionally, class inclusion problems have been used by Piagetian investigators to measure classificatory development. Each problem is made up of a set with one sub-set of objects i.e., a subordinate category is inclusive in the objects presented. A typical example of a class inclusion question in presenting a set of 10 green blocks, which are made up of 3 large and 7 small blocks is, "Are there more green blocks or more small blocks?" This type of question in ordinary conversation would refer to the comparison of two separate entities, generally mutually exclusive. The child is more likely to have been asked "Are there more boys or more girls in your class?" than "Are there more boys or more children in your class?" Presented in this way, the inclusion question is phrased in a familiar "exclusion" form.

In addition, as Braine (1962) points out, the nature of the quantitative relation is poorly defined since the picture presented confounds a class-inclusion relation with a part-whole relation (p. 52). The subordinate is nested within the superordinate and the question becomes a misleading one.

The act of categorization is obviously made up of many cognitive processes. Guilford (1968) suggests that it can be broken up into three stages: 1) awareness of attributes, 2) divergent or convergent productive activity and 3) verbalization, or to use Guilford's phrase, convergent production of semantic units.

The research design planned here takes these three stages into account; the first one is assumed to have developed to some elementary degree at least, in all the subjects, and the major experimental manipulations in this study are concerned with stages 2 and 3.

For the purpose of this study, the materials assembled for the categorization task include several levels of the hierarchy. This method of evaluation also precludes any one type of response from being the sole determinant of classification ability. The completion of the Question Game necessitates a sequence of questions and the feedback from each move can be cumulated for successful solution.

The Instrument

A methodological predecessor to this instrument is that used by Mosher and Hornsby (1965) to study the information-seeking behavior of children of three age levels. They used a set of 42 colored pictures of everyday objects, which could be classified variously by using dif-

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ferent criterial attributes. No optimal grouping pattern was decided upon by the experimenter, and no guiding instructions were given.

Several other object-sorting and class inclusion studies have used pictures, although there are a few examples of the use of three-dimensional representations, miniatures of real-life objects or abstractions like circles, squares, and triangles. The decision to use real-life objects in this study was reinforced by the statement of Sigel and Olmsted (1968) that,

> ...when used, classification exercises frequently contain geometric forms which are essentially non-sense items having little relevance to everyday experience. The claim that such materials are simpler than realistic items ignores the fact that real-life objects have a palpable reality whereas geometric forms are abstractions having little realistic reference (p. 2).

The authors also found that the level of representation (picture vs. object) made a difference in the categorizing behavior of lower-class children--pictures were more difficult for them to handle, than were objects. To avoid any potential problem arising from varying socio-economic levels, it was decided in this study, to use miniatures of real things.

The Question Game designed for this purpose originates in the game of Twenty Questions. Many alterations in the rules and requirements have been made. In Twenty Questions, the "answer" is selected from an infinite population of things; in the present study a finite set of 32 objects constituted the entire population from which the object to be identified is picked. These objects were carefully assembled on the basis of a hierarchy of taxonomic categories. They represent objects that children in this culture would have learned about in the normal course of events, including school experiences.

The choice of objects used for the Question Game depended, partially at least, on their availability in the market. This limitation was coped with satisfactorily since a great variety of inexpensive small objects were accessible. The objects varied in color, texture, and materials, and were all approximately the same size (2-3 inches). The criteria used by Clarke and Cooper (1966) Sigel and Olmsted (1967) Charlesworth (1968), and Davey (1968) in the selection of objects were also considered before final selection of the objects to be used.

If optimal taxonomic or functional categories were employed in the grouping questions Ss asked, the objects could be dichotomized at every level of the hierarchy. The optimal strategy would eliminate 16, 8, 4, 2, and 1 objects with each question respectively thus requiring 5 questions to solution. Ss using a dichotomous strategy would get maximal information with each question because negation of one-half of the set means affirmation of the other, and vice versa. (The list of objects and the classification schemes are included in the appendix).

The Scoring System

Bruner's (1960) statement that a kind of parameter can be specified to measure the extent to which an individual is cumulative and constraint sensitive in his information gathering has not been seriously taken up by his co-workers and students who seem at best to report

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percentages of types of questions and other simple descriptive data.

Rimoldi (1967) suggested a scoring system which would establish a kind of uncertainty reduction score. He described it as a schema-pulling-out method, in which the questions the _S_s asked to arrive at the solution were assigned values in terms of their relevancy and sequence. His system provided some guidelines for the scoring established in this study.

In the present study with the Question Game, each question was scored according to the proportion of objects removed from the board in response to the answer, yes or no. For instance, eliminating 16 objects from the set of 32, would get the same score as taking off 4 from a set of 8. The farther away from .5 in either direction, the less efficient the question would be and the lower the score. The scoring system was based partially on a risk-taking factor. A question which cleared .75 of the objects on the board would get the same score as that which removed .25 of the objects, since the amount of risk involved in the two questions is identical. The individual scores on the questions in the game were summed and this total was divided by the number of questions asked in that game. For instance, a game in which a score of 27 was made with 3 questions, and one where 81 was made with 9 questions, would be given the same overall score of 9. Thus a child who used a poor strategy and was lucky in obtaining the correct answer early would get the same score as the child who used a similar strategy but was unlucky. The mean score on three post-instructional-intervention games was the dependent variable on which the first statistical analysis was made.

The second part of the analysis concerned the types of categories produced by the Ss. On the basis of category types used in other studies of object sorting and classification (Annett, 1958; Sigel & Olmsted, 1967; Parker & Halbrook, 1969) four category types were designated for this study.

1) Nominal
2) Taxonomic
3) Functional
4) Descriptive

These four types were defined operationally in the following way. Nominal refers to labelling one object at a time, or what Mosher (1965) refers to as scanning. Examples of this: "Is it the cat?" "Are you thinking of the tractor?"

Taxonomic refers to a group label, a word relevant to the classification of the objects. Examples: "Is it a reptile?" or "Are you thinking of a musical instrument?"

Functional refers to an action or use of the object, what it could do or what could be done to it. Examples: "Does it walk on legs?" "Can you play music on it?"

Descriptive refers to questions using a perceptual attribute or one not classified as taxonomic or functional. Examples: "Is it bigger than a dog?" "Is it a red thing?"

As can be seen, all three types above, Taxonomic, Functional and Descriptive are indications of the ability to form groups. In a technical sense, or in another experimental situation the "class of red things" could be a valid (taxonomic) category. However for the purpose of this study they were treated separately as defined above. The number of objects eliminated by different categories in each game provided the data for the second part of the statistical analysis.

The Experimental Treatments

Referring specifically to their classification and seriation studies, Inhelder and Piaget (1964) assert that children need to perform a number of successive restructurizations actively before they can understand a logical operation and that "these are not passively transmitted by language (p. 4)." Only by operating upon objects does a child comprehend the relationship between a class and its sub-class. Although they appear to have generally used the verbal method of investigating the classification ability of children, Inhelder and Piaget conclude that class inclusion is a genuine logical operation and not a function of mere verbal facility.

The point of view espoused by Vygotsky (1962) is in strong support of the guiding function of verbalization. According to him, words help to focus attention, abstract and synthesize certain traits and symbolize them. The role of instruction is also preponderant in his theory. To cite an example, he suggests that school instruction in scientific concepts with their hierarchical system of interrelationships help to establish a system in dealing with the concepts of everyday life, i.e., spontaneous concepts. Piaget's stand is that spontaneous operations have to precede any learning. Vygotsky thus counters Piaget on two points--the importance of the verbal tool and the efficacy of didactic intervention.

It was decided to use categorization of seven year olds as the testing ground for the opposing views of Piaget and Vygotsky. From Piaget's theory was extracted the experimental treatment of active structuring of groups of objects by the children. From Vygotsky's theory was derived the treatment of the reception of verbal cues to aid in structuring the groups. Piagetians would support the argument that categories would be more effectively acquired if children had the opportunity to combine and recombine objects actively. Those who espouse the primacy of language in structuring thought and cognitive behavior would argue that being presented with the label denoting each group would more effectively help the acquisition of categories, than trial-and-error operations in grouping.

The two experimental treatments were 1) Construction of Categories and Labelling (CC) 2) Reception of Categories and Labels (CR).

CC Subjects in this treatment condition were encouraged to impose their own organization on the input by being instructed to "put things together that go together"--a commonly used instruction in object sorting studies. They were also asked to give labels to the groups by the question "What are these?" or "Why are these things together?" The labels and explanations given by Ss were recorded. After this, they were asked to put the objects in groups of 4, 8 and 16 respectively. If they were unable to do so, the reasons why they could not were solicited.

CR Subjects in this treatment condition were provided with appropriate labels for the hierarchical structure by being asked to attend carefully to E's categorization. The objects were then grouped at three hierarchical levels--8 groups of 4, 4 groups of 8 and 2 groups of 16. As the objects were grouped, E named the categories. The Ss did not handle the materials at this time.

Ss in both treatment groups were thus made aware of the possibilities of different types and levels of classification of the given objects and the potential for symmetrical groups. Ss in CC had the opportunity to manipulate the objects, and in examining the bases for their categories, were encouraged to see similarities and differences. It must also be noted that in providing a more structured framework by suggesting number constraints, the general weakness of the object sorting situation as an "intellectual projective technique (Braine, 1962)" is, to some extent, remedied. Ss in CR watched the E put the objects in groups and name each category. They concentrated on acquiring the planned classification scheme with appropriate verbal cues.

The Sample

The original design for this study had an additional developmental hypothesis. In the pilot test, two age levels were included and second and fifth graders were tested. A majority of fifth graders performed so well in the pre-instruction game that the ceiling effect made intervention effects indeterminable. Since the theoretical implications discussed earlier were also most relevant to the younger group, it was decided to get the entire sample from grade two for the major study.

The subjects for this study were the second graders in the Randall School, in Madison, allocated by the U.W. Instructional Research Laboratory for the purpose of this research. The sample size was determined on the basis of the following criteria:

1) A difference greater than or equal to one within-treatment standard deviation was considered important.

2) A difference less than or equal to one-fourth of one standard deviation was considered trivial.

3) The appropriate power against the specified alternatives was to be .1 and .9 respectively.

Given these criteria for a simple two-cell design, the total sample needed was 70 with 35 in each cell. The alpha level was fixed at .05.

When the school allocated for the purpose was contacted it was found that there were altogether 80 children in the second grade (47 boys, 33 girls, mean age 7 years, 5 months). The subjects were randomly assigned to the treatments. Later three protocols had to be dropped when it was found that three children had been under some handicap at the time of participation in the experiment.

Procedure

Every subject took part in the categorization game individually in a room allocated by the school for the purpose. A few minutes of unstructured interaction to establish rapport preceded the actual test.

The non-judgmental aspect of the situation was clearly explained and the 'fun' quality of the game emphasized.

The 32 objects were placed on the board and the S was asked to name each object as E pointed to it. Common terms were established for all objects. No object was unidentified by any S, but if he hesitated to name any object, he was given a label for it.

The Rules of the Game (Games 1 and 2)

I have a new game for you today which I would like you to play. It is called the Question Game. There are many things on this board. Let me see if you can name them for me. (S named each object in the order it was pointed to on the board, and the labels denoting individual objects were supplied by E, if there was hesitation on the part of Ss).

O.K.? This is the game. I am going to think of one of these things. You will have to find out which one by asking me questions. I can only answer yes or no. You can ask me a question that refers to one thing or to a group of things. If I say "No" to what you asked about, you can take it off the board. If I say "Yes" to the things you asked about, leave those things on the board and take away the other things. To play the game really well, you will have to try and clear the board quickly. Try and find out what I am thinking about, in as few questions as possible. You will understand better as we play it. Go ahead. (Games 1 and 2 were played before the instructions).

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Intervention Treatment CC: Instructions

I want you to put things together that go together. What are these? How do they go together? Now try and put all these things into groups of 4. Why are these in a group? Now put them in groups of 8 and tell me what you have in each group. I want you to try and put all these things in only two groups. (E observed and took notes on entire proceedings).

Intervention Treatment CR: Instructions

I want you to watch carefully while I put these together into groups. First I am going to put them together in groups of 4. Next, I am putting them into groups of 8. Finally I am going to put all the things here into two groups. (E supplied S with exact taxonomic label at each level of the hierarchy--8 subordinate categories, followed by 4, and then by 2 superordinate. Actual labels in the Appendix).

Post-treatment Instructions CC & CR (Game 3)

Now, we go back to the game we first played. Try and remember what you learned about putting things in groups, when you play the game again. Remember, the best way to play is to ask as few questions as you need, to find out which thing I am thinking about.

Post-treatment Instructions CC & CR (Games 4 & 5)

We will play the same game again. You can ask the same questions as earlier or different ones--whatever you think will help you to get to the answer quickly. Remember, the best way to play this game is to ask as few questions as possible. Try and use the groups you learned about earlier in playing the game.

Note: To ensure that there was no grapevine effect (contamination), each S was requested not to discuss the game with anyone else until all the testing was completed two weeks later. The teacher had given similar instructions and for the second graders in this sample, the thrill of "keeping a secret" seemed to have been sufficient to restrain them from passing on any information to their peers. An informal check on this was made in the few minutes prior to the game. The Ss knew that they were going to play a game, but had no information about it.

Method of Analysis

The study yielded two kinds of data on which the analysis of variance and covariance as well as regression analysis were carried out. The first was the efficiency or competence in the Question Game as measured by the scoring system described earlier. The second involved the different types of categories used by the Ss in formulating questions: Nominal, Taxonomic, Functional and Descriptive. The number of objects eliminated in each game by each type of category was the quantitative measure used. Since the total number of objects was constant and the 4 categories were a linear combination summing to 32 in every game, the Descriptive category was left out of the statistical analysis. However, the bar graphs (Figs. 3-13) depict the contribution of each of the 4 types of categories.

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Correlations were computed to examine the strength of the relationship of the dependent variable (post-intervention scores in games 3, 4 and 5) with the independent variable (pre-intervention scores in games 1 and 2), age (CA) of the Ss as of Sept. 1968, mental age (MA) as measured in the Thorndike Lorge Test administered by the school in Sept. 1968, and intelligence (IQ) defined operationally as the ratio of MA to CA. It was found that MA was available only for 71 Ss and the first set of correlations were computed on these 71 Ss for whom all the data was available.

A subsequent analysis of variance and covariance with scores on games 1 and 2 treated as covariates, and with MA added as a covariate (mean value of MA substituted for missing data) was performed (N = 77). The correlation of MA to performance score as well as correlations between the scores on the series of 5 games were computed. A multivariate test of the differences between the types of categories used in the questions was carried out, as well as a step-wise regression to analyze the contribution of each independent variable (covariates were category types in two games prior to intervention) to the use of categories in the games following the instructional intervention. Correlations of the categories across the series of games were also computed.

IV

RESULTS

The first hypothesis in the study that the two types of instructional intervention would affect overall efficiency scores differentially was not supported. The difference between the mean scores of the three post-instructional games of the two treatment groups, CC and CR, was not significant and the null hypothesis was not rejected. Not only did the difference between the group means fail to achieve statistical significance, but the scores of the two groups in a series of five plays of the categorization game were remarkably parallel (Fig. 1). Discussion of this finding follows a full presentation of the data.

A univariate analysis of variance of the difference between the pre-instruction score (mean of games 1 and 2) and post-instruction score (mean of games 3, 4 and 5) reached significance ($p < .0001$). The correlation (multiple $r = .50$) between the two sets of scores (Table 1) was also statistically significant.

The difference score (DS) was calculated by subtracting the mean of the two pre-instruction games from the mean of the three post-instruction games. Usually a difference score is interpreted cautiously as there is a tendency for it to become inflated. The nega-

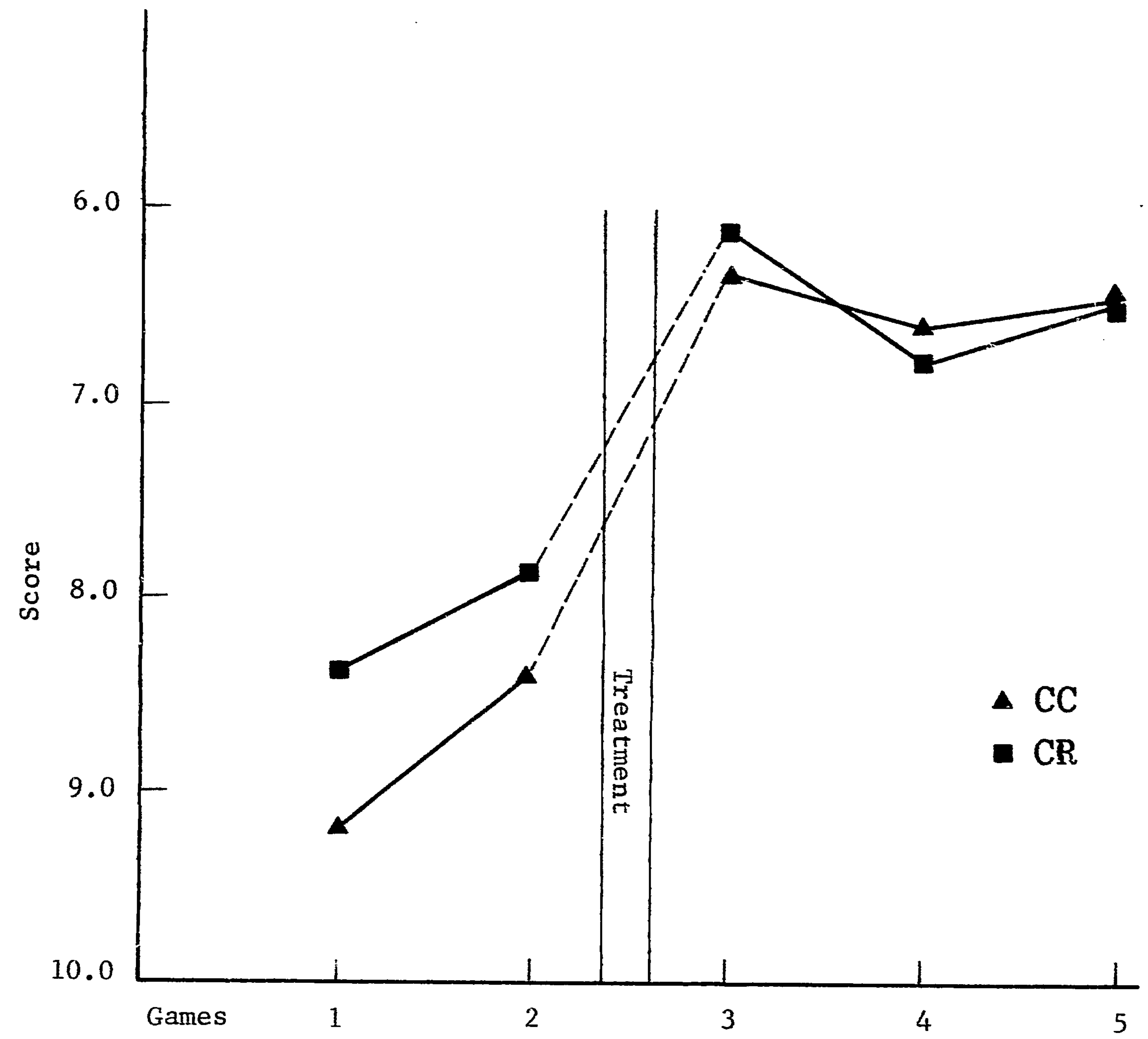

Fig. 1. Mean Efficiency Score in 5 Games of CC and CR

N.B. Competence in the game is inversely related to the score.

Table 1

Sample Correlation Matrix

(N = 77)

	Pre-instr. Score (2 games)	Post-instr. Score (3 games)	Difference (DS)	CA	MA	IQ
Pre-instruction Score (2 games)	1.00					
Post-instruction Score (3 games)	.50	1.00				
Difference between pre and post scores (DS)	-.67	.31	1.00			
CA	.23	.24	.05	1.00		
MA	.26	.39	.05	.07	1.00	
IQ	.14	.27	.07	-.31	.93	1.00

Table 2

Correlation Matrix of MA and Scores on 5 Games

(N = 77)

	MA	1	2	3	4	5
MA	1.00					
1	.23	1.00				
2	.21	.58	1.00			
3	.28	.28	.38	1.00		
4	.30	.33	.44	.61	1.00	
5	.38	.41	.43	.55	.49	1.00

Table 3

Mean Category Types in 3 Post-instruction Games

(Number of objects = 32)

Exp. Group	Nominal	Taxonomic	Functional	Descriptive
CC (N = 40)	5.61	8.51	11.92	5.96
CR (N = 37)	6.58	13.25	7.25	5.02

tive relationship (- .67) between pre-instruction performance and DS, and the moderate positive correlation of .31 between DS and post-instruction scores are both in the expected direction.

An inspection of Fig. 1 suggests that the data could be fitted to a Markovian two-stage model, so marked is the jump from the pre-intervention level to the post-intervention one. A parallel phenomenon is seen in the use of types of categories: there is a noticeable decrease in the individual labelling (Nominal) questions and a rise in Taxonomic and Functional categories (Table 6). An inspection of Table 6 shows that not only are all the univariate F values significant, but a step-down F analysis reveals that 3N, 3T and 3F have the highest values, thus indicating that the first game following the intervention accounts for a large part of the variance in use of the categorizing questions.

Both CA and MA have a near-zero correlation with DS. This is contrary to expectation especially in view of the consistent positive relationship between MA and competence in the game. There is a low positive correlation between CA and performance score which seems to be constant through the experimental treatment, the correlation with pre- and post-instruction scores being .23 and .24 respectively.

The relationship between MA and performance in the games is in concordance with most research findings on cognitive tasks. The correlation of .26 between MA and mean score in the first two games increased to .39 after the instruction. Improved performance following the intervention seemed to be related to MA. Concomitantly the

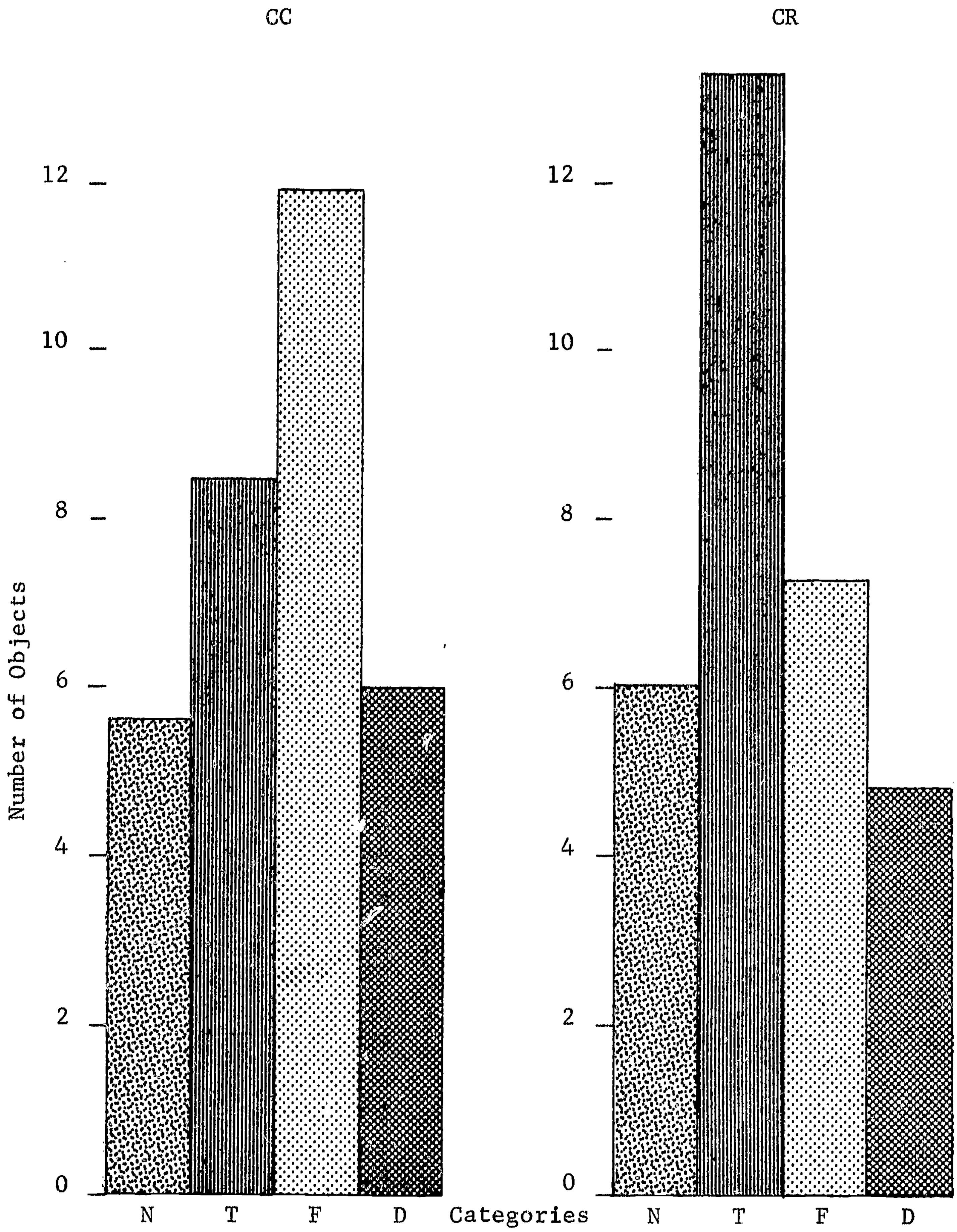

Fig. 3. Mean Nominal, Taxonomic, Functional and Descriptive Categories in 3 Post-instructional Games.

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Table 4

Mean Category Types in 5 Games of CC and CR

(Number of objects = 32)

Categories	Games / Treatments	1	2	3	4	5
Nominal	CC	16.4	11.6	5.3	6.6	5.4
	CR	14.2	10.9	6.8	7.2	5.6
Taxonomic	CC	3.5	4.2	8.5	7.3	6.3
	CR	3.7	4.5	14.6	11.8	13.3
Functional	CC	6.8	8.1	12.2	11.7	13.7
	CR	7.9	8.9	6.1	9.1	6.5
Descriptive	CC	5.3	8.1	6.0	6.4	6.6
	CR	6.2	7.7	6.5	3.8	6.6

correlation between IQ and pre-instruction games, $r = .14$ goes up to $r = .27$ in the post-intervention series. Considering that there is a strong (.93) correlation between IQ and MA in this sample, their parallel trends are not unexpected.

In a reanalysis of the data MA was treated as a covariate. The chi square test for the hypothesis of no association between the dependent variable (scores on games 3, 4 and 5) and the independent variable (MA) was significant ($p < .0004$). An interesting finding is that the relationship of MA to task performance becomes gradually stronger (Table 2). The correlations across the sequence of 5 games are .23, .21, .28, .30 and .38 respectively. This can be interpreted as an indication of MA becoming a more stable predictor of performance as the game progresses.

The matrix presented in Table 2 depicts inter-game correlations of .58 between the first and second games and .61, .55 and .49 between the third and fourth games, third and fifth games, and fourth and fifth games respectively. These correlations give some indication of the reliability of the measure.

Although the two experimental groups were not different in terms of their total efficiency score, they were significantly different in the kinds of categories they employed to group the objects. The finding that Ss in CC use predominantly Functional categories, Ss in CR use predominantly Taxonomic categories, and both groups make equivalent scores (Fig. 1) can be accounted for by the fact that both types of categories are equally efficient in grouping. A multivariate analysis

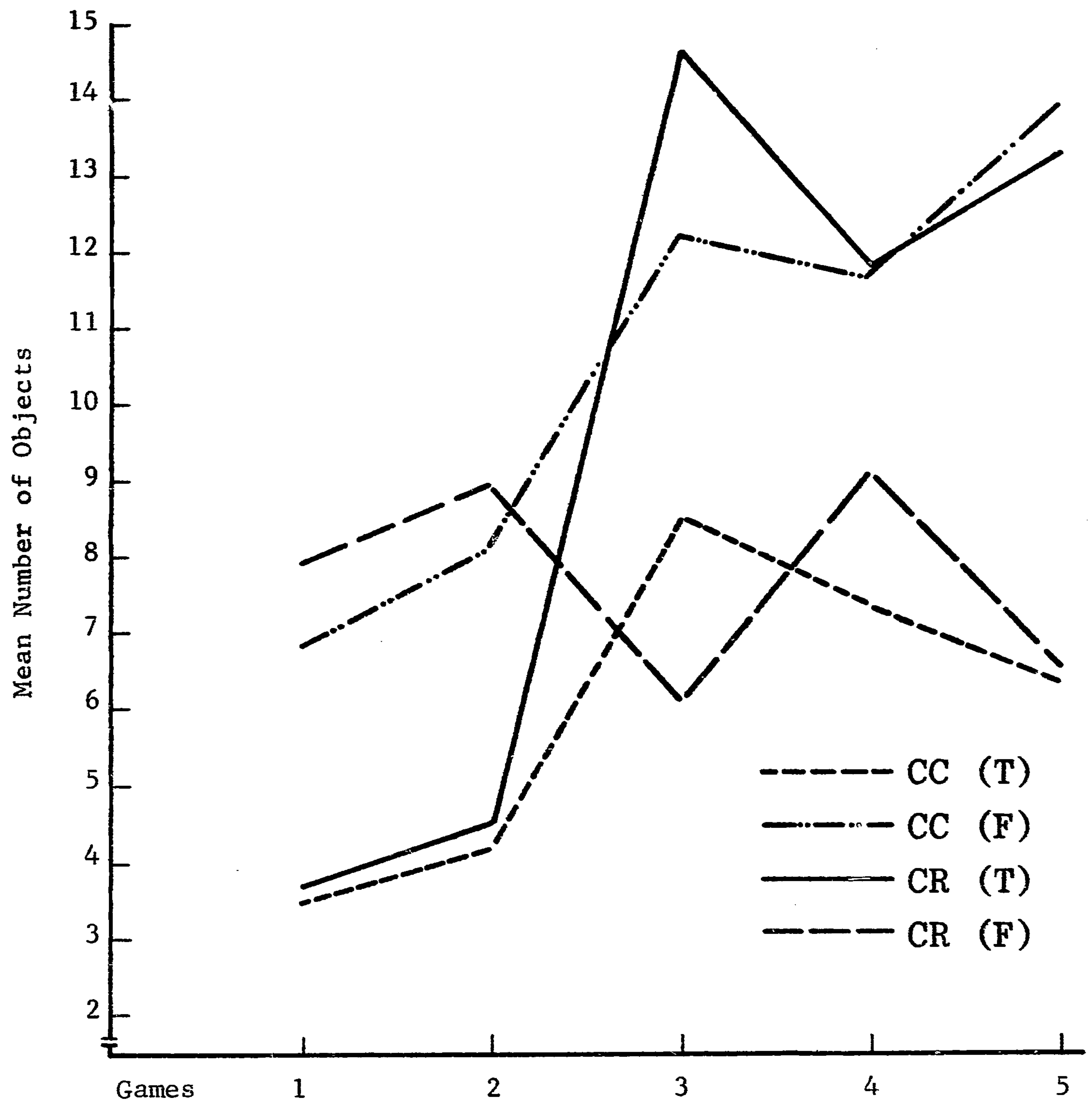

Fig. 2. Mean Taxonomic and Functional Categories in 5 Games (CC and CR)

Table 5

Analysis of Variance of 3 Categories

(Nominal, Taxonomic, and Functional)

in 5 Games of CC (N = 37) and CR (N = 37)

Source	df	MS	F
Between subjects			
A (CC-CR)	1	19.73	
Subj. w. groups	72	87.64	
Within subjects			
B (Games)	4	31.34	2.08
AB	4	10.92	
B x subj. w. groups	288	15.09	
C (Categories)	2	204.99	
AC	2	958.53	2.34
C x subj. w. groups	144	409.73	
BC	8	1159.53	15.30*
ABC	8	245.31	3.24*
BC x subj. w. groups	576	75.78	

* $p < .01$

Table 6

Nominal, Taxonomic and Functional Categories

on 3 Post-instructional Games

Step-down Regression Analysis

Variable	Univariate F	p <	Step-down F	p <
3N	4.79	.0004	4.79	.0004
4N	5.72	.0001	2.45	.0328
5N	4.29	.0010	0.70	.6469
3T	4.30	.0010	6.43	.0001
4T	3.89	.0021	1.72	.1286
5T	4.92	.0004	1.13	.3529
3F	3.69	.0031	3.93	.0022
4F	3.20	.0078	0.73	.6264
5F	2.04	.0709	1.42	.2216

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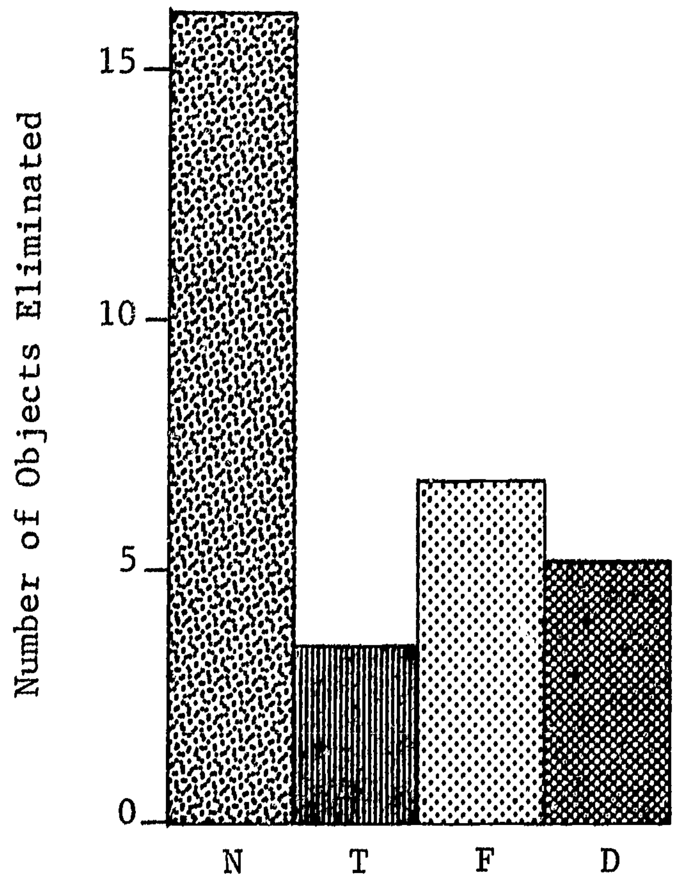

Fig. 4. Mean N, T, F and D Categories in Game 1 (CC)

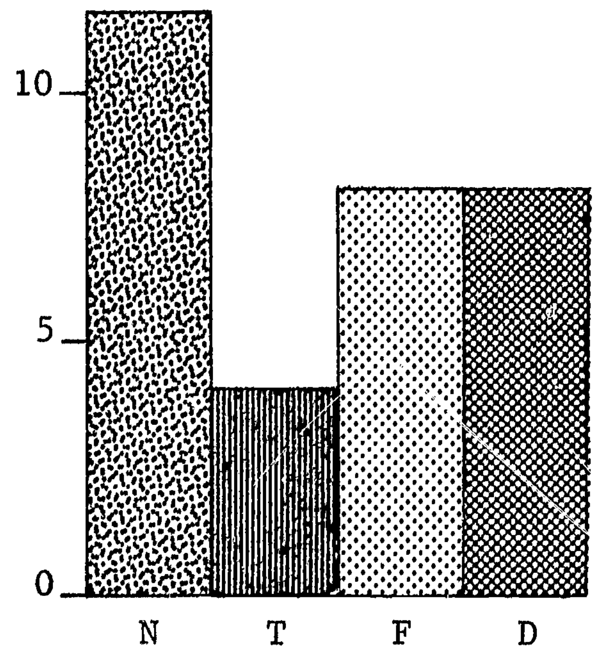

Fig. 5. Mean N, T, F and D Categories in Game 2 (CR)

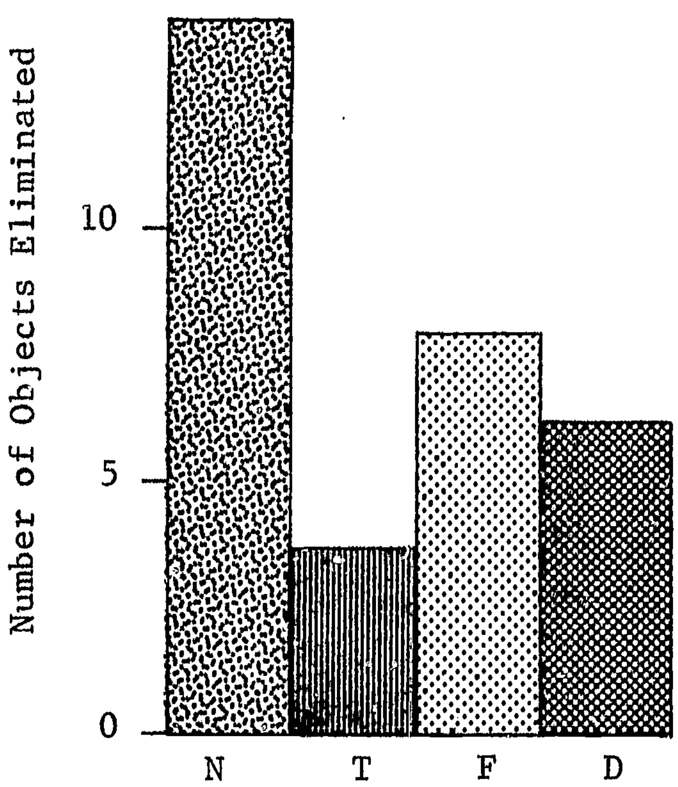

Fig. 6. Mean N, T, F and D Categories in Game 1 (CR)

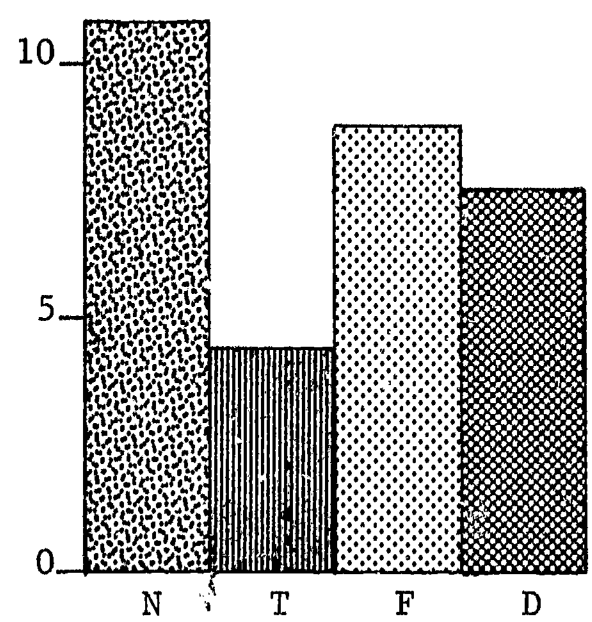

Fig. 7. Mean N, T, F and D Categories in Game 2 (CR)

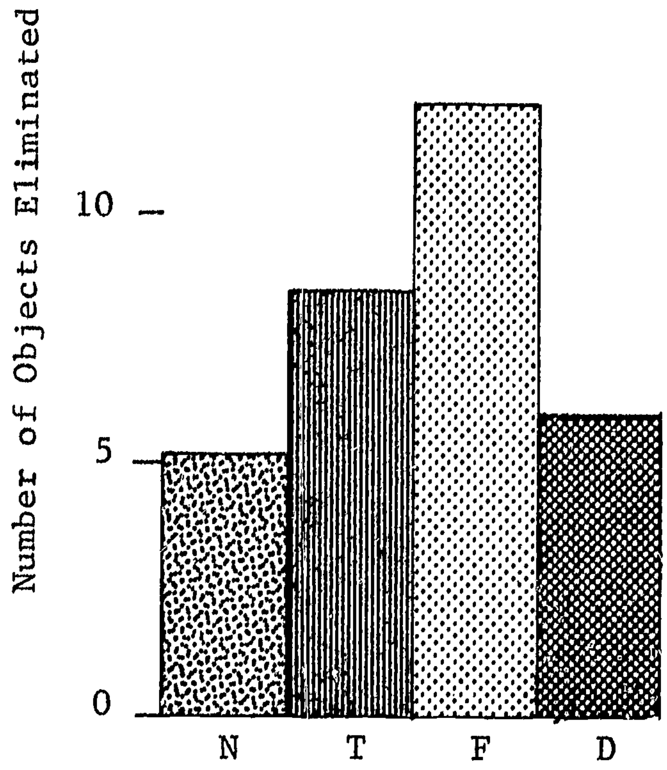

Fig. 8. Mean N, T, F and D Categories in Game 3 (CC)

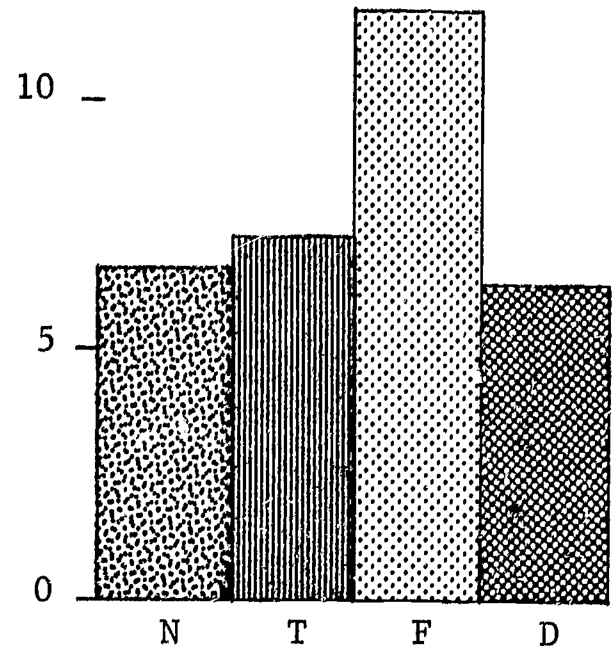

Fig. 9. Mean N, T, F and D Categories in Game 4 (CC)

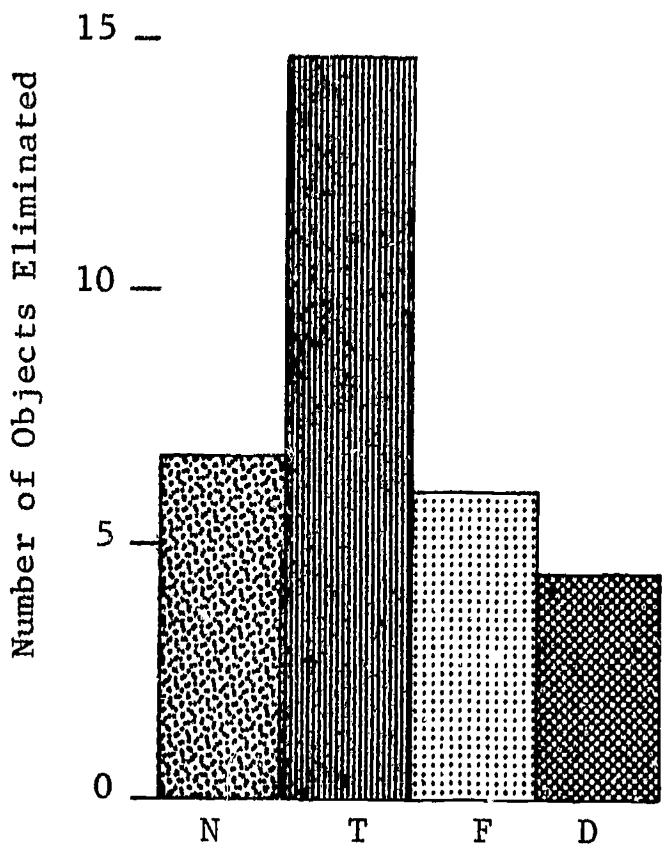

Fig. 10. Mean N, T, F and D Categories in Game 3 (CR)

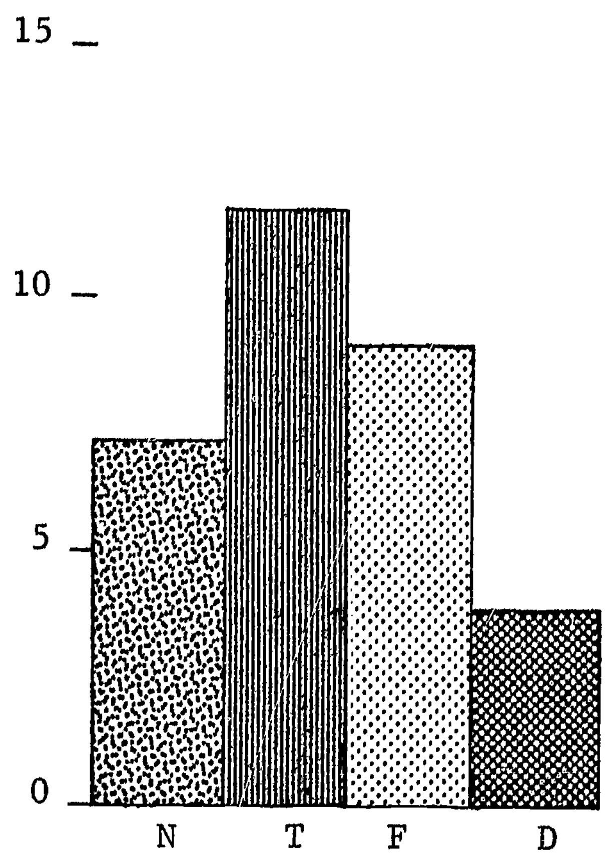

Fig. 11. Mean N, T, F and D Categories in Game 4 (CR)

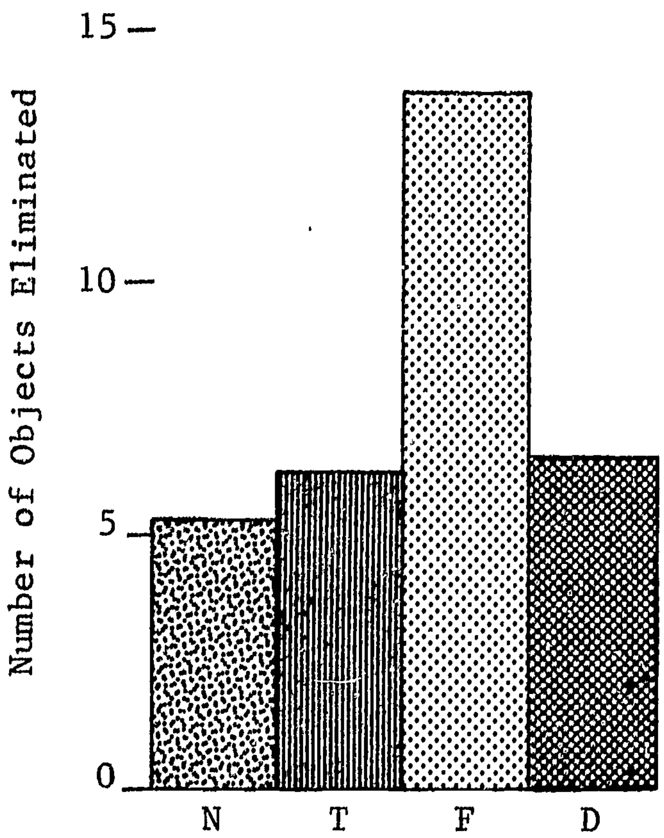

Fig. 12. Mean N, T, F and D Categories in Game 5 (CC)

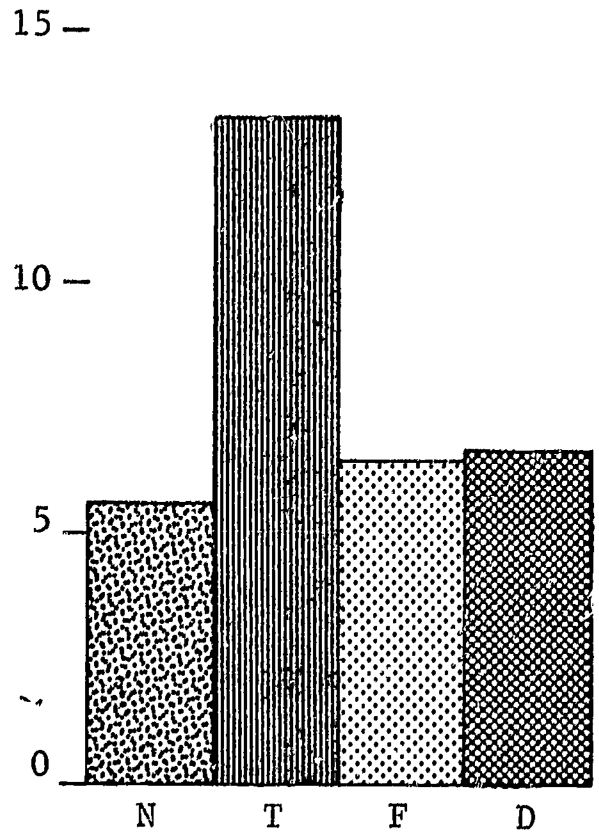

Fig. 13. Mean N, T, F and D Categories in Game 5 (CR)

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of variance of the differences in the category types across the post-intervention games was found to be significant ($p < .03$). The subjects in both treatments used Nominal and Descriptive categories to approximately the same extent; the CR group used Taxonomic labels significantly more ($p < .02$) than CC; and complementarily, the CC group used Functional categories significantly more often ($p < .03$). The patterning of these two categories across the series of games is depicted in Fig. 2. With category-types used in the pre-instruction games as the covariates, a multivariate analysis of the differences in use of categories in the following games was significant. The F value for the test of independence between the dependent and independent variables was 2.53 ($p < .0001$). The data presented in Table 5 indicate that the two-way interaction effect between games and categories, and the three-way interaction between games, categories and treatments were clearly beyond the level of chance.

V

DISCUSSION

The two methods of instructional intervention selected for this study were both effective in producing a significant change in the scores, but while there were predictable differences in the types of categories used by the subjects in formulating questions, the difference between the two experimental groups in competence in the game proved to be nonsignificant. To account for the near-equal impact on performance of the two treatments, one would have to specify the cognitive processes involved in each condition and evaluate the possible effects of the interventions.

A subject assigned to the treatment group CC is asked to put things together that go together, a standard instruction in object sorting situations. This is, in effect, an invitation to the subject to impose his own organization on the complex collection of objects before him. It encourages him to look for similarities on the basis of which the diverse objects could be divided into groups. In this connection, a comment of Mandler's (1968) is to be remembered that, "It is what similarity is _about_ that is important in discussing the problem of similarity (p. 110)." In the present study, conceptual similarity was considered more important then perceptual similarity, and recognition of class membership more appropriate than choice of attributes not relevant to class or function. In observing the subjects of the CC group in the free sorting situation, it was noted that they distinguished objects mostly in terms of their use, function, or typical action. The spontaneous approach of young children thus seemed to be not to make distinctions that were mainly logical, but ones that were experientially relevant. In a discussion of abstraction and concept formation, Miller (1951) made a similar observation:

> It is not the logical aspects of induction that concern us but the psychological aspects. We hunt for similarities and try to discover a functional relation among them (p. 237).

While the CC subjects did use some descriptive attributes and some taxonomic labels, especially in the instances where they seemed obvious or were high frequency words, there was a marked tendency on their part to use more functional criteria.

In being asked for a label or for the attribute which formed the basis of the grouping, all the responses indicated that the subjects were operating on some grouping principle and that categorizing was not arbitrary or random. While the criteria they used often varied from those of the experimenter, common trends among the group could be detected; occasionally the choice of grouping rules seemed unique to one individual. It has been suggested that being asked a "why" or a "how" question forces an attempt to form a logical class or category. For instance, Gagne and Smith (1962) point out that requiring subjects to verbalize during practice has the effect of making them think of new reasons for their moves and this facilitates both the

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discovery of general principles and their employment in solving successive problems. Although their reference is to a problem solving situation of a different kind, the general principle that verbalization channels action is applicable to the present experimental situation. In the first part of the intervention in CC, object sorting was accompanied by verbal explanation; this was then followed by the quantitatively structured categorization treatment (groups of 4, 8 and 16). It is likely that the earlier verbalization might have encouraged the derivation of principles, which were then used in restructuring the objects into groups of the suggested sizes.

It must be remembered, on the other hand, that the ability to group objects does not presuppose the ability to label them. Guilford (1968) says that "...forming the class idea and verbalizing it are two quite different operations (p. 273)." Kofsky (1966) in an attempt to validate Piaget's theoretical statements on classification abilities of children also concludes that a task requiring verbalization of the child is different from a task that requires manipulation of material, no matter how similar the content of the two. The observations recorded during the free sorting sessions of the CC group confirm the above finding and support the distinction between forming a category and verbalizing it. There were instances in the study when subjects who had good categories were not able to state the grouping rule they had used or produce the most appropriate labels for them.

Some of the methodological conditions of verbal recall studies can be generalized to the present experimental situation. Whereas in clustering experiments, clusters used by the subject and not designated by the experimenter were treated as error, in this study, any category suggested by the subject was deemed acceptable. Since the scoring system was based on the proportion of objects on the board eliminated with each question, those who had constructed their own groups on a principle that they could articulate, could use them. To cite an example, a subject in CC had classified 2 boats, 2 water birds, 2 reptiles and 2 jungle animals as "they all go in water". His later question of "Is it something that goes in water?" entitled him to take off all the eight things that he had earlier assembled under that functional principle. Thus the score measured competence in the game and not concordance with the categories made up by the experimenter.

It became apparent that what made the categorizing system of those in CC as efficient as that planned by the experimenter was the second part of the treatment that suggested a structural constraint in the number of objects per group (4, 8 and 16). Given a framework of this kind, most subjects were able to produce subordinate and superordinate classes more or less approximating to those used in the design. Since they had manipulated the objects and combined them in different ways, the classes they finally arrived at were probably more stable than those in the CR treatment condition.

The situation in the CR group is analogous to a number of typical classroom situations where students are asked to attend to specific aspects of the teacher's behavior and selected attributes of the stimulus objects. And as in a classroom, the assumption that the information is necessarily new or the child's mind a tabula rasa is unwarranted. When the experimenter grouped the objects in the taxonomic hierarchical pattern and supplied labels for them, the subjects orienting to the situation already had a system of categories. An examination of the pre-instruction games reveals that in the first game 37% were "guessers" i.e., their questions specified only one object at a time. On the second game only 25% were guessers; 12% of the whole or one-third of the original guessers seemed to have arrived at some grouping principle without specific instructions to that effect. Thus at the end of the second game and before the instructional intervention, 75% of all the subjects had some categories.

A comparison with the clustering phenomenon in free recall studies will clarify the processes included in the CR condition. The subject's organization of the input material directs the order of recall of items. Tulving (1962) describes a related measure called "subjective organization," which is, in effect, a measure of intra-individual consistency, employed when there is more than one output phase. In the present study any grouping can be seen as analogous to clustering, and consistency in the use of a category over the first two games, as similar to subjective organization. Hence any experimental procedure intended to substitute an individual's clusters and his subjective organization should technically be treated as an interference paradigm.

Support for the hypothesis of an interference condition comes from a concept recall study by Mandler and Pearlstone (1966) in which they indicate that to the extent that the subject must suppress, extinguish or ignore his own system of conceptualization, such activity will interfere with the acquisition of the E-defined conceptual categories. Their data supported the assumption of interference in a constrained (in contrast to a free) concept task. Applying this principle to the CR condition, if a subject already had used categories and attributes not included in the taxonomic scheme presented to him, but nevertheless which he had found effective in the pre-instruction games, he would be in conflict between using his own proven subjective categories and trying out the recently-acquired "right" categories. On the other hand, if the new taxonomic labels were more obvious or if they corresponded to the ones developed by the subject, the didactic situation would strengthen the association between group and label and lend competence in forming questions. For instance, the class of four musical instruments seemed to be an obvious one, and receiving a label for it seemed to enhance its use in subsequent questions. It is a fairly common observation in psycholinguistics that knowing the name of an object makes it easier to discriminate and recognize it. A logical extension of this to the task of categorization is that knowing the label for the category would make it easier to conceptualize its definitive aspects and assemble the objects that are inclusive in it.

The theory that the verbal cue induces grouping into appropriate categories is not wholly supported. One of the problems in assessing the use and acquisition of the selected taxonomic categories arises from the difficulty in determining whether a subject has comprehended the essential criteria of a category or is merely repeating a label. Some evidence of this ambiguity was observed in the testing situation. For instance, a subject who asked "Are you thinking of transportation?" was using the right label. This might not be evidence that he would identify the crucial attribute of the class. Following a negative answer, he might focus only on some of the members of the category and realize as he was taking those things off, that other members could legitimately be included. The scoring system did not take into account subtleties like second thoughts and serendipity. Thus the recency of the taxonomic label might make it more probable and the inference that the subject has acquired hierarchical classification may not be justified. This is a moot point; however, since the main dependent variable in this study was the proportion of objects eliminated with each question which was accurately quantified, this specific problem did not substantially affect the results.

Only by delineating the cognitive processes that might have been influenced by the intervention can one explain the equal impact of the two methods in inducing competence in the Question Game. The complexity of the task selected appears to need a multi-factor theory to account for all the variance. It would seem reasonable to assume that the experimental control over a minimal number of variables in this study may not have been sufficient to keep out all the "noise" from the data. However, to the extent that inferences can justifiably be made from the observations, it was found that in both treatments the hierarchical structure or the inter-relatedness of the objects was emphasized through the progression from smaller to larger groups. This common factor seemed to be strong enough to equalize the effects of the rest of the intervention. In the CR group the subjects attended to the ascending levels of the categorical hierarchy and to the suitable labels as presented by the experimenter. In the CC group they were supplied with a numerical structure within which they could fit the objects. In some ways this was akin to a word game where the number of letters in each word is specified and where that constraint aids in the solution. Subjects in the CC group sometimes developed the categories that had been planned by the experimenter, although they did not always produce the taxonomic labels for them; even in instances where they responded with class names in the sorting situation, in subsequent games they maintained a preference for referring to functional or descriptive attributes of objects.

The earlier theoretical controversy regarding the ascending <u>vs</u>. descending order of the hierarchy of categories and the respective difficulty of either for the child was not directly tested in this study. However it became clear that there was no marked preference to proceeding from specific to generic terms or vice versa. The choice was situation-specific and seemed to be largely determined by what has been termed "psychological reality." For instance, the superordinate "animal" was used frequently while a subordinate category like "mammal" seemed less accessible in recall. Some of the smaller subordinate classes like "jungle animals" for example, were also used more often. When Inhelder and Piaget (1964) collected their data on classification they noted that the "level of reasoning" varied with the character of the content. They cite the instance of children who in dealing with animal categories performed less adequately than with flowers or abstract shapes. The authors conclude from this that animals are "more remote from everyday experience and therefore more abstract (p. 110)." The suggestion that animals are "more abstract" than triangles and squares is semantically indefensible and experientially unsupported. It is possible that the children in thier sample were unfamiliar with animals, a feature that was by no means characteristic of the several children included in the pilot tests and in the main study under discussion here.

Some principles that pertain to the natural acquisition of language in childhood can be extended to the selective learning of labels in the CR condition. In the child's early vocabulary, it is "the utility of various categorizations (Brown, 1958(a), p. 20)" that determines the sequence in which words are acquired, rather than abstraction or concreteness per se. Brown also suggests that there are two types of abstraction in children's usage: abstraction from a failure to differentiate and the more mature abstraction that follows differentiation. It is reasonable to assume that the second graders in this sample were not in the earlier stage of using undifferentiated abstractions. But it is not easy to make an accurate assessment of whether their abstract terms were the product of discernment of essen-

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tial attributes or were simply more commonly used words within the culture.

An alternative explanation of the responses of the CR group originates from an inspection of the frequency count of the labels provided. It is likely that thé remoteness of categories was less responsible than the frequency of the label for its subsequent use in the game. A brief inspection of the Thorndike Lorge (1944) word frequencies of some of the words confirms this hypothesis. (The Thorndike Lorge frequencies of the names of the individual objects and the subordinate and superordinate labels used in the CR treatment are given in the Appendix). "Animal" (AA) was used more often by CR subjects than "mammal" (6) while "furniture" (A) tended to be used more often than "man-made things", the superordinate term to cover the 16 inanimate objects in the set. Thus categories which had a low frequency in a child's repertoire were probably used sparingly. A content analysis was not made but if it were, it is felt that there would not be a one-to-one correspondence between general frequency and usage. An instance of this non-correspondence would be the use of "reptile" (8) as often as "bird" (AA). Obviously there were several other factors operating on the selective learning and use of terms. One could still reiterate the general principle however, that the higher the frequency of a word in the culture, the greater the tendency for it to be used, remembered and recalled, irrespective of the level of concreteness.

Among the patterns of categorization behavior observed, an interesting one was this: after a majority of objects had been eliminated

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with category-questions, the subjects tended to scan the objects and phrase their questions about single objects even when grouping was still possible. This could be attributed to the fact that the objects left on the board probably shared many conceptual attributes and the discriminations required to divide them into classes would have to be very fine because "lower level classes are more tightly defined than higher order classes (Beach, 1964, p. 23)." The scanning behavior could also be a function of the reduced risk: for instance, if there were eight objects on the board the chance of picking the right object by guessing was one in eight, while using the optimal dichotomous rule would still require three questions to solution. Almost invariably, the young subjects take the former option. This observation is confirmed by Bruner (1966) who notes that the subject tends to give up constraint seeking behavior when the number of objects is reduced.

This leads to another consistent finding about the experimental behavior of children under ten years of age--they are notoriously inconsistent in their performance. They do not always make optimal moves and maximize their results as adults would, but seem to be "playing games!" Kofsky (1968) in summing up her attempt to apply scalogram analysis to categorization abilities refers to the unreliability of children's performance. She says that "young Ss are often less aware of the need to be consistent and are more likely to perform in a random fashion on tasks than adults (p. 202)." The inconsistency on task performance could have added to the error variance in this study as well. The child was likely to perseverate on one type of response, to change a successful strategy for a novel one, or to be distracted by the objects themselves.

In his critique of the object sorting experiment Braine (1962) refers to it as an intellectual projective technique where the response criteria are vague and no definition of a "good" sorting is given. This was, partially at least, remedied in the present study because the categories were evaluated in terms of their efficacy in the game, specifically, the proportion of objects removed with each question. Another criticism levelled at this experimental task by Braine is that "in the case of inadequate response, one has less confidence that the child's optimal response has been elicited than one has in a learning task where the correct responses are reinforced (p. 51)." To all those committed to the study of behavior the estimation of inferred processes poses a constant challenge. There is no legitimate way to decide that a subject's performance on an intelligence test or a personality questionnaire is in fact "optimal," and yet most clinicians and psychologists do accept such operationally defined and empirically observed behavior as valid data. While a stated response can in most circumstances, be considered an indication of a theoretically postulated antecedent condition, a non-response cannot be treated as certain evidence of its absence.

A reinforcement scheme could have been included in the design at the cost of vastly increasing the complexity of the experimental situation. It was assumed that the middle-class population available for this research would be composed of well-socialized children for whom adult approval was in itself a reinforcement. Also, judging from the pre-pilot and the pilot tests undertaken earlier, the game devised for the study seemed to be intrinsically motivating and on the whole, the interest and enthusiasm of the participants was at an encouragingly high level. It must be remembered too that a great number of testing and learning situations are analogous to the general set up of this study.

The results showed a significant correlation of .50 between pre-instruction and post-instruction performance. This relationship can be considered supporting the argument that a developmental theory would offer for intra-individual consistency. A finding that might lend some support to the Piagetian view is the positive correlation of .23 between CA and performance; this in conjunction with a correlation of -.31 between CA and IQ, and a near-zero correlation (.07) between CA and MA, suggests that age per se lends an advantage to cognitive tasks. Proponents of the salience of maturation to cognitive development would consider these data as confirming their views.

The moderate positive correlation between MA and task performance is highly predictable. The more interesting data in this connection are those that reveal an increasingly stronger relationship as the games progress (Table 2). Noteworthy also is that MA is correlated .39 with post-instruction scores, while IQ has a .27 correlation. Neimark & Lewis (1968) concluded their study on a logical problem solving task with the same observation regarding the relatively higher predictor--mental age. However, it must be noted that MA is not correlated highly with all of the positive scores, as would be expected. The correlations of MA with pre-instruction scores, difference scores and post-instruction scores were .26, .07 and .39 respectively. This indicates clearly that although more of the variance in competence following intervention could be accounted for by MA, the change score itself could not be attributed to it. All the subjects improved their competence at the game, not only the brighter ones. Yet, post-instruction performance was correlated with MA fairly consistently. It is possible that in the face-to-face relationship with an adult in both instruction and game sessions, motivational or some other non-controlled factor may have been operative.

In drawing conclusions regarding the possible relationship between intelligence and competence in the categorization game, two points will have to be kept in mind. First, the MA reported in this study was the score in a Thorndike Lorge (paper-and-pencil) test administered in the classroom. It was a verbal test and appeared closely related to the regular school tasks. It is likely that verbal facility may, in fact, have been the common factor between performance in the categorization game and in the IQ test. Second, the sample was selected from a middle and upper socioeconomic class population. The mean IQ of the group tested was 109, the standard deviation was 15 and so statements about MA must be taken as referring to a group that would be placed slightly above the mean of the general population.

Middle-class children who have generally received encouragement for verbal activity are likely to perform well at the task devised for this study. It might also be hypothesized that the intervention treatment in CR would be more effective in the cases of those for whom the labels are verbal cues to be recognized and recalled, rather than learned anew. A pilot test run in a rural school indicated some support to this contention: there was a slight preference in favor of CC over CR in that group. It was inferred that if the taxonomic labels were not already in the child's repertoire, the CR treatment could be frustrating and futile. The pilot sample was not large enough to serve more than a heuristic purpose. It would be worthwhile in the future to set up hypotheses that include socioeconomic class as an added variable.

The shape of the curve in Fig. 1 warrants an explanation. The dramatic jump from the pre-instruction level to the post-instruction level in both treatments has already been discussed. The pre-instruction series were intended partially as a control group; that there was some insight or incidental learning on the part of one-third of those who began the game with guessing is undeniable. Whether or not the same rate of self-teaching would have continued over five games would have been worth investigating. However, the statistical constraints required to make probability statements about the population and the differential effect of the two methods of intervention made it difficult to have a control group in this study without increasing N substantially. For the amount of additional information one would get, a control group is desirable, and further research in this topic should attend to this recommendation.

The most striking aspect of the curve is its rise after the intervention. The recency of the perceptual clusters and verbalization must have resulted in a strengthening of the associative bond between category and label. Recency may, therefore, have been relatively important in the recall of categories. A slight drop in scores on game 4 was observed in both groups. By game 5 the level of performance is restored. One could speculate that there was a practice effect, or that the instructions seemed ambiguous at first and became clear later in the game. A possible alternative explanation could be based on consolidation theory (Farley, personal communication). Since these differences between scores games 3, 4 and 5 are small and nonsignificant, caution must be exercised in interpreting them.

The types of categories used in formulating the questions clearly. fell into different patterns in the two treatment groups and since this appears to be a function of the interventions, the results have to be evaluated in some detail. Judging from the pre-instruction games, there was a preference on the part of all the subjects for Functional grouping as can be seen in the means of 3.6 and 4.4 Taxonomic categories, compared to 7.4 and 8.5 Functional categories, on games 1 and 2 respectively of all the Ss (CC and CR). On the post-instruction games 3, 4, and 5 respectively, the CC group has 12.2, 11.7 and 13.7 (Fig. 8, 9, & 12) Functional questions as compared to the CR group with 6.1, 9.1 and 6.5 (Fig. 10, 11, & 13). On the Taxonomic questions, the situation is reversed; CC uses 8.5, 7.3 and

6.3 Taxonomic questions, compared to CR's 14.6, 11.8 and 13.3 on the three games. What seems apparent is that given the Taxonomic labels (CR) the subjects use them immediately after, but there is a drop of three points in game 4 in this category. A rise of 3 points in the Functional category compensates the loss. This must be interpreted as more than gaining in the roundabouts what is lost in the swings. The Taxonomic labels, since they are probably not from the subject's own repertoire, tend to get attenuated or lost, while the Functional mode which has already been shown to be used effectively by most subjects even prior to intervention is substituted instead. In the CC condition, grouping by function remains a popular response. The inconsiderable drop in the use of Functional questions of subjects in game 4, and the gradual decline in their use of Taxonomic questions also lends credence to the idea that for children of this age, class and category labels are not as accessible as Functional or Descriptive ones.

In summing up this brief discussion about use of types of categories it must be reiterated that the distinctions between them are fine and that in a general sense the difference in constructing categories could be reduced to one of a syntactic preference for the use of nouns (Taxonomic), verbs (Functional) and adjectives (Descriptive). Children of 7-8 years of age in second grade tend to prefer action-words and to conceive of objects in terms of function or use rather than in terms of taxonomy.

In conclusion, a basic philosophic problem at the core of the study must be mentioned. This concerns the difficulty of transforming pertinent principles drawn from the theories of Piaget and Vygotsky into viable experimental methods that would be accepted both by the proponents of the theories as legitimate theoretical offshoots and by the "tough minded" methodologists as acceptable design. Quantification of the identified dependent measure and statistical treatment of the data in this study were slightly complicated by the low reliability of the measure. The inference drawn from the results can be considered salient to the extent that all the earlier transformations from theory to method to measurement to results have been valid and adequate.

This questioning (the is-it-science syndrome) is probably an occupational hazard of researchers of human behavior and no claim to uniqueness is made here; however the experience of dealing with the infinitely complex cognitive activities of young children kindled greater awareness of the tenuous links in the chain of knowledge, that are frequently credited with more strength.

Speculating about the educational implications of this study leads to the realization that the two methods tested here are parallel to the discovery and didactic methods. And if the results of this experiment are generalized, one has to concede that both approaches seemed to have an equivalent effect on task efficiency. A reasonable conclusion to draw then, would be given a learning task that is intrinsically motivating and a situation where adult attention is assured for the period of learning, there is a demonstrated change in the child's competence. What better perspective for the educator's influence on the cognitive process?

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OBJECTS USED IN THE CATEGORIZATION GAME
(Number of objects = 32)

chair	cat
table	dog
dresser	cow
cupboard	horse
guitar	lion
banjo	tiger
trumpet	elephant
harmonica	hippopotamus
car	swan
racing-car	duck
tractor	pheasant
bulldozer	dove
ship	snake
boat	lizard
airplane	alligator
helicopter	turtle

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THORNDIKE-LORGE FREQUENCIES OF OBJECT NAMES,

SUBORDINATE AND SUPERORDINATE LABELS

chair	(AA)	furniture (A)
table	(AA)	
dresser	(7)	
cupboard	(12)	

guitar	(4)	musical (39) instruments (42)
banjo	(2)	
trumpet	(17)	
harmonica	(2)	

car	(AA)	road transport (28)
racing-car	(1)	
tractor	(12)	
bulldozer		

ship	(AA)	transport (28) (non-road)
boat	(AA)	
airplane	(16)	
helicopter		

cat	(A)	farm (AA) animal (AA)
dog	(AA)	
cow	(A)	
horse	(AA)	

lion	(A)	jungle (16) animal (AA)
tiger	(30)	
elephant	(35)	
hippopotamus	(1)	

swan	(19)	bird (AA)
duck	(49)	
pheasant	(3)	
dove	(19)	

snake	(28)	reptile (8)
lizard	(7)	
alligator	(6)	
turtle	(13)	

animal (AA)
man-made things
mammal (6)
non-mammal
transport (28)
non-transport

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SCORING SYSTEM FOR CATEGORIZATION GAME

Ratio of objects indicated to total number of objects on the board		Score
1/2	1/2	1
3/7	4/7	2
3/8	5/8	3
1/3	2/3	4
1/4	3/4	5
1/5	4/5	6
1/6	5/6	7
1/7	6/7	8
1/8	7/8	9
1/9	8/9	10
1/10	9/10	11
1/20	or less than 1/20	12
Redundancy (no objects removed)		12

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