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Quantifying and Interpreting Group Differences in Interest Profiles

Patrick Ian Armstrong,[1] Nadya A. Fouad,[2] James Rounds,[3] and Lawrence Hubert[4]

Abstract

Research on group differences in interests has often focused on structural hypotheses and mean-score differences in Holland's (1997) theory, with comparatively little research on basic interest measures. Group differences in interest profiles were examined using statistical methods for matching individuals with occupations, the C-index, *Q* correlations, and Euclidean distance measures. Profile similarity across U.S. racial-ethnic groups was evaluated with students and employed adults who completed the General Occupational Themes (GOT) and Basic interest scales (BIS) of the Strong Interest Inventory (SII). Obtained results suggest that profile shape varies systematically by gender and employment status, with the Euclidean distance measure being more effective than *Q* correlations for representing these differences and *Q* correlation more effective than the C-index. Group differences in interest profiles may lead to men and women receiving differential feedback on the fit between their interests and different careers, which may contribute to gender differences in the pursuit of careers in the fields of science, technology, engineering, and mathematics.

Keywords

profile similarity, racial-ethnic group differences, human sex differences, interest assessment, multidimensional scaling

Holland (1959, 1997) proposed that individuals can be matched to career choices using six interest-based categories: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C), collectively referred to by the first-letter acronym RIASEC. Holland's theory currently stands as the dominant model used in applied settings such as career counseling to help individuals with career-related choices (Campbell & Borgen, 1999; Rayman & Atanasoff, 1999). A number of techniques have been developed to evaluate congruence between an individual's

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interests and future career choices based on Holland's (1959, 1997) theory of interest types (Brown & Gore, 1994; Rounds & Day, 1999). Although the structural hypotheses of Holland's model and mean-level differences in RIASEC scales have been examined, there is limited research on group differences in profile shape and the impact this may have when linking interests to career options. If the scores obtained on RIASEC-based measures vary systematically by gender and across racial-ethnic groups, it follows that individuals from different groups will receive different feedback when these measures are used to help identify career choices and clarify future aspirations. In the current study, we investigate this issue by examining the extent to which group differences in profile shape are represented in measures of RIASEC congruence and profile similarity.

In addition to Holland-based measures, interests can also be assessed using measures of basic interests, which measure interest in homogenous sets of work activities that are narrower than the broad RIASEC types (Day & Rounds, 1997). Donnay and Borgen (1996) found that basic interests may reflect the multidimensional nature of work more effectively than Holland-based measures. However, when compared to Holland's theory, there is comparatively little research on using basic interests to match individuals to career choices. Therefore, in addition to examining group differences in profile similarity at the RIASEC level, we will extend the analyses to include basic interests. Additionally, we will examine how gender and group differences in interest profiles may affect the career choices and other feedback presented to members of diverse populations when interest measures are used for assessment purposes and in person-environment fit research by examining the range of agreement between groups by matching interest profiles to a set of 102 occupations.

Interests and Career Choices

Vocational interest measures are effective tools for predicting the current majors and future aspirations of students (Gasser, Larson, & Borgen, 2004, 2007), the current occupations of employed adults (Donnay & Borgen, 1996; Larson & Borgen, 2002), and the occupations chosen by students for their careers up to 23 years later (Hansen & Campbell, 1985). When Holland-based measures such as the strong interest inventory (SII; Donnay, Morris, Schaubhut, & Thompson, 2004; Harmon, Hansen, Borgen, & Hammer, 1994) or the self-directed search (SDS; Holland, Fritzsche, & Powell, 1997) are used for assessment purposes in applied settings, scores obtained on the six RIASEC scales are often summarized as a three-letter code. In career counseling, this code represents a category of occupations that can be used as a starting point for exploring occupations (Holland, 1997). For example, if an individual's three highest interests scores are for the Investigative, Social, and Artistic scales, then their three-letter code would be ISA, with the first letter representing the strongest area of interest, the second letter the second strongest interest, and so forth.

The concept of assigning three-letter codes is straightforward, but in practice, the process of assigning and interpreting codes can become more complicated. For example, with the SII, a three-letter code is assigned to an individual's results on the measure based on the three highest General Occupational Theme (GOT) scores obtained. In some cases, however, the individual may have a *depressed* or *flat* profile, and they will not receive a Holland code (see Donnay et al., 2004; Harmon, et al., 1994). It is also the case that a code may be given with less than three letters, depending on the number of GOT scales with low scores. When moving from the individual's Holland code to the world of work, due to similarities in the occupations listed in categories with similar codes (i.e., ISA and SIA, RIC and IRC, etc.) it is recommended that the exploration of occupations be expanded to include permutations of the code obtained by an individual. The RIASEC code-based approach for identifying occupations is not always effective in applied settings because the distinctions between categories with similar codes are somewhat arbitrary and may be confusing to clients. As noted by

Holland, Powell, and Fritzsche (1997), "Unfortunately, clients often look only for occupations whose codes are identical to their own" (p. 20).

Holland (1997) defines congruence as the degree of compatibility between an individual's interests and the characteristics of a work environment, as measured using the RIASEC typology. Holland's recommended use of three-letter codes has led to disagreements over the best way to measure congruence, with different formulas been put forward to quantify Holland's method. For the SDS, Holland, Powell, et al. (1997) recommend using a number of different formulas, including the Hexagonal model index, the Zener-Schnuelle index (Zener & Schnuelle, 1976), and the Iachan agreement index (Iachan, 1984). Brown and Gore (1994) reviewed the mathematical formulas and distributions of the various congruence indices that have been proposed, and developed their own measure, the C-index. Of the various measures proposed, the C-index appears to be the most effective across the full range of possible congruence scores, although it requires modification when using codes of unequal lengths (Eggerth & Andrew, 2006).

Basic Interests and Congruence

Basic interest scales (BIS) group together work activities to transcend specific situations or job descriptions by identifying shared properties of occupations such as context, setting, objects of interest, and processes. As noted by Day and Rounds (1997), in comparison to RIASEC scales, basic interests allow for finer distinctions between areas of vocational interests. When examining the validity of the BIS of the 1994 edition of the SII, in comparison to the Holland-based GOTs, Donnay and Borgen (1996) found the BIS to be the most valid predictors of occupational group membership, and concluded that "Basic interest scales more effectively deal with the reality of a complex multivariate space" (p. 288). However, the BIS in this inventory are described as subdivisions of the six Holland RIASEC types (see Harmon et al., 1994, p. 69), and when SII results are presented to individuals, basic interest scores are grouped by Holland type. Despite the potential utility of basic interests, there has been little research examining how individuals can be matched to occupations on the basis of their basic interests (Rounds & Day, 1999). Additionally, congruence measures equivalent to the RIASEC-based C-index (Brown & Gore, 1994) have not been developed for basic interests.

Profile Shape and Group Differences

Studies of the between-gender and cross-cultural validity of measures based on Holland's RIASEC model have typically focused on either the structural order predictions in the theory (Armstrong, Hubert, & Rounds, 2003; Day, Rounds, & Swaney, 1998; Fouad, Borgen, & Harmon, 1997) or have examined mean-score differences between groups (Betz, Harmon, & Borgen, 1996; Fouad, 2002). Although this research provides important validity evidence for Holland's model, the larger question of how group differences in RIASEC interest scores may affect the results obtained in career counseling assessments is not addressed. The order hypothesis in the Holland model is based on degree of similarity: Investigative and Artistic are more similar than are Realistic and Social. This difference is represented spatially by the distance between each type in the model and is measured by the correlation between RIASEC scales (see Holland, 1997, pp. 34-36). According to Holland's model, the correlation between I and A measures should be higher than the correlation between R and S measures, but this does not tell us anything about the number of individuals with Investigative, Artistic, Realistic, or Social interests. A positive correlation between I and A indicates that some individuals like both Investigative and Artistic occupations and/or activities, but it also follows that there will be individuals who are neutral in their attitude toward both types of work activities and that some individuals will dislike both types. Without an evaluation of the relative distribution of likes and dislikes across groups, it is possible that individuals with different racial-ethic backgrounds may have preferences for different areas of the RIASEC circumplex. This issue is simply not assessed in the types of structural analysis used to evaluate Holland's RIASEC model.

Studies examining mean-score differences in RIASEC scales partly address concerns about the impact of interest measures on career assessment outcomes by examining the extent to which there are group differences in RIASEC interest scores. For example, Fouad (2002) examined racial-ethnic group differences in SII scores for samples of students and employed adults and found that the largest gender difference in interests was on the R scale ($\eta^2 = .10$), with men scoring higher than women, with the A scale ($\eta^2 = .03$) and S scale ($\eta^2 = .02$) showing the largest difference for women scoring higher than men. However, this is an indirect test of how these scores influence the interpretation of the results of a RIASEC assessment, because interpretation is based on relative differences in scores across the six types. By focusing on individual scales instead of systematically examining differences in profile shape across groups, differences in how RIASEC interest scores may affect the assessment process may be obscured in the current research.

In their seminal paper on profile similarity, Cronbach and Gleser (1953) identified three components of profiles: shape, elevation, and scatter. A profile's *shape* reflects the extent to which two individuals or groups have similar configurations and is consistent with Holland's idea of *congruence*. Profile shape can be measured using a *Q correlation*, which ranges from -1.00 to $+1.00$, with a score of 0 indicating no similarity in shape between the profiles, positive values approaching 1.00 indicating increasingly similar profile shapes and negative values approaching -1.00 indicating increasingly dissimilar (or opposite) profile shapes. *Elevation* is defined as the mean of all scores in a profile. Differences in profile elevation reflect the extent to which individuals or groups score higher or lower on a set of measures. *Scatter* is defined as the square root of the sum of squares of the individual's deviation scores about their mean score, a measure of intraindividual (or intragroup) variability in scores across the profile. Individual and group differences in profile scatter reflect the extent to which individuals have more or less variability in scores across a set of measures. Scatter corresponds with Holland's concept of *differentiation*, the extent to which an individual has a clearly defined pattern of interests matching a single RIASEC type. Cronbach and Gleser recommend using a Euclidean distance statistic to measure profile similarity, because it simultaneously accounts for profile similarity in terms of shape, elevation, and scatter.

It could be argued that a three-letter code reflects the interest profile of an individual. However, using three-letter codes discards 50% of the profile information obtained in the assessment process. This loss of information is somewhat problematic because theories of interests differentiate between positive interests that will move individuals toward certain objects and negative interests that will move individuals away from other objects (see Savickas, 1999, pp. 21-33). This distinction is reflected in interest measures that use a like–dislike rating scale, such as the SII (Donnay et al., 2004; Harmon, et al., 1994), SDS (Holland, Powell, et al., 1997), and the Unisex edition of the ACT interest inventory (ACT, 1995). Therefore, when the results obtained from interest inventories are reduced to a three-letter code, potentially useful information about the interrelations among an individual's likes and dislikes is discarded. By using a measure of profile similarity such as the *Q* correlation or Euclidean distance techniques, it is possible to use the full set of interest scales when measuring profile similarity. Additionally, RIASEC-based techniques cannot be extended to measures of basic interests. Thus, by using *Q* correlation and Euclidean distance profile-based techniques, it will be possible to extend previous research on congruence to include basic interests.

The Current Study

The primary objective of the current study is to evaluate interest profile differences across gender, racial-ethnic group, and employment status. Two measures of profile similarity were used: the

Q correlation, a measure of profile shape that corresponds to Holland's idea of congruence, and Euclidean distances, a measure of the three profile components of elevation, scatter, and shape. RIASEC data for the current study were obtained from Fouad (2002), representing the interests of male and female African American, Asian American, Hispanic American, Native American, and Caucasian American high school students and successfully employed adults. Unpublished BIS data from this sample were also used in the current study. Unidimensional (Hubert, Arabie, & Meulman, 1997) and multidimensional (Kruskal & Wish, 1978) scaling analysis will be used to evaluate group differences in profile shape and provide an interpretive framework to identify potential effects of group differences in interests when using RIASEC-based measures for assessment purposes in applied settings.

Methods

Data Sources

Data on the RIASEC interests of samples representing five racial-ethnic groups in the United States were obtained from Fouad (2002). Fouad's study arguably represents the most comprehensive investigation of group differences in mean-level RIASEC interest scores. Therefore, these data represent an important starting point for using profile shape techniques to investigate group differences in interests. Fouad (2002, pp. 286-287) reports mean interest scores for the six RIASEC interest areas, as measured by the GOTs of the SII (Harmon et al., 1994) for 20 samples representing male and female college students and successfully employed adults who self-identified as African American, Asian American, Native American, Caucasian American, or Hispanic American. In addition to the data published in Fouad (2002), previously unanalyzed and unpublished basic interest scores from the SII were also obtained from the same sample for use in the current study.

Sample Characteristics

Employed adults. As reported by Fouad (2002), samples of employed adults were drawn from the more than 18,000 individuals in the general reference sample for the 1994 revision of the SII who indicated their race/ethnicity and who had been in their occupation for at least 3 years. These employed adults indicated they were satisfied with their occupation, were doing typical tasks for that occupation and indicated some predetermined level of success in the occupation. Individuals who identified themselves as belonging to one racial/ethnic group included 378 African Americans (211 women, 167 men), 363 Asian Americans (178 women, 185 men), 17,368 European Americans/Caucasians (8,668 women, 8,700 men), 349 Hispanics/Latinos (170 women, 179 men), and 77 Native Americans (40 women, 37 men). This study included all of above professionals except for the Caucasian group. Fouad reported that because of the disparity in sample size, a 10% random sample was drawn from the Caucasian sample, balanced for gender (n = 1,699; 840 women, 859 men).

The average ages of the employed adults in the Fouad's (2002) sample were 40.4 ($SD = 9.28$) and 42.5 years ($SD = 9.2$) for Native American women and men, respectively; 40.07 ($SD = 9.28$) and 46.24 ($SD = 10.3$) for Caucasian women and men; 38.1 ($SD = 9$) and 42.7 ($SD = 10.2$) for Asian American women and men; 43.3 ($SD = 10.9$) and 44 ($SD = 10$) for African American women and men; and 38.3 ($SD = 9.6$) and 41.3 ($SD = 9.6$) for Hispanic/Latino women and men. Their average educational levels were 5.25 years for Native Americans, 6.36 for Whites, 6.87 for Asian Americans, 6.21 for African Americans, and 6.06 for Hispanics/Latinos, where 5 represented an associate's degree and 6 represented a bachelor's degree. The professionals as a group indicated they were satisfied with their work and had been employed an average of between 12.7 (Hispanics) and 16.5 years (African Americans).

Students. Fouad (2002) reports that student samples were obtained from the publisher's database of individuals who had completed the SII in 1999 and who had self-identified as members of the five racial-ethnic groups corresponding to the obtained samples of employed adults. The SIIs were drawn from the publisher's database by collecting all individuals within that ethnic group who had taken the SII over several months with the objective of collecting samples of at least 400 for each of the ethnic/racial groups; in many cases, the target time period yielded more than 400 participants. Students completing the SII were informed that their responses would be used for research purposes.

Fouad's (2002) sample included a total of 399 Native Americans (224 women, 175 men), 510 Whites (288 women, 222 men), 1,434 Asians (864 women, 570 men), 794 African Americans (495 women, 299 men), and 500 Hispanics/Latinos (331 women, 169 men) composed this group (N = 3,637). Average age of the student group was 23.42 (SD = 9.78) and 23.8 years (SD = 10.4) for Native American women and men, respectively; 22.8 (SD = 9.8) and 22.2 (SD = 10.2) for Caucasian women and men; 22.2 (SD = 7. 84) and 22.8 (SD = 8.6) for Asian American women and men; 24.41 (SD = 10.1) and 23.02 (SD = 10.7) for African American women and men; and 20.78 (SD = 8.8), and 25.12 (SD = 9.3) for Hispanic/Latino women and men.

Measures

RIASEC interests. Employed adults completed the SII research form (Harmon et al., 1994), containing 379 items, but the scores used were based on the same items completed by the student group. The SII assesses vocational interests and compares an individual's interests with those of individuals in various occupations. RIASEC interests were measured using the GOT scales of the SII. Median GOT internal consistency reliability is reported in the SII manual as being .92, with a range from .90 to .95; the median test–retest reliability is .86, with a range from .84 to .91. Validity evidence based on differences between occupation groups and academic majors on each of the six RIASEC scales is presented in the SII manual along with a summary of other validity research (Harmon et al., 1994, pp. 58-63).

Basic interests. The 1994 edition of the SII also includes 25 measures of basic interests. As reported in the Strong manual (Harmon et al., 1994, pp. 82-90), the mean Cronbach coefficient α reliability for these scales was .85 (SD = .05) and the average test–retest reliability over a period of 1 to 6 months, with four samples of college students and adults, was .84 (SD = .05). Numerous studies, including Donnay and Borgen (1996), have demonstrated the predictive validity of the SII's Basic Interest measures.

Procedure

Harmon et al. (1994) provided details of the data collection for the SII professional groups. Professionals were drawn from the 50 occupational groups identified as targets for new or revised criterion groups for the 1994 SII revision. Participants were contacted, invited to complete the SII, and sent a copy of their profile in return for their participation. A total of more than 38,000 individuals in 50 occupations responded; 18,000 were selected to compose the general reference sample and the professional group. A 10% random sample of Caucasians was drawn from the general reference sample. Student samples were drawn from the database of SII test takers over several months in 1999, until at least 400 were collected for each racial-ethnic group (see Fouad, 2002).

Analyses

Measures of profile similarity. The first step of the data analysis in the current study was to calculate measures of profile similarity between the 20 samples representing male and female students and successfully employed individuals who self-identified as African American, Asian American, Native American, Caucasian American, or Hispanic American. Two measures of profile similarity discussed by Cronbach and Gleser (1953) were calculated for the GOT and BIS scales. First, *Q* correlations were used to quantify the degree of similarity in profile shape across the 20 groups as measured by GOT and BIS profiles. Second, Euclidean distances were also used to quantify profile similarity between each sample as a function of elevation, scatter, and shape of the GOT and BIS profiles. Additionally, the C-index (Brown & Gore, 1994) was calculated for the GOT scores between groups, although there is no equivalent to the C-index for BIS scales.

Occupation interest profiles. RIASEC profiles for the 102 SII occupations with both male and female reference samples were obtained from the SII manual (Harmon, et al., 1994). BIS profiles for these occupations were obtained for the same reference samples using data from Armstrong, Smith, Donnay, and Rounds (2004). C-index, RIASEC *Q* correlations and Euclidean distances, and BIS *Q* correlations and Euclidean distances were calculated for each of the 20 groups on each of the 102 occupations to evaluate the degree of fit between group interest profiles and the occupational interest norms. These data were then used to evaluate the level of agreement between fit measures by correlating the fit measures across the 102 occupations for each group. Correlations between Euclidean distance measures and *Q* correlations and C-index values were reversed to simplify the interpretation of observed results.

Multidimensional scaling (MDS). The method of nonmetric MDS (Kruskal & Wish, 1978) was used to develop two-dimensional spatial representations of the interrelations among the RIASEC profiles of the 20 samples of male and female college students and successfully employed adults representing five racial-ethnic groups. The MDS analyses were conducted separately for each measure of profile similarity. MDS techniques were used to identify a representation of the interrelationships among the groups in a two-dimensional space so that the intergroup distance within that space corresponds to the degree of profile similarity between groups. This technique provides a framework for understanding and interpreting the structure of interest profiles by distilling the interrelations between group's interest profiles into a small number of underlying dimensions. Property vector fitting (Kruskal & Wish, 1978) was used to identify gender and education/employment dimensions in the MDS solutions.

Linear unidimensional scaling (LUS). As will be discussed below, the results of the two-dimensional MDS analyses of the RIASEC *Q* correlation measure of interest profile similarity suggests that different structural models may be appropriate for interpreting each set of results. There was a good fit to the two-dimensional model for the Euclidean distance data, but for the *Q* correlation data, the results suggest that a simpler, unidimensional scaling model may be more appropriate for interpreting the obtained results. However, the nonmetric MDS techniques used to fit the two-dimensional model are not appropriate for fitting a unidimensional scale due to the effects of local optima (Hubert, Arabie, & Meulman, 2007). Therefore, an alternative scaling technique, LUS (Hubert et al., 1997, 2007) will be used to fit the *Q* correlation data to a unidimensional scaling solution.

As outlined in Hubert et al. (1997, 2007), there are two key steps in the LUS analysis. First, a linear ordering of the 20 groups is determined using quadratic assignment, a heuristic technique for identifying good orderings of the groups according to structural constraints specified by a linear target matrix. The fit of the data matrix to the specified structure is measured using a cross product index (CPI, the sum of the products of corresponding entries in the data and target matrices), with larger values indicating a better fit (see Hubert & Schultz, 1976). From a random starting permutation, a baseline value for the CPI is calculated and then a series of local operations are used to make changes to the ordering of groups with the objective of improving the fit of the data to the specified

Table 1. Range of Agreement Between Congruence Measures Across Groups Based on Matching Interest Profiles to 102 Occupations

	Correlations Between Measures			
Measure Comparison	*M*	*SD*	Minimum	Maximum
C-index with *Q*-GOT	.57	.17	.12	.78
C-index with *Q*-BIS	.47	.14	.04	.61
C-index with Euclidean GOT	.36	.18	.05	.66
C-index with Euclidean BIS	.35	.15	−.05	.54
Q-GOT with *Q*-BIS	.80	.10	.57	.91
Q-GOT with Euclidean GOT	.56	.23	−.03	.91
Q-GOT with Euclidean BIS	.61	.11	.35	.82
Q-BIS with Euclidean GOT	.41	.25	−.13	.83
Q-BIS with Euclidean BIS	.66	.12	.32	.86
Euclidean GOT with Euclidean BIS	.76	.08	.52	.88

NOTE: BIS = Basic interest scale; C = C-index; GOT = General Occupational Theme; *Q* = *Q* Correlation. Correlations between Euclidean distances and other measures are reversed in direction to produce a consistent interpretation of magnitude.

structure, as measured by increases in the CPI. The entire data matrix is reordered in a series of iterations until no improvements can be made to the CPI value, producing a final ordering of the 20 groups.

The second step in the LUS analysis is to estimate distances between each group in the linear structure. Iterative projection is used to minimize a least squares loss function that minimizes the squared discrepancies between the original data and the distances between objects in a linear structure. The data analysis occurs in a series of repeated steps, or iterations, during which different sets of distances between each group are evaluated to see whether any incremental improvements in fit are obtained. When not additional improvements can be made in model fit, a final set of distances are calculated between the 20 groups in the linear model. An additive constant is included for the calculation of a variance accounted for (VAF) statistic.

Results

Measures of Profile Similarity

Table 1 presents the range of correlations between the five fit measures (i.e., C-index, *Q* correlations of RIASEC profiles, Euclidean distances of RIASEC profiles, *Q* correlations of BIS, and Euclidean distances for BIS) for the 102 SII occupation samples. Of the 10 possible comparisons between fit measures, 3 involve using different statistics to quantify fit on the basis of RIASEC interests. The mean correlation between C-index and *Q* correlations for the RIASEC scales was .57, with a range from .12 to .78. In comparison, the mean correlation between the *Q* correlations and Euclidean distances with the RIASEC scales was similar at .56 with a range from −.03 to .91 and the mean correlation between the C-index and Euclidean distances for the RIASEC scales was somewhat lower at .36, with a range from .05 to .66. These results suggest that, when comparing RIASEC-based fit measures, although there is some general agreement between these measures of fit to occupations, there is also unique variance associated with each approach.

In addition to the comparisons between RIASEC-based fit measures, it is also possible to compare the *Q* correlations from RIASEC and BIS scales and also the Euclidean distance measures for the scales. The average correlation between RIASEC and BIS *Q* correlation measures of profile fit to occupations was .80 with a range from .57 to .91, and in comparison, the average correlation for the Euclidean distance measures was .76 with a range from .52 to .88. These results suggest that when moving from the six RIASEC scales to the 25 BIS in the SII, there is generally strong agreement when matching group interest profiles to occupational incumbent interest profiles using either the *Q* correlation or the Euclidean distance technique. The remaining comparisons included in Table 1 involve crossing interest measurement level with different fit statistics (e.g., C-index for RIASEC scales with Euclidean distance for BIS), and these values tend to be lower than in cases when comparisons are based on a single level of interest measurement or fit statistic.

MDS Analyses

To provide additional interpretive information on the degree of similarity in RIASEC and BIS profiles across the 20 samples, the C-index, *Q* correlation, and Euclidean distances were analyzed using non-metric MDS. Figure 1 presents the two-dimensional solution for the C-index measure. The stress value for the two-dimensional solution was .112 with a VAF of .939. These results indicate that the fit of the matrix of C-index values was a good fit to two-dimensional MDS solutions. Property vector fitting results for gender and student/professional groups were not a good fit to the C-index MDS results. For gender, the R^2 value was .18, and for professional/student vector, the R^2 value was .31. The orientation of these vectors is illustrated in Figure 1 for comparison purposes with subsequent results.

Figure 2 presents the two-dimensional solutions for both RIASEC-based measures of profile similarity. For the *Q* correlation matrix, the stress value for the two-dimensional solution was .058, with a VAF of .979; for the Euclidean distance matrix, the stress value for the two-dimensional solution was .060, with a VAF of .984. These results suggest that the fit of both matrices to two-dimensional MDS solutions were a good fit to the data. With the *Q* correlation results for the RIASEC scales, the 20 groups are arranged in a curved linear ordering, with the 10 male samples on one side of the two-dimensional plot of the MDS results and the 10 female solutions on the other side. This result clearly indicates that there are gender differences in the shape of RIASEC profiles. The Asian American, Hispanic, and Caucasian adult samples are at the extreme ends of this linear ordering, with the student samples falling in between. This suggests that male and female employed adults tend to have less similar RIASEC interest profile shapes than comparable student samples. This effect is not constant across racial-ethnic groups; however, because the African American and Native American employed adult samples are intermixed with the student samples. Property vector fitting results for gender with the *Q* correlation MDS results supports the observation that gender is an important dimension underlying group similarity in RIASEC profiles with an R^2 value of .87. The orientation of the vector is illustrated as a solid line in Figure 2, which clearly differentiates between male and female samples. However, despite the observation that there are larger male–female distances for professionals in the MDS solution, the professional/student vector R^2 value was only .24.

In comparison to the *Q* correlation results, with the MDS for the Euclidean distances measure of profile similarity the male students, female students, male employed adults, and female employed adults form four distinct clusters. The one exception to this pattern is the sample of Native American female employed adults, who are located in between the male and female student clusters. Property vector fitting results indicated that both gender and professional/student vectors were a good fit for the Euclidean distance MDS structure, with R^2 values of .79 for gender and .71 for professional/student. As illustrated in Figure 2, with the Euclidean-based MDS of RIASEC profile similarity, the orientation of the vectors provides clear separation between male and female samples and between student and professional samples. These results raise potential concerns with the use of using employed adults to generate norms for interpreting the interests of students.

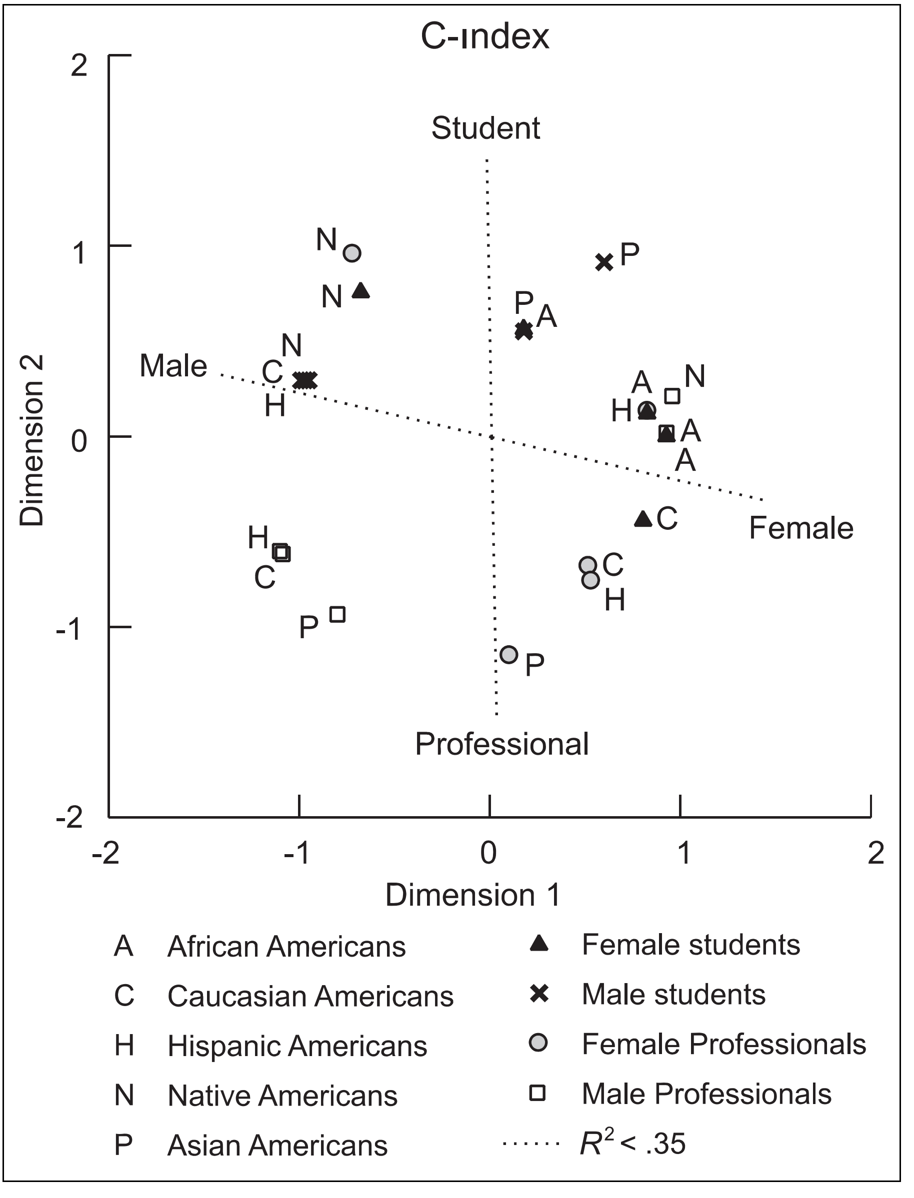

Figure 1. Multidimensional scaling (MDS) analysis of C-index measure of RIASEC profile similarity across 20 racial-ethnic group samples.

Figure 3 presents the two-dimensional solutions for both BIS-based measures of profile similarity. For the *Q* correlation matrix, the Stress value for the two-dimensional solution was .089, with a VAF of .964; for the Euclidean distance matrix, the stress value for the two-dimensional solution was .115, with a VAF of .916. These results suggest that the fit of both matrices to two-dimensional MDS solutions was a good fit to the data. Property vector fitting results for gender with the *Q* correlation MDS results suggest that gender is an important dimension underlying group similarity in BIS profiles. For the gender vector the R^2 value was .85; in comparison the professional/student vector R^2 value was .13. In Figure 3, the gender vector is again illustrated as a solid line with

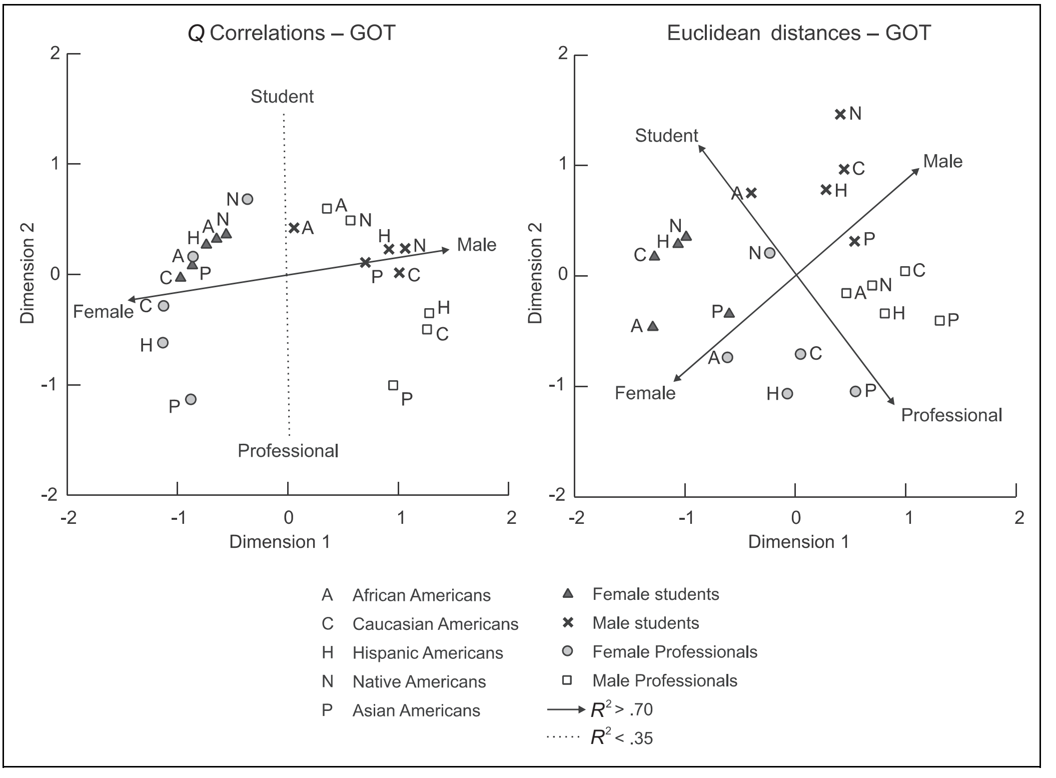

Figure 2. Multidimensional scaling (MDS) analysis of *Q* Correlation and Euclidean distance measures of RIASEC interest profile similarity across 20 racial-ethnic group samples.

the professional/student vector as a dotted line for comparison purposes. Consistent with the results for the *Q* correlation results for the GOT-based interest measures, the orientation of the vector clearly differentiates between male and female samples for the *Q* Correlations based on Basic interests. Also consistent with the GOT results, both gender and professional/student were a good fit for the BIS-based Euclidean distance MDS structure, with R^2 values of .91 for gender and .78 for professional/student. As illustrated in Figure 3, with the Euclidean-based MDS of BIS profile similarity, there is clear differentiation between male and female samples and between student and professional samples.

LUS Analysis of Q Correlations

In the two-dimensional MDS analysis of the intergroup *Q* correlations, the 20 groups are arranged in a horseshoe shape, indicating that a unidimensional scale may be a more appropriate representation for the data (Kendall, 1971). To evaluate this possibility, the *Q* correlations were reanalyzed using a unidimensional scaling method developed by Hubert et al. (1997). The results of the unidimensional scaling solution are presented in Figure 4, including illustrations of the RIASEC profile shapes for the samples of employed adults. The linear ordering of the 20 samples is equivalent to the ordering observed in the horse shoe-shaped pattern from the two-dimensional MDS solution, with Asian American, Caucasian, and Hispanic American samples anchoring the end points of the linear continuum. The VAF for this solution is .94, as compared to the two-dimensional MDS solution's VAF of .979; this small change in VAF when moving from a two-dimensional to a unidimensional scale supports the use of the more parsimonious model to interpret profile shape similarity across groups.

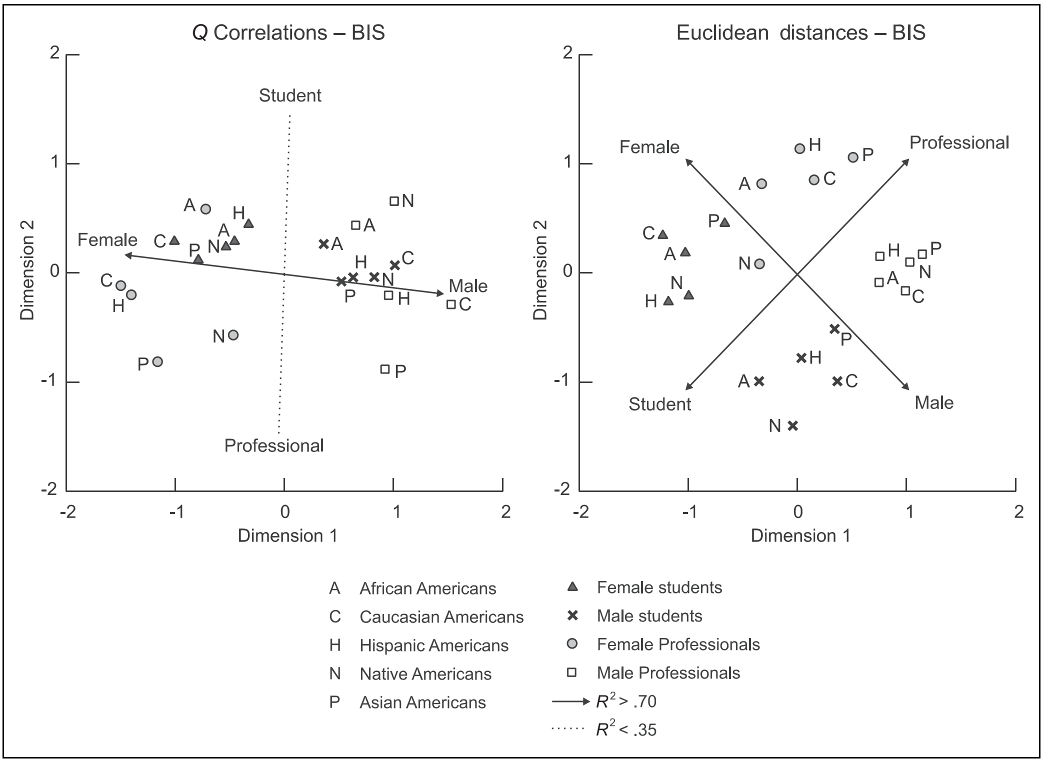

Figure 3. Multidimensional scaling (MDS) analysis of *Q* Correlation and Euclidean distance measures of Basic interest scale (BIS) interest profile similarity across 20 racial-ethnic group samples.

The unidimensional scaling results suggest that that male and female employed adults tend to have less similar RIASEC interest profile shapes than comparable student samples. It should again be noted that effect is not constant across racial-ethnic groups, because the African American and Native American employed adult samples are intermixed with the student samples. Adding the illustrations of the RIASEC profiles for the professionals demonstrates that depending on group membership, individuals are likely to receive different types of feedback when Holland-based measures are used in career counseling. Asian American employed males score highest on the Investigative scale and lowest on the Artistic scale. Caucasian and Hispanic American employed males score highest on Realistic and lowest on Artistic. Native American and African American employed males score highest on Social and lowest on Artistic. Native American employed females score highest on Conventional and lowest on Investigative. African American employed females score highest on Social and lowest on Realistic. Caucasian, Hispanic, and Asian American employed females score highest on Artistic and lowest on Realistic. The current results suggest that when using RIASEC interest measures to identify occupations that are congruent career choices, recommendations will vary depending on the gender and racial-ethnic identity of the test taker.

Discussion

The current study extends the research on group differences in RIASEC scale scores by examining group differences in interest profile similarity across 20 samples of male and female students and employed adults from diverse U.S. racial-ethnic groups. Measures of profile similarity were used

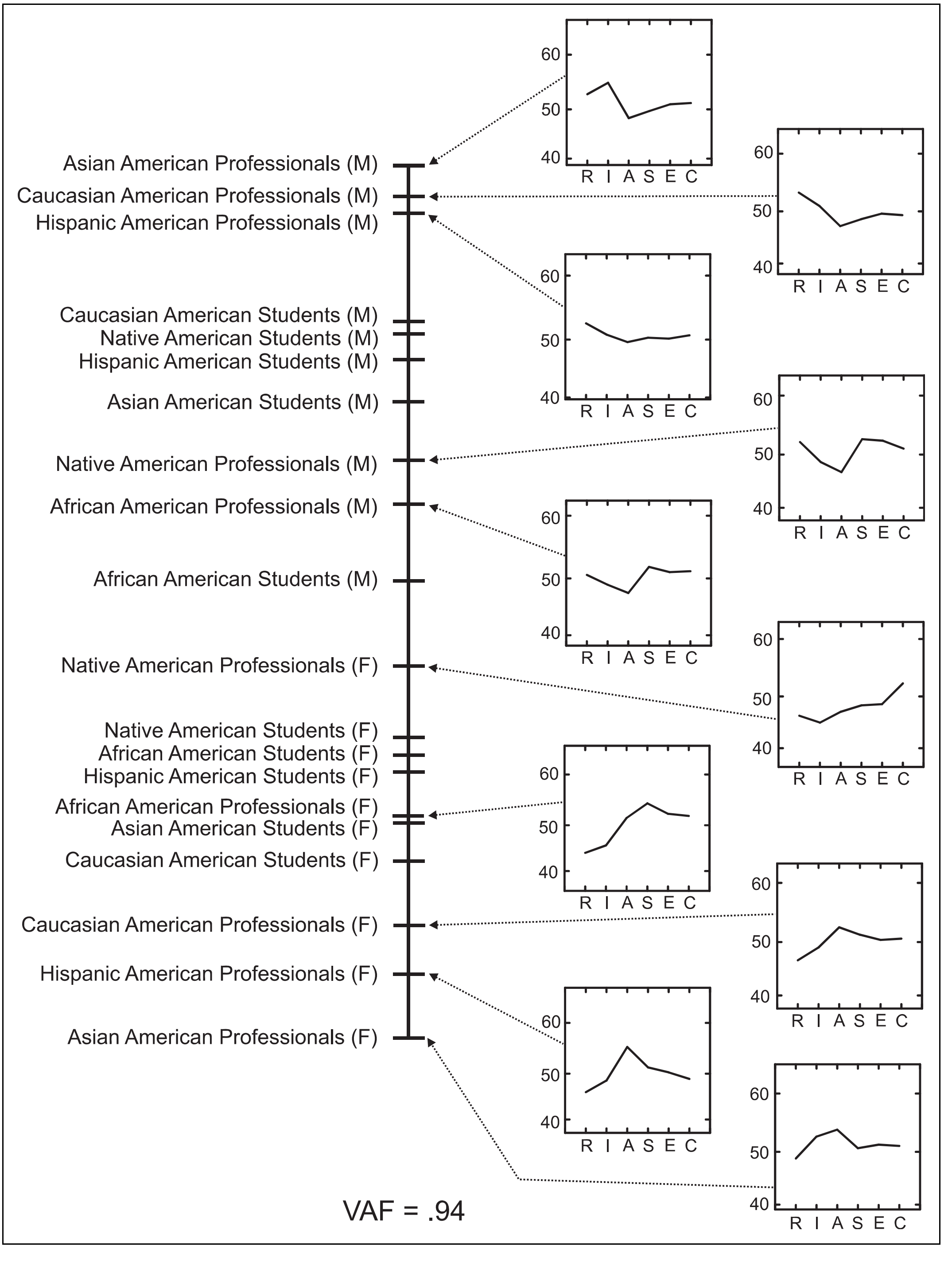

Figure 4. Linear unidimensional scaling (LUS) of *Q* correlations of interest profile similarity across 20 racial-ethnic groups with RIASEC profiles for female and male professionals.

to evaluate both RIASEC and basic interest profiles: *Q* correlations to quantify the degree of similarity in profiles based on shape, and a Euclidean distance measure that quantifies degree of similarity as a function of shape, elevation, and scatter. Additionally, the C-index was used to measure similarity of RIASEC interests. Consistent with previous research on gender differences, the results for the *Q* correlations suggest that there are gender differences in the shape of RIASEC profiles. Additionally, linear scaling of the *Q* correlations suggests that there are gender differences in the shape of RIASEC profiles and that male and female employed adults tend to have less similar RIASEC interest profiles than comparable student samples. This effect is not constant across racial-ethnic groups, with Asian American, Caucasian, and Hispanic American samples displaying the largest male–female differences in profile shape. The Euclidean distance measure of profile similarity demonstrated that groups can be differentiated as a function of both gender and employment status on the basis of their interest profiles. When compared to profile-based techniques, the C-index does not appear to be as sensitive to gender and group differences in interests. Obtained results highlight the importance of choosing appropriate statistical methods for matching individuals to career choices and also raise questions about the importance of gender and racial-ethnic identity when interpreting the results of an interest inventory.

Quantifying and Interpreting Interest Profiles

When interpreting RIASEC assessment results or measuring person-environment fit, the most frequently used approach involves three-letter codes, which is a simplified profile shape analysis that discards one half of the interest results. One of the key advantages of using the current three-letter code methods for matching individuals to occupations is ease of use. For example, the SDS can be scored by hand by a client. A multivariate index of profile similarity may be more accurate but may also be more difficult to explain to a client. Additionally, it should be noted that congruence measures, such as the Brown-Gore index, often give greater weight to matches on the first letter of the Holland code. This practice of assigning more weight to the highest area of interest is consistent with Holland's (1997) theory. Therefore the profile similarity measures analyzed in this article represent a potential break from Holland's theory, because all six types are weighted equally when calculating congruence based on a *Q* correlation or Euclidean Distance. However, the time may have come to move beyond congruence measures based on three-letter codes. Unlike the older three-letter codes available through traditional resources such as the Dictionary of Holland Occupational Codes (Gottfredson & Holland, 1996), full RIASEC profiles have become available for all occupations in the U.S. Labor market through the O*NET database. More importantly, unlike congruence indices developed specifically for three-letter codes, the profile-based methods used in this article could be extended to interest measures that are more complex and multidimensional than the six RIASEC types, such as basic interests (Donnay & Borgen, 1996).

In their classic paper on profile similarity, Cronbach and Gleser (1953) note that the notion of profile similarity has to be addressed in the context of how the measures in question are being interpreted. Their recommendation of the Euclidean distance statistic for measuring profile similarity is predicated on the assumption that all three components of a profile (shape, elevation, and scatter) are relevant in the context where the measure is being applied. However, with interest measures, it has been suggested that profile shape is the critical component that affects their use and that profile level is mostly irrelevant (Gottfredson & Jones, 1993; Savickas, 1999). For example, Prediger (1998) evaluated the role of profile elevation in the concurrent and predictive validity of RIASEC-based interest measures using both cross-sectional and longitudinal data. Prediger reported that differences in profile elevation did not affect the validity of the measures, as demonstrated by the match between interest-based Holland type and membership in Holland-based criterion groups.

Traditional objections to the use of profile elevation information in applied settings (Gottfredson & Jones, 1993; Prediger, 1998; Savickas, 1999), arise from evidence which suggests that profile elevation does not correspond with an individual's strength of interests. Although the current analysis does not suggest that profile elevation can be tied to strength of interest, it does not follow that profile elevation is irrelevant to person-environment fit. In fact, the results obtained in the MDS analyses here suggest that adding profile elevation and scatter information may help clarify the nature of group differences in interests. When the between-group MDS results are compared for the two profile similarity measures, it appears that the Euclidean distance technique may provide clearer picture of group differences as a function of RIASEC interests. However, additional research is needed to determine the clinical utility of the scatter and elevation information included with the Euclidean distance measure of profile similarity. Profile elevation may have clinical utility because depressed profiles are often interpreted as an indicator of underlying developmental issues for specific clients that need to be addressed as part of the counseling process (see Donnay et al., 2004; Harmon et al., 1994).

One of the more interesting findings in the current article is the high level of agreement between *Q* correlations and Euclidean distance measures when comparing the fit of groups to occupational norms by level of interest measurement. Researchers have suggested that the RIASEC scales are not sufficient to represent the full range of individual differences in interests (Donnay & Borgen, 1996; Rounds, 1995). Therefore, part of the rationale for an increased emphasis on basic interest measures in the assessment process is the potential to improve the recommendations made to individuals in career counseling and other applied settings (Armstrong et al., 2004). However, in the current study, the average correlation between fit measures using RIASEC and BIS scales was .80 when based on *Q* correlation measures of profile shape and was .76 when based on a Euclidean distance measure of profile shape, elevation, and scatter. These results suggest that similar occupations will be recommended on the basis of either the RIASEC or BIS interest measures. Therefore, additional research may be needed to clarify the practical improvements in career counseling outcomes when using BIS instead of RIASEC measures.

Group Differences in Interest Profiles

Our obtained results suggest that on average, the interest profiles of men and women have different shapes, and this may lead to different occupations being recommended to men and women who complete interest inventories. When using the C-index to measure fit, these differences may be somewhat obscured but can be seen in both the *Q corr*elation and Euclidean distance results. Additionally, differences between students and employed adult samples are more clearly illustrated with Euclidean distance measures than with *Q corr*elations. Similar results by gender and employment level are seen across the RIASEC and BIS levels of interest assessment. Previous research by Lippa (1998) has identified large gender differences on the People-Things dimension of interest (Prediger, 1982), with men expressing stronger interests for working with things and women expressing stronger interests for working with people. This gender difference in interests has important implications for understanding the different career trajectories of men and women (Lubinski & Benbow, 2006). Based on the findings presented here, additional research is needed to determine the impact of gender differences in interest profile shape on the assessment process, especially in educational settings where students are considering careers in fields such as science, technology, engineering, and mathematics.

When measuring profile similarity using the *Q* correlation technique, it appears that the observed gender differences in profile shape for the professional group samples are somewhat contingent upon racial-ethnic group. As illustrated in Figure 4, the gender difference in profile shape is larger for Asian American, Caucasian, and Hispanic employed adults than for Native American and

Hispanic employed adults. In applied settings, such as career counseling, this may result in different outcomes when matching members of these groups to occupations. Therefore, the choice of technique for measuring profile similarity across gender and racial-ethnic groups and for linking interests to occupations is a critical issue for determining the validity of RIASEC measures. Measures of profile shape, in particular, may produce differential outcomes in career counseling and other applied settings for men and women from racial-ethic groups. The current results suggest that additional research is needed to determine the impact of racial-ethnic group differences in interest profile shape on the assessment process.

Limitations and Future Directions

In the current study, we have focused on the interpretation of interest profiles using group-level data. The current findings provide a starting point for understanding how group differences in interests contribute to differential outcomes in career counseling. However, additional research is still needed to evaluate how individual differences in interest profile similarity, the choice of interest measure, and the choice of profile similarity measure affect the assessment process. The results obtained in the current study demonstrate that group differences in profile shape have implications for how interest measures are interpreted in applied settings. However, additional research is needed to examine the role of academic experiences and other factors in the observed differences between student and adult samples. In particular, because the samples of employed adults were obtained from the SII database, these samples may not represent the full range of occupations where members of different racial-ethnic groups are employed. Racial-ethnic group differences in interest profile shape may reflect differences in the types of employment opportunities perceived as being available by members of each group. Future research on differences between students and professionals should include information on students' intended areas of study, because students may have interests that are more similar to professionals in their chosen field of study than to broad samples of employed adults.

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