Developmental level and concept learning: Interaction of age and complexity¹

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Abstract

A study utilizing 60 children demonstrated a strong interaction effect between developmental level and problem complexity on trials to solution of a relational concept formation problem. Some S's from both developmental groups were unable to verbalize the concept even though meeting a "trials correct" criterion of solution.

Problem

Klugh et al (1964) have reported data which indicates an inversion of the expected relationship between developmental level and trials to solution of a concept problem. In two studies these investigators found fourth grade children took more trials to solution of a relational concept problem than did first graders. Friedman (1965) has supported this finding of a decline at the fourth grade level and relates it to a problem the fourth grader may have in the efficient use of verbal mediation. Our concern in the present study was with the relationship between problem complexity, defined in terms of irrelevant dimensions, and developmental level, as these affected trials to solution of a relational concept problem. Previous research (Klugh et al, 1964) attempted to investigate the complexity variable but the nature of the complex problem made solution too difficult for the younger children. The present study reports a modification of directions and a correction technique which appears to make the solution somewhat easier for the younger S's.

Method

S's used in this study were 60 elementary school children, 30 five- to six-year-olds and 30 nine- to ten-year olds. The younger and older groups were further sub-divided into two groups of 15 S's each and matched on the Stanford-Binet vocabulary sub-test. One group at each age level was assigned the simple concept task, the other group was assigned the complex concept task.

The apparatus was a modification of the Yerkes problem box. This device housed 12 evenly spaced levers so that any one or more could be pushed forward by E toward S. A hidden selector switch enabled E to arrange for one of these bars, when pressed, to sound a buzzer signifying a correct choice. For S's in the complex problem group, E presented a varied pattern of from four to nine bars at each trial. For S's in the simple problem group E always presented four adjacent bars but the particular four bars chosen from among the 12 varied from trial to trial. The correct choice for both problems was always the second bar from S's right regardless of the number or the spacing of the bars presented. If S's first choice was incorrect, he was

shown the correct choice for that trial by E, then all levers were retracted and a different group of levers presented for the next trial. The same sequence of settings was used for all S's within each task group. S was told at the beginning of the study that there was a rule he could discover which would allow him to be right on every trial. The criterion for solution was five consecutively correct choices. All S's were tested privately and individually and were given a cup of candy at the conclusion of their participation. The informing response by E is an attempt to reduce the trials required for solution of the complex problem for younger S's. It should be noted that "complexity" is here identified with the number of irrelevant dimensions following the work of Bourne & Restle (1959). The more complex problem had two irrelevant dimensions, number of bars and spacing of bars. These were not permitted to vary in the simple problem where four adjacent bars (though of course not the same four bars) were always presented.

Results

Six of 15 S's in the younger-complex problem group could not reach criterion within 105 trials. The mean trials to criterion of the various classifications appear in Table I.

Since the data from both complex problem groups were skewed and had larger variances than the simple problem groups a log transformation of all scores was performed. Bartlett's test was not significant for the transformed scores. These data were then subjected to a 2 x 2 analysis of variance. This resulted in a between ages $F=4.64$, $df=1/56$, $p<.05$; between complexity $F=19.27$, $df=1/56$, $p<.01$; interaction of age and complexity $F=32.8$, $df=1/56$, $p<.01$. "t" tests revealed significant differences between all cells in Table I except between age groups on the simple problem.

After S had reached criterion he was asked if he could tell the rule for finding the correct bar. Of the 54 children who reached criterion, 13 could not verbalize the concept. On the simple concept, of the 5-6 year olds, 4 of 15 were unable to verbalize the concept; of the 9-10 year olds, 2 of 15 could not. On the com-

Table 1. Mean Trials to Criterion

Age	Task		Mean
	Simple	Complex	
9-10 yr.	10.1	21.9	16.0
5-6 yr.	10.9	65.1	38.0
Mean	10.5	43.5	

plex concept, of the 5-6 year olds, 5 of 9 achieving criterion were unable to verbalize the concept; of the 9-10 year olds, 2 of 15 could not.

Discussion

It is apparent from these data that there is a considerable interaction between the number of irrelevant dimensions involved in these concepts and developmental level of the child on trials required to solution. It is also apparent that a child may acquire a "solution" which he cannot verbalize. The results of this study, however, fail to support the previously found inversion of the normally expected relationship between developmental level and trials to solution. There were, of course, important procedural differences between this study and Klugh et al (1964). First, S was shown the correct response following each incorrect trial. Second, S was told that there was a rule which if followed would insure the correct solution at each setting. Even with

these changes, there is still a surprising similarity for older and younger S's on the simple problem, especially since it was still sufficiently difficult that 6 of the 30 children could not verbalize the solution even though achieving a "trials" criterion. The answer may lie as Friedman (1965) suggests, in a more careful attention to what verbal processes are going on when the solution is attempted.

References

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Note

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Reply

There are several matters of fact that should be presented prior to any consideration of issues of inference and interpretation raised by Clement. (1) Lachman & Field (1965) investigated serial verbal learning; the Ss were specifically instructed to attempt to learn the material in sequence. (2) A similar study has been completed with words ordered at a low approximation to English. The recall curve in that study overtakes and crosses the recognition curve somewhere between trial 64 and 128 (to be reported at Psychonomic Society, Chicago). (3) Experiments are now underway with word order randomized on each trial and learning set varied; speculation as to outcome at this point would be presumptuous.

Since the influence of approximation to English may now be ignored, the issues raised by Clement reduce to an extremely important problem: the nature of the recognition construct. The conclusions of Lachman & Field were not arrived at solely in the context of their single isolated study, but rather involve by implication the findings of several other investigators. Tulving (1962) has demonstrated that in the absence of a fixed serial order, Ss will impose their own order of "subjective organization" upon a list of words, and that training, degree of SO, and recall covary. Serial order, therefore, is but one method of organizing words and a very efficient one. Given a short training list or an unpaced recognition test, the Ss as Clement suggests are likely to use organization habits to RECALL all or part of the list prior to each "recognition" decision. Ss may covertly emit a sequence of words by means

of serial or other organization habits until a word is generated that matches the word in the recognition alternative. I am disinclined to consider this behavior recognition but insist that it is properly characterized as "recall and matching-to-sample." The 1.5 sec. time limit, thus, was deliberately imposed to insure that recognition was tested rather than recall and matching-to-sample.

A number of verbal recognition studies happen to have employed at least an overall time limit and long training lists. Murdock's (1963) data suggest that an elimination strategy is likely and Lachman & Field's data imply that appropriate recognition of incorrect alternatives occurs rather early in training perhaps even more quickly than recognition of correct alternatives. It is, therefore, not unreasonable to conclude that the almost universal finding of superior recognition is at least in part reflecting an elimination strategy during recognition testing.

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