DOCUMENT RESUME

ED 068 056 HE 003 506

AUTHOR	Boutwell, Richard C.
TITLE	Effect of Task Sequence and Memory Support on Indian College Students. Final Report.
INSTITUTION	Brigham Young Univ., Provo, Utah. Dept. of Instructional Research and Development.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Regional Research Program.
BUREAU NO	BR-2-H-006
PUB DATE	Dec 72
GRANT	OEG-8-72-0002(509)
NOTE	27p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	American Indians; *Cognitive Processes; College Students; *Evaluation; *Higher Education; *Learning Processes; *Memory

ABSTRACT

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Richard C. Boutwell
Department of Instructional Research & Development
370 ARLC
Brigham Young University
Provo, Utah 84601

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This research report herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of this project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

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Acknowledgements

I am indebted to Dr. M. David Merrill, who serves as my sponsor of the experiment, and to Dr. Robert D. Tennyson, whose encouragement and support kept me on my appointed task. I wish also to express appreciation for Tom Garrow, a Mohawk, whose advice in data collection was invaluable. I would also like to thank all the Indian students who served as subjects for this study.

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Richard C. Boutwell Brigham Young University

ABSTRACT

The multivariate effect of task sequence, memory support, and state anxiety was investigated using a nonverbal concept acquisition task. Ninety-six Indian college students were randomly assigned to four treatment conditions resulting from the task sequence, easy-to-hard and hard-to-easy, and memory support versus nonmemory support. Subjects receiving the easy-to-hard sequence did significantly better on the performance test than the hard-to-easy sequence ($p < .01$). Also, the memory support treatment groups had significantly fewer errors on the performance test than the nonmemory support condition ($p < .01$). The instructional condition of easy-to-hard sequence plus memory support, as the optimal treatment, provides manipulatable variables for applied usage.

EFFECT OF TASK SEQUENCE AND MEMORY SUPPORT ON INDIAN COLLEGE STUDENTS

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Since the 1950's psychologists have investigated theoretical questions concerning the relationships between subject anxiety and performance in a variety of tasks (Hughes, Sprague, & Bendig, 1954; Kamin & Fedorchack, 1957; Lucas, 1952; Mandler & Sarason, 1952). The theoretical position of Spence (1958) and Taylor (1956) on competing response tendencies related to anxiety status has been generalized to instructional tasks where interactions of affective states with cognitive factors would result from highly anxious subject scores being inferior to low anxious subject scores on a difficult task, and a reversed relationship (disordinal interaction) on a an easy task (O'Neil, Spielberger, & Hansen, 1969; Tennyson & Woolley, 1971). In the latter, easy and hard task conditions were defined empirically.

Two critical attributes of an anxiety by task interaction study are essential: (a) measured anxiety differences, and (b) an empirically based task difficulty contrast.

Research studies (Tallmadge, Schearer, & Greenberg, 1968; Dunham & Bunderson, 1969; Merrill, 1970; Tennyson & Boutwell, 1972a) indicate that the disordinal interaction predicted by Spence and Taylor is highly elusive. The results of these studies seem to have been dependent upon the varying methods used for defining easy and hard tasks. These studies lacked explicitly stated procedures governing empirical task difficulty and analyses required for accurate testing of the theoretical assumption of anxiety and cognitive interaction. In a recent study by Tennyson and Boutwell (1972b), a system was used in which an empirically defined difficulty level was assigned to a concept acquisition task. This approach appears to provide a method for more adequately arriving at an empirical definition of task hardness in the context of the anxiety by difficulty interaction tasks.

The second challenge is that of adequately defining anxiety. Spence and Taylor identified two anxiety effects. First, they identified as increased Drive (D) the attribute which induces higher performance scores in tasks with few competing error responses (Spence, Farber, McFann, 1956). The second, labeled Stimulus-derived (Sd), is that anxiety effect which results from emotional states and has a generally disruptive effect on personal performance. The cue aspect of Sd anxiety elicits from the subject incorrect responses based on the attention-evoking attributes of the task. That is, if the task has a relatively high number of incorrect choices, the subject with high Sd anxiety is likely to choose those incorrect responses because of their strong response-eliciting characteristics. The subject with high Sd is unable to discriminate between correct and incorrect responses since the strength of the incorrect responses is increased. Spence regarded disruptive anxiety as a nuisance because it occurred only under certain task conditions and was hard to control.

There has been considerable research in the measurement field on the sequencing of item difficulty and individual anxiety characteristics in test performance (Alpert & Haber, 1960; Brenner, 1964; Berger, Munz, Smouse & Angelino, 1969). Given a no-timed testing situation, Munz and Smouse (1968) showed that low anxiety subjects had higher correct scores on a hard-to-easy sequence than on easy-to-hard or random sequences, while high anxiety subjects' scores were higher on an easy-to-hard or random sequence than on hard-to-easy sequences. Tennyson and Boutwell (1972b), using a multivariate data analysis, showed that subjects receiving an easy-to-hard sequence had significantly higher scores on the learning task than subjects receiving the reverse sequence. Also, within-task state anxiety measures resulted in a hypothesized disordinal interaction between the two sequence groups. If those results obtained in group settings can be generalized to an individualized environment of task difficulty, sequence differences might be associated with differential performance level by learners of varying anxiety levels.

Subjects reporting high state anxiety are more likely to employ random acquisition strategies and make random choices on a performance test when not given self-reinforcement or memory support (Wolfgane, 1962). Sieber, Kameya, and Paulson (1970) concluded that highly anxious subjects are neither "cautious or accurate problem solvers" when critical information is not available. Research has suggested (Boutwell & Tennyson, 1972) that the difference between performance in high anxiety and low anxiety subjects may be related to the amount of self-reinforcement or memory support they receive during a task. In a functional individualized program, memory support allows the subject to return to the learning display during the performance test.

Hypotheses

The purpose of this study was to investigate the effect of state anxiety, task difficulty sequencing, and memory support on concept identification. The first hypothesis was that a replication of the Tennyson and Boutwell (1972b) study results would be obtained which showed the significant effectiveness of the easy-to-hard sequence task. The extension here was the inclusion of a memory support condition similar to that investigated in the Boutwell and Tennyson (1972) study. Along with the combination of the sequence variable and memory support variable, a further extension was the use of a multivariate analysis design using three repeated state anxiety measures and two task performance test measures. The optimal treatment, in terms of test performance, was hypothesized to be an easy-to-hard sequence plus memory support. A third hypothesis was that task sequence would effect within-task anxiety levels, resulting in a disordinal interaction.

Method

Subjects

The subjects were 96 students chosen from undergraduate Indian educational classes at Brigham Young University who were randomly assigned experimental treatments. No one experimental group had a disproportionate number of males to females. The range of ages within these groups was from 19-27 years. Each subject volunteered and was paid for their services.

Task

This task required first the reading of a definition that included two prompted examples and two prompted nonexamples, then the identification of examples of RX_2 crystals from a list containing new examples and nonexamples. A prompted instance is one which includes information indicating each attribute individually separated, identified, and defined.

A definition containing a list of the relevant attributes of RX_2 crystals was presented to the subjects for the task, drawing their attention to the basic repeating two-to-one ratio in crystal structure of the atoms. This concept was further elaborated as follows: "For a given atom there will be another two atoms attached to it in repeating fashion." The subjects were also told that symmetry of the crystal was irrelevant. Each page of each task consisted of a single shaded crystal picture taken from Crystal Structure by Wyskoff (1963), see Figure 1.

Insert Figure 1 about here

Instance Probability Analysis

In order to obtain empirical validation of the task difficulty level defined as competitive response strength of hard and easy items, Tennyson and Boutwell (1972c) described an instance probability analysis for rating and categorizing all the items of the proposed task according to how hard they were for the subjects to recognize. The RX_2 crystal concept identification task was formulated according to this analysis and then administered to 100 subjects from the same target population as the one used in the experiment. Each instance to be used in the task was tested for relative probability of response. High probability items were defined as those instances correctly identified by 70 percent or more of the subjects. Low probability items were those instances correctly classified by less than 30 percent of the subjects. High probability instances in this study constituted an "easy task" and low probability instances made up the "hard task." During the treatment, all subjects received successively a hard/easy or an easy/hard segment and each segment had 20 examples and 20 nonexamples. The concept was used because the task had to be a previously unencountered concept and none of the subjects reported any previous knowledge of RX_2 crystals.

Treatments

The independent variable of memory support involves either permitting or barring subjects from returning to the RX_2 crystal definition and the prompted examples and nonexamples. The two difficulty levels of the task, hard and easy, were crossed with the two conditions of memory support. Being able to return to the exemplified definition was in effect supplying additional information to the subject since concept identification strategies may very well depend on subject self-feedback. Feedback was only possible in the memory support condition.

Each of the two tasks in the experiment were preceded by task directions, a definition of the RX_2 crystals, including their relevant attributes and two prompted examplars and nonexamplars. The memory support versus nonmemory support condition was introduced only after the task had begun. The programs given the subjects were completely self-instructional. Responses were recorded on IBM answer sheets. No feedback was given concerning the correctness of the responses.

Anxiety Measures

The State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Luschene, 1969) measures two anxiety dimensions: state anxiety (A-State) which fluctuates according to environmental conditions such as taking a test, and trait anxiety (A-Trait) which is assumed to be a relatively constant personality variable that remains stable regardless of environmental change. The test manual for the State-Trait Anxiety Inventory reports a .75 correlation with the Institute for Personality and Ability Testing Anxiety Scale, 1963. Since the entire experimental setting took place in an hour, the (A-State) measure was the only one used, because of its high degree of relevance to the testing situation.

The A-State (Form X-1) scale required the subjects to indicate how they felt "at the moment" by responding to twenty bi-polar items, ten of which were reversed to insure balance of the questionnaire. The subjects responded to items such as "I feel tense," according to a four-point scale: very much so (4), moderately so (3), somewhat (2), and not at all (1). The possible range of scores was from a minimum (low anxiety) of 20 to a maximum (high anxiety) of 80. The pretask mean scores were similar to other scores reported by other studies using the A-State Inventory. Tennyson and Woolley (1971) reported a high anxiety group mean of 45, O'Neil et al. (1969) also reported a high anxiety group score of 43.

Procedures

Each experimental treatment was administered individually. After subjects were presented the first of three (A-State) anxiety tests, the subjects returned the first test to the experimenter to be scored and the subjects were then assigned into one of three anxiety levels: low, medium, and high. After being assigned to their initial anxiety level, the subjects were randomly assigned to one of four possible treatments of the factorial design. The treatments were contained in color-coded self-instructional booklets.

The booklet introduction identified the experimenter and the department conducting the study, and followed with directions. Directions were on the method of responding to the IBM answer sheet. Next, instructions for memory support stated explicitly whether the subject could return to the prompted examples and nonexamples or not. The experimenter was always present to help ensure compliance with the instructions and to control the environmental setting. Following the instructions came the prompted examples and nonexamples pointing out the relevant and irrelevant concept attributes. The subjects then classified ten new examples and ten nonexamples for the first task. After he had identified these twenty new instances, he was administered the second A-State Anxiety Inventory to measure how he felt during the first task. Then, starting with the memory support instructions, this procedure was repeated. A second task was taken and concluded with the third A-State Anxiety Inventory measuring how the subject felt during the second task. The last page thanked the subjects for their time and asked them to turn in the materials.

Results

Dependent variables. Five dependent variables were analyzed using a multivariate statistical design. These were the two correct total scores on the easy and hard crystal identification tasks, respectively, and the three STAI A-State Scale scores; the first taken at the beginning session, the second after the first task, and the final at the conclusion of the second task. Statistical power values were derived according to procedures outlined in Cohen (1969). A medium effect size of .25 was established for all data analyses. An alpha level of .01 was predetermined for all tests to keep beta sufficiently small for the n-size used in the experiment.

The multivariate analysis was selected because of the interdependence of the various measures for each subject. The second and third STAI-A -State Scales can only have meaningful interpretation by the assumption that the task affected anxiety level, and that anxiety affects task performance. Likewise, the two tasks are dependent because they are composed of similar instances, varying only in difficulty.

Two independent variables, task sequence and memory support, were factored into four treatment groups. Groups I and II received an easy-to-hard sequence of tasks, while groups III and IV received a reverse sequence. Memory support was given to groups I and III, that is, they were allowed to return to the instructional materials; groups II and IV could not. The tasks and A-State (2) and (3) means for groups III and IV have been reversed for analysis purposes (See Table 1). The multivariate analysis of variance resulted in a statistical difference between four groups ($\underline{U} < .31$, $\underline{df} = 5, 3, 88$, power = .99).

Insert Table 1 about here

Task sequence. Combining the two task scores, the overall performance score means showed the two easy-to-hard sequence groups doing significantly better with a mean score of 26.14, while the hard-to-easy groups had a mean score of 18.60 ($\underline{U}$ .59, $\underline{df}$ = 2, 1, 88, power = .88). A second analysis hypothesis was a univariate test comparing the groups on the easy task. The result was a significant difference between the two sequences, with the easy-to-hard sequence having a mean correct score four points higher than the hard-to-easy sequence ($\underline{U} < .60$, $\underline{df} = 1, 1, 88$, power = .77). The size of the difference in mean scores between the two sequences on the easy task results in significance with any multivariate hypothesis test. A second univariate hypothesis test on the hard task showed that the easy-to-hard sequence was significantly better on the task than the other sequence ($\underline{U} < .62$, $\underline{df} = 1, 1, 88$). These findings indicate that an easy-to-hard sequence does result in higher performance on a hard task over a learning task beginning with a hard task, while an initially hard task seems to have debilitating effects on succeeding performance in the learning task.

Memory support. In previous studies (Tennyson & Boutwell, 1972a, b; Boutwell & Tennyson, 1972) subjects were not allowed to return to the instructional sections of the task during the no feedback test. That is, given a definition followed by two examples and two nonexamples the subjects were required to identify instances as either positive or negative without further instruction. This study investigated the variable of memory support by designing a condition similar to the prior studies and a second which directed subjects to return to the instructions when needed. Using the multivariate hypothesis blocking on memory support, a significant Wk's U associated with the memory support condition, with a total score mean of 24, having a higher correct score than the nonmemory support treatment, mean of 20.7 ($U < .79$, $df = 2.1, 88$, power = .88). A univariate analysis was performed on each task with the memory support having a significantly higher score on both tasks; easy task ($U < 76$, $df = 2, 1, 88$), hard task ($U < .86$).

STAI A-State. The measure of subject state anxiety was a dependent function of sequence and task demands within the experimental treatments. The first measure of A-State was administered to the subjects as the first treatment, resulting in no difference of means between the four groups ($U < .99$, $df = 1, 3, 88$, power = .77). The A-State (1) mean of 36 compares with the average A-State score of 37 reported by the STAI manual (Spielberger, et al., 1969). A-States (2) and (3) were taken following each of the tasks and asked subjects to respond according to how they felt within the task. In both univariate tests on A-State (2) and (3) there was no significant difference between the means. However, the reported A-State did increase after the subjects were performing on the tasks. A-States in both tasks increased to 44, a significant gain after the initial measure.

Optimal condition. The purpose of instructional research is the systematic investigation of variables and conditions thought to have practical use in development. The present study extends prior research of task sequence by introducing memory support. The hypothesized optimal sequence and condition was easy-to-hard with memory support. Using a multiple comparison analysis for multivariate data (Morrison, 1967), group I, with a total mean of 28.4, had the highest significant score of the four conditions (See Table 1). The second easy-to-hard group (group II) had the second highest mean, which was significantly better than groups III and IV, which did not differ. When analyzing the two tasks univariately, the easy task mean differences were significant ($U < .56$, $df = 1, 3, 88$, power = .88) as were the hard task means ($U < .48$, $df = 1, 3, 88$).

On the easy task the multivariate multiple comparison was the same as the total score comparison. On the hard task groups I and II did not differ ($p < .05$), but they did have higher means than groups III and IV, which did not differ.

Discussion

To further test the Spence-Taylor Drive Theory which proposes that competing response tendencies interfere with learner performance differential given a difficult and easy task, was the initial purpose of this study. According to the Spence-Taylor Theory, high anxious subjects generate a high level of Sd, the inhibiting aspect of anxiety which mistakenly drives them to the strongest response competing for their attention. Oftentimes whether the response is correct or not, the highly anxious subject will choose it because of its strength or dominance.

The experimental findings of this study did not support the Spence-Taylor Theory of disordinal anxiety by task performance hypothesis. The lack of effect is related to the findings in the STAI A-State anxiety profile analysis which showed nonsignificant difference between A-States (2) and (3). The implication is that in order for the disordinal interaction between performance and anxiety to occur, there first must be a difference in anxiety levels, which did not exist at anxiety test two or three. This then must be interpreted to mean that since hypothesis three was not supported, the Spence-Taylor competing response theory was not tested since there were no differences in the subjects' anxiety during task performance. On the other hand, the A-State scores (2) and (3) did increase significantly from A-State (1).

What is needed to test the theory is a task which raises the anxiety for the high anxious subjects and not the low anxious subjects, or at least raises their anxiety level equally. Herein may lie one of the fundamental problems found in many anxiety-by-task performance interaction experiments. The results may be less a function of the subject's anxiety level than the task which he is asked to complete. If this then is the case, knowing the subject's anxiety level before the task is of little instructional design value since in an instructional setting the task induced effects may change abruptly and often.

The results of the data analysis showed the effectiveness of the easy-to-hard sequence, replicating Tennyson and Boutwell (1972b). These findings indicate that an easy-to-hard sequence does improve performance on the hard task over a learning task beginning with a hard task, while an initially hard task seems to have debilitating effects on succeeding performance in the learning task. Combining this sequence of memory support with the easy-to-hard sequence which provides an additional source of information to the learner in the completion of his task results in an increasingly optimal instructional design for concept acquisition. This higher level of classification behavior relieves the learner from memorizing irrelevant material. These results confirm the value of the memory support condition in obtaining higher correct task scores.

The fact that there exists a larger amount of contradictory data concerning the interaction between subject anxiety and task performance is possible because interaction depends partly on the task and not just the subject's anxiety level. A-State anxiety level is task specific. Trait anxiety has been measured with task interaction experiments and generally has been unsuccessful in supporting the Spence-Taylor disordinal interaction theory (Boutwell & Tennyson, 1972). Future anxiety-by-task interaction studies will probably also be contradictory unless controls are adopted to actually assure a predetermined level of the subject's anxiety for a particular task. What is suggested here is that tasks may be empirically designated easy and difficult, but unless the experimenter knows the anxiety-evoking characteristics of the task beforehand, there is little certainty of the hypothesized outcome. On the other hand, the instructional value of the optimal task sequence with memory support provided to relieve the learner of unnecessary cognitive processing, is not contradictory and deserves greater implementation in development design.

Conclusion

The experimental research reported here is not a comparison of Indian to non-Indian students. Rather it reflects a set of conditions here defined as sequence of item difficulty and memory support which are in constant use in classrooms everywhere.

The generalizations reported here do not proport to speak for classrooms everywhere, either, only to Indian students in institutions of higher learning. The memory support condition can be restated in the instructional conditions as: allowing the student to review the previously studied instructional material as often as he likes, as he takes a concept identification examination using previously unencountered concept instances. The conclusions reached are that the sequence of item difficulty within a concept task should be easy to hard, or simple to complex, in order that the student may assimilate all the generalizations of the concept and finally to allow him to discriminate between concepts. This simple to complex procedure has been the accepted rule using task analyses of instructional materials. The research here suggests that the rule should also apply to item difficulty when teaching and testing for concept acquisition.

The second conclusion reached concerns the instructional strategy of the student when learning the new concept. Allowing the student to return to the previously learned instances in the instruction during a concept acquisition test, which has new unencountered instances, negates the unnecessary and wasteful task of memorizing nonrelevant instructional materials. In other words, during the test the student quickly discovers which attributes are relevant to concept identification, which in turn allows him to investigate and study in the instruction. Therefore, the procedure becomes one of constantly returning to the instruction in order to extract enough information which allows the student to make a correct choice concerning the concept membership of an instance.

The final conclusion suggested here, as well as any implication for classroom use rests on the conditions of the two experimental treatments which define suggestions for optimal instruction. The instructional conditions of easy-to-hard item sequence plus memory support was found to be significantly superior to any other measured treatment. As a cautionary note it should be emphasized that for any concept learning task, the test of student proficiency must include new unencountered concept examples and nonexamples. In this way concept acquisition is tested, not merely instance memorization behavior.

The research reported here suggests that the concept acquisition test begin with easy examples and nonexamples and proceed to more difficult test examples. In addition, the student the student should be allowed to return to previously learned, memorized concept examples and nonexamples. This procedure permits him, if need be, to learn the subtleties of the concept so that he might make a more rational and presumably correct concept membership decision.

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TABLE 1

Multivariate Means

Treatment Groups	Dependent Variable Measures				
	A-State (1)	Easy	A-State (2)	Hard	A-State (3)
Easy - Hard Memory	35.8	15.7	43.8	12.7	41.2
Easy - Hard Non-Memory	36.2	12.4	40.7	11.4	41.9
Hard - Easy Memory	36.3	11.5	40.6	8.2	42.3
Hard - Easy Non-Memory	36.8	10.3	43.6	7.3	44.3

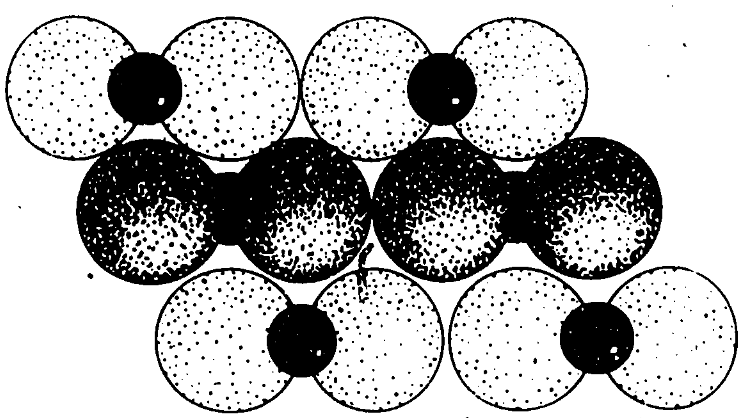

Figure 1. An example of an RX_2 crystal.