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ABSTRACT

Subjects for an investigation of the effects of training with a computer and past computer experience on the computerized aptitude test performance of college students were 92 undergraduates at the University of North Carolina at Charlotte, who participated in a test study utilizing six Apple II+ microcomputers. The study was conducted to determine whether: (1) computerized test performance would be significantly enhanced and the concomitant anxiety level would be significantly lowered by increasing the amount of training with the computer prior to testing; and (2) increasing the amount of training with the computer would significantly reduce the difference between the mean anxiety level occurring with a computerized test and the mean anxiety level occurring with a paper-and-pencil test. Test performance was measured by the number-correct score on an arithmetic reasoning test. Results indicate that neither training immediately before testing nor past computer experience appear to significantly affect computerized test performance or the concomitant anxiety level. The mean paper-and-pencil test score was higher than the mean computerized score, however, and it is suggested that differences between pencil-and-paper and computerized test performance may be the result of human error and deficiencies of the computer software. A list of references completes the document. (JB)

The Ffects of Training on Computerized Aptitude Test Performance and Anxiety

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Punning head: Training and Test Performance

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(1) The effects of training on computerized aptitude test performance and anxiety

(2) Topical Session

a. General--Organizational-Industrial

b. Additional--Other: Measurement

c. Cognitive Process--Other: Measurement

(3) Purpose

Despite the advantages of computerized testing (see Burke & Normand, 1984; Space, 1981), the completion of a computerized test may be more difficult for some and easier for others. The effects, if any, of computerized testing procedures on examinees' performance are not clear. The relatively few studies which have been conducted have provided mixed results. completion of different arithmetic reasoning tests by computer has been found to enhance (Johnson & Mihal, 1973), hinder (Lee, Moreno, & Sympson, 1984), and not affect performance (Wildgrube, 1982). Lee et al. (1984) suggested more research to identify factors which may affect performance on computerized tests. The literature (see Hansen & O'Neil, 1970; Hedl, O'Neil, & Hansen, 1973; Johnson & White, 1980; Johnson & Johnson, 1981) suggests that interacting with a computer may evoke a significant amount of anxiety to affect performance. Johnson and White (1980) found that a minimal amount of training with a computer aided the performance of elderly subjects on a computerized test. Their

results suggest that with training it is possible to reduce the negative effects of testing with a computer. Their results also suggest that those who have more experience with computers are at an advantage when taking a computerized test.

This study sought to investigate the effects of training with a computer and past computer experience on the computerized aptitude test performance of college students. This study was conducted to determine (a) if computerized test performance would be significantly enhanced and the concomitant anxiety level would be significantly lowered by increasing the amount of training with the computer prior to testing and (b) if increasing the amount of training with the computer would significantly reduce the difference between the mean anxiety level occurring with a computerized test and the mean anxiety level occurring with a paper-and-pencil test. Test performance was measured by the number-correct score on an arithmetic reasoning test.

Methods

(4) Subjects

Subjects were 92 undergraduates at the University of North Carolina at Charlotte and were given course credit for participation. There were 44 subjects (25 females and 19 males) in the Training Condition (Tr) and 48 subjects (29 females and 19 males) in the No Training Condition (NTr). Five of the subjects

were black and 87 were white. The mean age was 21.59 years.

Tests

Arithmetic Reasoning Test. Two forms (ARPP and ARCOMP) of an arithmetic reasoning test were developed. Items were selected from a pool of word problems. The items on the two forms were matched judgmentally in terms of apparent difficulty and mathematical principles required. Each form contained 30 multiple-choice items. The difficulty level of the tests was equivalent to that of high school math. The test required knowledge of basic algebra and geometry. One form of the test was completed by paper-and-pencil (ARPP). The other form of the test was completed by computer (ARCOMP). The number-correct score on the ARCOMP served as the dependent variable.

Personal Preference Questionnaire. A 20-item Personal Preference Questionnaire (PPQ) was developed. The PPQ consisted of nonreactive multiple-choice questions similar to those used by Johnson and White (1980). The PPQ served as a practice tool for the subjects assigned to the Training Condition.

Computer Experience Questionnaire. A 5-item Computer Experience Questionnaire (CEQ) was developed. For each item, subjects indicated the amount of experience they had with a computer in performing specified tasks. An example of an item is, "In the past year, how many letters or reports have you written using a word processor?" Options ranged from zero to more than three. Scores on the CEQ were used as a measure of past

computer training and experience.

State-Trait Anxiety Inventory. The State scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) measured anxiety level.

Apparatus

Six Apple II+ microcomputers were used to administer the ARCOMP. The microcomputers were housed in separate rooms, each approximately 12 feet X 12 feet. The test questions were displayed singly on a cathode-ray tube (CRT), and the subjects typed the answers on a keyboard. Keys used to enter answers were specially labelled with bold, black letters on a white background.

(5) Procedure

Subjects were randomly assigned to the Tr and the NTr Conditions. All subjects completed two testing sessions. Each subject worked individually on each test. Time limits were not imposed and omitting of items was not allowed with any of the tests.

Testing Session I. Subjects were tested in groups of two to seven. At the beginning of the session, subjects were told that the purpose of the study was to evaluate the arithmetic reasoning test and not the subjects as individuals. The test administrator remained in the room until all subjects had completed the tests. Each subject completed the ARPP then the STAI (STAI1), using paper-and-pencil for both. The ARPP was typed on standard typing

paper with 10 questions per page. The ARPP consisted of instructions for completing the ARPP, three sample questions, and the 30-item test. Answers for the ARPP were recorded on standard answer sheets to be read by an optical scanning machine. The ARPP served as an independent measure of a given subject's arithmetic reasoning ability and was a covariate in the data analysis. Standard forms for the STAI were used.

Testing Session II. At least one week after Session I, each subject completed the following tests in the specified sequence: the STAI (STAI2), the PPQ, the ARCOMP, the STAI again (STAI3), and the CEQ. The test administrator did not remain in the room while the subject completed the ARCOMP. She was present only to give instructions and to begin the computer program. All subjects were told that the test administrator would be available if additional assistance was needed.

Subjects in the NTr Condition completed all materials except the ARCOMP by paper-and-pencil. In administering the ARCOMP, the computer delivered (1) instructions on how to use the computer to indicate one's answers, (2) the test instructions for the ARCOMP, (3) three sample questions, and (4) the 30-item ARCOMP.

Subjects in the Tr Condition completed the PPQ and the ARCOMP by computer; they completed the STAI2, the STAI3, and the CEQ by paper-and-pencil. The Tr subjects practiced with the computer prior to completing the ARCOMP. The practice consisted of (1) completing the PPQ by computer and (2) feedback regarding one's

PPQ and sample question answers. Tr subjects were shown a paper computer printout of their answers to the PPQ and the three sample questions before they began the ARCOMP. The Tr subjects were also given additional verbal assurance by the test administrator that the computer would provide assistance and directions as needed.

(6) Results

No significant differences between the Tr and the NTr subjects' ARCOMP scores were found. Nor was ARCOMP performance found to be significantly related to past computer experience (as measured by the CEQ). There was no significant difference between the anxiety levels of the Tr and the NTr subjects after the computerized test, as measured by STAI3. Mean anxiety level was significantly higher after the ARPP than after the ARCOMP, and the mean ARPP score was significantly higher than the mean ARCOMP score.

Regression analysis was used to perform an analysis of covariance, with ARCOMP the dependent variable, ARPP a covariate, Amount of Training (Tr and NTr) the independent variable, and CEQ a measure of past computer experience. A significant interaction between ability (as measured by the ARPP) and Amount of Training was not found. The analysis showed that neither Amount of Training nor past computer experience accounted for a significant amount of ARCOMP variance.

A separate analysis of covariance showed that anxiety level

after the computerized test was not significantly related to the Amount of Training or past computer experience. STAI3 was the dependent variable and STAI2 the covariate. The Amount of Training and computer experience were the independent variables.

Since the Tr subjects and the NTr subjects were not significantly different in terms of STAI3 scores, all subjects were combined and a t-test was computed between anxiety level after the ARPP and anxiety level after the ARCOMP. Anxiety level was significantly higher after the ARPP ($\bar{X}$ = 38.1209, SD = 10.492) than after the ARCOMP ($\bar{X}$ = 34.8132, SD = 9.321), $t(90) = 3.3671$, $p < .01$), two-tailed test. The mean ARPP score ($\bar{X}$ = 19.696, SD = 6.270) was significantly higher than the mean ARCOMP score ($\bar{X}$ = 17.870, SD = 6.163), $t(91) = 4.298$, $p < .01$, two-tailed test.

(7) Implications and Conclusions

Neither training immediately before testing nor past computer experience appears to have significantly affected computerized test performance or the concomitant anxiety level. It appears that with college students, familiarity with the comupter is not an important factor in achieving optimal performance with a computerized arithmetic reasoning tests. These findings suggest that students' past equal access to computers may not be an important issue when testing young adults with computers. Computerized testing did not appear to discriminate against those who had less computer experience. These findings are contrary to

those of Johnson and White's study with elderly subjects. Perhaps for the college students at least a minimum amount of past computer experience was sufficient to equalize examinees. The mean CEQ score was 4.728 (SD = 3.228). Only one subject had had no past computer experience.

Although this study was not designed to compare paper-and-pencil test performance with computerized test performance, it is interesting to note that the mean paper-and-pencil test score was significantly higher than the mean computerized test score. Moreover, not only was the mean ARPP score significantly higher than the mean ARCOMP score but the former was accompanied by a significantly higher anxiety level than the latter, indicating that the heightened anxiety level did not have a significant adverse effect on test performance. The ARPP and ARCOMP were developed to be as similar as possible in terms of content and difficulty. The matching of the items was done judgmentally, but it is felt that close equivalence was achieved. The significant difference between the mean ARPP score and the mean ARCOMP score is consistent with other studies (Lee et al., 1984; Sachar & Fletcher, 1977). The current study focused on the effects of the amount of training and anxiety level on computerized test scores. Given the results of this study, it is felt that the differences found by some studies between paper-and-pencil test performance and computerized test performance may largely be due to human error

and deficiencies of the computer software. Some subjects in the current study remarked that some of the responses entered were done so by mistake. Responses to the computerized test could not be changed and subjects could not review past items. It is suggested that only software that allows the conveniences of paper-and-pencil tests, e. g., the ability to change answers and the ability to review past items, be used in future applications.

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