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- In the context of A and B, it is hypothesized that different associations would be elicited.

SUBJECTS

The Ss were 70 introductory psychology students at the University of Nebraska. Participation in experiments was required of all introductory students, but they were free to select the particular experiments in which they participated. Ss were run in three groups of 13, 27, and 30 Ss each.

PROCEDURE

Since Willner (1964) found the analogy problems of the type used in the Miller Analogies Test to be among those least soluble through word association, it was decided to select 25 problems from the Miller Analogies Practice Tests provided by Friedberg (1967). Seven different tests were constructed from these problems. First, the control group received an analogy test composed of the 25 problems. Six other tests were constructed using the same D choices that the control group received; however, each test had a different combination of the A, B, and C parts. Group A received a test booklet containing only the A parts with instructions to choose a word from the list of four alternatives accompanying each item to go with the first word. Groups B and C received similar booklets and instructions except that the items contained only the B and C parts, respectively. Group ABC received all three of the analogy parts, as well as the D choices, but with the word association instructions. All external clues identifying these as analogy problems were removed. Group ABC received the three A, B, and C parts in their original order; Groups BCA and CAB were given test booklets identical to those given to Group ACB except that the parts occurred in different orders (i.e., according to the order indicated by their symbols). The test booklets were shuffled and handed to Ss as they entered the experimental testing room. Written instructions accompanied each booklet, and the only oral instructions offered were comments on information to be included on the IBM answer sheets. After S completed and turned in his test booklet, he was given a postexperimental questionnaire asking him for his impressions of the experiment and how he chose his answers. The entire procedure took from 10 to 25 min.

RESULTS

Answers were scored in terms of whether or not they correctly completed the analogy problems. One question was discovered to contain a typographical error and had to be discarded in the scoring, leaving a total

Word association and verbal analogy problems

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Previous attempts to identify verbal analogy problems that can be solved on the basis of word association did not take account of the possibility that associations to a word are different when that word is in the context of other words than when it is presented alone. The various parts of 25 verbal analogy problems were presented, individually and in combinations, to Ss with instructions to choose responses on the basis of word associations. Ss receiving all three of the stimulus parts of the analogy problems chose answers that completed the corresponding problems significantly more often than Ss given only one of the stimulus parts. This result, and other factors, led to the conclusion that it is not possible to eliminate totally the word association bias of verbal analogy problems.

In spite of the considered importance of analogical reasoning in the measurement of intelligence (Willner, 1964) and in the construction of scientific explanations (Dreistadt, 1968, 1969; Oppenheimer, 1956), there is very little empirical data on analogical reasoning as a psychological process. This deficit can be attributed to (1) the lack of an adequate theoretical conception of the process and (2) inadequate experimental tasks in which to investigate the relevant variables.

It is possible to view analogical reasoning in terms of rule construction and utilization. Analogies have the general form, A is to B as C is to D, where the various parts of the analogy can be virtually anything. When presented as a problem-solving task, Part D is some particular item which S must either supply or select from among a list of similar items. According to a "Rule Model" of analogical reasoning, S finds or constructs a rule which connects the attributes of A to the attributes of B and then applies this rule to the attributes of C in order to generate D. When the analogy problem is presented in a multiple-choice format, S identifies the correct answer by comparing the attributes generated by

the application of the rule to C against the attributes of various alternatives provided. This model is consistent with previous proposals for describing analogical reasoning (Dreistadt, 1968; Goldstein, 1962; Willner, 1964) and is closely related to recent models of human conceptual behavior (Haygood & Bourne, 1965).

Although an effort has been made to devise appropriate tasks, the lack of adequate experimental materials is more difficult to remedy. For example, some analogy problems can be solved without knowledge and/or application of the "Rule Model" simply because parts C and D have a high association value. Goldstein (1962) and Willner (1964) constructed verbal analogy problems in which the biasing influence of word association was reduced by eliminating items in which Part C had a strong tendency to evoke Part D, regardless of Parts A and B and the rule connecting their attributes. In both studies only Part C was presented as the word association stimulus. However, as Woodworth & Schlosberg (1954) and Cofer (1957) report, the associations to a word vary in relation to the context in which it appears. Thus, if Part C were to appear

of 24 problems. Of the possible 24 correct answers, Group A obtained a mean of 5.36, Group B a mean of 7.80, Group C a mean of 8.08, Group ABC a mean of 12.67, Group BCA a mean of 10.89, Group CAB a mean of 10.10, and the control group a mean of 13.89. Four planned comparisons were carried out using Dunn's multiple comparison procedure (Kirk, 1968), where the error term had 62 df, and the selected alpha was .05. The combined mean of Groups ABC, BCA, and CAB was significantly greater than the combined mean of Groups A, B, and C. Groups BCA and CAB were significantly greater than Group C. Although Group ABC did not differ significantly from the control group, the mean of Group ABC was significantly greater than the combined mean of Groups BCA and CAB.

On the postexperimental questionnaires, many of the Ss given all three parts of the analogy problems gave strong indications that they were responding to the items as if they were analogy problems. Eight Ss in ABC, four Ss in BCA, and four Ss in CAB, rated by an independent judge, stated that they saw some relationship between two of the words and proceeded to select their answer so that it had the same relationship to the remaining word. The other Ss in these groups generally indicated that they saw some relationship between the words, but it was not clear from their remarks that they were answering the questions as they would analogy problems. The frequencies for Groups BCA and CAB were combined and compared with those for Group ABC in a 2 by 2 contingency table. The χ^2 was found to be significant ($df = 1$, $p < .05$).

DISCUSSION

Since the groups given all three of the A, B, and C parts from the analogy problems were significantly higher than those given only one of the parts, the hypothesis for this study is supported. Further support can be seen in the significant difference between Groups BCA and CAB combined and Group C. These results suggest that the procedures employed by Goldstein (1962) and Willner (1964) may not eliminate all of the possible bias in verbal analogy problems due to word association variables. Ss choose the correct answer more often when all the words of the analogy problem are presented. Therefore, it is necessary that several different procedures be used in order to identify and eliminate the items affected by word association variables.

There were some interesting order effects, i.e., Group ABC was significantly better than Groups BCA and CAB combined at choosing the words which would have solved the analogy problems. This effect was also seen in the replies of the Ss to the postexperimental questionnaire, where there was a significantly greater tendency among Ss in ABC to view the questions as analogy problems. These findings corroborate a similar one by Cofer (1957) that the order in which verbal items are presented influences the relationships which S imposes on those items.

The conclusion that Goldstein's (1962) and Willner's (1964) technique does not adequately evaluate associative variables in analogy problems must be qualified in terms of Ss' replies to the postexperimental questionnaire. Since many Ss selected their answers as though they were working analogy problems, it is difficult to describe the task presented

to Groups ABC, BCA, and CAB as being a typical "word association" task. Such a result also suggests that it may not be possible to identify and eliminate completely the word association bias of verbal analogy problems. There are also some implications here for studies of word association per se, particularly those where a multiple-choice format has been employed. It is possible that the multiple-choice format effectively sets S to search for relationships between the items and to choose his responses on that basis.

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