COMPUTERIZED VERSUS STANDARD PERSONALITY

MEASURES: EQUIVALENCY, COMPUTER
ANXIETY, AND GENDER DIFFERENCES

by

JEFFERY SCOTT LANKFORD, B.S., M.S.

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ABSTRACT

Since the development of the microcomputer in the mid-1970's, the use of computerized personality testing (CPT) has rapidly increased. While there are clear advantages to administering personality tests on computers, some individuals have negative reactions to computer use that may carry over into measures of affect, such as depression or purpose in life.

The inherent differences between computerized and standard administrations may lie in the individual's reaction to working with a computer. Researchers have found that computer interaction does not bring out positive emotions for some individuals. A true fear or anxiety toward computers exists for many of these persons. These are the persons whose CPT scores may be affected.

Additionally, there has been a lack of research investigating the effects of gender and computer anxiety on CPT scores. Previous research has generally focused on establishing validity criteria for computerized testing. The present study examined the association between computer anxiety and personality test scores across computerized versus standard administrations. Gender differences across administration formats were also assessed. Measures of math, state, and trait anxiety were obtained on all subjects to differentiate these measures from computer anxiety.

The results of this study indicated that depression and purpose in life test scores varied as a function of computer anxiety with computerized administration. Subjects with high computer anxiety scores had significantly higher depression scores and lower purpose in life scores with computerized administration, but these affect measures showed no relation to computer anxiety with standard paper-and-pencil administration. These results held up when the variance associated with the measures of math, state, and trait anxiety was removed. The results suggest that computerized and standard administrations may yield non-equivalent personality test scores depending upon the examinee's computer anxiety level.

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CHAPTER I

INTRODUCTION

Since the development of the microcomputer in the mid-1970's, the use of computerized versions of personality tests has rapidly increased. While there are clear advantages to administering personality tests on a computer, some individuals have negative reactions to computer use that may affect responses on computer-administered tests. Many tests have been transferred to computer without regard to possible differences caused by mode of presentation. Hofer and Green (1985) have cautioned that the integrity of computerized testing is being threatened by hasty application without competent validation and evaluation of this new technology. Test suppliers offer the same norms and cutting scores from conventional tests to interpret computer-administered tests without determining the equivalence of the two modes.

The inherent differences between computerized and standard administrations may lie in the individual's reaction to working with a computer. Some people report that interacting with a computer is an anxiety-provoking experience that brings out negative emotional responses (Raub, 1982). Cambre and Cook (1985) have further defined "computer anxiety" as a fear of computers as evidenced by

physiological changes or self-report measures. The effects of computer anxiety are far-reaching, affecting persons who in one manner or another must interact with a computer, including those who are administered personality tests.

It was the purpose of this study to determine the association between computer anxiety and measures of positive and negative affect when using computerized versus standard administration. Gender differences in computer anxiety scores and personality test scores across the two modes of administration were assessed. To further clarify the association between computer anxiety and computerized personality test (CPT) scores, measures of state, trait, and mathematics anxiety were obtained on all subjects. Psychometric properties and differences between the computerized and standard personality tests were an additional focus of this study. See Appendix A, the Expanded Review of Literature, for a more complete discussion of (1) a history and report on the use of computers in society, (2) the literature on computer anxiety, and (3) a review of studies that have addressed the use of computerized personality tests.

Conceptual Framework

When assessing affect through self-reports on computer terminals, a negative reaction to the computer itself could affect the way individuals respond on these

inventories. A possible explanation for response differences for some individuals is that an anxiety state may be introduced when an individual is asked to use a computer terminal. The term that is often used to describe this state is computer anxiety. Raub (1982) defined computer anxiety as the complex emotional reactions that are evoked in individuals who interpret computers as personally threatening. Raub also found that a substantial portion of computer users perceive the interaction with a computer as threatening, complex, and task demanding. The interaction with a computer can also threaten an individual's sense of self-worth and uniqueness, and diminish self-esteem (Cancro and Slotnick, 1970). When persons react anxiously toward computer use, any resultant negative self-evaluative cognitions could carry over into measures of affect, such as depression or purpose in life.

Exactly how and why computer anxiety may affect personality measures when using CPT have not been definitively answered, but the present study sought to explore the relationship between CPT scores, computer anxiety, and other anxiety measures. Although knowledge of the relationship between these variables does not show causality, clues have been provided about underlying mechanisms that could influence CPT scores.

Computer Use

Computer usage is becoming a part of the daily routine for many individuals. Computers are now used in libraries, banks, offices, and retail stores. The saving of time and space and the speed of retrieval of stored information have made computers indispensable in industrial and educational settings. The recent growth in the availability of computers in the work environment has made familiarity with computers and the ability to use them effectively a requirement for success in most fields (Marcoulides 1988). Loyd and Gressard (1984) indicated that designers of school curricula are no longer arguing whether computers should be used in the classroom, but rather when they should be introduced.

The increase in the use of computers can generally be traced to a change in the United States' economy from production to service. The new occupations being created by this change are placing increased demands for computer literacy. The typist of yesterday is the word processor of today. Draftsmen have now become auto-CAD (computer-assisted drafting) technicians. Contemporary telephone operators need a working knowledge of computers to perform their jobs, as older switchboards are giving way to computerized control boards.

When computers are introduced into work settings, employees often react with opposition to the new

technology. Mahmood and Medewitz (1989) report that employees resist the implementation of computers for two reasons: (a) they fear being replaced by the computers; and (b) they experience anxiety when confronted with the need to learn to use such "sophisticated and technical" equipment. A demonstration of industry trends and the need for workers and students to acquire computer literacy does not assure a reduction in anxiety about learning how to use a computer. Banks and Havice (1989) find that many avoid computer use, because they view it as akin to math or a testing situation--something to be put off or avoided at all costs.

Computer Anxiety

Computer anxiety affects a substantial number of workers and students. Paul (1982) estimated that at least 30% of the community dealing daily with computers experience some form of anxiety about computers (Paul 1982; Morrow, Prell, and McElroy, 1986). Weeter and Halcomb (1986) found that 24% of the 157 students in their sample reported Computer Anxiety Scale (COMPAS) scores that indicated they experienced anxiety toward computer use. Educational and employment status does not guard one from the effects of computer anxiety. Based on a survey of 43 graduate students and 109 undergraduate students, Cohen and Waugh (1989) found that the graduates reported computer

anxiety to the same degree as the undergraduates. Howard (1984) surveyed 136 business managers and found that nearly one-third of the managers reported experiencing computer anxiety. Computer anxiety impacts all areas of society, with females reporting more computer anxiety than males (Dambrot, Malek, Silling, Marshall, and Garver, 1985; Siann, Macleod, Glissov, and Durndell, 1990; Parasuraman and Iqbaria, 1990; see Appendix A, the Expanded Review of Literature for a discussion of these studies).

Cambre and Cook (1985) report that computer anxiety involves an array of emotional reactions including fear, apprehension, hope, and personal threat. The causes for the emotional reactions that make up computer anxiety are probably many. Banks and Havice (1989) list some of the fears about computers that users may have: breaking the machine, looking stupid, encountering indecipherable error messages, working with a "powerful other," inadequate documentation, losing control, disappointment, and a sense of futility. A true fear or anxiety toward computers (cyberphobia) exists for many individuals. Barrow and Karris (1985) report that sufferers of computer anxiety show many of the same characteristics as those who suffer math anxiety; however, in a survey of female ($n=314$) and male ($n=311$) undergraduates, Weeter (1986) found a weak correlation between trait anxiety and computer anxiety scores ($r=.148$). It appears that computer anxiety may

CHAPTER II

METHOD

Subjects

Undergraduate student volunteers (N=131) from introductory psychology classes at Texas Tech University were studied. They were assigned in a restricted random fashion to either computerized or paper-and-pencil administration. Students were not informed of the room they would be assigned to prior to the experiment to prevent computer-anxious students from avoiding participation in the sessions conducted in the computer lab. Students received extra course credit for their participation in the study.

Materials

Computer Anxiety Rating Scale (CARS)

The Computer Anxiety Rating Scale (CARS) is composed of 20 Likert-scale scored items (see Appendix D). It was developed by Heinssen, Glass, and Knight (1987) to assess the relative level of computer anxiety in individuals. Each student was administered this scale in its standard paper-and-pencil format prior to being assigned to one of the administration conditions. Based on the CARS scores of 270 undergraduate students, Heinssen, Glass, and Knight (1987) reported an internal consistency of $\underline{r}=.87$, with a test-retest reliability of $\underline{r}=.70$ (4-week interval), and reported

be differentiated from generalized trait anxiety, but shows some relation to math anxiety.

Computerized Personality Testing

There has been a rapid growth in the use of computerized personality testing (CPT) in recent years due to the low cost and wide availability of microcomputers and their associated software. The conventional personality inventory requires the examinee to make a written response to a typed stimulus presented on paper. When these tests are converted to software versions, the response becomes a key press to an item presented on a video screen. CPT has become popular with psychologists because it is a quick and convenient method to administer tests. Test suppliers have capitalized on the popularity of CPT by marketing more software versions of traditional personality tests.

Questions have been raised as to whether CPT is equivalent to standard administrations. Honaker (1988) has stated that CPT may change response requirements that may result in two different tests, rather than equivalent forms of the same test. Honaker has suggested that computer-linked factors such as computer anxiety may affect test performance in such a manner that a computerized and conventional version of a test are measuring different constructs. Hofer (1985) has cautioned that test validity, norms, and cutting-score data gathered from paper-and-

pencil administrations may not be valid for computer-administered tests.

When computerized and standard forms produce equal mean scores, identical distribution and ranking of scores, and correlate to the same degree with scores on any other variable, then norms developed for standard forms may be appropriately generalized to computerized forms (Honaker, 1988). However, when differences between forms are found, Hofer (1985) discussed the three ways to deal with score differences across the two modes of administration. When differences involve simple mean differences, then adding a constant to scores could be solution to equating forms. If distributions differ, then an equipercentile conversion of scores across forms may be possible. When the two forms yield scores that are ranked differently, or correlate divergently with relevant external variables, then it is likely that the same construct is not being measured across the two forms, and generalization of data from one form to the other would not be appropriate (Hofer and Green, 1985).

The majority of the studies that have examined the equivalency of computerized and conventional forms have focused on the Minnesota Multiphasic Personality Inventory (MMPI; Honaker 1988). Results of equivalency studies are mixed, with some finding significantly higher and/or lower scores on the scales, and others finding no significant differences at all. However, in a review of these MMPI

studies, Honaker (1988) concluded that it is premature to assume that the two formats yield equivalent scores. Methodological problems cited were software variations across studies and short test intervals in repeated measures designs. Honaker also found that some studies did not report analyses that would have addressed possible differences between the two administration formats. Lushene, O'Neil, and Dunn (1974) reported that negative affect was significantly associated with computer administration, and obtained significant differences between computerized and conventional forms of the MMPI with their subjects. In reviewing this study, Honaker (1988) concluded that individuals who respond to computer administration negatively are more likely to show non-equivalent results across computer and conventional formats.

In a study that addressed the equivalency of the Beck Depression Inventory (BDI) across computerized and conventional modes of presentation, George, Lankford, and Wilson (1990) found that the correlation between BDI scores and Computer Anxiety Rating Scale (CARS) scores was significantly greater for the computer administration condition than the paper-and-pencil administration condition ($r = .52$ vs $r = .13$; $p < .04$; $n = 97$; see Appendix F, Pilot Study for a short report of this study). When trait and state anxiety were partialled-out in a regression

analysis, the partial correlation between BDI and CARS scores again was significantly greater for the computer administration condition than the paper-and-pencil administration condition ($r=.462$ vs. $r=.016$; $p<.01$). These analyses indicated that high computer anxiety levels were associated with elevated negative affect scores, which allows one to infer that differences between the modes of presentation may be attributed to negative reactions to computer administration.

Determining the equivalency between computerized and conventional versions of psychological tests is not the only concern with CPT. Hofer (1985) reviewed some of the legal and ethical issues surrounding the use of CPT. The legal issues cited were: litigation involving unqualified users, the validity of CPT reports used as legal evidence, and claims of cultural bias. Hofer stated that the increasing use of CPT will likely lead to civil litigation involving claims of defamation, negligence, discrimination, and lack of due process. Ethical issues noted were the lack of standards for the use of CPT, lack of equivalency, and the impact of CPT on computer-anxious examinees.

Despite the concerns and criticisms of CPT, the use of software versions of psychometric tests is likely to increase rather than decrease. The present concerns with CPT focus on equivalency issues. Honaker (1988) stated there is a need for research on individual differences that

might affect the equivalency of computerized and conventional forms. CPT is rapidly leaving the infancy stage and will soon be more open to public scrutiny. Research is needed to ensure that CPT measures are as valid and reliable as the paper-and-pencil formats upon which they are based.

Statement of Problem

There is a lack of research addressing the effects of computer anxiety on CPT measures. This study will examine the psychometric properties of computerized versus standard measures of positive and negative affect. The measures of affect will be the Beck Depression Inventory (BDI; Beck, 1967), and the Purpose in Life Test (PIL; Crumbaugh and Maholick, 1964). The correlation between the BDI and PIL has been reported by Tuorila (1986) to be $r = -.76$ ($n=124$). The high negative correlation between the two scales allows for two measures to be obtained that share a good deal of common variance, without the confounds of carry-over effects associated with repeated measures.

The BDI and PIL are Likert-type scales that are readily adaptable to computerized administration. The correlations between the scores on these scales and computer, math, state, and trait anxiety will be compared across gender and type of administration. The internal

consistency reliability of the BDI and PIL will be assessed across the two formats to determine the stability of CPT scores in comparison to corresponding paper-and-pencil test scores.

CHAPTER II

METHOD

Subjects

Undergraduate student volunteers (N=131) from introductory psychology classes at Texas Tech University were studied. They were assigned in a restricted random fashion to either computerized or paper-and-pencil administration. Students were not informed of the room they would be assigned to prior to the experiment to prevent computer-anxious students from avoiding participation in the sessions conducted in the computer lab. Students received extra course credit for their participation in the study.

Materials

Computer Anxiety Rating Scale (CARS)

The Computer Anxiety Rating Scale (CARS) is composed of 20 Likert-scale scored items (see Appendix D). It was developed by Heinssen, Glass, and Knight (1987) to assess the relative level of computer anxiety in individuals. Each student was administered this scale in its standard paper-and-pencil format prior to being assigned to one of the administration conditions. Based on the CARS scores of 270 undergraduate students, Heinssen, Glass, and Knight (1987) reported an internal consistency of $\alpha=.87$, with a test-retest reliability of $\alpha=.70$ (4-week interval), and reported

the following correlations between CARS scores and other variables in a survey of undergraduate students ($n=270$): Computer Attitude Scale ($r=-.74$), Math Anxiety Rating Scale ($r=.26$), Spielberger Trait Anxiety Scale ($r=.20$), and Scholastic Aptitude Test-quantitative ($r=-.32$).

State-Trait Anxiety Inventory (STAI)

The State-Trait Anxiety Inventory (STAI) was developed by Spielberger, Gorsuch, and Lushene (1970). The scale is comprised of two sets of 20 self-report Likert-scaled items. The STAI was used in this study to partial out general anxiety in the correlational analyses. Based on the STAI scores of over 3000 undergraduate students, Spielberger et al. (1970) reported an internal consistency of $r=.89$, with test retest reliabilities of: $r=.82$ (20-day interval), and $r=.75$ (104-day interval).

Phobos Mathematics Anxiety Inventory

The Phobos (Ferguson, 1986) is composed of 30 Likert-scale scored items. It is a self-report measure of mathematics anxiety. The Phobos is based on the 96-item Mathematics Anxiety Rating Scale (MARS). The Phobos was formed using 10 of the MARS items identified as loading heavily on Math Test Anxiety, 10 MARS items identified as loading heavily on Numerical Anxiety, and 10 items referring to math topics that may be labeled as more abstract than

those included in the MARS. Based on a survey of undergraduate and graduate students, Martin (1991) reported the split-half reliability of the Phobos to be $r=.85$, with a Cronbach's alpha coefficient of $r=.93$.

Beck Depression Inventory (BDI)

The Beck Depression Inventory (BDI; Beck, 1967) is a 21-item, self-report measure that efficiently assesses the degree of depression in individuals. It may also provide information regarding an individual's negative cognitions (Beck, 1967). The internal consistency of the BDI has been reported, from various samples, to range from $r=.73-.92$ (Beck, Steer, and Garbin, 1988).

Purpose in Life Test (PIL)

The Purpose in Life Test (PIL) is composed of 20 Likert scale scored items. It is a self-report, positive affect scale. Crumbaugh and Maholick (1964) developed the PIL to test Frankl's basic concept of Existential Vacuum, or the lack of meaning and purpose in an individual's life. Reliability coefficients for the PIL reported by Reker and Cousins (1979) are as follows: corrected split-half reliability, $r=.77-.87$; test-retest reliability $r=.83$ (one-week interval), $r=.79$ (6-week interval).

Procedure

Male ($n=66$) and female ($n=65$) subjects were assigned in a restricted random fashion to one of two experimental conditions: 1) computer administration or 2) paper-and-pencil administration. Students had no prior knowledge of the condition to which they would be assigned. This was to prevent computer-anxious subjects from avoiding the sessions conducted in the computer lab. Conditions were made as comparable as possible across groups. At the beginning of each experimental session, students completed a consent form and written versions of the computer, mathematics, state, and trait anxiety scales. All students were then moved to another room and received either a computerized or standard version of the BDI and PIL.

Students in the computer-administration condition were administered the tests on terminals linked to a Digital Equipment Micro VAX II computer located in the psychology department laboratory. Test content and directions for the computer-administered inventories were identical to their corresponding paper-and-pencil versions. For a more complete description of the procedures and the actual instructions to the students, see Appendix B. At the close of each session the students were debriefed then dismissed.

Design

A factorial design was used to analyze the data. Two separate ANOVAs were used to analyze the BDI and PIL scores. These were three-way ANOVAs with two discrete factors (gender and type of administration) and one continuous factor (computer anxiety scores). The first step in accomplishing this analysis was to ensure that the distributions of computer anxiety scores across the four gender by type of administration cells were comparable in terms of means and variances. An ANOVA using computer anxiety as the dependent measure was used to check for mean differences, and Chi-square analyses were used to check for differences in variances among the four cells. A relatively high alpha value of $p=.25$ was used as the minimum level of significance in these analyses to be certain the distributions did not significantly differ. To lessen differences across groups, extreme outlying scores in the distributions were removed. No experimenter bias was involved in these score deletions since at this step of the analysis the dependent measures had not been analyzed. Once the distributions of computer anxiety scores among the four cells were shown to be equivalent, then the analysis proceeded.

The next step in the analysis was to calculate a squared multiple correlation between the factors and their possible interactions. Coded linear vectors were used corresponding

to groups. Values for each source were then systematically excluded from the multiple correlation, the correlation between the remaining sources were then squared and subtracted from the correlation between all sources initially calculated. The remaining variance obtained for each source value was then multiplied by the sum of squares total. Orthogonal coding of gender and type of administration resulted in sum of squares that were additive with no overlap. The error term was calculated by subtracting the multiple correlation from one (1.0) and then multiplying this value by the sum of squares total. At this point, the main effects and interactions were analyzed in the three-way ANOVA generated from the multiple correlations (see Table 2.1).

Additional Analyses

The four anxiety measures (computer, math, state, and trait) were entered into a Pearson's correlation matrix with the BDI and then the PIL. The matrices had four cells divided by gender and type of administration. Differences in the correlations between the anxiety and dependent measures were assessed across the four cells and across type of administration. A series of partial correlations followed, removing each of the four anxiety measures to assess their contribution to the prediction of the criterion across type of administration.

Table 2.1
ANOVA Source Sum of Squares Derivations from
Multiple Correlations

Source	Sum of Squares	df
Administration Type(A)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.B,C,AB,AC,BC,ABC})$	1
Gender(B)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,C,AB,AC,BC,ABC})$	1
Computer Anxiety(C)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,B,AB,AC,BC,ABC})$	1
Admin Type*Gender(A*B)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,B,C,AC,BC,ABC})$	1
Admin Type*CompAnx(A*C)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,B,C,AB,BC,ABC})$	1
Gender*CompAnx(B*C)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,B,C,AB,AC,ABC})$	1
Admin*Gen*CompAnx(A*B*C)	$SST(R^2_{y.A,B,C,AB,AC,BC,ABC} - R^2_{y.A,B,C,AB,AC,BC})$	1
Error	$SST(1 - R^2_{y.A,B,C,AB,AC,BC,ABC})$	123
Total	SST	130

Note:

SST = Sum of Squares Total = SS_y

N = 131

The reliability of the dependent measures in both computerized and standard formats was then calculated. Cronbach's alpha coefficients were used to accomplish the reliability analyses.

Expected Outcomes

The following outcomes were predicted to be significant at the $p < .05$ level or better. An expected main effect was a difference in scores for computer versus paper-and-pencil administration conditions. The computer administration condition was expected to yield significantly higher BDI scores and significantly lower PIL scores than the paper-and-pencil administration condition.

An interaction between type of administration and computer anxiety was expected. Subjects receiving computer administration with higher computer anxiety levels were expected to report significantly higher BDI scores and significantly lower PIL scores than paper-and-pencil, high computer anxious subjects.

A gender by type of administration interaction was expected. Females receiving computer administration were expected to report significantly higher BDI scores and significantly lower PIL scores than males receiving paper-and-pencil administration.

An interaction between gender and computer anxiety was expected, with high computer anxious females reporting

higher BDI scores and lower PIL scores than low computer anxious males.

The three-way interaction between gender, type of administration, and computer anxiety was expected to be significant, with high computer anxious females receiving computer administration reporting higher BDI scores and lower PIL scores than low computer anxious males receiving paper-and-pencil administration.

In terms of correlational analyses, the Pearson's correlations between computer anxiety and each of the dependent measures was expected to be significantly greater for computer administration than paper-and-pencil administration.

CHAPTER III

RESULTS

Results are presented in three sections. The first section presents the results of preliminary analyses conducted to ensure the means and distributions of computer anxiety scores were comparable across groups, and also includes a report of the reliabilities of the dependent measures. The second section presents results of the hypotheses based on the factorials used to analyze the dependent measures. The third section presents correlational analyses. (See Appendix C, Additional Analyses for a detailed compilation of the Pearson's correlational matrices.)

Preliminary Analysis

Computer Anxiety Rating Scale Scores

The design chosen to analyze the data in this study was a factorial design using multiple correlations to derive the sum of squares for each source (see Table 2.1). This allowed a continuous variable (computer anxiety scores) to be combined with two discrete variables (type of administration and gender) in the factorial design. To meet assumptions required for the factorial, the means and variances of computer anxiety scores had be comparable across the four gender by type of administration cells.

Prior to examining the dependent measures, six subjects with extremely high or low computer anxiety scores were deleted from various groups to equalize the means and distributions. The computer anxiety scores were then entered into an ANOVA to check for mean differences. Significant mean differences were not found across the type of administration by gender cells ($F(1,127)=.15, p<.702$). A Likelihood Ratio Chi-Square analysis was then conducted to assure the variances of computer anxiety scores across the four cells were equal. No significant differences in variances were found ($\chi^2(1)=1.324, p<.250$). The means, standard deviations, and variances for the four gender by administration cells are presented in Table 3.1. The mean computer anxiety score for the entire sample was 42.80 with a standard deviation of 9.82. The range of computer anxiety scores was from 20 to 71. The possible range that could be obtained was 20 to 100. Any score of 50 or higher would indicate some degree of computer anxiety. Approximately 22% of the subjects that participated could be described as computer anxious. The computer anxiety scores obtained in this study are consistent with scores reported in the literature for undergraduate subjects.

Internal Consistency

A Cronbach's alpha coefficient was calculated on the dependent measures used in this study. These scales were

Table 3.1
Means, Standard Deviations, and Variances
for Computer Anxiety Rating Scale (CARS) Scores

Administration Type	Gender	N	Mean	Standard Deviation	Variance
Computer	Male	33	42.576	10.494	110.125
Computer	Female	32	44.500	9.040	81.722
Paper-&-Pencil	Male	33	40.516	9.060	82.084
Paper-&-Pencil	Female	33	43.667	10.561	111.534

Note:

Difference among means ($F(1,127)=.15$, $p<.70$)

Difference among variances ($\chi^2(1)=1.32$, $p<.25$)

the Beck Depression Inventory (BDI) and the Purpose in Life Test (PIL). Coefficients were calculated across type of administration to compare reliabilities of these scales as they were presented in computerized and paper-and-pencil formats.

The internal consistency reliability estimates for the BDI were as follows: paper-and-pencil administration $\underline{r}=.81$ ($\underline{n}=66$); computer administration $\underline{r}=.71$ ($\underline{n}=65$). The PIL internal consistency reliability estimates were as follows: paper-and-pencil administration $\underline{r}=.94$ ($\underline{n}=66$); computer administration $\underline{r}=.86$ ($\underline{n}=65$). It appears that computer administration resulted in a modest but non-significant deflation in the Cronbach's alpha coefficients in comparison to paper-and-pencil administration.

Analyses Related To Hypotheses

The following results will be presented in two sections: one for the data analyzed in the BDI ANOVA and one for the data analyzed in the PIL ANOVA. A short comparison of the results across the two dependent measures will then follow. Both ANOVAs used to analyze the dependent measures had the same characteristics. Each was a three way ANOVA with two dichotomized variables; administration type (computerized, and paper-and-pencil), and gender (male and female); and one continuous variable (Computer Anxiety Rating Scale; CARS) scores. When reviewing results, it should be kept in mind

Table 3.2
Beck Depression Inventory (BDI)
ANOVA Summary Table and Means

Source	df	Sum of Squares	Mean Square	F	p<
ADM	1	11.625	11.625	0.80	.37
GEN	1	3.926	3.926	0.27	.60
CA	1	112.668	112.668	7.76	.01
ADM*GEN	1	169.672	169.672	11.68	.001
ADM*CA	1	74.905	74.905	5.16	.025
GEN*CA	1	4.853	4.853	0.33	.56
ADM*GEN*CA	1	9.121	9.121	0.63	.43
Error	123	1786.162	14.522		
Total	130	2172.932			

Note:

ADM = Type of Administration (Computer and Paper & Pencil)

GEN = Gender (Male and Female)

CA = Computer Anxiety Rating Scale (CARS) Scores

BDI Scale Means and Standard Deviations

Administration Type	Gender	Mean	Standard Dev
Computer	--	6.32	4.34
Paper & Pencil	--	5.72	3.83
--	Male	6.20	3.39
--	Female	5.85	4.71
Computer	Male	5.39	3.05
Computer	Female	7.28	5.24
Paper & Pencil	Male	7.00	3.57
Paper & Pencil	Female	4.45	3.70

**Figure 3.1: Beck Depression Inventory (BDI)
Regression Lines by Type of Administration**

receiving paper-and-pencil administration reported higher BDI scores than females receiving paper-and-pencil administration (Figure 3.2).

The fourth hypothesis predicted a significant interaction between gender and computer anxiety. This hypothesis was not supported ($F(1,123)=.33$, $p<.56$; see Table 3.2).

The last hypothesis predicted there would be a significant three-way interaction between type of administration, gender, and computer anxiety. This hypothesis was not supported ($F(1,123)=.63$, $p<.43$; see Table 3.2).

Purpose in Life Test (PIL)

The first hypothesis predicted that the PIL scores for the computer administration condition would be significantly lower than the paper-and-pencil administration condition. This hypothesis was supported ($F(1,123)=3.85$, $p<.05$; see Table 3.3). Computer administration did result in lower mean PIL scores. The mean PIL score for paper-and-pencil administration was 111.89 ($n=65$) versus the computer administration PIL mean of 107.70 ($n=66$).

The second hypothesis predicted a significant interaction between type of administration and computer anxiety. The results supported this hypothesis ($F(1,123)= 3.88$, $p<.05$; see Table 3.3). Directions of this interaction were such that the subjects receiving computer administration

Figure 3.2: Beck Depression Inventory (BDI) Means as a Function of Gender and Administration Type

Table 3.3
Purpose in Life Test (PIL)
ANOVA Summary Table and Means

Source	df	Sum of Squares	Mean Square	F	p<
ADM	1	573.899	573.889	3.85	.05
GEN	1	704.192	704.192	4.72	.03
CA	1	2542.980	1542.980	17.05	.0001
ADM*GEN	1	2997.232	2997.232	20.10	.0001
ADM*CA	1	579.253	579.253	3.88	.05
GEN*CA	1	181.159	181.159	1.21	.27
ADM*GEN*CA	1	65.226	65.226	0.44	.51
Error	123	18345.662	149.152		
Total	130	25989.603			

Note:

ADM = Type of Administration (Computer and Paper & Pencil)

GEN = Gender (Male and Female)

CA = Computer Anxiety Rating Scale (CARS) Scores

PIL Scale Means and Standard Deviations

Administration Type	Gender	Mean	Standard Dev
Computer	--	107.71	12.51
Paper & Pencil	--	111.89	15.39
--	Male	107.50	15.12
--	Female	112.17	12.75
Computer	Male	110.03	13.27
Computer	Female	105.31	11.40
Paper & Pencil	Male	104.97	16.60
Paper & Pencil	Female	118.81	10.31

with higher computer anxiety scores reported lower PIL scores, while the low computer anxious subjects receiving computer administration reported higher PIL scores. The PIL scores for subjects in the paper-and-pencil administration conditions showed a slight, but non-significant decrease with increasing computer anxiety (Figure 3.3).

The third hypothesis predicted a significant interaction between type of administration and gender. This hypothesis was supported ($F(1,123)=20.10$, $p<.0001$; see Table 3.3). The directions of this interaction were such that females receiving computer administration reported lower PIL scores than males receiving computer administration. While males receiving paper-and-pencil administration reported higher PIL scores than females receiving paper-and-pencil administration (Figure 3.4).

The fourth hypothesis predicted a significant interaction between gender and computer anxiety. This hypothesis was not supported ($F(1,123)=1.21$, $p<.27$); see Table 3.3).

The last hypothesis predicted there would be a significant three-way interaction between type of administration, gender, and computer anxiety. This hypothesis was not supported ($F(1,123)=.44$, $p<.51$ see Table 3.3).

**Figure 3.3: Purpose In Life Test (PIL)
Regression Lines by Type of Administration**

Figure 3.4: Purpose in Life Test (PIL) Means as a Function of Gender and Administration Type

Comparison of BDI and PIL Results

For the most part, the outcomes of the ANOVA generated hypotheses were the same for both the BDI and PIL. This is not surprising since the correlation between the BDI and PIL scores for this sample ($n=131$) was found to be $r=-.53$ ($p<.0001$). A notable exception was that the main effect gender was significant for the PIL ($F(1,123)=4.72$, $p<.03$; see Table 3.3), but non-significant for the BDI ($F(1,123)=.27$, $p<.60$; see Table 3.2).

Although the main effect computer anxiety was not predicted to be significant, it was found to be for both the BDI ($p<.01$), and the PIL ($p<.001$). This indicated that computer anxiety scores significantly differed across reported affect scores. It is suspected that the significant interaction with computer anxiety and type of administration may be an explanation for the main effect significance. However, the significance of the main effect computer anxiety does not confound the other results reported in this study.

Correlational Analyses

The following results will be presented in two sections. The first section will be an examination of Pearson's correlations (see Tables in Appendix C), as they were presented in matrices divided by gender and by type of

administration. The dependent measures BDI and PIL were placed in the matrices with the Computer Anxiety Rating Scale (CARS), as well as measures of math, state, and trait anxiety (see Chapter II, Methods for a complete description of the scales used in this study). These ancillary anxiety measures played a crucial role in the partial correlation analyses that follow the Pearson's correlation analyses.

Pearson's Correlations

Consistent with the ANOVA interaction between type of administration and computer anxiety, the correlation between the BDI and CARS significantly differed across computer and paper-and-pencil administration conditions $r=.42$ vs. $r=.002$ ($Zr=2.54$; $p<.001$; see Figure 3.1). No trend in the data is evident in the scatter-plot of BDI by CARS for paper-and-pencil administration (Figure 3.5), but a distinct positive trend can be noted in the scatter-plot for computer administration (Figure 3.6). The correlation between the PIL and CARS also significantly differed across administration conditions $r=-.55$ (computer) vs. $r=-.09$ (paper-and-pencil; see Figure 3.3). Again, in the paper-and-pencil administration condition, no trend in the data is evident in the scatter-plot of PIL by CARS scores (Figure 3.7), but a definite negative trend can be noted in the scatter-plot for computer administration (Figure 3.8). The correlations between measures for computer administration

Figure 3.5: Beck Depression Inventory (BDI) by Computer Anxiety Rating Scale (CARS) Scatterplot for Paper-and-Pencil Administration

Figure 3.7: Purpose in Life Test (PIL) by Computer Anxiety Rating Scale (CARS) Scatterplot for Paper-and-Pencil Administration

Figure 3.8: Purpose in Life Test (PIL) by Computer Anxiety Rating Scale (CARS) Scatterplot for Computer Administration

are presented in Table C.1, and for paper-and-pencil administration in Table C.2.

The correlations between CARS scores and the dependent measures significantly differed across the four gender by administration cells as well. The cells with the greatest contrast between BDI by CARS correlations were females receiving paper-and-pencil administration ($r = -.05$) versus males receiving computer administration ($r = .59$). The cells with the greatest contrast between PIL by CARS correlations were males receiving paper-and-pencil administration ($r = -.17$) versus computer administration ($r = -.68$). The correlations between all measures across the four Administration by Gender cells are presented in Tables C.3 through C.6. The correlations are presented in matrices in Appendix C.

Partial Correlation Analyses

Measures of math, state, and trait anxiety were obtained for the purpose of partial correlation analyses. Each of these anxiety measures was partialled out of the correlations between computer anxiety and the dependent measures across administration conditions. For clarity in presentation, the partial correlation analyses have been divided into two sections: the first for the BDI analysis and the second for the PIL analysis.

Beck Depression Inventory Analysis

The original Pearson's correlations between CARS and BDI scores across administration types were $r=.002$ (paper-and-pencil) versus $r=.42$ (computer). When math anxiety was partialled out, the resulting correlations were $r=0$ (paper-and-pencil) versus $r=.43$ (computer). When state anxiety was partialled out, the resulting correlations were $r=0$ (paper-and-pencil) versus $r=.45$ (computer). Partialling out trait anxiety yielded the following correlations, $r=0$ (paper-and-pencil) versus $r=.49$ (computer). When math, state, and trait anxiety were all partialled out together, the resulting correlations were $r=0$ versus $r=.49$. (See Table 3.4 for a listing of these partial correlations.) When math, state, and trait anxiety were partialled out, the differences in the CARS by BDI correlation across administrations increased slightly, which indicates the anxiety measures may have been acting as modest suppressor variables.

Purpose in Life Test Analysis

The original Pearson's correlations between CARS and PIL scores across administration types were $r=-.09$ (paper-and-pencil) versus $r=-.55$ (computer). When math anxiety was partialled out, the resulting correlations were $r=-.09$ (paper-and-pencil) versus $r=-.55$ (computer). When state anxiety was partialled out the resulting correlations

Table 3.4
 Beck Depression Inventory (BDI)
 Partial Correlation Analysis

Administration Type	Pearson's CA*BDI	[MA] Removed	[SA] Removed	[TA] Removed	[MA SA & TA] Removed
Paper-&-Pencil	.002	0	0	0	0
Computer	.42	.43	.45	.49	.49

Note:

CA = Computer Anxiety

MA = Math Anxiety

SA = State Anxiety

TA = Trait Anxiety

were $r = -.09$ (paper-and-pencil) versus $r = -.56$ (computer). Partialling out trait anxiety yielded the following correlations, $r = -.10$ (paper-and-pencil) versus $r = -.57$. When math, state, and trait anxiety were all partialled out together, the resulting correlations were $r = -.09$ versus $r = -.57$. A listing of these partial correlations can be found in Table 3.5. The slight increase in the difference between the PIL and CARS correlations across administration type, indicates that the partialled anxiety measures may have been acting as modest suppressor variables.

Post-Hoc Analyses

The significant interaction between gender and type of administration for both the BDI and PIL called for post-hoc analyses to compare differences between mean affect scores across administrations for males and females separately. One-tailed univariate t -tests were used to accomplish these analyses. The mean BDI scores for males were higher for paper-and-pencil versus computerized administration (7.01 vs. 5.39); however, this difference was non-significant ($t = 1.90$; $p < .06$; $n = 66$). Females, on the other hand, reported higher BDI mean scores for computer administration versus paper-and-pencil administration (7.28 vs. 4.45). The difference between these means was significant ($t = -2.52$; $p < .01$; $n = 65$)

Table 3.5
 Purpose in Life Test (PIL)
 Partial Correlation Analysis

Administration Type	Pearson's CA*PIL	[MA] Removed	[SA] Removed	[TA] Removed	[MA SA & TA] Removed
Paper-&-Pencil	-.09	-.09	-.09	-.10	-.09
Computer	-.55	-.55	-.56	-.57	-.57

Note:

CA = Computer Anxiety

MA = Math Anxiety

SA = State Anxiety

TA = Trait Anxiety

The post-hoc results for the PIL were comparable to the BDI results. The mean PIL scores for males were lower for paper-and-pencil versus computerized administration (104.97 vs. 110.03); however, this difference was non-significant ($t=-1.37$; $p<.18$; $n=66$). Females reported lower PIL scores for computer versus paper-and-pencil administration (118.82 vs. 105.31). The difference between these means was significant ($t=5.01$; $p<.0001$; $n=65$).

Summary of Results

A trend found among all of these results is a difference in dependent measures across computerized versus paper-and-pencil administration. In the preliminary analyses, the internal consistencies of the dependent measures were found to be modestly deflated in the computer administration condition; however, the differences were not significant. The main effect Type of Administration was significant for the PIL ($p<.05$), with computer administration subjects having higher PIL mean scores than paper-and-pencil administration subjects. The interaction between Type of Administration and Computer Anxiety was significant in both the PIL and BDI ANOVAs as was the Type of Administration by gender interaction.

Significantly higher correlations between the CARS and both of the dependent measures were found for computer administration versus paper-and-pencil administration.

These correlations across administrations became even more disparate when measures of math, state, and trait anxiety were partialled out. Differences in the correlation between the CARS and the dependent measures were also found among the four gender by type of administration cells. Gender effects were most apparent when Gender by Type of Administration Means were compared. Females receiving computer administration reported higher BDI scores and lower PIL scores than males receiving computer administration. Post-hoc analyses indicated that mean affect scores for females were significantly different across administrations; whereas, mean affect scores for males were not.

CHAPTER IV

DISCUSSION

Administration Types and Computer Anxiety

Hypothesis one predicted a significant main effect for type of administration. It was expected that computer administration would result in a significant elevation in BDI scores and a significant decrease in PIL scores. This hypothesis was supported ($p < .05$). The PIL scores for computer administration were significantly lower than the scores for paper-and-pencil administration. The BDI means were not significantly different across administration formats, but in a pilot study conducted by George, Lankford, and Wilson (1990), computer administration was found to result in significantly higher mean BDI scores ($p < .05$). The inconsistency in these results are similar to what has been reported in the computerized personality testing literature. Honaker (1988) in a review of computerized versus paper-and-pencil MMPI studies reported that half of the studies reported significant mean differences across formats. Although the present study did not yield significantly higher BDI scores with computer administration, there was a trend in this direction (see Tables 3.3 and 3.4). Mean differences are a direct source of non-equivalence across administration formats.

The second hypothesis predicted that the interaction between type of administration and computer anxiety would be significant. The results supported this hypothesis for both the BDI and PIL. Subjects with higher computer anxiety levels reported higher BDI scores and lower PIL scores. The traditional paper-and-pencil format data showed no association between reported affect and computer anxiety level (see Figures 3.1 and 3.3). This significant interaction is enlightening when one considers the non-significant main effect for type of administration for the BDI. Although no mean differences were found across administrations, BDI scores varied as a function of computer anxiety in the computer administration condition. If one were making a case for equivalence solely on the basis of comparing means across administration formats, then differences in BDI scores associated with computer anxiety would have been overlooked.

The Pearson's correlations demonstrated further support for the second hypothesis. The correlation between affect and computer anxiety was significantly greater for computer administration than paper-and-pencil administration. Similar findings were reported by George, Lankford, and Wilson (1990; see Appendix F). Despite the presence or absence of a type of administration main effect, the significant difference between correlations appears to hold. It can be concluded that significantly higher correlations

between computer anxiety and reported affect with computer administration appears to be a relatively robust and replicable phenomenon.

When measures of math, state, and trait anxiety were partialled out, the correlations between affect and computer anxiety scores became even more disparate across administrations (see Tables 3.4 and 3.5). The outcome of these partial correlations showed that although there were significant intercorrelations among the anxiety measures, the variance accounted for in the computer anxiety by affect correlations was not overlapping with generalized or math anxiety. This lends evidence for the validity of computer anxiety as it has been differentiated from math anxiety and generalized anxiety states.

Gender Issues

The third hypothesis predicted a significant interaction between type of administration and gender. This hypothesis was strongly supported by the data. With computer administration, females reported higher BDI scores and lower PIL than paper-and-pencil administration, while males reported slightly higher BDI scores and lower PIL scores with paper-and-pencil administration (see Figures 2 and 4). The results lead to the conclusion that males and females react differently to the two administration formats. The difference between the paper-and-pencil versus computer

administration BDI means were significantly different for females ($p < .01$), but the difference between means across administrations was non-significant for males. The same results held for the PIL with females showing a significant difference between means across administration type ($p < .0001$), but males showing no significant mean differences. These results indicate that computer administration is more likely to affect the CPT scores of females than males.

In terms of mean differences, males and females did not significantly differ in self-reported computer anxiety, but males did report significantly lower PIL scores. The explanation for the significant gender main effect for the PIL is not forthcoming within the bounds of this study. A possible explanation may be that male undergraduates are less apt to have a grasp on a defined meaning and purpose in their lives than their female counterparts. The significantly lower PIL scores for males were consistent with results reported in the literature (Crumbaugh and Maholick, 1964; Reker and Cousins, 1979).

The interaction between gender and computer anxiety was predicted to be significant, but this hypothesis was not supported. Although females reported more negative affect and less positive affect during computer administration, computer anxiety apparently does not account for this effect. This is further clarified when the non-significant

three-way interaction between administration, gender, and computer anxiety is taken into account. Although gender and computer anxiety have independent effects on the dependent measures, both variables significantly interacted with type of administration. It can be concluded that computer administration is more likely to affect females than males.

Conclusions and Implications

The results of this study raise important questions about the equivalency of computerized and standard personality measures. The significant interaction between computer anxiety and type of administration suggests that computer anxiety may influence personality test scores when using computer administration. In the computer administration condition, BDI scores were generally higher when computer anxiety levels were high, and lower when computer anxiety levels were low. The opposite held true for PIL scores. The association between computer anxiety and affect scores was not found with the paper and pencil administration condition. This suggests that computer administered personality tests may yield scores that are non-equivalent to traditional paper-and-pencil tests. Computerized personality test (CPT) scores obtained from students with higher levels of computer anxiety may be a reflection of a negative reaction to the computer rather than a response to the actual construct being measured.

It should also be pointed out that the subjects who participated in this study were undergraduates whose prior exposure to computers is probably significantly greater than what would be expected for the general population. Cambre and Cook (1977) found that adults tended to report more computer anxiety than children and teenagers. Future research including age as a variable would broaden the scope of the present study. The effects of computer anxiety on CPT scores would probably be exacerbated in older adult populations since they are more likely to experience higher levels of computer anxiety (Raub, 1981).

The present study indicates that generalization of CPT scores to scores on paper-and-pencil tests may not be uniformly acceptable. Studies that have addressed differences between the two types of administration have yielded mixed results. Some of these studies have verified the validity and reliability of CPT measures, while others do not (Space, 1981). The present study found the internal consistency of the computerized personality measures to be lower than their corresponding paper-and-pencil versions. Although these differences were not significant, the computerized BDI internal consistency ($\alpha=.71$) for this sample was not within the lower ranges of estimates reported in the literature (Beck, Steer, and Garbin, 1988).

If CPT scores are affected by an individual's computer anxiety level, then errors could be made when these scores

are used for diagnosis, selection, or placement. The use of CPT is likely to increase into the foreseeable future.

Caution should be exercised when interpreting scores due to the large number of persons who could be affected. Although seemingly impractical, it may be judicious to obtain an individual's computer anxiety level prior to interpreting CPT results. Another solution would be to develop separate norms for software versions of personality inventories that are appropriate to the differences found from corresponding traditional formats.

The present study has striven to create a greater understanding of the effects of CPT by including gender issues. Differentiating the effects of computer anxiety from generalized and math anxiety has also proven to be a major outcome of this study. Future research including subjects from more heterogeneous populations would probably increase the generalizability of the results found in this study.

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APPENDIX A
EXPANDED REVIEW OF LITERATURE

Introduction

Computers are pervasive in society. They have been applied to many fields, including psychology. The use of computers in psychological testing began in the 1960's with an automated version of the MMPI (Butcher, Keller, and Bacon, 1985). Psychologists realized the conveniences of computerized personality testing (CPT) and test suppliers responded with software versions of the more popular tests. Today, most psychological tests are offered in both traditional and software formats (Turkington, 1984).

CPT is a quick and efficient means of administering tests, but questions have been raised as to whether computerized and traditional administrations of personality tests are equivalent. Equivalency studies in the literature have yielded mixed results (Honaker, 1988). Hofer and Green (1985) noted that the same norms and cutting scores from traditional personality tests have been used to interpret computer-administered tests without determining the equivalence of the two modes. In almost all cases of automated testing involving micro-computers, validation procedures for the tests have employed only a relatively small sample of subjects (French and Beaumont, 1987).

The differences between computerized and traditional tests may lie in the individual's reaction to the computer itself. Some persons react negatively to computer use. Cambre and Cook (1985) have defined computer anxiety as a

fear of computers as evidenced by physiological changes or self-report measures. One-fourth to one-third of computer users experience computer anxiety (Paul, 1982; Weeter and Halcomb, 1986). The effects of computer anxiety are far-reaching, affecting persons who in one manner or another must interact with a computer, including those who are administered personality tests. In a study using computer administration of the Beck Depression Inventory (BDI), George, Lankford, and Wilson (1990) found that high computer anxiety levels were associated with elevated BDI scores. Honaker (1988) stated there is a need for research on individual differences that might affect the equivalency of computerized and traditional administrations.

Computer Usage

Since the introduction of the first commercial computer in the early 60's, computerization in the U.S. has taken place at a rapid pace. Shore (1985), speaking on computers, stated "not since the invention of the printing press has a new technology had such far reaching implications-affecting so much so fast." Today there are millions of computers in use, and millions more are being sold every year (Shore, 1985). Shore reports that most of these computers are desktop versions or personal computers (PC) that were invented in the mid-1970's. The role of computers in U.S. society

has become increasingly important since the PC was introduced.

The proliferation of computerized systems in industry, government, and education has resulted in greater numbers of persons interacting with computers on a daily basis. As industrialized society has become more dependent upon computers for normal daily existence, more individuals are finding themselves in situations where the interaction with a computer is unavoidable. Without computers, devices such as phones, airliners, and life-support equipment cease to operate.

As computer technology continues to be applied to new areas, computer literacy will soon be as much a necessity as reading literacy (Heinssen, Glass, and Knight, 1987). Computer use has increased to the point where it is today largely because of the cost-effectiveness of computer systems. The amount of information that can be stored on magnetic tape or disks in comparison to paper is so great that a computer information system takes up only a small fraction of the physical space required for a standard file system. When it comes to retrieving needed information quickly, computer systems have a clear advantage over manual systems where information is slowly retrieved from files. Communication via computer networks has resulted in more efficient and rapid exchanges of information and money.

Computers in the Workplace

Computers made their way into the workplace in the 1960's as industry began to discover the accuracy and efficiency of automated machinery. The shift in the United States economy from production to service has created a dependence on information technology that can only be provided through the use of computers. Improving productivity is an important issue as American firms are searching for methods to increase their competitiveness in world markets. Many companies are turning to computers to increase both productivity and profits.

The use of computers in industry has resulted in large productivity gains in both manufacturing and service industries (Harrington, 1988). In manufacturing, computers and robots have been implemented on assembly lines to take over highly repetitive or hazardous tasks. In the service industries, computers have allowed for greater efficiency and improvements in service. A recent trend is the linking of computers over telephone lines that have allowed more persons to "telecommute" (work in their homes over the telephone lines). This has resulted in organizational productivity while decreasing the amount of in-office employee congestion (Harrington, 1988).

Computer usage was once the domain of computer scientists, but the community of computer users is becoming increasingly heterogeneous, including laborers, managers,

and administrators (Paxton and Turner, 1984). The increasing use of computers in the workplace has made familiarity with computers and the ability to use them effectively a requirement for success in most fields (Marcoulides, 1988), but the implementation of computers in the workplace is often met with opposition by employees. Mahmood and Medewitz (1989) report that employee resistance to computerization is often based on the employees' fear of being replaced by the computer, or feelings of anxiety when confronted with learning how to use such "sophisticated and technical" equipment. Cancro and Slotnick (1970) reported that many employees resent computers because the computer can do many things more accurately and faster than they are able to, which in turn threatens individual self-worth and uniqueness. Despite these problems, the use of computers in industry is predicted to accelerate into the foreseeable future (Salvendy, 1982). Because of this, educators are faced with the responsibility of improving computer skills to keep pace with the technological advances in industry.

Computers in Education

Computer instruction is rapidly becoming an important component of the educational process (Gressard and Loyd, 1986). Educators have been given the responsibility of developing computer skills in their students. The National Commission on Excellence in Education recommends computer

literacy as one of five new basic skills for high school students (Mahmood and Medewitz, 1989). Loyd and Gressard (1984) indicate that designers of school curricula are no longer arguing whether computers should be used in the classroom, but rather when they should be introduced.

Computer assisted instruction (CAI) is increasingly being used in the classroom. Main-frame systems have been in place in university settings since the 1950's, and the application of the microcomputer in educational settings in the 1970's significantly facilitated the growth of CAI (Pagliaro, 1983). Pagliaro stated that because the microcomputer had so many attractive features such as portability and low cost, it produced a wider interest in CAI among educators than had the previous main-frame types of CAI delivery. The application of the microcomputer to CAI has resulted in an increased use and public awareness of computers (Pagliaro, 1983).

As computers continue to be applied in educational settings, their resulting effects on the students who use them will need to be examined. Students with negative attitudes toward computers will need assistance in overcoming their anxiety so that they can meet the expectations of schools and society (Gressard and Loyd, 1986). In order to provide this assistance, a more comprehensive understanding of the effects of computer anxiety is needed.

Computers in Psychology

Main-frame computer systems began to be established on most university campuses by the mid-1950's, and psychometricians were among the first to use them (Fowler, 1985). Computers in this era were mainly used to standardize normative data, and to score and interpret aptitude and interest tests. Fowler stated that this resulted in large testing companies such as the Educational Testing Service (ETS) moving from mechanical scoring machines to computers. Computers were first applied to psychological test administration in the 1960's when an automated version of the MMPI was administered via a main-frame computer system (Jackson, 1985).

Within the past several years, microcomputers have changed the way psychologists administer and score tests. When tests are administered through discs on microcomputers, test scores are available within minutes instead of days or weeks (Turkington, 1984). The relative low cost and convenience of microcomputer administrations has facilitated the growth of computerized personality testing (CPT). Because many personality tests are relatively simple to adapt to computer administration, it follows that there is currently an automated version of practically every established assessment device (Butcher, Keller, and Bacon, 1985). It is now possible to automate the entire process of psychological testing from providing instructions,

presentation of items, scoring and norming of data, to the output of narrative and interpretive statements (Jackson, 1985).

Psychologists are continually finding new applications for computers. Computer-assisted psychological assessments, interviews, and expert systems are already in place. These applications are only as reliable as the programmers who develop them. Psychologists who use computer applications bear the responsibility to refrain from offering services beyond their expertise. The growing use of computers by psychologists calls for an exploration of the effects of human-computer interaction.

Computer Anxiety

Computers are impacting our lives in a multitude of directions, which makes it vital that we develop a thorough understanding of their psychological effects on the user. There exists a substantial portion of computer users who perceive the interaction with computers as threatening, complex, and task demanding (Raub 1982). Morrow, Prell, and McElroy (1986) reported that at least 30% of the business community dealing daily with computers experience some form of anxiety about computers. Weeter and Halcomb (1986) found that 24% of 157 students surveyed showed some degree of computer anxiety. As computer usage increases throughout the world, it is becoming apparent that computers are here

to stay. Now effective means are needed to explore how individuals are affected by computerization.

Defining Computer Anxiety

The idea of using computers does not bring out positive emotions for many individuals. A true fear or anxiety toward computers (cyberphobia) exists for many of these persons. Computer anxiety has been defined by Raub (1982) as the complex emotional reactions that are evoked in individuals who interpret computers as personally threatening. This definition is a description of an anxiety state rather than trait in that the emotional reactions fluctuate according to the presence (real or anticipated) or absence of a computer (Raub, 1982). Because computer anxiety is probably an anxiety state, it is susceptible to change over time.

Cambre and Cook (1985) report that computer anxiety is a fear of computers as evidenced by physiological changes or self report measures that evoke an array of emotional reactions including fear, apprehension, hope, and personal threat. The causes for the emotional reactions that make up computer anxiety are probably many. Banks and Havice (1989) list some of the fears about computers that users may have: breaking the machine, looking stupid, encountering indecipherable error messages, working with a "powerful other," inadequate documentation, losing control,

disappointment and a sense of futility. Computer anxiety may result from a resistance to utilizing computer technology, planning to work with a computer, or actually interacting with a computer (Cambre and Cook, 1985).

Measuring Computer Anxiety

There are several scales available to measure computer anxiety in individuals. The scale chosen for use in this study was Heinssen's Computer Anxiety Rating Scale (CARS). Heinssen, Glass, and Knight (1987) described the development of the CARS. The CARS was developed following a two-step procedure. First, potential items were generated by interviewing persons who identified themselves as either computer anxious or having no computer anxiety at all. These individuals were then asked to relate their thoughts and feelings about computers. In addition to the items generated from the interviews were items which previous research had found to load significantly on a "computer anxiety" factor (Raub, 1982). A pool of 26 potential CARS was then submitted to a panel of seven independent judges who rated each item on a five-point scale according to how much anxiety it reflected. Nine items that received an average rating of 2.0 or below were selected as low computer anxiety statements and the eleven items receiving an average rating of 4.0 and above were chosen for high computer anxiety statements. These final 20 items that were

selected make up the CARS. Subjects respond to items on 5-point Likert scales.

Included in the Heinssen et al. (1987) CARS research was a study to establish the validity and reliability of the scale. Introductory psychology students ($n=270$) participated in the study. In addition to receiving the CARS, students completed the Computer Experience Questionnaire (CEQ), the Computer Attitude Scale (CAS) (with three subscales measuring computer liking, computer confidence, and computer liking), the Mathematics Anxiety Rating Scale (MARS), the Test Anxiety Scale (TAS), Spielberger's Trait Anxiety Inventory (STAI) and the mechanical interest scale from the Kuder Preference Record. Pearson correlations were then conducted to examine the relationship between the CARS and other measures. The following correlations were reported: Computer Attitude Scale (Anxiety $r=.69$, Liking $r=-.60$, Confidence $r=-.74$), Computer Experience Questionnaire $r=-.33$, Mathematics Anxiety Rating Scale $r=.26$, Test Anxiety Scale $r=.20$, Trait Anxiety $r=.20$, and Kuder Mechanical Interest $r=-.48$. All of these correlations were significant at the $p<.05$ level or less. Based on these significant correlations, Heinssen et al. concluded the CARS was a valid measure of computer anxiety. In addition, high internal consistency and test-retest reliability were found. A Cronbach alpha of .87 was reported. A test-retest reliability of $r=.70$

(four-week interval) indicates the stability of the test. In a final analysis of the CARS data, Heinssen et al. found that although women reported higher levels of computer anxiety ($M=44.57$, $SD=10.94$) than men ($M=41.97$, $SD=12.81$), this difference was not significant ($p<.08$).

Meier and Lambert (1990) assessed the psychometric properties of three computer anxiety scales (including the CARS). The CARS was compared with the Attitudes Towards Computers Scale (ATC), and the Computer Aversion Scale (CAVS). All three scales were found to be reliable measures in terms of internal consistency with Cronbach's alpha coefficients ranging from $\alpha=.87$ to $\alpha=.96$. The scales also demonstrated substantial convergent validity. Of the three scales, the CAVS and CARS shared the most common variance ($r=.62-.67$). The ATC correlations with the other two scales were much lower ($r=.14$ to $-.57$). Although all three scales were equivalent in terms of reliabilities, the CAVS and CARS were found to be more sensitive to age, gender and cognitive ability differences (Meier and Lambert, 1990).

Correlates of Computer Anxiety

Several studies have examined correlates of computer anxiety in various student populations. Campbell (1988) used the Newman Computer Anxiety Scale to survey correlates of computer anxiety in a survey of male ($n=536$) and female

($n=539$) students in grades five to twelve. Results of regression analyses revealed that perceived computer ability, fear of computer hardware, availability of a computer in the home, and perception of math ability were significant predictors of computer anxiety for both males and females. Availability of a computer at school was found to be a significant predictor of computer anxiety only for the female students.

Morrow, Prell, and McElroy (1986) examined ten potential correlates of computer anxiety by surveying male ($n=108$) and female ($n=65$) undergraduate students. A computer scale developed by Heinssen (1987) was used to measure computer anxiety in the students. Of the ten potential correlates, eight were found to have a significant correlation with computer anxiety. Typing speed and video game ownership showed no relation to the criterion. The strongest correlates were computer knowledge ($r=-.45$), computer experience ($r=-.43$), external locus of control ($r=.30$), and math anxiety ($r=.36$). Based on these results, Morrow et al. concluded that familiarization and experience with computers may offer a potential means for reducing computer anxiety.

The relationship between computer anxiety and computer achievement was explored by Marcoulides (1988). University students ($n=72$) were administered the Computer Anxiety Scale and a mathematics anxiety scale. Computer experience

was assessed, and computer achievement was evaluated as the number of successfully completed computer homework assignments. Results indicated that computer anxiety was a better predictor of computer achievement than previous computer experience ($r=.71$ vs. $r=.37$). A correlation of $r=.28$ between math anxiety and computer anxiety scores indicated there may be some overlap between the two constructs. Marcoulides noted that computer anxiety was present in many subjects regardless of previous computer experience.

Gressard and Loyd (1986) administered three scales measuring computer attitudes (anxiety, confidence, and liking), and a mathematics anxiety scale to university students ($n=106$). Results indicated a significant association between higher computer anxiety and lower computer confidence ($r=.83$) and computer liking ($r=.81$). Math anxiety was found to be significantly correlated with computer anxiety ($r=.51$), which suggests that students who tend to be math anxious also tend to be computer anxious. Because of this, it was concluded that the basic anxiety management techniques developed for the treatment of math anxiety may be appropriate for the treatment of computer anxiety. This would involve providing students with exposure to computers in a non-threatening, non-academic situation (Gressard and Loyd, 1986).

Raub (1982) examined correlates of computer anxiety in undergraduate students ($n=73$). Students completed a battery that contained a computer usage check list, a computer attitudes questionnaire, the Spielberger Trait Anxiety Inventory, and a mathematics anxiety scale. Regression analyses revealed that computer experience ($r=.44$), math anxiety ($r=.29$), and trait anxiety ($r=.31$) all contributed significantly to the criterion of computer anxiety.

Studies have shown that math anxiety is a significant correlate of computer anxiety (Morrow et al., 1986; Marcoulides, 1988; Gressard and Loyd, 1986; Raub, 1982). This suggests that those individuals who are prone to math anxiety may also be prone to computer anxiety. Cambre and Cook (1985) have reported that computer anxiety affects the individual in a manner analogous to math and test anxiety. Computer experience has been shown to be negatively associated with computer anxiety (Raub 1982; Morrow et al., 1986; Gressard and Loyd, 1986), but computer experience does not necessarily result in a reduction in self-reported computer anxiety (Marcoulides, 1988).

Gender and Age Differences

Computer anxiety has been found to differentially affect individuals according to sex and age. Females describe themselves as computer anxious more often than males, and adults tend to be more fearful about the use of computers

than children and teenagers (Cambre and Cook, 1987). Older individuals may experience more computer anxiety because computers were not available to them when they were in school.

There is a large body of evidence that supports the notion that females are more likely to experience computer anxiety than males (Dambrot, Malek, Silling, Marshall, and Garver, 1985; Gilroy and Desai, 1986; Parasuraman and Igbaria, 1990; Siann, Macleod, Glissov, and Durndell, 1990; Wilder, Mackie and Cooper, 1985). Wilder et al. (1985) surveyed students in grades kindergarten to 12 ($n=1600$), and found that boys reported being more receptive to computers than girls at all ages. A second part of this same study surveyed 134 incoming college freshmen concerning attitudes towards computers and found that women were significantly less comfortable than men in dealing with computers. In a survey of undergraduate males ($n=136$) and females ($n=190$), Gilroy and Desai (1986) found that women reported higher levels of computer anxiety on the Computer Anxiety Scale than men.

Parasuraman and Igbaria (1990) examined computer anxiety and attitudes toward microcomputers among male ($n=114$) and female ($n=52$) managers employed in a variety of organizations. It was reported that the female managers showed significantly more computer anxiety reported on Heinssen's (1987) Computer Anxiety Rating Scale and negative attitudes

toward microcomputers than their male counterparts. Math anxiety was more likely to be negatively associated with attitudes toward microcomputers for females in the sample than males ($r = -.40$ vs. $r = -.21$).

In an observational study with primary school children ($n=114$), it was found that when boys and girls of about nine years of age were given access to computers for an exercise, the boys tended to physically crowd out the girls (Siann et al., 1990). This finding was consistent with previous studies the authors had completed with younger children. It was concluded that girls were less likely to voluntarily seek out the use of computers than boys. Unless educators take effective measures to counter this trend, girls will be less likely than boys to gain experience and feel competent with computers during their school years and, thus, may experience more anxiety and negative attitudes toward computers later in life (Siann et al., 1990).

In a large scale survey of male ($n=342$) and female ($n=599$) undergraduate students, Dambrot et al. (1985) reported that females held more negative attitudes toward computers, scored lower on computer aptitude, and had less prerequisite math ability and math course work than males. More males than females had knowledge of computers and had completed computer-related courses. It was concluded that the study provided some support for the contention that the gender gap in mathematics and science may be extended to

computers, and that remedial intervention would be necessary for women to improve their aptitudes and resultant attitudes toward computers.

Computerized Personality Tests

There has been a rapid growth in the use of computerized personality testing (CPT) in recent years due to the low cost and wide availability of microcomputers and their associated software. The conventional personality inventory requires the examinee to make a written response to a typed stimulus presented on paper. When these tests are converted to software versions, the response becomes a key press to an item presented on a video screen. CPT has become popular with psychologists because it is a quick and convenient method to administer tests. Test suppliers have responded to the popularity of CPT by marketing software versions of nearly all of the personality measures available (Turkington, 1984).

Questions have been raised about the use of computerized personality tests (French and Beaumont, 1987; Hofer, 1985; Hofer and Green, 1985; Honaker, 1988; Jackson, 1985; George, Lankford, and Wilson (1990); Skinner and Pakula, 1986). These questions raised about CPT include equivalency with traditional formats, validation procedures, and effects with computer anxious individuals. Despite the concerns some researchers have expressed with CPT, the use of software

versions of personality tests is likely to increase rather than decrease. CPT is rapidly leaving the infancy stage, and will soon be more open to public scrutiny.

Equivalency and Validity Issues

A number of studies have dealt with equivalency issues of computerized versus standard versions of personality inventories. The major objective of these equivalency studies was to enable norms, cutting scores, and validity data from conventional formats to be generalized to computerized formats of the same tests (Hofer and Green, 1985). Almost all tests used in CPT have been adapted from a paper-and-pencil format (Jackson, 1985). It would then be assumed that test developers and suppliers have ensured that scores from the two methods of administration are equivalent, but this is usually not the case. Most of the computerized personality tests available have not been validated, and worse yet, some testing software being used has not been adequately debugged for programming errors (Hofer and Green, 1985).

Two types of equivalence have been discussed by Honaker (1988)--psychometric and experiential. Psychometric equivalence refers to two forms of a test producing equal mean scores, identical distribution and ranking of scores, and correlation to the same degree with scores on other variables (e.g., computer anxiety). When mean score and

distribution differences are found, it is inappropriate to generalize data across forms. Hofer (1985) discussed the three ways psychometrically non-equivalent data can be dealt with. When CPT results in a simple mean shift, then adding a constant to all CPT scores could possibly equate the two modes. When the shapes of the two distributions differ, an equipercentile conversion would be necessary. If examinees are ranked differently across the two modes of administration, then different constructs are being measured and no equating of scores would be possible.

Although psychometric equivalence has been the focus of equivalency studies, Honaker (1988) stated that further evaluation of experiential equivalence is warranted. Experiential equivalence refers to how the tests differ in the way they are experienced by the examinee. The factors involved in experiential equivalence include emotional, perceptual, and attitudinal reactions to the two forms. These effects can occur in the presence or absence of psychometric equivalence. Computerized and traditional forms can be psychometrically equivalent, yet be experienced by the examinee in ways which make the forms nonequivalent (Honaker, 1988). An early MMPI equivalency study found that computer administration resulted in higher levels of initial anxiety (measured by reports on Spielberger's State Anxiety Inventory) than the conventional mode (Lushene, O'Neil, and Dunn (1974). The Lushene et al. study also reported

elevated scores on several scales for subjects in the computer administration condition.

The MMPI was the first personality test to be converted to computerized administration. Since that time, the majority of equivalency studies have focused on the MMPI. In a review of these MMPI equivalency studies, Honaker (1988) found incomplete and sometimes conflicting results. Honaker noted various methodological problems that may have led to these mixed results. One problem cited was software differences. Equivalency studies have used varying programs administered on different computers, each with a different computer-user interface. Item presentations and response requirements have subsequently varied from one program to another, leading to conflicting results across studies regarding mean score differences (Honaker, 1988). This indicates that information from one program cannot be generalized to other programs.

Honaker has noted that a majority of the MMPI equivalency studies have used repeated measures designs. A potential problem for repeated measures designs is the test-retest interval. Hofer and Green (1985) have stated that it is important that the interval between computerized and paper-and-pencil administrations be sufficient to avoid a recall of previous responses. Honaker reported a relatively short interval between administrations in the MMPI studies that ranged from 3 days to one week. It was concluded that

the high test-retest and between-mode correlations reported in these studies partially reflects a memory factor, and that studies examining longer intervals are needed. Although repeated measures designs minimize error, useful information can be obtained from between-group designs, especially when mean scores and distribution scores are of concern (Honaker, 1988).

Of the 9 MMPI studies reviewed by Honaker, 6 found significant differences on one or more scales across the two modes of administration. However, there has not been consistency in the scales which were reported to be affected by mode differences. Lambert, Andrew, Rylee, and Skinner (1987) found significantly lower scores for computer administration. However, White, Clements, and Fowler (1985) found significantly higher scores on the computer version. Schuldberg (1987) found computer administration to result in significantly higher scores on some scales, but significantly lower scores on other scales. Russell, Peace, and Mellisop (1986) found no significant mean differences across the two modes at all. Honaker stated that it is probable that the different findings across these studies reflect methodological differences.

It cannot be automatically assumed that computer-administered versions of personality tests are parallel forms of paper-and-pencil versions. Very few test consumers or test publishers have recognized the need for validity

studies in this area (Butcher, Keller, and Bacon, 1985). Hofer and Green (1985) have reported that the integrity of CPT is being threatened by hasty applications without competent validation of the new technology. French and Beaumont (1987) report that the studies that have attempted to validate computerized tests have employed only a relatively small sample of subjects.

A major concern regarding CPT is that extraneous factors incidental to the computerized administration may affect test responses. Computer-linked factors might change the instrument in such a way that the computerized and paper-and-pencil version of a test do not measure the same construct (Hofer, 1985). When responses are changed, the validity data from conventional tests cannot be generalized to computerized tests. Hofer and Green (1985) have concluded that CPT validation studies are lacking and inadequate. Honaker (1988) has asserted that research is needed to validate CPT that focuses on possible interactions between individual characteristics and administration formats.

Individual Differences

When personality tests are administered to individuals on a computer, the emotional reactions to the computer itself may vary from individual to individual. Factors such as computer anxiety have been associated with elevated

negative affect scores (George et al., 1990). Computer administrations often result in attitudinal and perceptual reactions in individuals that differ from those in response to traditional paper-and-pencil administrations (Honaker, 1988). Some have suggested that the computer might elicit greater frankness in responding, although there is not much evidence for this (Jackson, 1985).

Not every group member will be uniformly affected by taking a test on a computer (Hofer, 1985). Individual subject characteristics are likely to affect equivalence. Although findings have suggested that the two modes can be perceived and experienced differently by examinees (Lushene et al., 1974), differences that may affect examinees' scores have not been adequately investigated. Honaker (1988) stated that if scores from the two formats covary differently with an external variable, e.g., computer anxiety, then the equivalency of the two formats is likely to vary as a function of that variable.

Computer-administered tests may cause uneasiness for individuals who have had fewer opportunities for developing computer skills (Skinner and Pakula, 1986). Rezmovic (1977) reported that CPT results in an increase in score variance in comparison to paper-and-pencil administrations. A suggested explanation was that the examinees' ability to interact with the equipment may have been a confounding variable. Other reasons cited included computer anxiety

and the novelty of the automated test situation (Rezmovic, 1977). Skinner and Pakula (1986) stated that the populations under consideration are important factors affecting any potential differences in the validity of computerized and traditional forms.

There is very little data available to test administrators today that can be used to make decisions as to when one should not use CPT with a particular individual. Green (1985) indicated that users of CPT need to have more information regarding what test-taker characteristics may lead to non-equivalence and knowledge of how to remedy the non-equivalence when it exists. Mere group membership is not likely to be a good predictor of non-equivalence. Hofer (1985) concluded that characteristics that may be direct sources of non-equivalency, such as negative computer attitude, would be a good focus of study.

Legal and Ethical Issues

Hofer (1985) reviewed some of the legal and ethical issues surrounding the use of CPT. The legal issues cited were: litigation involving unqualified users, the validity of CPT reports used as legal evidence, and claims of cultural bias. There is concern that computer technology is unevenly distributed and that groups that have a lack of computer experience will be disadvantaged if forced to take tests on computers. If a disproportionate ratio of ethnic,

gender, and age subgroups are determined to be detrimentally classified by computerized personality tests, it could lead to court claims of discrimination (Hofer and Green, 1985).

There is a concern that CPT software may fall into the hands of unqualified and lay users. Matarazzo (1983) has predicted a "flood of litigation involving unqualified users." Test suppliers have voluntarily refrained from providing clinical tests to non-psychologists, but have been less cautious in the distribution of CPT software (Hofer, 1985).

Ethical issues noted by Hofer (1985) were the lack of standards for the use of CPT, equivalency problems, and the impact of CPT on computer anxious examinees. It is the responsibility of the test consumer to ensure that the examinee is not adversely affected by computerized administrations. Defining ethical standards for the use of CPT would be a starting point to protect the public. It would also be appropriate to require test suppliers to provide evidence of the comparability of computerized and paper-and-pencil formats (Jackson, 1985).

Conclusion

There is a lack of research exploring the relationship between computer anxiety and CPT measures. George et al. (1990) found an association between high levels of computer

anxiety and elevated negative affect scores. Cambre and Cook (1985) have reported that computer anxiety results in negative emotional reactions such as fear, apprehension, and diminished self-worth. It is plausible to question whether highly computer-anxious individuals would be more likely to endorse negative versus positive self-evaluative items on computerized measures of affect. The present study will strive to create a better understanding of the role of computer anxiety when using computerized administrations. The personality measures chosen for this study were the Beck Depression Inventory (BDI), a measure of negative affect, and the Purpose in Life Test (PIL) a measure of positive affect. Psychometric properties of these two measures were compared across the two modes of administration.

APPENDIX B
EXPANDED METHOD

Procedure and Instructions

The students in the computer condition were administered the personality measures on terminals linked to a Digital Equipment Micro VAX II computer. Basic testing programs were designed that were "user friendly," so that students with no previous knowledge or experience with computers could easily complete the task. To assist in controlling error variance, directions and wordings in each item of the computer-administered inventories were identical to their corresponding paper-and-pencil versions. Items were presented sequentially one screen at a time. The students responded to each item by simply typing the appropriate letter to their desired response option. If an answer change was desired, the student was able to delete any response and replace it with another, just as they would be able to erase an answer on a standard version of the inventory. In the lower portion of the monitor display, instructions were given on each question prompting the student to press the return key when ready to continue. A "lock-out" was included in the administration program that prevented moving on to the next question until a response was received. Students were asked basic demographic information on a single screen after completing the task.

Each experimental session was run in groups of 15 to 25 students. The computer administration groups completed the

task in the Psychology Department computer lab. The paper-and-pencil administration groups completed the experiment in a classroom. All students initially completed a consent form. The following instructions were then read:

As stated in the consent form, you will be participating in a study that will explore the effects of automated versus standard measures of affect. You will now be completing a series of questionnaires and/or tasks.

Please take the time to carefully read instructions when given, and feel free to ask any questions you may have at any time.

Each student was then given a written version of the Computer Anxiety rating scale (CARS), the Spielberger State and Trait Anxiety Scale (STAI), and the Phobos Mathematics Anxiety Scale. After completing these questionnaires, students were then read the following:

The questionnaires you are about to complete will ask you to report how you are feeling by responding to a set of statements. Please make sure you answer all of the questions in the order they are presented. Please do not omit any items...

In addition to these instructions, students in the computer administration conditions were read the following statements as they were demonstrated on a keyboard that was held up by the experimenter to facilitate the instructions:

...the questionnaires will be presented on the video screens in front of you. Press the enter key to turn your screen on. Press the key that has the letter or number that corresponds to the answer you choose. If you wish to change an answer, use the backspace or delete key and then type in the new answer. Upon completion, please answer the biographical information asked for on the last screen.

Students were then administered computerized or paper-and-pencil versions of the Beck Depression Inventory (BDI) and Purpose in Life test (PIL). At the close of each experimental session, students were debriefed, then dismissed.

APPENDIX C
ADDITIONAL ANALYSES

Table C.1
Pearson's Correlations for Computer Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.724	1.000				
CARS	-.553	.420	1.000			
Math	-.329	.324	.528	1.000		
State	-.327	.447	.246	.285	1.000	
Trait	-.349	.569	.183	.338	.689	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .24$ or more are significant at the $p < .03$ level ($n=65$).

Table C.2
Pearson's Correlations for Paper-and-Pencil Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.344	1.000				
CARS	-.088	.002	1.000			
Math	-.003	.042	.595	1.000		
State	-.344	.334	.129	.175	1.000	
Trait	-.399	.208	.175	.262	.752	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .25$ or more are significant at the $p < .03$ level ($n=66$).

Table C.3
 Pearson's Correlations
 for Males Receiving Computer Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.640	1.000				
CARS	-.677	.592	1.000			
Math	-.407	.396	.489	1.000		
State	-.199	.191	.324	.333	1.000	
Trait	-.227	.369	.225	.333	.769	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .34$ or more are significant at the $p < .05$ level ($n=33$).

Table C.4
 Pearson's Correlations
 for Females Receiving Computer Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.834	1.000				
CARS	-.365	.324	1.000			
Math	-.167	.235	.564	1.000		
State	-.481	.598	.188	.275	1.000	
Trait	-.501	.727	.139	.360	.632	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .36$ or more are significant at the $p < .05$ level ($n=32$).

Table C.5
 Pearson's Correlations for
 Males Receiving Paper-and-Pencil Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.099	1.000				
CARS	-.171	.195	1.000			
Math	.051	.320	.550	1.000		
State	-.336	.620	.222	.214	1.000	
Trait	-.406	.458	.157	.137	.705	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .34$ or more are significant at the $p < .05$ level ($n=33$).

Table C.6
 Pearson's Correlations for
 Females Receiving Paper-and-Pencil Administration

	PIL	BDI	CARS	Math	State	Trait
PIL	1.000					
BDI	-.448	1.000				
CARS	-.218	.051	1.000			
Math	-.230	.107	.616	1.000		
State	-.292	.027	.114	.191	1.000	
Trait	-.420	.030	.228	.383	.778	1.000

Note:

PIL = Purpose in Life Test

BDI = Beck Depression Inventory

CARS = Computer Anxiety Rating Scale

Math = Phobos Mathematics Anxiety Scale

State = Spielberger State Anxiety Scale

Trait = Spielberger Trait Anxiety Scale

All correlations of $\pm .36$ or more are significant at the $p < .05$ level ($n=33$).

APPENDIX D
COMPUTER ANXIETY RATING SCALE

COMPUTER ANXIETY RATING SCALE

Social Security# _____ - ____ - _____

This questionnaire deals with the feelings and attitudes people have about computers. Please indicate how much you agree with each of the following statements by using the scale below:

1-----	2-----	3-----	4-----	5-----
I strongly
disagree
with this
statement		I neither
agree nor
disagree with
this statement		I strongly
agree with
this
statement
-
- ___ 1. I feel insecure about my ability to interpret a computer printout.
- ___ 2. I look forward to using a computer on the job.
- ___ 3. I do not think I would be able to learn a computer programming language.
- ___ 4. The challenge of learning about computers is exciting.
- ___ 5. I am confident that I can learn computer skills.
- ___ 6. Anyone can learn to use a computer if they are patient and motivated.
- ___ 7. Learning to operate computers is like learning any new skill -- the more you practice, the better you become.
- ___ 8. I feel that if I don't learn how to operate computers I will be left behind on the job or in careers.
- ___ 9. I am afraid that if I begin to use computers I will become dependent upon them and lose some of my reasoning skills.
- ___ 10. I am sure that with time and practice I will be as comfortable working with computers as I am working with a typewriter.
- ___ 11. I feel that I will be able to keep up with the advances happening in the computer field.
- ___ 12. I dislike working with machines that are smarter than I am.
- ___ 13. I feel apprehensive about using computers.

1-----	2-----	3-----	4-----	5-----
I strongly disagree with this statement		I neither agree nor disagree with this statement		I strongly agree with this statement

- ___ 14. I have difficulty in understanding the technical aspects of computers.
- ___ 15. It scares me to think that I could cause a computer to destroy a large amount of information by hitting the wrong key.
- ___ 16. I hesitate to use a computer for fear of making mistakes that I cannot correct.
- ___ 17. You have to be a genius to understand all the special keys contained on most computer terminals.
- ___ 18. If given the opportunity, I would like to learn about and use computers.
- ___ 19. I have avoided computers because they are unfamiliar and somewhat intimidating to me.
- ___ 20. I feel computers are necessary tools in both educational and work settings.

APPENDIX E
CONSENT FORM

CONSENT FORM

I hereby give my consent to participate in the research project entitled, "The effects of attitude and gender on the equivalency of automated vs. standard measures of affect" This study will be conducted in sessions lasting about one hour. During this session, I understand that I will be asked to report information about myself and my attitudes regarding certain subjects. I understand that I am a volunteer for this experiment and that I may withdraw at any time without penalty. Furthermore, I understand that I will receive a one hour bonus point coupon for my participation. I understand that all data will be completely confidential and that my name will be not used to identify my scores after the data have been collected. I also understand that my scores will be used for research and educational purposes only.

Finally, I understand that J. Scott Lankford has agreed to answer any questions I may have concerning procedures and has informed me that I may contact the Texas Tech University Institutional Review Board for the Protection of Human Subjects by writing them in care of the Office of Research Services, Texas Tech University, Lubbock, TX 79409 or by calling (806) 742-3884. I understand that Dr. Robert W. Bell, faculty sponsor of this experiment can also be contacted for further information (phone: (806) 742-1334).

If this research causes any physical injury to participants in this project, treatment is not necessarily available at Texas Tech University or the Student Health Center, nor is there necessarily any insurance carried by the university or it's personnel applicable to cover any such injury. Financial compensation for any such injuries must be provided through the participant's own insurance program. Further information about these matters may be obtained from Dr. Robert M. Sweazy, Vice Provost for Research, (806) 742-3884, Room 203 Holden Hall, Texas Tech University, Lubbock, TX, 79409. I understand that I may not derive any therapeutic treatment from my participation in this study. I understand that I may discontinue this study at any time I choose without penalty.

 Name of subject: _____ Phone: _____

Signature of Subject: _____ Date: _____

Experimenter's
 Signature: _____ Date: _____

APPENDIX F
PILOT STUDY

Spring 1990

"The Effects of Computerized vs. Paper-and-pencil
Administration of the Beck Depression Inventory"

Problem:

This research focuses on the problem of whether administration of the Beck Depression Inventory (BDI) on computer terminals will yield different scores than the standard paper-and-pencil version of the BDI. The effects of computer anxiety on BDI scores when using computer administration were also addressed by obtaining a relative measure of computer anxiety on subjects in the study. It was hypothesized that computer administration of the BDI would yield higher scores than standard paper-and-pencil administration. It was also hypothesized that the correlation between BDI scores and computer anxiety scores would be greater for computerized versus paper-and-pencil administration.

Method:

97 Subjects (45 male, 52 female) from introductory Psychology classes participated in the study. Subjects were administered the BDI either through computer administration ($n=48$) or paper-and-pencil administration ($n=49$).

A program for administering the BDI through the Psychology department's Micro VAX II computer was developed that allowed subjects in the computer condition to take the BDI on computer terminals in the department's computer lab.

Wording and directions for items on the computer version of the BDI were identical to the corresponding paper-and-pencil version. There were 15-20 subjects per experimental session.

Heinssen, Glass, and Knight's (1987) Computer Anxiety Rating Scale (CARS) was used as the measure of computer anxiety.

Results:

BDI mean scores were significantly greater ($p < .05$) for computer administration than paper-and-pencil administration (8.21 vs. 6.02).

Further analyses revealed the correlation between the BDI depression scores and CARS scores was significantly greater for computer administration than paper-and-pencil administration (see Figure F.1).

Figure F.1: Pilot Study--BDI Regression Lines
by Type of Administration

Conclusions:

The findings of this study suggest that computer administration of the BDI is not equivalent to standard paper and pencil administration. The significant difference between the computer anxiety and BDI correlations across type of administration suggests that computer anxiety may possibly elevate BDI scores during computer administration, but not during paper-and-pencil administration.

Note:

This pilot study that preceeded the dissertation research is presently in press in the Computers In Human Behavior journal.