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The fit of Holland's RIASEC model to US occupations

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Abstract

Holland's [Holland, J. L. (1959). A theory of occupational choice. *Journal of Counseling Psychology, 6*, 35–45; Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources, Inc.] RIASEC types were initially developed using a restricted range of occupational titles. Holland's type classification system has been extended to encompass the full range of occupations in the US, using both statistical and expert rating methods. However, the extent that Holland's classification model is sufficient to represent the full range of occupational interests has not been examined. Multidimensional scaling (MDS) was used to analyze college students' (266 men, 572 women) interests in occupations representing approximately 85% of the US labor market. A two-dimensional MDS solution of the full set of occupations did not fit Holland's model, but limiting the analysis to occupations used in Holland-based measures produced the expected RIASEC structure. In comparison, a three-dimensional solution included Prediger's [Prediger, D. J. (1982). Dimensions underlying Holland's hexagon: Missing link between interests and occupations? *Journal of Vocational Behavior, 21*, 259–287] dimensions (Things/People and Data/Ideas) consistent with Holland's model, but also included prestige and sex-type dimensions that were not orthogonal to Prediger's dimensions. These results demonstrate that the RIASEC types are not sufficient to represent the full range of occupational interests and are confounded with prestige and sex-type.

Keywords: Structural validity of interest measures; Occupational interests; RIASEC model; Occupational prestige; Sex-type

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1. Introduction

Almost 40 years ago, Holland, Whitney, Cole, and Richards (1969) identified the RIASEC hexagon that has formed the basis of Holland's (1959, 1997) theory of six vocational interest types and parallel work environments (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional; referred to by the acronym RIASEC). The hexagon, or circumplex (Tracey & Rounds, 1995), a structural model used to represent the inter-relations among the six types and work environments (see Fig. 1) has been central to Holland's theory and application in applied setting. Subsequently, numerous structural studies have supported the typology with measures of the RIASEC personality types (e.g., Day & Rounds, 1998; Rounds & Tracey, 1993), and with work environments (Rounds, Smith, Hubert, Lewis, & Rivkin, 1999; Tracey & Rounds, 1992). Despite these efforts, the fundamental question of the sufficiency of the RIASEC types and work environments remains unanswered. To date, there have been no published studies that directly and systematically evaluate Holland's model with occupations that represent the full range of employment opportunities in the US labor market. The purpose of the present study is to evaluate how well Holland's RIASEC model generalizes to occupations that represent majority of the US workforce.

Although there is substantial empirical support for Holland's (1959, 1997) RIASEC structure, this evidence is found primarily with measures specifically designed to measure the six types (see, for example, the meta-analysis by Tracey & Rounds, 1993). At the occupational level, there is surprisingly little research evaluating how well the six types represent the structure of the US labor market. When Holland (1958) developed the VPI, a small number of occupational titles were chosen to represent the six types. Subsequently, different strategies have been used to generate RIASEC codes for occupations in the US, including incumbent sample scale scores (Harmon, Hansen, Borgen, & Hammer, 1994), statistical prediction with US Department of Labor databases (Gottfredson & Holland, 1996), and expert ratings (Rounds et al., 1999). However, assuming that the RIASEC

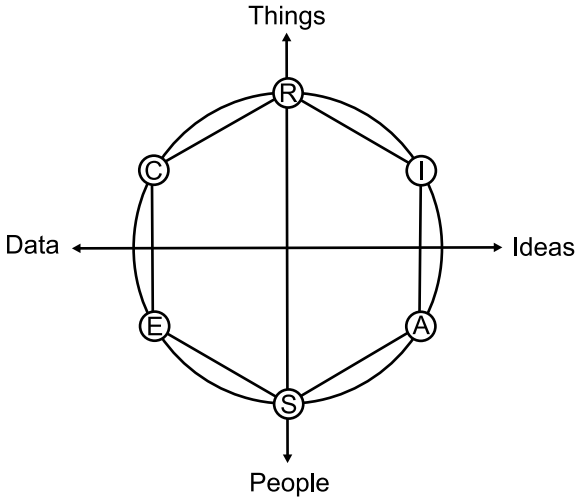

Fig. 1. Holland's (1959, 1997) interest types with Prediger's (1982) dimensions.

structure is the best fitting model for occupations, these strategies do not directly test the generalizability of Holland's model to the full range of US occupations.

In the present study, the US Department of Labor's *Occupational Outlook Handbook* (JIST Work Inc., 1997) was used to identify the predominant occupations that represent the world of work. It is hypothesized that the Holland model may be contingent upon using sets of occupational titles limited to those occupations clearly identified with a RIASEC type, such as those listed in the *Vocational Preference Inventory* (VPI, Holland, 1985). Therefore, using the predominant occupations in the US labor market would either provide stronger validity evidence for the Holland model, or provide a useful starting point for the development of a more representative model of occupations.

2. RIASEC model

Occupational titles are central to Holland's development of the RIASEC typology and its associated interest measures. In part, the rationale for the development of the Vocational Preference Inventory, which is entirely composed of occupational titles, is the assumption that preferences for occupations are an expression of personality (Holland, 1958, 1997). Holland (1997) notes that:

> Most interest inventories rest heavily on the assumptions that people perceive common occupations and their associated activities accurately and that these perceptions remain the same over long period of time. In the same way, a person's vocational preferences and choices rest on the same assumptions. If perceptions of occupations had no validity, interest inventories would have little or no validity, and the average person would have great difficulty in selecting suitable jobs.'' (p. 10).

From Holland's perspective, both occupational perceptions and occupational interest structures are organized according to the hexagonal model, which facilitate individuals' attempts to find occupations that match with their occupational interests (Holland, 1976, 1996).

Holland et al. (1969) first proposed that the inter-relations among the six RIASEC types can be represented by a hexagon structure. The hexagon was identified in an examination of the correlations among the RIASEC scales of the VPI. As shown in Fig. 1, the distances between the six types reflect the degree of similarity between the types, with the most similar types in adjacent positions around the hexagon, and the least similar types at opposite ends of the hexagon. Early attempts to evaluate the structural hypothesis developed by Holland et al. (1969), such as Cole and Hanson (1971), often suffered from methodological limitations (Hubert & Arabie, 1987; Rounds, 1995). Over time, however, comprehensive meta-analyses (Rounds & Tracey, 1996; Tracey & Rounds, 1993), combined with research using more representative samples (Day, Rounds, & Swaney, 1998; Fouad, Harmon, & Borgen, 1997) and increasingly sophisticated structural methods (Armstrong, Hubert, & Rounds, 2003) have provided empirical support for Holland's structural model. The preponderance of this evidence suggests that the RIASEC hexagon is valid for large representative samples of the US population, although there continues to be concern with US minority (Armstrong et al., 2003) and especially, international samples (Rounds & Tracey, 1996).

A critical limitation of previous structural investigations of Holland's theory is that these studies almost invariably use measures explicitly designed to replicate the six

RIASEC types. The focus of interest assessment research has been on measures designed to reflect the characteristics of the six RIASEC types, such as the Strong Interest Inventory (SII, Harmon et al., 1994), the Unisex edition of the ACT Interest Inventory (American College Testing, 1995), and the VPI (Holland, 1985). An analysis of one or more of these measures provides evidence of the extent to which the order predictions of Holland's theory are matched by Holland type measures. By comparing results between different groups, important validity evidence is obtained for the equivalence RIASEC measures with diverse populations (Fouad et al., 1997). This research does not, however, address the larger question of the extent to which the RIASEC types are sufficient to represent the full range of individual differences in occupational interests.

When a more extensive number of occupations have been used than are found in the VPI, a three-dimensional model has emerged. Tracey and Rounds (1996) in developing the spherical model of occupational interests selected 110 occupations that were not "pure" examples of the RIASEC types and that were at a skilled and nonskilled worker level. Most important, occupational titles were selected that bridged the six RIASEC types (c.f., Trapnell, 1989). Einarsdottir and Rounds (2000) used 110 occupational title items from the Strong Interest Inventory (Harmon et al., 1994). In neither study was there an attempt to choose a representative sample of US occupations. Nevertheless, expanding the number of occupations resulted in three-dimensional spatial models of occupational interests.

3. Dimensional interpretations of RIASEC structure

Several proposals have been advanced to account for the RIASEC interest space. The most well know is Prediger's (1982; Prediger and Swaney, 2004) claim that the RIASEC structure is best represented using two bipolar dimensions (see Fig. 1). These two dimensions reflect preferences for four work tasks: Things, People, Data, and Ideas. Things tasks involve nonpersonal processes, such as producing and repairing. People tasks involve interpersonal processes, such as helping and persuading. Data tasks involve impersonal processes, such as recording and organizing facts. Ideas tasks involve intrapersonal processes, such as creating and discovering. Based on an analysis of the 3rd and the 4th editions of Dictionary of Occupational Titles (DOT), Prediger developed bipolar Things and People (i.e., T/P) dimension and Data and Ideas (i.e., D/I) dimension, with these two dimensions being independent. Prediger's dimensions are essentially predicated on Holland's circumplex structure: The better that the circumplex model fits RIASEC data, the better the fit of Prediger's dimensions (Rounds & Tracey, 1993). In the present study, we evaluate the fit of Prediger's dimensions in two- and three-dimensional space.

When researchers began to reinterpret Holland's (1959, 1997) model in terms of underlying dimensions, a logical extension of the model that emerged was the potential for adding a third dimension to the RIASEC structure (Rounds & Day, 1999). Tracey and Rounds (1996) presented a three-dimensional structure of occupational interests with prestige as the third dimension. They suggested that vocational interests are found to lie on the surface of a sphere, with the third dimension of prestige orthogonal to two Holland-circumplex dimensions. Occupational prestige is a broad construct with many highly related referents such as status, educational level, behavioral control, and responsibility (Tracey & Rounds, 1996). Typically, as occupations increase in prestige, they require more education, provide more financial compensation, are more complex, involve exercising

more authority, and require higher levels of ability (Gottfredson, 1996). In fact, the VPI (Holland, 1958, 1985) includes a Status scale to measure people's career concern about prestige and power.

Tracey and Rounds (1996) identified three methodological artifacts that may contribute to failures to incorporate a prestige dimension into interest models. First, the prestige range of occupations used in most studies is limited. Second, studies often fail to sample prestige variance evenly across the six RIASEC scales, with prestige variance confounded with RIASEC scales. For example, the R and C types tend to have a larger proportion of lower prestige occupations. Third, most studies focus on scale scores instead of item scores, and scale scores confound prestige variance with content variance. Researchers, therefore, may fail to extract a third dimension of prestige because the measures contain a limited range of items and are conducting analyses at the scale level instead of the individual item level.

In response to Tracey and Rounds (1996), Harmon (1996) suggested that similar methodological concerns may limit the emergence of sex type as an interest dimension, and hypothesized that sex type may emerge as a dimension if a study included items representing the full range of variation in sex type. In an item level analysis of SII occupational titles, Einarsdottir and Rounds (2000) demonstrated that sex-type emerged as an interest dimension in a three-dimensional structure. They noted that, according to studies of Gottfredson's (1981, 1996) theory, sex-type and prestige are also confounded in research on occupational aspirations. Male sex-typed occupations vary from high to low prestige while female sex-typed occupations cluster in the middle to low prestige with few high-prestige female sex-typed occupations. Einarsdottir and Rounds (2000) concluded that investigators are unlikely to detect sex-type and prestige as two separate dimensions in the interest structure. In an attempt to avoid these potential methodological artifacts that impact the analysis of prestige and sex-type interest dimensions, the present study used occupations representative of US workforce that include considerable prestige and sex type variation.

4. The present study

In the present study occupational interest structure was investigated using a set of occupational titles identified by the US Department of Labor as representing approximately 85% of the US labor market and workforce. It is proposed that comprehensively surveying the domain of occupational titles is important for identifying the core dimensions of interest structure. This strategy addresses an important limitation of previous studies, which have based their findings on RIASEC measures that have a restricted range of interests represented by the types. We evaluated Holland's model in a two- and three-dimensional occupational space. In the two-dimensional test, we compared the results obtained using the comprehensive set of occupational titles to the results obtained on a benchmark, the occupational titles from the VPI (Holland, 1985). We expected that VPI occupational titles would show a better fit than the comprehensive set of occupational titles. To examine the incremental improvements in fit and the explanatory power of a two- compared to a three-dimensional models of occupational interests, a dimensional analysis of the occupational space was conducted We tested the capacity of a two- versus a three-dimensional occupational structure to capture Prediger's dimensions of T/P and D/I and the dimensions of prestige and sex-type. The dimensional analysis was important for accurately locating

the RIASEC model in three-dimensional space and allowed a test whether prestige and sex-type dimensions are confounded.

5. Methods

5.1. Participants

Participants were college students enrolled in sections of a career development and exploration course offered at a large Midwestern university. They completed the survey as part of a research participation requirement in the course. The surveys were distributed to the students in class, with a total of 867 surveys returned. Participants ($n = 22$) who had more than three missing values were excluded from the study. Participants who did not report their sex ($n = 7$) were also excluded because the analysis examined differences between men and women in interest structure, resulting in a total of 838 study participants, 266 men and 572 women. Participants were asked to indicate their racial or ethnic identity with 6.6% identifying as Asian American, 6.8% as Hispanic American, 16.6% as African Americans, 0.1% as Native Americans, and 68.1% as Caucasian (1.8% did not report ethnicity). With respect to year in college, 28.9% were freshmen, 30.2% sophomores, 15.4% juniors, 24.5% seniors, and 1.0% graduate students (1.1% did not report year in school). Participants reported the following fields of study: 50.6% in Social and Behavioral Science, 15.2% in Business, 10.2% in Science or Engineering, and 21.5% undecided (2.5% did not report their major field). The average age of participants was 19.78 ($SD = 2.04$).

5.2. Occupational preference inventory

We developed an inventory, called the Occupational Preference Inventory (OPI), to measure occupational interests. The OPI item pool initially contained 277 occupation titles from the Enhanced Occupational Outlook Handbook (EOOH; JIST Work Inc., 1997). The EOOH contains 250 major occupations that cover about 85 percent of all jobs in the US Occasionally, the EOOH has occupations that combine two titles. For example, accountant and auditor are listed as one occupational title. In such cases, we separated the occupational title into two titles for the OPI. After 27 titles from the EOOH were separated into two distinct occupational titles, the 250 EOOH titles yielded 277 occupational title items. For each occupation on the OPI participants were instructed to "show how much you think you would like or dislike doing that kind of work" on a 7-point scale, with the anchors of 1 labeled "strongly dislike," 4 labeled "indifferent," and 7 labeled "strongly like."

5.3. Matching OPI occupations to O*NET occupations

The Occupational Information Network (O*NET) database (O*NET Resource Center, 2003) was used to provide the interest and prestige information for the OPI occupations. The O*NET was developed by the US Department of Labor as an electronic successor to the final version of DOT (U.S. Department of Labor, 1991). Four documents were used to match the OPI occupations to O*NET occupations: job descriptions in EOOH, job titles and descriptions of O*NET occupations (O*NET Resource Center, 2003), the crosswalk table between the DOT and the O*NET job titles (O*NET Resource Center, 2003), and

the crosswalk table between Standard Occupational Classification (SOC) and O*NET job titles (O*NET Resource Center, 2003). While matching the OPI occupations to O*NET, nine occupations were excluded because they were either too ambiguous or too general. For example, the job title *painter* can be interpreted as either an artist's occupation or as a type of construction worker. Among the remaining 268 OPI occupation titles, 244 were exact matches either to O*NET, DOT, or SOC job titles. The remaining 24 titles were matched by two of the authors based on the similarity of their job descriptions in EOOH to the job descriptions of O*NET occupations. There was agreement on the matching of titles for 21 of the 24 occupations, yielding an agreement rate of 87%. Disagreements were resolved by discussion between raters. The final version of the OPI contained 268 occupational titles.

5.4. Assignment of Holland codes to occupations

O*NET RIASEC ratings (Rounds et al., 1999) were used to assign each of the OPI occupation into one of the Holland's six types. Each occupation in O*NET database has an occupational interest profile indicating how descriptive and characteristic the occupation is for each RIASEC work environment. Rounds et al. (1999) examined the structural validity of these ratings, and reported that the O*NET RIASEC ratings were consistent with the structure of Holland's theoretical model, supporting the validity of the ratings. A recent study by Eggerth, Bowles, Tunick, and Andrew (2005) comparing the RIASEC codes of occupations from the O*NET, the *Dictionary of Holland Occupational Codes* (DHOC; Gottfredson & Holland, 1996), and the Strong Interest Inventory (Harmon et al., 1994) has also demonstrated the validity of first-letter codes of occupations listed in the O*NET, with 79% agreement with the DHOC, and 71% and 74% agreement with the female and male reference norms (respectively) from the Strong Interest Inventory. The distribution of the RIASEC types across the 268 OPI occupational titles (frequency and percent in parentheses) is: R (80, 29.85%), I (41, 15.30%), A (24, 8.96%), S (38, 14.18%), E (45, 16.79%), and C (40, 14.93%).

5.5. Work-task, prestige, and sex type variables

Four variables were created to represent Prediger's (1982) work-task dimensions, as well as measures of prestige, and sex-type. We used Prediger's (1982) formulas and terms (i.e., T/P and D/I) to represent the two work-task dimensions based on the RIASEC scale scores for each occupation. Scores for each occupation on the RIASEC scales were obtained from the O*NET database. The formula for the T/P score was $2.00 \times (R - S) + I + C - A - E$; and for the D/I score was $1.73 \times (E + C - A - I)$. For example, the T/P score of dancer is $2 \times (4 - 4) + 2.67 + 2.33 - 6.67 - 3.67$ (i.e., -5.33) and its D/I score is -5.77.

Three variables were used to construct a measure of prestige for the OPI occupations: (1) vocational preparation, (2) a composite score of two need-reinforcers, recognition and social status, and (3) mean annual salary. Vocational preparation required for each occupation came from the O*NET Job Zone ratings (Oswald, Campbell, McCloy, Rivkin, & Lewis, 1999). A Job Zone is a group of occupations that are similar in how much overall experience, education, and on-the-job training people need to be able to do the work. The O*NET Job Zone uses a five-point scale: 1 = little or no preparation, 2 = some

preparation, 3 = medium preparation, 4 = considerable preparation, and 5 = extensive preparation. The distribution of the 268 OPI occupational titles across the five Job Zones (frequency and percent in parentheses) is: little or no preparation (31, 11.57%), some preparation (47, 17.54%), medium preparation (61, 22.76%), considerable preparation (90, 33.58%), and extensive preparation (39, 14.55%).

Need-reinforcers, derived from the Theory of Work Adjustment (Dawis & Lofquist, 1984), characterize the nature of the work and the conditions in work environments. *Social Status* refers to the extent that workers in the occupations "would be looked up to by others in the company and the community." *Recognition* refers to the extent that workers in the occupation "receive recognition for the work they do." Need-reinforcer occupational scores were obtained from the O*NET database (McCloy et al., 1999). Because these two need-reinforcers are highly correlated across O*NET occupations ($r = .85$, $n = 268$), a composite need-reinforcer variable was constructed by calculating the mean of the Social Status and Recognition scores.

The 2003 mean annual salary (MAS) of each occupation was obtained from the Occupational Employment Statistics Survey (Bureau of Labor Statistics, 2004b). A composite variable representing prestige was created from a principle components analysis. Only the first component had an eigenvalue larger than 1, accounting for 79.05% of the total variance, indicating that the three variables are highly related. The regression function for the composite prestige variable had similar weights for all three variables: Prestige = 0.37 * z-Job Zone + 0.37 * z-MAS + 0.38 * z-Reinforcer.

To construct a measure of the sex-typing of occupations, we initially used the approach of Einarsdottir and Rounds (2000). Occupations were coded according to the percentage of female employees using the 2003 annual average data of the *Current Population Survey* (Bureau of Labor Statistics, 2004a). The information, however, was only available for 213 of the 268 occupations. To develop an alternative method for all of the 268 occupations, we calculated the difference between female ($N = 572$) and male ($N = 266$) mean interest ratings for each occupation. To evaluate the similarity of these sex-type estimates, we correlated the percentage of female employees with the interest difference scores for the 213 occupations. For example, the mean interest difference score of Guard is −1.10 (female $M = 2.03$ and male $M = 3.13$) and the percentage of female guards is 12% or the mean interest difference score of Register Nurse is 1.17 (female $M = 3.93$ and male $M = 2.76$) and the percentage of female registered nurses is 92%. The correlation was .78, indicating that interest-rating difference methodology produced an effective indicator of the sex-typing of an occupation that is similar to the percent estimates of female employees (see Rounds, 1995, for application of this method to scale scores).

5.6. Analysis

To evaluate sex-differences in interest structure, separate correlation matrices were calculated for women and men. Because there was missing item data, pairwise deletion was used in calculating the correlations. These correlation matrixes were then scaled using the three-way (individual differences) MDS. The fit index of Variance Accounted For (VAF) and the salience weights were examined to determine if there are sex differences in interest structure.

We used several techniques to determine if Holland's model was best represented in three dimensions. First, MDS yields a spatial representation that was examined to

evaluate Holland's hypothesis that the types are ordered in a circular fashion of R-I-A-S-E-C. Secondly, a correspondence index (CI; Hubert & Arabie, 1987) was calculated to examine the violations and agreements of Holland's order hypothesis (i.e., the relations between the adjacent types are stronger than the relations between the alternate types, and the relations of the alternate types are stronger than the relations between the opposite types). The CI is calculated from the number of agreements minuses the number of violations, and then it is divided by the total number of agreements and violations (or predictions).

Although there is a probabilistic interpretation of CI, the *p*-value only tests the random-labeling hypothesis, i.e., the random selection of order conjectures from the given data. Therefore, this procedure does not provide direct information whether the spatial arrangement of Holland's model holds (Rounds, 1995). To avoid confusion, the *p*-values of CI were not reported. Instead, the CI values of this study are compared to a US benchmark, developed on 73 US RIASEC correlation matrices (Rounds & Tracey, 1996). The mean CI value of the benchmark is .70 with a lower bound 99% confidence interval of .66. As a third test of the Holland structure, we used the technique of Circular Unidimensional Scaling (CUS, Hubert, Arabie, & Meulman, 1997) to evaluate the circular ordering of the RIASEC types, following established procedures for using the CUS technique to evaluate Holland's model (see Armstrong et al., 2003). The CUS technique fits the observed distances between types to a circumplex model, and uses a VAF statistic to evaluate model fit. To address potential concerns with the effects of local optima, 500 random starting permutations were used for each analysis. Finally, we examined the fit of the Prediger's T/P and D/I dimensions. If the occupations show a reasonable fit to Holland's model, these dimensions should be well represented in the MDS solution. We used the R^2 measure of VAF from the property vector fitting results to evaluate how well Prediger's dimensions were represented.

6. Results

The evaluation of the extent to which Holland's model is sufficient to account for occupational structure begins with fitting of Holland's model in a two-dimensional structure, using both the 268 OPI occupations and the subset of 49 VPI occupations. Next, we evaluated the fit of Holland's model in a three-dimensional structure using the same data. Evaluations of Holland model fit are based on a direct test of Holland's RIASEC order hypotheses, and the extent to which either two- or three-dimensional solutions account for variables representing Prediger's (1982) T/P and D/I dimensions, and measures of Prestige and Sex-Type. Holland's model was also evaluated by comparing the results obtained with the full set of OPI occupations and the subset of VPI occupations. Before using a combined sample of men and women in the MDS analyses, we first conducted an analysis of sex differences, testing whether the occupational interest structures for men and women were similar.

6.1. Sex differences in occupational interest structure

As a first step in the data analysis, the potential for gender differences in structure were examined. We expected to find similar occupational interest structures for women and men since it is rare to find sex differences in vocational interest structures (e.g., Anderson,

Tracey, & Rounds, 1997). Correlations among the 268 OPI items were calculated separately for male and female students, and were then submitted to a three-way (individual differences) multidimensional scaling (MDS) analysis. Two dimensions were extracted. Table 1 presents the stress, proportion of variance accounted for (VAF), and dimensional salience weights from the two-dimensional solution by sex. The stress, VAF, and the salience weights are very similar for the male and female samples, suggesting that a common occupational interest structure is present for both groups. The combined (male and female) two-dimensional MDS configuration is shown in Fig. 2. To represent the locations of the six RIASEC types, centroid coordinates were calculated by averaging the coordinates of the occupations with same letter RIASEC code.

6.2. Holland's model in two-dimensions

The MDS configuration presented in Fig. 2 does not support Holland's model, with the A-type occupations clustering between the S and the E occupations rather than between I and the S occupations. The order of the mean points is RISAEC with a reversal of A and S. The CI is .47, considerably below the lower bound of 99% confidence interval of .66. Furthermore, as illustrated in Fig. 3, the Circular Unidimensional Scaling (CUS) analysis of the 268 occupation solution (with the S and A types reversed) provides stronger evidence that the order hypothesis of the RIASEC model is not supported. Overall, these results indicate that Holland's circular order model is not well represented in two dimensions when examining the structure of occupational interest items that represent the full range of occupations in the US labor market.

Table 1
Three-way MDS fit indices and salience weights for two- and three-dimensional solutions by occupational sets

Solution	Stress	VAF	Dimensional weight		
			Dim 1	Dim 2	Dim 3
268 OPI occupations					
Two-dimensional					
Women	0.27	0.62	0.68	0.65	—
Men	0.29	0.58	0.66	0.66	—
Combined	0.28	0.60	—	—	—
Three-dimensional					
Women	0.20	0.72	0.59	0.57	0.51
Men	0.21	0.68	0.56	0.56	0.55
Combined	0.20	0.70	—	—	—
49 VPI occupations					
Two-dimensional					
Women	0.21	0.77	0.70	0.68	—
Men	0.20	0.79	0.71	0.66	—
Combined	0.20	0.78	—	—	—
Three-dimensional					
Women	0.14	0.84	0.56	0.54	0.60
Men	0.15	0.83	0.63	0.58	0.47
Combined	0.15	0.84	—	—	—

Note. VAF, Variance Accounted For; Dim, Dimension; OPI, Occupational Preference Inventory; VPI, Vocational Preference Inventory.

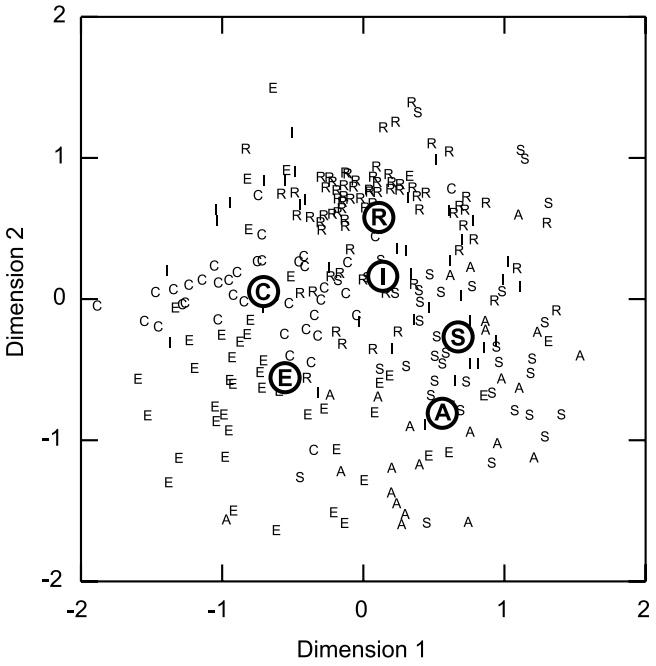

Fig. 2. Two-dimensional MDS configuration of the 268 OPI occupations plotted by first-letter RIASEC code. Centroid coordinates for each RIASEC type are circled.

Rounds (1995) found strong support for Holland's model by using scales from measures designed to assess Holland's RIASEC model. To further examine whether the present data can provide similar evidence, we analyzed a subset of OPI occupations that matched occupations in the VPI, a measure used by Holland et al. (1969) to develop the hexagonal model. The VPI contains 84 occupations titles, 14 occupations for each RIASEC type. Two graduate students who are familiar with Holland coding of occupations independently matched the 84 occupations to O*NET occupations. They agreed on 70 of the 84 occupations, including both OPI-VPI occupational matches and non-matches, for an overall agreement rate of 83%. The first author resolved the 14 disagreements between raters. A total of 49 OPI occupations were matched to VPI occupations, and were assigned RIASEC codes from the VPI, resulting in 10 R, 11 I, 8 A, 4 S, 7 E, and 9 C occupations.

Three-way MDS of the 49 VPI occupations again indicated that men and women share a similar structure (see Table 1). Fig. 4 illustrates the two-dimensional MDS solution for these occupations. These results provide support for Holland's model, with the occupations of the same type clustering together and distributed in a RIASEC-consistent ordering. The mean RIASEC item coordinates also support Holland's arrangement of the six types. The CI was calculated on the distances among the mean RIASEC item coordinates. The CI value for this set of occupations was .67, within the benchmark CI 99% confidence interval. Also, as illustrated in Fig. 3, the CUS analysis of the 49 VPI occupations supported the RIASEC order hypothesis. In short, these results show that Holland's model is well represented in two dimensions when the analysis is restricted to the 49 VPI

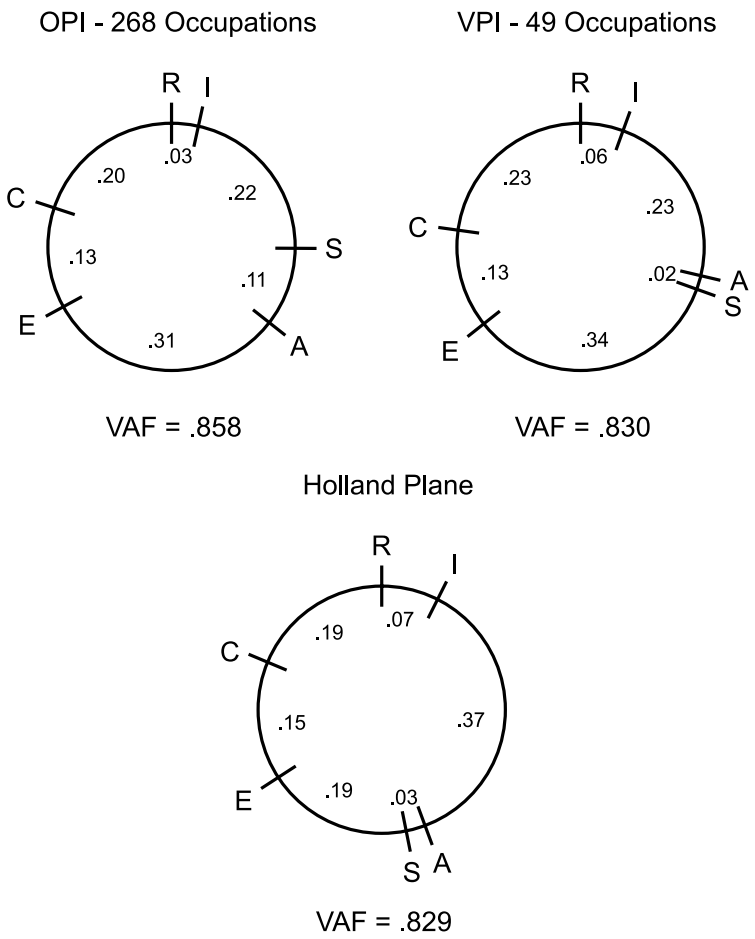

Fig. 3. Circular Unidimensional Scaling results for RIASEC centroids obtained from the two-dimensional MDS solution for 268 OPI and 49 VPI occupations and the Holland Plane of the rotated three-dimensional MDS solution for 268 OPI occupations.

occupations, but when the full range of occupations in the US labor market is evaluated, the Holland model is not supported.

6.3. Comparisons between two- and three-dimensional models

To compare the fits of a two-dimensional and a three-dimensional model, a three-way MDS was performed for both the 268 OPI occupations and the 49 VPI occupations. Both three-way MDS solutions showed that men and women have similar three-dimensional structures (see Table 1). Therefore, the three-way MDS solution from the combined sample was used. For the 268 OPI occupations, the VAF increases 10% from a two-dimensional solution (VAF = .60) to a three-dimensional solution (VAF = .70). For the 49 VPI occupations, the addition of a third dimension increased VAF by 6% (from .78 to .84). Property vector fitting (Kruskal & Wish, 1978) was used to examine whether a

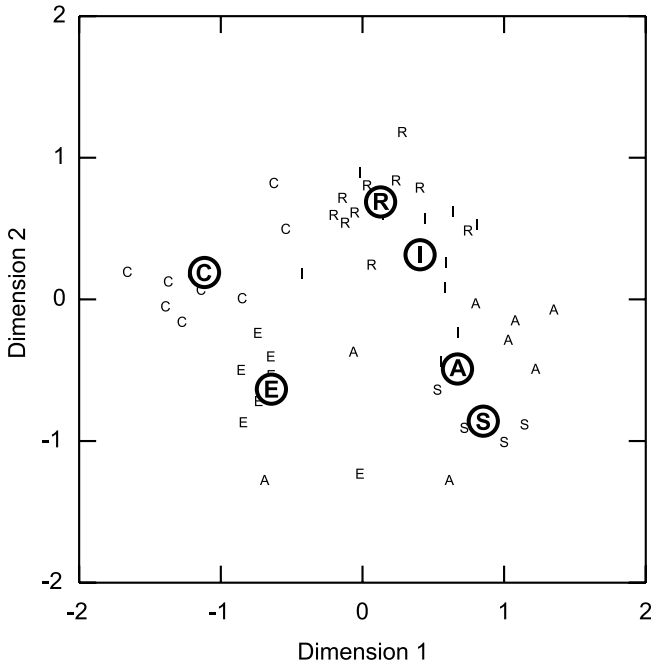

Fig. 4. Two-dimensional MDS configuration of the 49 VPI occupations plotted by first-letter RIASEC code. Centroid coordinates for each RIASEC type are circled.

three-dimensional solution represented Holland's interest structure more effectively than a two-dimensional solution. Measures of T/P, D/I, and Prestige were regressed on the two-dimensional and then the three-dimensional stimulus coordinates. Characteristics that achieved R^2 (VAF) values greater than .50 were included in figures.

Table 2 shows the MDS and property vector fitting results for the 268 OPI occupations and 49 VPI occupations. For the OPI occupations, T/P can be located as a dimension in the two-dimensional configuration with a VAF of .56. D/I and Sex Type, however, are not as well represented as T/P, and Prestige does not emerge as a dimension. However, in the three-dimensional configuration, all three properties are well represented. Specifically, the

Table 2
Variance Accounted For (VAF) from property vector fitting analysis of four interest variables

Solution	Interest variable			
	Things/People	Data/Ideas	Prestige	Sex type
268 OPI occupations				
Two-dimensional	0.56	0.38	0.08	0.42
Three-dimensional	0.68	0.61	0.51	0.54
49 VPI occupations				
Two-dimensional	0.86	0.69	0.13	0.68
Three-dimensional	0.92	0.75	0.12	0.85

Note. OPI, Occupational Preference Inventory; VPI, Vocational Preference Inventory.

addition of a third dimension increased the explained variances (R^2) of D/I from .38 to .61, Prestige from .08 to .51, and Sex Type from .42 to .54. For the VPI occupations, in comparison, T/P, D/I, and Sex Type are well represented in a two-dimensional MDS configuration, and Prestige did not emerge in either the two-dimensional or the three-dimensional configuration.

The property vector fitting results indicated that a three-dimensional model represented the interest structure of US occupations better than a two-dimensional model. Prestige cannot be located in the VPI occupations in a two-dimensional or a three-dimensional model. To examine whether the lack of Prestige dimension is due to restriction of range, we calculated the mean and standard deviation of Prestige for both the 268 occupations and the 49 VPI occupations. The prestige range for the 268 occupations is from −2.01 to 3.50 with a M of .00 and a $SD = 1.00$, while the prestige levels of the 49 VPI occupations range from −1.29 to 2.48 ($M = .33$ and $SD = .77$). These results suggest that restriction of range may be the reason why the prestige dimension could not be found in the VPI occupational configuration.

6.4. Holland's model in three-dimensions

The regression results have shown that the four interest dimensions fit well in the three-dimensional OPI solution (see Table 2). The T/P and D/I vectors form a two-dimensional plane that represents Holland's model, embedded in the larger interest space of the three-dimensions extracted in the MDS analyses of OPI occupations. Conceptually, this represents a subspace, or Holland plane, in the larger interest space of occupations in the US labor market.

By creating a vector that is orthogonal to the Holland plane, a new three-dimensional space was formed by rotating the original MDS coordinates. Table 3 shows the regression results of T/P, D/I, Sex-type, and Prestige on this new three-dimensional space. As illustrated in Fig. 5, in the rotated three-dimensional solution, dimensions 1 and 2 are now strongly aligned with measures representing Prediger's T/P and D/I dimensions. In this solution, as illustrated in Figs. 5 and 6, prestige is now aligned somewhat with both dimensions 2 and 3, and sextype is aligned with dimension 1. These results clearly demonstrate that prestige and sextype are embedded within Holland's model when examining occupational interests. Prestige is orthogonal to both Sex Type and T/P, and has a negative association with D/I. Sex Type is also essentially orthogonal to D/I and is almost parallel with T/P, but in opposite direction. The CI calculated on the distances between the RIASEC

Table 3
Interest variable directional cosines for three-dimensional MDS solution

Interest variable	VAF	Dimension weight		
		Dim 1	Dim 2	Dim 3
Things/People	0.68	0.82	0.00	0.00
Data/Ideas	0.61	−0.16	0.78	0.00
Prestige	0.51	−0.03	−0.43	−0.62
Sex-type	0.54	−0.72	−0.02	0.17

Note. VAF, Variance Accounted For; Dim, Dimension.

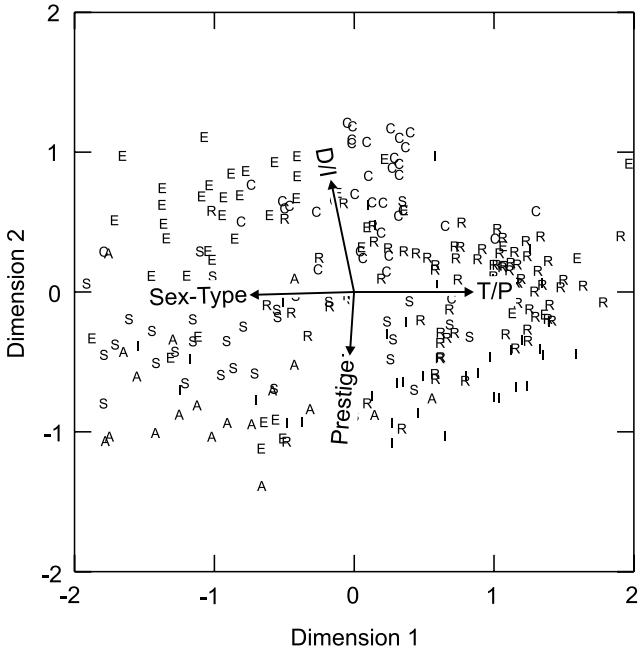

Fig. 5. Property vector fitting results for the Holland plane (dimensions one and two) of the rotated three-dimensional MDS solution, with occupations plotted by first-letter RIASEC code. D/I, Data/Ideas; T/P, Things/People.

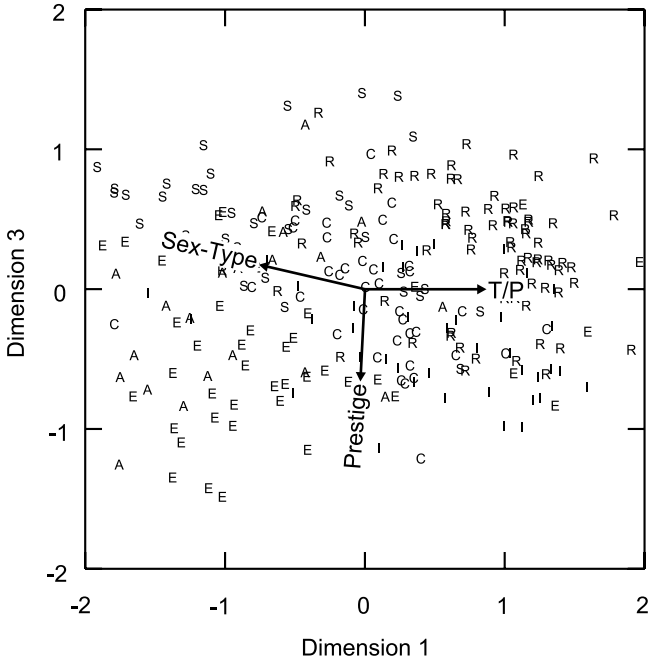

Fig. 6. Property vector fitting results for dimensions one and three of the rotated three-dimensional MDS solution, with occupations plotted by first letter RIASEC code. T/P, Things/People.

mean coordinates on the Holland Plane is .72 which is higher than the US benchmark of .70 (Rounds & Tracey, 1996). When the distances between the six RIASEC types on this Holland Plane are evaluated using CUS (see Fig. 3), the ordering is consistent with Holland's theory. Overall, these results strongly support the use of a three-dimensional model to represent occupational interest structure that includes Holland-based T/P and D/I dimensions.

To further evaluate the embedding of prestige and sex-type in Holland's RIASEC types, we computed the mean prestige and sex-type level of the RIASEC occupations (see Table 4). The results of the two ANOVAs indicated there were significant differences among the RIASEC types for both Prestige, $F(5, 262) = 40.45$, $p < .001$, $\eta^2 = .44$, and Sex Type, $F(5, 262) = 26.68$, $p < .001$, $\eta^2 = .34$. Consistent with Gottfredson's (1978, 1980) findings, the R and C occupations have the lowest prestige level, and I occupations have the highest prestige level. For sex-type, the R occupations have the lowest score (in the direction of male type), and the S occupations have the highest score (in the direction of female type). These results demonstrate that men prefer the R occupations more than women, and women prefer the S occupations more than men.

7. Discussion

In the present study, the structure of interests was investigated using a set of occupations representing approximately 85% of the US labor market. To date, almost all studies of vocational interest structure have focused on existing interest inventories. These measures often reflect the characteristics of the six Holland RIASEC types, because that is what they are designed to measure, and perhaps it is not surprising that the structural hypothesis of Holland's model is supported by analyses of these inventories. This RIASEC-based research does not, however, address the larger question of identifying the key dimensions of individual differences in occupational interests. By using a more representative set of occupations, the underlying dimensions of interest structure were examined without preordaining the emergence of a Holland model.

Table 4
Means and standard deviations of prestige and sex-type variables by RIASEC type

Type	*N*	*M*	*SD*	Min	Max
Prestige					
Realistic	80	−0.61	0.75	−2.01	2.01
Investigative	41	1.07	0.76	−0.06	3.50
Artistic	24	0.65	0.40	−0.20	1.54
Social	38	−0.12	0.88	−1.84	1.76
Enterprising	45	0.48	0.83	−1.87	2.48
Conventional	40	−0.69	0.72	−1.74	1.29
Sex-type					
Realistic	80	−0.71	0.45	−1.59	0.52
Investigative	41	−0.38	0.54	−1.14	1.08
Artistic	24	0.09	0.64	−0.54	1.77
Social	38	0.39	0.58	−1.14	1.31
Enterprising	45	−0.16	0.62	−1.57	1.87
Conventional	40	−0.20	0.39	−1.17	0.80

Note. Min, minimum value; Max, maximum value.

The results for Holland's model in the current analyses were somewhat mixed: The RIASEC model was *not* identified in a two-dimensional occupational space, as expected, but was identified in a more complex three-dimensional space. This finding has important implications for the interpretation of Holland's model and RIASEC-based measures. These results also provide a starting point, similar to lexical hypothesis research in the personality area (Saucier & Goldberg, 1996), for the continued development of a model of interest structure that reflects the full range of employment opportunities in the US.

Does the present three-dimensional occupational map adequately define the domain of vocational interests? In part, the answer varies depending on the kinds of items researchers use to assess interests (see Rounds, 1995, for a review of the vocational interest domain). Kuder (1970) and Strong (1943) had different ideas on the kinds of items to include in a vocational interest measures. Kuder (1970) argued for the use of activity items only. Strong (1943) used a broad set of items including occupations, activities, leisure activities, school subjects, preferences, types of people, and person characteristics. Holland and Raymond (1986) began with occupations in the VPI but later with the Self-Directed Search, he expanded his item domain to include activities and self estimates of skills (competencies). Because the present study tested the generality of Holland's theory, occupational titles were used. Using the emergence of the Big 5 (Digman, 1989), as an exemplar, a structure and taxonomy of vocational interests will involve a variety of methods to assess interests and multiple studies that converge on a structural model.

7.1. Prestige as an interest dimension

This study supports the contention by Rounds and Day (1999) that a prestige dimension will emerge when items vary in their levels of prestige. Representing Holland's RIASEC model in two dimensions does not appear to capture vocational interest variability caused by prestige differences across occupations. Besides the work-task oriented dimensions, prestige is a variable contributing to occupational interests. Holland (1997) has stated that earlier versions of his interest theory focused more on the kind of work a person performs than on level of work (i.e., prestige, income, level of talented required, etc.), but he has also noted that level of work is a factor in vocational choice (Holland, 1959). Gottfredson and Holland (1996) proposed complexity as a third dimension, which they defined as the cognitive demands placed on workers, as a distinguishing feature of occupations. However, Holland's hypotheses about the level of vocational choices and achievement, and level of cognitive demand placed on workers have received little research attention.

Studies using occupations (Tracey & Rounds, 1996) or activities (Tracey, 1997) indicated that prestige can be interpreted as a third dimension that is independent, or orthogonal, to the two dimensions underlying Holland's types. The present study, however, demonstrated that prestige is not independent of Holland's types. The key differences between the results of Tracey and Rounds (1996) and the present study involve the number and type of occupations studied and how the spherical model was created. In the present study, the I and A occupations had the highest prestige levels, and the C and R occupations had the lowest prestige level. This replicates Gottfredson's (1978) findings that there is an association between Holland's occupational classification and prestige. As noted by Gottfredson, Holland, and Gottfredson (1975) these prestige differences in types of work may limit career options for individuals who aspire towards either

high- or low-level occupations. For example, in career counseling there would be few occupations to explore if an individual has strong C or R interests and also a strong preference for high prestige. Similarly, there may be limited occupational options for clients who have strong A or I interests combined with a preference for working in a less demanding, lower prestige occupation. The non-orthogonality of RIASEC types with prestige could also confound the assessment of interests with prestige preferences. For example, when completing an interest measure, an individual with prestigious aspirations may tend to prefer I and A occupations, and reject C and R occupations, irrespective of the work activities involved in the occupations.

The present study shows how work values and interests can be integrated with interests as an organizational framework. Prestige was assessed using need-reinforcers (social status and recognition) from the theory of work adjustment (Dawis, 2005). These need-reinforcers from the environmental side are considered occupational reinforcers and from the person side of the equation –work values. The present study found that these occupational reinforcers from the O*NET can be incorporated within an interest space. Similarly, Armstrong, Smith, Donnay, and Rounds (2004) developed the Strong Ring, a model that has interests as an organizational framework to integrate work values and skills. These studies and others (e.g., Ackerman & Heggestad, 1997; Mount, Barrick, Scullen, & Rounds, 2005) demonstrate that interest structures form the base for understanding how personality traits, values, and abilities are interrelated.

7.2. Sex-type as an interest dimension

The present study demonstrates that sex-type is also a dimension of occupational interest structure. Sex-type was found to be highly correlated with T/P, and orthogonal to the D/I and Prestige dimensions. Men scored higher than women on the Things end of T/P dimension (i.e., R occupations) and women higher than men on the People end (i.e., S occupations). These results are similar to previous studies that have examined sex-differences in vocational interests. For example, Tracey and Rounds (1992) analyzed SDS norm data that Holland collected from college and high school students in 1985 and 1987. In their database, more males had R and I as their first letter code than females and more females had S as their first letter code than males. Lubinski (2000) commenting on Lippa's (1998) research on gender and interest structure reported that the People (Social) and Things (Realistic) dimension is the "largest of all sex differences on major psychological dimensions" (p. 421). Helwig (2002) conducted a longitudinal study on children's occupational aspiration. His study showed that girls reported significantly higher levels of working with people than boys through Grade 2 to Grade 12, and boys reported significantly higher in working with things than girls from Grade 2 to Grade 10.

Gottfredson (1996) proposed developing cognitive maps of occupations by plotting dimensions based on sex-type and prestige level, and then embedding interests in the resulting occupation space. Her proposal represents an initial attempt to integrate interests, prestige, and sex-type. In comparison, The present results show that sex-type and prestige are confounded with Holland's type definitions. The current findings support the continued development of a more integrative approach to representing interests as part of a cognitive map that includes prestige level and sex type as dimensions.

7.3. Interpreting Holland's model

In the area of interest research, attempts have been made to draw parallels between the six Holland RIASEC types and the Big Five model of personality (see, for example, Larson, Rottinghaus, & Borgen, 2002; Mount et al., 2005). The emergence of the Big Five model of personality from lexical hypothesis research provides a comprehensive taxonomy for describing individual differences in personality (Goldberg, 1993). Although some researchers have argued that additional factors are necessary to capture the full range of individual differences (e.g., Block, 1995; Paunonen & Jackson, 2000), the debate over personality structure is now framed by the lexical hypothesis-based goal of representing the full range of personality adjectives. Attempts to draw parallels between the Big Five and the RIASEC types, as the initial development of the types, as outlined in Holland, 1959, did not involve a systematic, empirically-based evaluation of occupational interest structure that would be comparable to the lexical hypothesis. The present results, obtained using a representative set of occupational titles, clearly suggest that the six Holland types are not sufficient to represent the full range of individual differences in occupational interests. Therefore, calling the Holland types the 'Big Six' may be somewhat premature, and results obtained supporting the Holland's model in previous research may be an artifact of using the limited range of interest items in RIASEC-based measures.

In his critique of the lexical hypothesis and the five factor model of personality, Block (1995) identified two issues that are relevant to the study of occupational interest structure. First, Block claims that it is possible for researchers to bias the results of a lexical hypothesis-based study by imposing an a-priori structure. For example, with personality adjectives this may happen as researchers group words into categories to reduce the number of redundant synonyms. Rounds and Zevon (1983) have raised similar concerns with interest measures. The external criteria of using occupations that represent the most frequently employment opportunities in the US labor market was used in the present study to select occupations. This was done to evaluate the impact of item selection bias on the obtained results, and the selection of occupations does appear to impact the results of structural analyses. Holland's RIASEC model can be identified in a two-dimensional structure, but only if the analysis is limited to occupations from Holland's VPI. The RIASEC model is not identified when occupations are used that are representative of the full range of employment opportunities for the US workforce. The potential effects on the career counseling process of using assessment measures with a limited range of interest items is an important issue to explore in future research.

Another concern raised by Block (1995) is that research conducted with college students may bias results towards a simplified picture of personality structure due to developmental issues. Similarly, when occupational interests are examined, the emerging structure may reflect in some ways the limited work experiences of college students. This may limit the implications of the current findings to applications in college settings. Replication of the current study with different populations is required to address this concern. However, because Holland's model was originally developed with high school and college students, it seems unlikely that the limitations found here will be less of an issue when working with other groups. It is also worth noting that college students remain an important target audience for interest assessments, and more generally for career counseling interventions, making the structure of interests for this population and the validity of interest measures used with college students an important research question irrespective of the extent to which obtained results generalize to other populations.

8. Summary and conclusions

The finding that Holland's (1959, 1997) types are not sufficient to represent the full range of occupations in the US has important implications for the use of RIASEC-based assessment measures. For individuals whose interests fall within the occupational space represented by the types, current measures may be sufficient. However, with individuals considering career choices that fall outside the RIASEC types, current interest measures may present an overly restricted and distorted range of career choices. We also found that prestige and sex type were embedded in Holland's categorization of interest types, demonstrating the importance of level of work and the influences of socialization in occupational interest. It is important to incorporate prestige and sex type with work-task interests in practice. Finally, the present study demonstrated that the prestige dimension is attenuated if occupations with limited prestige levels are used for scale construction. In future investigations of occupational interest structure researchers should use a set of occupational titles that are more representative of the full range of employment opportunities considered by individuals.

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