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# Computer Anxiety: A Cross-Cultural Comparison of University Students in Ten Countries

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**Abstract** — *This study compared the construct of computer anxiety in university students across ten countries. A factor analysis of the Computer Anxiety Rating Scale (CARS) produced a three-factor model of computer anxiety (Interactive Computer Learning Anxiety, Consumer Technology Anxiety, and Observational Computer Learning Anxiety) for students in seven universities across the United States. The factor structures from students in nine countries (Australia, Czechoslovakia, Germany, Hungary, Israel, Italy, Japan, Spain, and Yugoslavia) were examined using Confirmatory Factor Analytic procedures. Each country's factor structure was first compared to the United States three-factor model and then modified to provide the best possible three-factor model of computer anxiety for each country. Results indicated that each country possessed a unique culture-dependent model of computer anxiety. For two countries (United States and Australia), Interactive Computer Learning Anxiety included learning to operate a computer plus encountering computer problems. For the eight other countries, Interactive Computer Learning Anxiety captured only the aspect of learning to operate and program computers while a separate Computer Victimization factor*

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*dealt with anxiety surrounding computer problems. The Observational Computer Learning Anxiety and the Consumer Technology Anxiety factors also differed between countries. Similarities and differences in the factor structures are discussed in light of cultural characteristics, computer education, and computer software and hardware.*

In the 1960s and 1970s, several studies examined negative psychological reactions to computer technology through traditional attitude measurement techniques. Since that time there has been an explosion of empirical literature in this area (cf. Glass, Knight, & Baggett, 1985; Rosen & Maguire, 1990).

In nearly all studies, computer anxiety has been assessed among groups of people in the United States. Although most researchers have studied undergraduate and graduate university students (Bandalos & Bensen, 1990; Chu & Spires, 1991; Cohen & Waugh, 1989; Gilroy & Desai, 1986; Glass & Knight, 1988; Gressard & Loyd, 1986; Heinssen, Glass, & Knight, 1987; Hudiburg, 1989; Igbaria & Chkrabarti, 1990; Jonassen, 1986; Jones & Wall, 1985; Jordan & Stroup, 1982; Kernan & Howard, 1990; Liu, Reed, & Phillips; 1990; Marcoulides, 1988, 1991; Marcoulides & Wang, 1990; Morrow, Prell, & McElroy, 1986; Parasuraman & Igbaria, 1990; Powers, Cumming, & Talbott, 1973; Raub, 1982; Rosen, Sears, & Weil, 1987; Sigurdsson, 1991; Weil, Rosen, & Wugalter, 1990), others have examined computer anxiety among school teachers (Gressard & Loyd, 1984; Honeyman & White, 1987; Issa & Lorentz, 1988, 1989; Kotlrik & Smith, 1989; Lindbeck & Dambrot, 1986; Mertens & Wang, 1988; Rosen & Weil, 1995; Simonson, Maurer, & Montag-Torandi, 1987), public school students (Koohang, 1986; Pilotte & Gable, 1990), business managers (Howard & Smith, 1986), or other people from the general population (Temple & Gavillet, 1990; Herkimer, 1985).

### *Crosscultural Comparisons*

Only four researchers have assessed computer anxiety or computer attitudes across more than one country. Allwood and Wang (1990) compared conceptions of computers among Chinese and Swedish college students majoring in psychology and computer science. Allwood and Wang showed some differences in conceptions of computers, with the Chinese students showing a more optimistic view of the future impact of technology. Collis and Williams (1987) examined gender differences in attitudes toward computers between Canadian and Chinese 8th and 12th grade students and found the Chinese students to be more positive in their attitudes toward computers (as well as science in general). Marcoulides and Wang (1990) and Marcoulides (1991) compared computer anxiety's structural components between Chinese and American college students and found that students from both countries with general computer anxiety and a separate computer equipment anxiety. Finally, in a public opinion survey of 9,000 people in six European countries (France, Germany, England, Italy, Norway, and Spain), the United States, and Japan, Vine (1985) reported comparative public opinions of top management, white collar workers, blue collar workers, farmers, and retired people concerning computers, with particular emphasis on the impact of technology in the workplace. Vine concluded that: "There are very great differences in country attitudes toward information technology. These differences reflect a whole range of cultural attitudes and the data must be interpreted with that in mind" (p. 21).

### Computer Anxiety Factor Structures

Unlike the study of mathematics anxiety, where two measures — the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972) and the Fennema-Sherman Mathematics Attitudes Scale (Fennema & Sherman, 1976) — have been used in the vast majority of all studies, researchers have used a variety of measures to assess computer anxiety. Only five measures have been used by more than one researcher. Of these five, only three have reported data concerning their factor structure (Rosen & Maguire, 1990).

Only two studies have compared the factor structure of computer anxiety between groups. Bandalos and Benson (1990) administered Gressard and Loyd's (1984) Computer Anxiety Scale (CAS) to 375 undergraduate and graduate men and women enrolled in an educational measurement and statistics course at a large Eastern university. In their sample, Bandalos and Benson found three factors, one interpreted as Computer Liking, another as Computer Confidence, and a third as Computer Achievement. Loyd and Gressard's original Computer Anxiety and Computer Confidence subscales were subsumed in the Computer Confidence factor. When the three-factor model was examined for males and females and for graduate and undergraduate students, Bandalos and Benson concluded that ". . . the factor structure of the revised 23-item CAS remained largely invariant when the goodness-of-fit of the model was assessed simultaneously over groups in each of the two grouping conditions." (p. 58).

Marcoulides and Wang (1990) administered Marcoulides, Rosen, and Sears' (1985) 20-item revised CARS to 437 undergraduate college students — 225 from a large urban university in Los Angeles and the other 212 from a college located in Hunan, Peoples' Republic of China. Marcoulides and Wang concluded that the construct of computer anxiety, as measured by their two-factor model, was invariant over the two samples.

### Limitations of Previous Research

Previous studies of computer anxiety have been limited in two ways. First, most studies have examined this construct solely with samples from the United States. Second, only two studies have examined the factor structure of computer anxiety between an American sample and a sample from another country).

### Present Study

This study is part of a larger, 2-year study of technophobia and technological sophistication (Weil & Rosen, 1995). This study deals with the limitations of earlier studies by assessing computer anxiety in ten countries and comparing the factor structure found in the United States to that found in nine other countries. Rather than simply testing whether the factor structure from each country "fits" the factor structure of the United States' sample (defined as being mathematically indistinguishable), this study first compares the factor structure produced from the United States samples to that of a country and then examines how modifications in the factor structure can provide for an incrementally better fit in that country. The improved factor structures for each of the nine countries are then examined in light of the availability of various types of technology, cultural characteristics, and other aspects of the teaching of technology in each country.

## METHOD

### Subjects

Over a 2-year period data were collected from 3,392 first-year students at 38 universities in 23 countries. Data from ten countries ($N$ = 2,456) that had sample sizes over 130 were used in this study. The sample sizes, mean ages, and gender distributions are displayed in Table 1.

### Instrumentation

The original 54-item Computer Anxiety Rating Scale was revised for the present study. First, after consultation with colleagues from different cultural groups, all items that might be biased toward the American culture were removed. Second, based on the original factor structure (Rosen et al., 1987) and a revision by Marcoulides et al. (1985), many items that were redundant were removed. Third, items were reworded to prevent any ambiguities in translation. Fourth, two new items were included that reflected anxiety toward technology that had become more pervasive since the creation of the original measure. These two items had been used and validated in an earlier study of school teachers (Rosen & Weil, 1995). The final form of the Computer Anxiety Rating Scale — Form C (CARS-C) — included 20 items rated on the same scale as the original Computer Anxiety Rating Scale (1 = "not at all", 2 = "a little", 3 = "a fair amount", 4 = "much" and 5 = "very much") yielding a total possible score ranging from 20 to 100, with higher scores showing more computer anxiety. This new scale differed from an earlier modification by Marcoulides et al. (1985) by including items that dealt with anxiety about consumer technology and indirect or passive computer interaction.

### Procedure

Requests were sent to colleagues world-wide for assistance in this project. Each colleague was sent a copy of the CARS-C and a set of instructions to read aloud to the students. Where necessary, colleagues were asked to provide their own translation of the measures. The German questionnaire was translated jointly by three psychologists at two universities (Heinrich-Heine University in Dusseldorf and Fachhochschule Wurzburg/Schweinfurt in Wurzburg). The Japanese translation was validated by a psychologist and a professor of Education in Hyogo. The Italian

**Table 1. Sample Sizes and Number of Universities From Each Country**

| Country | Sample Size | Number of Universities | Mean Age | Gender Distribution |
|---|---|---|---|---|
| United States | 473 | 6 | 21.99 | 28% M/72% F |
| Japan | 428 | 3 | 19.47 | 57% M/43% F |
| Australia | 278 | 3 | 21.20 | 20% M/80% F |
| Germany | 235 | 3 | 23.06 | 42% M/58% F |
| Hungary | 232 | 2 | 21.17 | 35% M/65% F |
| Spain | 195 | 2 | 20.70 | 20% M/80% F |
| Yugoslavia | 179 | 1 | 21.15 | 18% M/82% F |
| Italy | 166 | 2 | 20.78 | 14% M/86% F |
| Israel | 136 | 1 | 26.12 | 11% M/89% F |
| Czechoslovakia | 134 | 1 | 17.11 | 42% M/58% F |

questionnaire was translated by two psychologists at the University of Naples. The Spanish version was translated by two psychologists at the University of Madrid. The Hebrew version was translated by a psychology professor at the University of Tel Aviv. The Hungarian version was translated by two psychologists at the Hungarian University of Physical Education in Budapest. Finally, the English version was used in the United States, Australia, Czechoslovakia, and Yugoslavia.

## RESULTS

Since it was not known whether the students tested were familiar with the self-report anxiety measurement format used in this study, three pairs of items that were logically related ("Learning to write computer programs" & "Reading computer manuals"; "Thinking about taking a computer course" & "Taking a class in the use of computers"; "Learning how a computer works" & "Learning computer terminology") were correlated for each country. Since all correlations for all country samples were above .30 (most were above .50) and significant ($p < .01$), it was assumed that there was support for the valid use of the measurement scales.

### *A Three-Factor Model of Computer Anxiety*

Since the goal of this study was to compare the underlying structure of the computer anxiety construct across country samples and since past work demonstrated that computer anxiety is most likely composed of several intercorrelated subscales, the data from the students from the USA were subjected to a Principal Factors analysis with oblique rotation. The results from this analysis, using a factor loading cutoff of .30, are presented in Table 2.

Three clear factors emerged from this analysis, accounting for a total of 57.1% of the variance. As a further validation of the USA factor structure, a Confirmatory

**Table 2. Factor Loadings (> 0.30) of the Computer Anxiety Rating Scale (Form C) for First-Year University Students in the United States ($N = 473$)**

| Computer Anxiety Item | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| Learning to write programs | .85 | | |
| Learning computer terminology | .76 | | |
| Learning how a computer works | .75 | | |
| Reading a computer manual | .74 | | |
| Thinking about taking computer course | .69 | | |
| Taking a class in use of computers | .68 | | |
| Getting error messages from computer | .57 | | |
| Erasing or deleting from computer file | .53 | | |
| Applying for job requiring computer training | .49 | | |
| Thinking about buying a personal computer | .44 | | |
| Unable to receive info. — computer down | .33 | | |
| Resetting digital clock after power off | | .73 | |
| Programming a microwave oven | | .69 | |
| Taking test with computer scoring sheet | | .31 | |
| Watching someone work on personal computer | | .37 | .37 |
| Looking at computer printout | | | .77 |
| Watching a movie about intelligent computer | | | .62 |
| Visiting a computer center | | | .59 |
| Sitting in front of a home computer | | | .51 |
| Using the automated bank teller machine | | | .45 |

Factor Analysis was performed. This analysis indicated that the USA sample data did not differ significantly from the three-factor model ($\chi^2(166) = 190.02, p > .05$).

Factor 1 accounts for 31.7% of the variance and reflects Interactive Computer Learning Anxiety. The items included here seem to fit into the categories of learning about computers and how to operate computers, dealing with computer errors and mistakes, applying for a job that requires interactive computer knowledge, and thinking about purchasing a computer. These items demonstrated a strong overlap with Marcoulides et al.'s (1985) General Computer Anxiety factor.

Factor 2 (10.4% of the variance) reflects Consumer Technology Anxiety including (primarily) anxiety about resetting digital clocks and programming a microwave oven. Two other items loaded on this factor to a much lesser extent — taking a test with a computer scoring sheet and watching someone work on a personal computer. These are all items that were not included in Marcoulides et al.'s (1985) earlier revision of the CARS.

Factor 3 (15.0% of the variance) involves a more passive or Observational Computer Learning Anxiety. Each item in this scale places students in a situation where they must either observe computer equipment (computer center, home computer), computer products (printouts), ramifications of computer technology (a movie about an intelligent computer), others working with computers, or use a consumer application of technology (automated banking machines) where others might be observing them. These items included some items found on Marcoulides et al.'s (1985) Computer Equipment factor plus other items not included on that measure that helped to broaden the meaning of this form of computer anxiety.

As expected, the three factors were intercorrelated with Factors 1 and 3, reflecting two ways of learning about computers, most highly related ($r = .67$), followed by Factors 2 and 3 ($r = .45$) and then Factors 1 and 2 ($r = .25$).

### *Crosscultural Comparison*

The next step was to test, for each country, the hypothesis that the true model structure was independent of the data being analyzed. The goal was to determine if different data sets provided different parameter estimates of the population matrix. A decision was made to compare each country sample's correlation matrix separately to the USA three-factor model. An alternative analysis procedure would have been to compare all country samples' correlation matrices to the USA three-factor model simultaneously in a multiple groups analysis. However, due to some small sample sizes and great sample size variability, this may have provided unstable parameter estimates (Jöreskog & Sorbom, 1985).

The top half of Table 3 presents the relevant goodness-of-fit statistics from application of LISREL VI (Jöreskog & Sorbom, 1985). Examination of these data indicates that first, all chi-square tests indicated significant differences from the USA three-factor model. Second, the ratio of $\chi^2$ to degrees of freedom (with an expected value of 2.0) is above 2.0 for all but one country sample. The Goodness-of-Fit Index (GFI; Jöreskog, 1971) and Bentler-Bonnett Index (BBI; Bentler & Bonnett, 1980), are all less than .90, which indicates that the model does not fit the data (Bentler & Bonnett, 1980; Jöreskog, 1971; Wheaton, Muthen, Alwin, & Summers, 1977). The Root Mean Square measures (RMS) are nearly all between .06 and .09, showing suspect residuals after fitting the proposed model. Thus, the data presented in Table 3 indicated a lack of fit of all country sample data to the USA three-factor model.

**Table 3. Goodness-of-Fit Measures for the Three-Factor USA Model of Computer Anxiety Across Each Country Sample**

| Country | $\chi^2$ | df | $\chi^2$/df | GFI | BBI | RMS |
|---|---|---|---|---|---|---|
| Original model fit | | | | | | |
| Japan | 852 | 166 | 5.13 | .809 | .759 | .077 |
| Australia | 731 | 166 | 4.40 | .797 | .744 | .128 |
| Germany | 464 | 166 | 4.29 | .863 | .827 | .062 |
| Hungary | 445 | 166 | 2.68 | .841 | .799 | .076 |
| Spain | 346 | 166 | 2.08 | .847 | .806 | .070 |
| Yugoslavia | 403 | 166 | 2.43 | .803 | .750 | .077 |
| Italy | 424 | 166 | 2.55 | .800 | .747 | .082 |
| Israel | 467 | 166 | 2.81 | .756 | .691 | .080 |
| Czechoslovakia | 317 | 166 | 1.91 | .803 | .750 | .077 |
| Model fit following automatic modification | | | | | | |
| Japan | 609 | 157 | 3.88 | .866 | .820 | .060 |
| Australia | 418 | 158 | 2.65 | .865 | .820 | .053 |
| Germany | 403 | 163 | 2.47 | .851 | .807 | .065 |
| Hungary | 385 | 157 | 2.45 | .859 | .812 | .067 |
| Spain | 286 | 158 | 1.81 | .869 | .823 | .058 |
| Yugoslavia | 305 | 159 | 1.92 | .854 | .807 | .067 |
| Italy | 348 | 158 | 2.20 | .827 | .770 | .070 |
| Israel | 391 | 159 | 2.46 | .794 | .729 | .064 |
| Czechoslovakia | 243 | 161 | 1.51 | .843 | .796 | .067 |

A secondary goal of this study was to determine differences in the meaning of computer anxiety in different country samples. Accordingly, the "automatic modification" function of LISREL VI (Jöreskog & Sorbom, 1985) was used to ". . . let the program automatically modify the model sequentially, by freeing in each step, that fixed parameter or that equality constraint, which corresponds to the largest modification index and continue to do so for as long as this index is statistically significant." (p. II.22).

In this analysis, all residuals were fixed and the number of factors were fixed at three. This decision to limit the number of factors was derived from previous research with similar measurement tools (Bandalos & Benson, 1990; Marcoulides et al., 1985). The bottom half of Table 3 shows the goodness-of-fit indices that were derived following the automatic modification process. In every case, automatic modification provided a model with a better fit than the proposed United States three-factor model of computer anxiety. The $\chi^2/df$ ratios for nearly all countries (except Japan) are approaching the expected value of 2.0 while the GFI and BBI statistics are approaching .90. It should be noted that despite the automatic modification process, all $\chi^2$ tests still showed significant departures from the modified model. This suggests that alternative models may require different dimensionality.

Table 4 displays the modified factor loadings with two stars (**) used to denote loadings of .50 or more and one star (*) used to indicate loadings between .30 and .49. The results in Table 4 are quite complex and are best described country by country.

***Germany***. The factor structure of the three samples from Germany presents a different factor structure from that of the United States sample. Factor 1 appears to represent an Interactive Computer Learning Anxiety factor that is limited to the act of learning to use the computer. This factor also includes moderate loadings for applying for a job with computer training (an act of learning) and visiting a computer center. It is more poignant that this Interactive Computer Learning Anxiety

**Table 4. Factor Loadings Following Automatic Modification of the USA Model**

| Computer Anxiety Item | Germany | | | Japan | | | Australia | | | Hungary | | | Italy | | | Spain | | | Israel | | | Czechoslovakia | | | Yugoslavia | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 |
| Write program | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | * | |
| Learn terms | ** | | | ** | | | * | | | ** | | | ** | ** | | ** | | | * | | | ** | * | | ** | | |
| Learn works | ** | | | ** | | | * | | | ** | | | ** | | | ** | | | ** | | | ** | * | | ** | | |
| Read manual | ** | | | ** | | | ** | | | * | | * | * | * | | ** | | | ** | | | ** | | | ** | | |
| Think about course | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | |
| Take course | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | ** | | | * | * | | ** | | |
| Error messages | | ** | * | | * | | ** | | | | * | | | * | | | | * | | | ** | | ** | | | ** | | |
| Erase material | | ** | | | ** | | ** | | | | | | | | | | * | | ** | | | * | | | | ** | | |
| Apply comp job | * | ** | | * | * | | ** | | | * | | | * | | | ** | | | | | ** | ** | | | ** | | | |
| Think buy PC | | | * | * | * | | ** | | | ** | | | ** | | | * | | | * | | * | ** | | | * | | | |
| Computer down | | ** | | | ** | | * | | | * | | | | | | ** | | | | ** | | * | | | | ** | | |
| Reset digital clock | | | | | | * | | ** | | | * | | | * | | | ** | | | ** | | | * | | | * | | |
| Microwave oven | | | * | | | ** | | ** | | | * | | | * | | | ** | | | ** | | | | | | * | | |
| Comp scored test | | | | | | * | ** | | | | * | | | * | | | | * | | ** | | | | ** | | * | | |
| Watch someone PC | | | ** | | | ** | | | ** | | | * | | | | | | * | | | ** | | * | | | | ** | |
| Computer printout | | | * | | | ** | | | * | | | ** | | | ** | | | ** | | | * | | ** | | | | ** | |
| Movie about computer | | | * | | | * | | | ** | | | ** | | | * | | | * | | ** | | | * | | | | * | |
| Visit computer center | * | | | | | * | | | ** | | | ** | * | | | * | | | | | ** | ** | * | | | | ** | |
| Sit front home computer | | | * | * | | * | | | * | * | | | | | ** | | | ** | | | * | * | | | | | ** | |
| Use auto banking | | | | | * | ** | | ** | | | | * | | ** | | | ** | | | | | | | ** | | | * | |

*Loading of .30–.49.
**Loading of .50+.
*Note.* F1 = Factor 1; F2 = Factor 2; F3 = Factor 3.

factor does not include any of the items that reflect computer problems. Instead, Factor 2 includes high loadings for getting error messages from the computer, erasing material from a computer file, and finding that the computer is "down" plus a high loading for applying for a job requiring computer training. This appears to reflect a Computer Victimization factor[1] where the students feel that they are somewhat at the mercy of the computer technology. Finally, Factor 3 is a rather weak factor that includes only one high loading (watching someone work at a personal computer) and several lower loadings for other aspects that might reflect an Observational Computer Anxiety factor. It is interesting that the German sample did not contain a separate Consumer Technology factor with some of the consumer-related items showing moderate loadings on the Observational Computer Anxiety factor and the others (automated banking, resetting digital clocks) completely absent from the factor structure.

***Japan***. The factor structure for the three samples from Japan shows some similarities and differences with the United States and Germany. The first factor clearly reflects an Interactive Computer Learning Anxiety factor that is quite similar to that of the German sample. This factor includes all items that are related to learning to use the computer plus applying for a job requiring computer training, thinking about buying a personal computer, and sitting in front of a home computer. Perhaps to the students from Japan, these three activities are synonymous with learning to use computers. Factor 2 is clearly a Computer Victimization factor that includes all of the same items as the German factor plus moderate loadings for thinking about buying a personal computer, visiting a computer center, and using automated banking. Finally, Factor 3 a combination of a Consumer Technology Anxiety factor plus an Observational Computer Learning Anxiety factor with high loadings for both observational-type activities (examining a computer printout or watch someone work on a personal computer) and consumer technology behaviors (using automated banking or programming a microwave oven). This latter loading is particularly interesting, since a recent report indicated that 65 out of 100 Japanese homes have microwave ovens (Keizai Koho Center, 1989) while only 26% of the sample had used programmable microwave ovens at least once (Weil & Rosen, 1995).

***Australia***. The factor structure for the sample from Australia is quite similar to that of the United States. Factor 1 includes all of the same interactive computer learning items (including all computer problem items) plus taking a test with computer scoring. Factor 2 is a Consumer Technology Anxiety factor that includes strong loadings for all three consumer technology items (digital clocks, microwave ovens, and automated banking). Factor 3 includes the same observational computer anxiety items as the USA sample with the exception of automated banking.

***Hungary***. Factor 1 is clearly an Interactive Computer Learning Anxiety factor that includes all of the computer-learning items but does not include getting error messages or erasing material from a computer. Similar to the structure for the Japanese samples, sitting in front of a home computer is considered as part of the Interactive Computer Learning Anxiety factor. Factor 2 for the Hungarian samples includes four moderate loadings that resemble a weak Computer Victimization factor with resetting digital clocks, programming microwave ovens, and taking computer-scored tests included. Finally, Factor 3 is an Observational Computer Learning Anxiety factor that includes the same items as the USA factor except for sitting in

front of a home computer (which is part of Factor 1). In addition, there is a moderate loading for reading a computer manual.

***Italy***. The Interactive Computer Learning Anxiety factor for the Italian sample included items that assess anxiety about directly learning computer operations plus visiting a computer center. This factor does not include any of the items that appear in a Computer Victimization factor. Instead, Factor 2 includes getting error messages plus a variety of items that might comprise such a factor (learning terminology, reading computer manuals, resetting digital clocks, programming microwave ovens, taking computer scored tests, and using automated banking machines). Factor 3 is an abbreviated Observational Computer Learning Anxiety factor that includes only three items — reading a computer printout, sitting in front of a home computer, and watching a movie about an intelligent computer. Erasing material from a computer file, having the computer be "down," and watching someone work on a personal computer did not load on any factor.

***Spain***. For this country sample the Interactive Computer Learning Anxiety factor includes strong loadings for all learning experiences plus applying for a job requiring computer training and having the computer be "down" and moderate loadings for thinking about buying a personal computer and visiting a computer center. Factor 2 is a Consumer Technology Anxiety factor with strong loadings for all three consumer items plus a moderate loading for erasing material from a computer file. The inclusion of this item may suggest that this factor reflects consumer technology victimization anxiety. Finally, Factor 3 reflects an Observational Computer Anxiety factor plus a moderate loading for getting error messages that may suggest that this factor also has a victimization component.

***Israel***. Factor 1 is an Interactive Computer Learning Anxiety factor that includes all items that reflect active computer learning, erasing material from a computer file, and thinking about buying a personal computer. Factor 2 appears to reflect a combined Computer Victimization And Consumer Technology Anxiety factor including the computer being "down," digital clocks, microwave ovens, computer-scored tests, and movies about intelligent computers. Factor 3 may be viewed as another Computer Victimization factor that includes getting error messages, applying for a job requiring computer training, watching someone work on a personal computer, and visiting a computer center. As with the sample from Germany, automated banking anxiety did not load on any factor.

***Czechoslovakia***. The factor structure for Czechoslovakia includes all of the items from the USA Interactive Computer Learning Anxiety factor with the exception of getting error messages. This factor also includes both visiting a computer center and sitting in front of a home computer. Factor 2 includes two high loadings for getting error messages and viewing a computer printout and moderate loadings for seven other items that do not appear to present a unified theme. Factor 3 has two high loadings for taking a computer-scored test and using automated banking.

***Yugoslavia***. The structure for this country appears to clearly indicate an Interactive Computer Learning Anxiety factor that includes applying for a job requiring computer training but does not include computer problems; a Consumer Victimization Factor that includes all consumer items and all computer problem items; and an

Observational Computer Learning Anxiety Factor that is similar to that of the United States sample.

### *Overall Computer Anxiety*

Table 5 displays the means and standard deviations of the Computer Anxiety Rating Scale (Form C) for all countries. An analysis of variance demonstrated that these means differed significantly ($F(9, 2426) = 31.42$, $p < .0001$) while Scheffé's test indicated that Japan had significantly higher computer anxiety than any other country sample. The sample from Czechoslovakia did not differ from the sample from Italy, but did have significantly higher CARS scores than all other country samples. The remainder of the country samples did not differ from each other. In addition, Cochran's Test indicated that the variances, with a maximum/minimum ratio of 1.99, did not differ significantly ($p > .05$).

## DISCUSSION

Students in the United States displayed a straightforward three-factor model of computer anxiety that included the interrelated factors of Interactive Computer Learning Anxiety, Consumer Technology Anxiety, and Observational Computer Learning Anxiety. The final three-factor model for each country produced interesting differences in each country's experience of computer anxiety.

### *Interactive Computer Learning Anxiety*

The United States model suggested that university students were anxious about a variety of computer interactions that were subsumed under this first factor. The 11 items in this factor encompassed learning to use computers, taking courses, reading manuals, receiving error messages, erasing materials from computer files, applying for a job with computer training, thinking about purchasing a personal computer, and being told that the computer is "down." Each country displayed a first factor with some, but not all, of these components plus, in some cases, additional anxiety-provoking items.

**Table 5. Mean and Standard Deviation for CARS-T Ten Countries**

| | Computer Anxiety (CARS-T) | |
|---|---|---|
| Country | Mean | *SD* |
| USA | 37.93 | 14.16 |
| Yugoslavia | 37.16 | 11.07 |
| Spain | 38.84 | 11.15 |
| Japan | 47.76 | 14.67 |
| Italy | 42.00 | 12.32 |
| Israel | 32.14 | 10.40 |
| Hungary | 38.03 | 10.90 |
| Germany | 36.95 | 12.24 |
| Czechoslovakia | 45.35 | 12.64 |
| Australia | 38.15 | 12.21 |

*Note.* Higher CARS-T scores indicate higher computer anxiety (possible range = 20–100).

The most similar factor structure belonged to Australia, where all 11 items were included plus the addition of the anxiety aroused by taking a computer-scored test. All other Interactive Computer Learning Anxiety factors showed a different set of items than the USA factor of the same name. Two commonalites were evident. First, some or all of the items that referred to specific problems with computers were not found in this factor. Anxiety about getting error messages was absent from all eight, anxiety about erasing material from a file was missing from six of the eight, and anxiety about being told that the computer is "down" was not included in five countries' Interactive Computer Learning Anxiety factors. The only other items that were removed from the Interactive Computer Learning Anxiety factor during modification were anxiety about applying for a job requiring computer training (Israel) and anxiety about purchasing a personal computer (Germany).

Two other items from the Observational Computer Learning Anxiety factor were added during the modification process for some countries. Anxiety about visiting a computer center appeared to reflect direct computer interaction for the university students from Italy, Spain, and Germany and a combination of direct and observational computer interaction for the students from Czechoslovakia. Anxiety about sitting in front of a home computer was seen as more interactional than observational for students from Czechoslovakia and Hungary and a combination of the two for the students from Japan.

Overall, the variation in this first factor suggests that learning to use computers through direct interaction has a different meaning to students from different countries. For university students in the United States and Australia, learning to use computer technology includes encountering and dealing with problems. For all other students, learning to use a computer did not include encountering problems but did include visiting a computer center or sitting in front of a home computer.

### *Computer Victimization Factor*

These subtle but clear differences suggest that interactions with computers are not the same from country to country. Regardless of the level of computer anxiety, different actions are seen as direct computer interactions for different students. The most striking difference is the differentiation of Interactive Computer Learning and what may be viewed as a Computer Victimization factor. This factor appears in some form for eight of the country samples (excluding the United States and Australia) and includes, as a defining item, anxiety about getting error messages from the computer. Beyond this, the Computer Victimization factor contains a unique combination of items for each country.

For the samples from Germany and Japan the Computer Victimization factor includes all three items that deal with computer problems (error messages, erasing material, and computer "down") plus anxiety about applying for a job that requires computer training. The Japanese Computer Victimization factor also includes moderate loadings for visiting a computer center and using automated banking. Interestingly, for the German sample, anxiety about getting error messages also loaded on the third factor that included anxiety items from all three USA factors.

For the Japanese and German students, there may be a strong separate issue of feeling like a victim amidst the explosion of computer technology in their two highly industrialized nations. This may also reflect the value placed on "precision" that is seen as characteristic of these two countries.

These thoughts were echoed by Vine (1985) in his international comparative public opinion survey conducted by Louis Harris Survey Agency of France. Vine concluded that "Despite its renowned industrial efficiency and expertise, Germany has one of the lowest rates of usage of computers and word processors and is the most apprehensive about their application. Germans responded more negatively to every question in the survey than the populations of all the other countries with the exception of Japan." Vine also concluded that "Despite its industrial strength and technological expertise, Japan shows a low level of utilization of information processing systems, one of the lowest of the countries surveyed. . . . the Japanese demonstrate a general lack of exposure to information technology, which could be a cause of their malaise with the systems." (p. 22)

For both the United States and Australian samples, receiving computer error messages, having to erase computer information, and finding the computer "down" are seen as synonymous with learning to use the computer. Even though they may give rise to anxiety, they are seen as part of the learning process. However, in other countries, these computer problems seem to group with other anxiety-provoking situations. In Germany, Japan, and Israel, computer problems are grouped with anxiety about applying for a job that requires computer training. This is hardly surprising, given the advanced industrial computerization in these countries. In the remaining countries, the computer problems group with quite a variety of other anxiety-provoking items including consumer technology and other observational and interactive computer learning items. Each provides its own unique Computer Victimization factor that must be examined carefully to assess the breadth and depth of this fear of being victimized by technology. For example, in both Yugoslavia and Hungary, getting computer error messages forms a group with three consumer items — resetting a digital clock, programming a microwave oven, and taking a computer-scored test — while in Italy this item forms a cluster with these same three items plus anxiety about using an automated banking machine, learning computer terms, and reading a computer manual.

In summary, students in many countries, view encountering problems with a computer as a separate (and troubling) issue from learning to use a computer. The factor structure from each country, except the United States and Australia, indicated that students were feeling victimized not only by the computer, but by other aspects of technology including job prospects and computerized consumer gadgets.

### *Observational Computer Learning Anxiety*

For students in the USA sample, Observational Computer Learning Anxiety included watching someone work on a personal computer, viewing a computer printout, watching a movie about an intelligent computer, visiting a computer center, sitting in front of a home computer, and using an automated banking machine. In only one country (Yugoslavia) was this factor reproduced with no additions or deletions. For the remaining countries, this factor appeared with modifications including deletions (ranging from a single item to deletion of half the items) and additions (ranging from zero to five items).

The most common omissions were anxiety about visiting a computer center (by four countries) and anxiety about using an automated banking machine (by six countries). Visiting a computer center was often seen, not as Observational Computer Learning as with the USA students (who can just watch operators work at a computer center during a visit), but as either Interactive Computer Learning Anxiety by German, Italian, and Spanish students (where visit implies interaction

with the computers at the center) or as Computer Victimization Anxiety by Japanese students (who may feel that they are forced to interact with the computers when visiting the center). In many countries, the student's first view of a computer occurs during a visit to a computer center. For students in the USA, this is viewed as simply observing the computer being used, while for students in other countries it represents more direct interactional experiences.

Using an automated banking machine was either seen as Consumer Technology Anxiety (by Australia, Italy, and Spain), was absent from all factors (Germany and Israel), or was in a factor with a single other item (Czechoslovakia). It is interesting that students in the USA, Hungary, Yugoslavia, and Japan felt that using an automated banking machine elicited observational anxiety. Perhaps these students feel intimidated when other people are watching them use this relatively new banking system and their anxiety comes not from the direct interaction with the machine, but from the concern over being observed. It is fascinating that the Japanese students felt that this anxiety belonged both to the Observational Computer Learning and the Computer Victimization Factors. Perhaps these students feel uncomfortable with the long lines waiting to use the ATM and also feel as though they are forced to wait in these lines because their busy school schedule does not make it possible to transact banking during regular banking hours.

Nearly every other CARS-C item appeared as an addition to the Observational Computer Learning Anxiety factor for at least one country. Taken together, these additions and deletions from the USA Observational Computer Learning Anxiety factor suggest that for each country students have a different view of what it means to learn computers by observation. This is particularly important for countries where school students do not have the luxury of directly interacting with computers, but must observe someone else (teacher, computer specialist) doing the direct keyboard activity. Simply viewing someone else working rapidly on a computer may make a student feel incompetent and anxious and may inhibit future learning via computer.

### *Consumer Technology Anxiety*

Consumer technology anxiety, for students from the USA included resetting a digital clock, programming a microwave oven, taking a computer-scored test, and watching someone work on a personal computer, with the first two items (digital clock setting and microwave oven programming) accounting for most of the variance. In nearly all country samples (except Germany and Czechoslovakia) these two items were evident in the Consumer Technology Anxiety factor. However, the similarity ended there. In five country samples (Germany, Czechoslovakia, Yugoslavia, Italy, and Hungary) anxiety about getting an error message was seen as part of Consumer Technology Anxiety, while for four countries (Japan, Australia, Italy, and Spain) Consumer Technology Anxiety included using an automated banking machine. Other items that appeared more than twice included anxiety about watching a movie about an intelligent computer (four countries) and anxiety about viewing a computer printout (three countries).

People's lives are so intricately intertwined with technology that it is likely that the items on the CARS do not adequately capture the vast amount of "personal" technology that makes people anxious on a daily basis. It is likely that had the CARS asked questions about anxiety aroused by the types of technology that people find in their homes, their cars, their stores, and the rest of their lives, one might expect to find a Consumer Technology Anxiety factor that varies from country to

country as available technology differs. For example, while over 75% of all Americans and well over half of all Germans, Japanese, and Australians own telephones less than 30% of all Czechoslovakians, Yugoslavians, and Hungarians have these conveniences in their homes (Kurian, 1990). The same can be said of televisions (ranging from over 80% of the USA homes to less than 25% of the Yugoslavian homes), radios (ranging from over two per home in the United States to less than one in four homes in the Eastern Bloc countries), and even automobiles (owned by one in two adults in the USA, Germany, and Australia and only one in seven or eight adults in Eastern Bloc countries and Israel).

It is a myth to believe that just because a type of technology is available to nearly everyone, it will lose it's apprehensive qualities. For example, consider all of the videocassette recorders that blink 12:00 and only play prerecorded tapes (estimated to be in nearly half the American homes; Sweet, 1990) because their owners are anxious about using any of the computerized functions.

Thus, it appears that students in each country had their own consumer technology worries. For some students, this concern was more widespread and intertwined with a feeling of being victimized, while for others it was related to specific forms of technology. Regardless of the specifics, consumer technology poses a problem that is unique to each country.

### *Limitations*

This study was not performed to definitively identify the "exact" cultural representation of computer anxiety in each country. Rather, it was intended to demonstrate that the construct of computer anxiety has different meanings in different cultures and that those meanings may suggest differences in how technology will be assimilated into a given country.

There are several serious limitations to using the results of the present research to define the precise cultural interpretation of computer anxiety. First, there was no attempt to gather samples representative of all university freshmen in a particular country. This study is not meant to suggest that student data collected from six universities can represent students from more than 3,400 universities in the United States or that the three university samples can represent all universities in Japan (over 1,000) or Australia and Germany (approximately 100 each). Further, in three countries, only one university sample was collected and in another three only two samples were used. In spite of these sampling limitations, this study has provided a unique view of the cultural differences in the construct of computer anxiety in ten nations. Even without any assurance of representativeness, the results must be viewed as indicative of cultural differences that are deserving of additional study and understanding.[2]

A second limitation concerns sample sizes. As Boomsma (1982) suggests, sample sizes of 200 per group are recommended for multiple group analyses using Confirmatory Factor Analytic techniques. Five countries in this study had sufficient sample sizes but the other five were below 200. This may pose a problem for the use of this mathematical technique, particularly given the sensitivity of the $\chi^2$ statistic to sample size. This same statistic is also sensitive to nonnormality issues that were not tested in this study.

A third potential limitation concerns differences in age and gender among the ten countries. Based on past literature (Rosen & Maguire, 1990), there is some evidence that each of these characteristics is related to computer anxiety to a small degree and this may have affected the results of this study. Further, both Vine (1985) and

Collis and Williams (1987) reported gender differences in their crosscultural comparisons. Perhaps with larger samples of male and female university students in each country within-culture, crossgender comparisons could be examined.

A fourth limitation concerns the actual CARS translations in six countries. No controls were performed to check for the adequacy of these translations nor were back translations done in any systematic fashion. In addition, no assessment was made of the English proficiency of the Czech and Yugoslavian students who answered their questionnaires in English. As pointed out by Hocevar and El-Zahhar (1992), these issues may present interpretation problems. However, in all cases, translations were done with care and with some (unsystematic) back translation and English versions were used only with students who were proficient in that language.

A fifth potential shortcoming of this study concerns the limitation of each country's model to three factors during automatic modification. Based on earlier work with similar types of measures (e.g., Bandalos & Benson, 1990; Marcoulides et al., 1985) that found either two or three factors, this decision appears to have sufficient support.

### *Implications*

The results of this study present a picture of crosscultural conceptions of computer anxiety. These differences in the perception of computer anxiety may have a subtle to sometimes profound impact on how students in a particular country learn about computers.

This study has demonstrated clearly that computer anxiety is not a culture-free construct. It means very different things to students around the world. For some, the act of learning about computers includes dealing with all of the problems encountered along the way, while for others, computer problems are difficult and frustrating. Observing computer interactions has a different meaning in each country, with some students feeling worried about visiting computer centers or even being watched while they transact business at an automated banking machine. Finally, technological gadgets pose different problems for students in different countries.

These different cultural perceptions of computer anxiety can be understood by examining when and how computers and computerized technology are introduced to the student. In some countries, computers are introduced as early as children begin to attend school (e.g., USA, Israel, Australia, Germany, Japan), while in others, computers are even rare on university campuses (e.g., Yugoslavia). As suggested by the various factor structures, some students equate visiting a computer center with the same anxiety as if they are actually learning to interact with the computer themselves. For some students, having problems while they are learning to operate a computer is part of the learning process itself. For others, it is a totally different area of concern. Many groups of students equate learning to use the computer with envisioning a future job that requires computer training, while others link this future job with computer problems and difficulties. These differences are crucial in the way students are taught about technology. If computer error messages and other problems are a separate entity to a group of students, then that issue needs to be made a priority in initial introductions to the computer. If the lack of computer facilities necessitates that students must learn by a more observational style rather than a direct interactive style, other (different) anxiety-provoking issues may need to be addressed.

Another issue concerns software. Often software is written with little emphasis on the user. This is most often manifested in a poor user-interface, which places undo burden on the user to determine which actions are required and/or appropriate. In addition, when the software does not work according to specifications, the user is required to read a manual that itself arouses considerable anxiety. These problems are compounded by the different perspectives shown in the ten countries toward Interactive Computer Learning Anxiety. In countries where computer problems and learning are interconnected, this needs to be integrated into the software and the manual. In other countries, where computer difficulties are a separate issue or concern, the software needs to be created with special attention to errors and error messages. The manual also needs to address this issue carefully and prominently.

Computer hardware itself can generate a considerable amount of anxiety (Marcoulides & Wang, 1990). This study suggests that the hardware must also be tailored to the types of computer anxiety that students exhibit. In particular, the issue of Computer Victimization that arose in many country samples suggests that computer hardware that is more user-friendly and forgiving may help the student learn in a more comfortable fashion.

Finally, this study examined freshman university students only. With computer education in the United States and other countries beginning as early as elementary school, it is imperative that similar comparisons be done to expose the factor structure of younger students and of their teachers. With this information, better early intervention strategies can be developed to make computer education more effective (Weil et al., 1990).

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## NOTES

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[2]See Oyen's (1990) excellent book for a complete discussion of the value and limitations of comparative methodologies.

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