RELATIONSHIP BETWEEN READING ABILITY AND STATISTICS ANXIETY AMONG AFRICAN-AMERICAN GRADUATE STUDENTS: IMPLICATIONS FOR THE TEACHING AND LEARNING OF STATISTICS

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The several antecedents of statistics anxiety that have been identified, at best, identify students who are at risk for debilitative levels of statistics anxiety, thereby having only minimal implications for intervention. Further, these few interventions have tended to be teacher-centered rather than student-centered. The area of reading ability appears to offer a viable avenue for research on the antecedents of statistics anxiety. Because statistics textbooks often present complex material, students with low reading ability possibly are prone to experience high anxiety levels. To date, this link has not been formally investigated. Thus, this study examined whether reading ability predicts statistics anxiety levels among 92 African-American graduate students. A canonical correlation analysis revealed a strong multivariate relationship between reading ability and statistics anxiety. Instructional implications are discussed.

INTRODUCTION

The anxiety experienced by students who are enrolled in statistics courses is commonly referred to as statistics anxiety. Generally speaking, statistics anxiety is experienced by college students who have a limited background in quantitative research and statistics and who are enrolled in a course that requires that they analyze data utilizing statistical concepts and techniques (Onwuegbuzie, 1997; Sutarso, 1992). Zeidner (1990) described the feeling exhibited by statistics-anxious students as involving

> extensive worry, intrusive thoughts, mental disorganization, tension, and physiological arousal…when exposed to statistics content, problems, instructional situations, or evaluative contexts, and is commonly claimed to debilitate performance in a wide variety of academic situations by interfering with the manipulation of statistics data. (p. 319)

Although several antecedents have been identified, many of these factors are relatively immutable (e.g., gender, race, age), and thus, at best, identify students who are at risk for debilitative levels of statistics anxiety, thereby having only minimal implications for intervention.

The area of reading ability, comprising reading comprehension and reading vocabulary, appears to offer a viable avenue for research on the antecedents of statistics anxiety. Indeed, recently, reading ability has been found to be significantly related to student achievement in graduate-level research methodology and statistics courses (Collins and Onwuegbuzie, 2002; Onwuegbuzie, and Collins, 2002). Most notably, reading comprehension was found to be a strong predictor of students' ability to write up statistical results (Collins and Onwuegbuzie, 2004). Because students typically find that statistics textbooks present complex material, it is likely that a student with low reading ability is particularly prone to experience high levels of statistics anxiety.

READING ABILITY AND STUDENTS' RESEARCH EXPERIENCES

Onwuegbuzie and Collins (2002) documented that graduate students' scores on the Nelson-Denny Reading Test (NDRT; Brown, Fishco, and Hanna, 1993) were statistically significantly higher than were the normative sample of undergraduates (Brown *et al*., 1993). However, a small percentage of the graduate students' scores were extremely low in contrast to the normative sample. Disturbingly, several graduate students' scores pertaining to reading comprehension and reading vocabulary represented the 14th percentile and 24th percentile, respectively. Utilizing NDRT scores attained by a different sample of graduate students, Collins

and Onwuegbuzie (2002) reported a relationship between graduate students' understanding of research concepts, methodologies, and applications and students' reading abilities--with reading comprehension being the primary contributor to the model.

Recently, research has been conducted that examines the impact of reading ability on academic achievement of African-American graduate students in the context of research methodology courses (Collins and Onwuegbuzie, 2002/2003, 2004). Collins and Onwuegbuzie (2002/2003) replicated the methodology used in an earlier study (i.e., Collins and Onwuegbuzie, 2002) utilizing a sample of African-American graduate students. Multivariate analyses revealed that reading abilities (i.e., reading comprehension and reading vocabulary) were simultaneously related to African-American graduate students' achievement levels in a research methodology course. Results also indicated that 11.75% of the graduate students obtained scores that represented the first percentile of Brown *et al.*'s (1993) undergraduate norms. To expand the research in the area of reading ability among African-American graduate students, the purpose of the present study was to examine whether reading ability predicts levels of statistics anxiety.

METHOD

Participants were 92 African-American graduate students enrolled in several sections of a statistics course at a Historically Black College and University located in the eastern section of the United States. The participants (82.22%) were primarily female. Ages of the participants ranged from 22 to 62 years (M = 28.62, SD = 7.40). The number of research methodology courses previously taken by the sample members ranged from 0 to 9 (M = 2.26, SD = 1.95), with 15.7% of the participants having taken none. Similarly, the number of statistics courses taken by these individuals ranged from 0 to 5 (M = 1.56, SD = 1.16), with 18.0% of the sample members never having taken a statistics course. Also, the number of college-level mathematics courses taken by these individuals ranged from 0 to 9 (M = 3.07, SD = 2.07). Final grades predicted by students ranged from 70 to 100 on a 100-point scale (M = 90.00, SD = 6.36).

Participants were administered the Statistical Anxiety Rating Scale (STARS) and the NDRT (Form G) on the first day of class. The STARS, which was developed by Cruise and Wilkins (1980), is a 51-item, 5-point Likert-format instrument assessing statistics anxiety in a wide variety of academic situations. The STARS has six subscales. A high score on any STARS subscale represents high anxiety in that area. For the present study, the reliability of the STARS subscale scores, as measured by coefficient alpha, was as follows: worth of statistics (.93; 95% confidence interval [CI] = .91, .95), interpretation anxiety (.90; 95% CI = .87, .93), test and class anxiety (.90; 95% CI = .87, .93), computational self-concept (.87; 95% CI = .82, .91), fear of asking for help (.85; 95% CI = .79, .89), and fear of the statistics instructor (.78; 95% CI = .70, .89). The NDRT was utilized in this investigation to measure reading vocabulary and reading comprehension. This instrument, developed by Brown *et al*. (1993), is a 118-item test divided into two subtests, Vocabulary, which consists of 80 items, and Comprehension, which consists of 38 items and seven reading passages. Each item on the NDRT contains a five-choice response option. For the present investigation, score reliability, as measured by KR-20, was .93 (95% CI = .91, .95) for the reading vocabulary test and .78 (95% CI = .71, .84) for the reading comprehension test.

RESULTS

Canonical correlation analysis was used to determine the degree to which the reading ability variables were related to the statistics anxiety dimension scores (i.e., worth of statistics, interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, fear of the statistics instructor). Canonical correlation analyses provide indices of both statistical significance and practical significance. The canonical analysis revealed that both canonical correlations combined were statistically significant ($p < .05$). However, when the first canonical root was excluded, the remaining canonical root was not statistically significant. Together, these results suggested that the first canonical function was statistically significant, but the second canonical root was not statistically significant. Indeed, the first canonical correlation (R_{c1} = .42) was moderately educationally significant, contributing 17.7% (i.e., R_{c1}^2) to the shared variance.

However, the second canonical correlation (R_{c2} = .20) did not appear to be educationally significant. Consequently, only the first canonical correlation was interpreted.

An examination of the standardized canonical function coefficients revealed that, using a cutoff correlation of 0.3 recommended by Lambert and Durand (1975) as an acceptable minimum loading value, reading comprehension (1.11) made a significant contribution to the statistics anxiety composite. With respect to the statistics anxiety set, worth of statistics (-.49), interpretation anxiety (-.82), computational self-concept (.96), and fear of asking (-.45) for help made important contributions to the composite set, with computational self-concept and interpretation anxiety making by far the largest contributions, respectively. The structure coefficients indicated that both reading ability dimensions made important contributions to the first canonical variate. The square of the structure coefficient indicated that reading comprehension and reading vocabulary made very large contributions, explaining 98.01% and 50.41% of the variance, respectively. With respect to the statistics anxiety set, interpretation anxiety, fear of asking for help, and test and class anxiety made noteworthy contributions, with interpretation anxiety and fear of asking for help making the largest contribution—both explaining 43.56% of the variance.

Comparing the standardized and structure coefficients showed worth of statistics and computational self-concept served as suppressor variables because their standardized coefficients were large, whereas their structure coefficients were relatively small (Onwuegbuzie and Daniel, 2003). Also, although it played a role in the multivariate relationship between reading ability and statistics anxiety, test and class anxiety appeared to be collinear with at least one of the other statistics anxiety variables because its standardized coefficient was near-zero but its structure coefficient was somewhat significant. Similarly, reading vocabulary appeared to be somewhat collinear with reading comprehension.

DISCUSSION

The finding that reading ability had the strongest relationship with interpretation anxiety has intuitive appeal because it suggests that students with the poorest reading skills are more likely to experience anxiety when confronted with making a decision from or interpreting statistical data. The relationship between reading ability and statistics anxiety found in the current investigation is consistent with researchers (e.g., Baker, 1989) who have found that domain expertise is essential for use of adequate reading comprehension strategies. As noted by Baker (1989), in an attempt to understand the text, readers who are not familiar with a content domain often rely on word understanding, instead of using effective comprehension strategies. Unfortunately, students find the statistical information that appears in statistics outputs to be very different from the typical text that they have to negotiate throughout their degree programs (Onwuegbuzie, DaRos, and Ryan, 1997). Consequently, it is likely that for many African-American graduate students enrolled in these classes, effective comprehension strategies are replaced by word understanding, leading to high levels of interpretation anxiety. The strong relationship also found between reading ability and fear of asking for help might help to explain why some students exhibit help-seeking avoidance behaviors. Unfortunately, students who need assistance typically are the least likely to seek help, yielding an inverse relationship between help-seeking and the need for assistance (Karabenick and Knapp, 1988).

The current investigation indicates that for African-American graduate students in general and African-American female graduate students in particular, at the very least, reading ability may play an important role in the statistics learning context. Moreover, the fact that reading comprehension and reading vocabulary scores predict statistics anxiety suggests that poor reading ability can place a student at risk for both statistics anxiety and underachievement in statistics courses.

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