



Development and initial validation of brief public domain RIASEC marker scales ^{☆,☆☆}

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ABSTRACT

Although commercially developed interest measures based on Holland's RIASEC types are effectively used in a variety of applied settings, these measures have somewhat limited research utility due to their length and copyright restrictions placed by the test publishers. In the present study, two sets of 8-item RIASEC scales were developed using activity-based items selected from the 30-item RIASEC scales of the Interest Profiler, and two sets of 8-item RIASEC scales were developed using sets of 30 occupational job titles selected from the O NET database representing each Holland type. Responses to the items were obtained from three samples of college students with a total of 1024 female and 639 male participants. Results obtained in the initial development and validation process suggest that the sets of brief activity- and occupational-based RIASEC scales developed in the current study retain acceptable levels of reliability and convergent validity. The development of these brief public domain RIASEC interest measures addresses the copyright and length limitations of current scales and may be useful when conducting integrative research examining the inter-relations between Holland's types and other individual differences measures.

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1. Introduction

Holland's (1959, 1997) theory of interest types is currently the dominant mode of interest assessment, having influenced the development of numerous interest measures used in career counseling and other applied settings (Rounds, 1995). Despite the validity evidence for commercially developed Holland-based interest measures, such as the Strong Interest Inventory (SII) General Occupational Theme scales (Donnay, Morris, Schaubhut, & Thompson, 2005) and Self-Directed Search (SDS, Holland, Fritzsche, & Powell, 1997), the potential research uses of these measures are somewhat limited due to their length and the copyright restrictions often placed by test publishers (Liao, Armstrong, & Rounds, 2008). Goldberg (1999) has previously raised similar concerns about the effects of copyright restrictions in the area of personality research and has developed a set of public domain personality marker scales, the International Personality Item Pool (IPIP) to help free researchers from the constraints imposed by copyrighted personality inventories. Liao et al. have followed Goldberg's example by developing a set of public domain basic interest marker scales. The present study is a follow-up to Liao et al.'s work, outlining the development of public domain RIASEC marker scales. Structural and convergent validity evidence will be presented for two

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alternate sets of 8-item RIASEC marker scales developed from activity-based items from the Interest Profiler (Lewis & Rivkin, 1999) and for two alternate sets of 8-item occupation-based RIASEC marker scales developed from occupational titles in the O*NET database (Peterson, Mumbord, Borman, Jeanneret, & Fleishman, 1999).

2. Holland's RIASEC types and measures

Holland (1959, 1997) has proposed that individuals and occupations can be described by six interest-based categories: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). These six categories, collectively referred to by the acronym RIASEC, can be used to classify an individual's interests, occupations (Gottfredson & Richards, 1999; Muchinsky, 1999), and have influenced the development of interest measures (Campbell & Borgen, 1999). By matching an individual's interests to occupational characteristics by Holland category, it is possible to identify potential career choices for career counseling (McDaniel & Snell, 1999). A spatial model of the types was proposed by Holland, Whitney, Cole, and Richards (1969), using a hexagon to represent the inter-relations between the types in a circular clockwise ordering of R-I-A-S-E-C. Areas of the spatial model where the individual's interests are strongest can be identified using the results of an interest inventory, and the level of congruence for an occupational choice can be assessed by the distance between the location of strongest interests and an occupational choice (Rounds & Day, 1999).

A variety of RIASEC measures are currently available through test publishers and the US Department of Labor. The Unisex Edition of the ACT Interest Inventory (UNIACT, ACT, 1995) consists of 90 activity-based items with 15 items measuring each of the six RIASEC types. The current edition of the SII (Donnay et al., 2005) has 291 items, including activities, occupations, and academic subjects, of which 153 are used to measure interest in the six RIASEC types, with a range from 21 to 31 items per scale. The Vocational Preference Inventory (Holland, 1985) consists of 160 job titles, of which 84 are used to measure the RIASEC types (i.e., 14 items per type). The Self-Directed Search (Holland et al. 1997) has 228 items, including activities, competency statements occupations, and self-ratings of abilities, with 38 items used to measure each type. The Career Assessment Inventory (Johansson, 1986) consists of 370 items, including activities, occupations, and school subjects, of which 150 are used to measure interest in the six types (i.e., 25 items per type). Additionally, the Interest Profiler (Lewis & Rivkin, 1999) developed for the US Department of Labor has 180 activity-based items measuring the six types.

RIASEC measures, such as the SII, SDS, and UNIACT, are among the most frequently used assessments in vocational psychology. For example, American College Testing (ACT, 1995) reports that more than 3 million high school students and approximately 1 million college students and adults take the UNIACT each year. When used in applied settings such as career counseling, these scales can be very useful for the detailed examination of a client's interests. Additionally, Holland (1997) has argued that the process of completing a RIASEC-based assessment can be viewed as a career-related intervention in itself because the client is exposed to a wide range of career-related opportunities when completing the assessment. However, despite this clinical utility, the length of current RIASEC measures may hinder certain types of research. For example, using one of these commercial interest measures may limit the number of other assessments that may be included in a survey packet for studying the relationship between the RIASEC types and other constructs in the *Atlas of Individual Differences* proposed by Armstrong, Day, McVay, and Rounds (2008). Furthermore, the types of research questions and administration formats that can be used with commercial interest measures are limited by copyright restrictions used by test publishers to protect their instruments (Goldberg, 1999; Liao et al., 2008).

3. The Goldberg variations: Development of public domain RIASEC markers

Goldberg (1999) has suggested that the copyright restrictions used by test publishers may limit the types of research questions that can be investigated. For example, most publishers disallow the reproduction of their copyrighted inventories on public domain websites, and there is a tendency for commercial inventory publishers to discourage test development and comparative-validity studies that may undermine investments in current measures. Goldberg proposed that placing a set of personality items and scales in the public domain, referred to as *Personality Markers*, can free researchers from the constraints imposed by copyrighted personality inventories. Since the development of the public domain IPIP, over 80 studies using the public domain scales have been published, and the scales have been translated into 25 other languages (Goldberg et al., 2006). The initial success and growing popularity of the IPIP can be attributed to the a number of factors: The cost is free, items can be obtained instantaneously via the internet, the combinations of items used in each scale are not protected as proprietary information, and items can be presented in any order, interspersed with other items, reworded, translated into other languages, and administrated on the World Wide Web without asking permission of anyone (Goldberg et al., 2006).

In the field of vocational psychology, Liao et al. (2008) have suggested the commercial nature of the dominant interest measures may provide limited opportunity for comparative-validity studies or the development of new interest models. Similar to Goldberg's IPIP model, Liao et al. proposed the development of *Interest Markers* to be posted on the internet for research purposes, where the items and scales can be obtained freely without extra cost, available easily for inspection, translated into other languages, and administrated without asking permission. It should be noted that other researchers have developed interest measures that are available on the internet, such as the Personal Globe Inventory (PGI, Tracey, 2002). The PGI includes both activity and occupation based items and can be used to assess both interests and self-efficacy; however, in order to measure both interests and self-efficacy, individuals must rate each item more than once, which confounds the distinction between interests and confidence. Therefore, we propose to extend the work of Liao et al. by developing brief

RIASEC-based measures using the items developed by the US Department of Labor for the Interest Profiler (Lewis & Rivkin, 1999) and occupation titles selected from the O*NET database to develop sets of alternate forms RIASEC scales to provide new research opportunities for examining the inter-relations between important career-related constructs, such as interests and self-efficacy.

There are a number of reasons why the items for the Interest Profiler and the O*NET database are an effective starting point for the development of brief RIASEC measures. Foremost, the IP items are already in the public domain and are available for use without copyright restrictions. Second, IP RIASEC scales include 30 items per Holland types allowing for a sufficient number of items to develop a 10-item short-form (Clark & Watson, 1995). Importantly, the IP items have been selected to represent the world of work, by including work activities in broad work content areas and across wide levels of training requirements. The Interest Profiler's development goals were designed to meet the needs of a wide range of persons in career development situations, particularly those seeking positions that require lower levels of formal training or education, making the measure suitable for broader use than existing interest inventories. Third, the IP scales have been shown to be sufficiently reliable and valid for use with career counseling clients (Rounds, Mazzeo, et al., 1999; Rounds, Walker, et al., 1999). Finally, the IP items have been shown to fit Holland's RIASEC hexagonal, suggesting structural validity and relation to same named-scales of other Holland RIASEC measures. In summary, these characteristics of the IP make it a good candidate to develop RIASEC short-form measures. Additionally, the O*NET database is a good option when selecting occupational titles for use in occupation-based interest scales, due to the wide range of data available for each occupation. The range of data includes RIASEC interest ratings that can be used to group occupations by Holland type, educational/training requirements, ability requirements, knowledge areas, and work activity requirements, all of which can be used to select occupations that represent the full range of employment opportunities associated with each RIASEC type.

4. The present study

The primary objective of the present study is to develop sets of brief RIASEC marker scales for use in research, where it may be useful to have Holland-based interest measures that are shorter than commercial interest assessments. An important challenge in the development of these RIASEC scales is to balance the breadth of information encompassed in each type with this goal of reduced length. Based on an examination of other interest measures, such as the PGI (Tracey, 2002), a decision was made to develop 8 items scales. To develop alternative forms of each RIASEC type, two sets of 8-item RIASEC scales were developed using activity-based items selected from the 30-item RIASEC scales of the Interest Profiler, and two sets of 8-item RIASEC scales were developed using 30 occupational job titles, representing each Holland type. Occupations were selected from the O*NET database on the basis of the RIASEC ratings and ratings of work requirements and characteristics to ensure that each type was represented by a range of occupations. Convergent validity evidence will be presented for the brief activity-based scales by correlating scores with participants' ratings of interests in occupations and with scores obtained from the Strong Interest Inventory. Convergent validity evidence for the brief occupation scales will be presented by correlating scores on these scales with participants' results on the Interest Profiler. Circular Unidimensional Scaling (CUS, Hubert, Arabie, & Meulman, 1997) will be used to evaluate the structural validity of the brief RIASEC scales by testing the circular order hypothesis of Holland's (1959, 1997) model.

5. Methods

5.1. Participants

Sample 1 consisted of 814 college students (494 female, 322 male) from a large Midwestern university. Participants were recruited from a psychology department participant pool and agreed to complete survey instruments in exchange for course credit. The mean age of participants in sample 1 was 19.7 years with a range from 17 to 50. Of these students, 52.0% reported being enrolled as Freshmen, 26.1% as Sophomores, 13.4% as Juniors, and 8.1% as Seniors (0.4% did not report their academic standing); 3.4% self-identified as African American, 3.9% as Asian American, 2.3% as Hispanic American, and 87% as White/Caucasian (3.4% identified as Native American, multi-racial, or did not report an ethnic identity).

Sample 2 consisted of 534 college students (328 female, 206 male) from a large Midwestern university. Participants were recruited from a psychology department participant pool and agreed to complete survey instruments in exchange for course credit. The mean age of participants in sample 2 was 19.5 years with a range from 17 to 31. Of these students, 49.4% reported being enrolled as Freshmen, 27.3% as Sophomores, 14.4% as Juniors, and 7.9% as Seniors (1% did not report their academic standing); 1.7% self-identified as African American, 3.3% as Asian American, 2.5% as Hispanic American, and 89.1% as White/Caucasian (3.4% identified as Native American, multi-racial, or did not report an ethnic identity).

Sample 3 consisted of 313 college students (202 female, 111 male) from a second large Midwestern university. Participants were recruited from a career development course offered in the educational psychology department of a large Midwestern university and agreed to complete survey instruments in exchange for course credit. The mean age of participants in sample 3 was 19.6 years with a range from 18 to 23. Of these students, 57.3% reported being enrolled as Freshmen, 26.8% as Sophomores, 5.7% as Juniors, and 9.6% as Seniors (0.6% did not report their academic standing); 18.8%

self-identified as African American, 8.3% as Asian American, 7.7% as Hispanic, and 59.4% as White/Caucasian (5.8% identified as Native American, multi-racial, or did not report an ethnic identity).

5.2. Measures

5.2.1. Interest Profiler

The Interest Profiler (Lewis & Rivkin, 1999) contains 180 activity-based items with 30 items representing activities in each of the six Holland types across a wide range of training requirements. The Interest Profiler was originally designed as a self-scored career exploration interest assessment to measure the six RIASEC Holland types and also has been adapted for computer-based assessments (Rounds, Mazzeo, et al., 1999; Rounds, Walker, et al., 1999). The assessment tool has been adapted for the current research study by changing the self-scored three-point scale with a five-point Likert-type response format, where participants indicate their interest in each activity from 1 (*strongly dislike*) to 5 (*strongly like*). Scores are computed by summing responses for each of the six Holland types.

The development of the item pool for the IP involved a series of steps and huddles in the selection of items. Initially, taxonomy was created to ensure that the item pool adequately covered the six RIASEC constructs, the entire world of work, and included work activities with a variety of training requirement levels. To ensure extensive coverage of the world of work, the 66 work groups in the GOE (US Department of Labor, 1979) were used as work content area targets in the taxonomy. This taxonomy guided the writing and selection of items. Four judges trained in the Holland system assigned each of the work groups to one of the six RIASEC types and then the judges assigned items to work groups. A major source of items came from existing Department of Labor interest instruments, e.g., US Employment Service Interest Inventory (US Department of Labor, 1981).

After writing items to fill out the taxonomy, 500 items were administered to a tryout sample ($N = 1123$) collected from six states (Florida, Michigan, New York, North Carolina, Texas and Utah). Participants were heterogeneous in terms of ethnic diversity (38% African American, 33% White non-Hispanics, 25% Hispanic, and 4% members of other racial/ethnic groups). Based on data generated from this item pool tryout, final items were chosen with the intent to create six internally consistent scales that would demonstrate conformity to Holland's theory of vocational interests; meet the taxonomy goals, especially for maximum training level and work content representation; and minimize gender and racial/ethnic endorsement rate differences. This process led to the selection of 30 items for each of the six scales, for a total of 180 items in the final IP measure. Lewis and Rivkin (1999) reported coefficient alphas ranging from .95 to .97 for each of the six scales. Evidence for convergent and discriminant validity is supported by comparing the Interest Profiler with the Interest-Finder (Wall, Wise, & Baker, 1996) with a median correlation of .82 for similar scales and a median correlation of .46 for dissimilar scales (Rounds, Mazzeo, et al., 1999; Rounds, Walker, et al., 1999).

5.2.2. Occupational interest measure

A second set of 180 interest items were developed by selecting job titles were from the O*NET database (Peterson et al., 1999) to create measures of occupational interests in each of the six Holland types. Occupations were initially grouped by RIASEC category using the interest ratings in the O*NET database (Rounds, Smith, Hubert, Lewis, & Rivkin, 1999). The occupations were then clustered separately by Holland type, based on ratings of education level, ability requirements, knowledge areas, skills, needs, work activities, and work contexts obtained from the O*NET database to ensure that a diverse set of occupations were represented for each type. Occupations were then selected from each RIASEC clustering solution and evaluated by the researchers for comprehensibility and consistency with the Holland model with 30 occupations selected to represent each Holland type.

5.2.3. Strong Interest Inventory

Participants in sample 3 completed the 1994 edition of the Strong Interest Inventory (Harmon, Hansen, Borgen, & Hammer, 1994). The SII assesses vocational interests and compares an individual's interests with those of individuals in various occupations. RIASEC interests were measured using the General Occupational Theme (GOT) scales of the SII. The GOT scales include items measuring interest in activities, occupations, and academic subjects with a range from 20 to 33 items per RIASEC scale. 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. Numerous studies, including Donnay and Borgen (1996), have demonstrated the predictive validity of the SII. Comprehensive reliability and validity information is included in the test manual (Harmon et al., 1994).

5.3. Analyses

5.3.1. Item selection methods

A combination of statistical and rational methods was used to select items from the 180 item Interest Profiler for the activity-based RIASEC short-form scales. Sample 1 was used to create a combined-gender correlation matrix of the 180 activity item inter-correlations. This 180×180 correlation matrix was then scaled in two dimensions using multidimensional scaling (Kruskal & Wish, 1978). Items were selected on the basis of their locations in the two-dimensional space and on their

Table 1
Reliability coefficients for activity-based RIASEC scales from sample 1

Scale	Females			Males		
	30-Item scale	Set A	Set B	30-Item scale	Set A	Set B
<i>Activities</i>						
Realistic	.95	.87	.84	.96	.90	.88
Investigative	.95	.89	.89	.96	.89	.91
Artistic	.96	.86	.84	.96	.88	.84
Social	.95	.80	.85	.96	.85	.89
Enterprising	.93	.84	.79	.93	.84	.81
Conventional	.97	.92	.93	.97	.91	.92

Note: Results obtained from 816 college students (494 female, 322 male).

RIASEC content. Sample 2 was used to validate these initial findings for the Interest Profiler items and also to develop brief occupation-based scales using the same methods.

5.3.2. Circular unidimensional scaling

The fit of the RIASEC short-form measures to Holland's (1997) structural model was evaluated using CUS (Hubert et al., 1997; Hubert, Arable, and Meulman, 2006). Armstrong, Hubert, and Rounds (2003) have demonstrated the utility of the CUS approach for evaluating RIASEC order hypotheses. CUS directly evaluates the two essential elements of a circumplex structure, the ordering and spacing of scales around a circle. The analysis begins with a random permutation of the data matrix and uses a series of operations to improve the fit of the data to the specified circular 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 the scales in a circular structure. An additive constant is included in the model for the calculation of a VAF statistic for interpreting model fit. Armstrong et al. (2003) found that the VAF statistic ranged from .61 to .95 for the unconstrained CUS model when fit to large representative samples of students and employed adults from different racial-ethnic groups in the US and proposed a cutoff of .60 for a good fit based on a Monte Carlo analysis of the VAF statistic and Cohen's (1988) effect size criteria.

6. Results

6.1. Activity-based scales

A list of the activity items selected for the alternate forms brief RIASEC measures are presented in Appendix A. Coefficient alpha measures of internal-consistency reliability were calculated for all scales. Table 1 presents the reliability results for the full 30-item Interest Profiler and the alternate forms 8-item scales for sample 1. The 30-item Interest Profiler scales had reliabilities ranging from .93 to .97 with a mean of .95. In comparison, the brief 8-item activity scales selected from the full set of Interest Profiler items had reliabilities ranging from .79 to .93 with a mean of .87. Table 2 presents the reliability results for the full 30-item Interest Profiler and the alternate forms 8-item scales for sample 2. In sample 2, the full length scales had reliabilities ranging from .93 to .97 with a mean of .95, and the brief activity scales had reliabilities ranging from .79 to .94 with a mean of .88. Means and standard deviations for the 8-item activity-based scales are presented in Table 3. These results suggest that the reliability of the Interest Profiler's RIASEC scales can be maintained at an acceptable level while substantially reducing the number of items.

Convergent validity evidence for the brief activity-based scales is presented in Table 4. The brief activity scales display strong correlations with participants' rating of interest in occupations with a range of .72 to .87 and a mean of .80. Additional convergent validity evidence is provided by correlations with the SII scales with a range of .56 to .72 and a mean of .64. Fig. 1

Table 2
Reliability coefficients for activity-based RIASEC scales from sample 2

Scale	Female			Male		
	30-Item scale	Set A	Set B	30-Item scale	Set A	Set B
<i>Activities</i>						
Realistic	.95	.88	.82	.97	.90	.89
Investigative	.96	.90	.90	.96	.91	.91
Artistic	.97	.89	.87	.97	.89	.87
Social	.96	.84	.88	.97	.89	.91
Enterprising	.95	.88	.87	.93	.84	.79
Conventional	.97	.93	.94	.97	.91	.92

Note: Results obtained from 534 college students (328 female, 206 male).

Table 3
Means and standard deviations for 8-item Interest Profiler RIASEC measures

Scale	Female		Male	
	Mean	SD	Mean	SD
<i>Set A activities</i>				
Realistic	1.54	0.61	2.47	0.86
Investigative	2.62	1.05	2.85	0.95
Artistic	2.92	1.03	2.84	0.96
Social	3.50	0.81	2.75	0.88
Enterprising	2.66	0.93	2.61	0.76
Conventional	2.07	0.90	2.42	0.83
<i>Set B activities</i>				
Realistic	1.67	0.58	2.59	0.85
Investigative	2.44	1.02	2.78	0.93
Artistic	2.89	0.99	2.91	0.93
Social	3.22	0.94	2.53	0.90
Enterprising	2.59	0.90	2.68	0.72
Conventional	2.11	0.96	2.40	0.90

Note: Results obtained from 534 college students (328 female, 206 male).

Table 4
Convergent validity for 8-item Interest Profiler RIASEC scales

Scale	30-Item occupations	SII
<i>Set A activities</i>		
Realistic	.87	.63
Investigative	.82	.61
Artistic	.86	.67
Social	.72	.67
Enterprising	.73	.56
Conventional	.78	.67
<i>Set B activities</i>		
Realistic	.87	.62
Investigative	.82	.59
Artistic	.86	.70
Social	.75	.72
Enterprising	.73	.56
Conventional	.73	.68

Note: Results for O*NET occupation-based scales obtained from 534 college students (328 female, 206 male). Results for SII obtained from a separate sample of 313 college students (202 female, 111 male).

illustrates the CUS results for men and women in sample 1. In all four CUS analyses, the ordering of RIASEC types around the circumplex structure was consistent with Holland's model. For female participants, the VAF of the CUS model was .76 for the Set A activity items and was .73 for the Set B activity items. For male participants the VAF of the CUS model was .79 for the Set A activity items and was .72 for Set B activity items. The VAF results obtained in the CUS analysis are above the cutoff value of .60 from Armstrong et al. (2003). These results provide structural validity evidence by demonstrating that the brief Interest Profiler RIASEC scales produce inter-correlations that are consistent with the order predictions of Holland's (1959, 1997) model.

6.2. Occupation-based scales

A list of the occupational job titles selected as items for the alternate forms brief RIASEC measures are presented in Appendix B. Table 5 presents the reliability coefficients for full 30 set of interest ratings in sets of 30 occupations and the alternate forms 8-item occupation-based scales for sample 2. The 30 items scales had reliabilities ranging from .92 to .95 with a mean of .94, and the brief 8 item occupation scales had reliabilities ranging from .74 to .88 with a mean of .84. These results suggest that the reliability of the O*NET based RIASEC occupational interest scales can be maintained at an acceptable level while substantially reducing the number of items. Means and standard deviations of the 8-item alternate forms occupational interest scales are presented in Table 6.

Convergent validity evidence for the brief occupation-based RIASEC interest scales is presented in Table 7. When the brief 8-item occupation scales are correlated with the brief activity-based scales, the mean correlation is .78 with a range of .73 to .86. Fig. 2 illustrates the CUS results for the activity- and occupation-based scales in Sample 2. In all four CUS analyses, the ordering of RIASEC types around the circumplex structure was consistent with Holland's model. For the activity-based scales, the VAF of the CUS model was .80 for the Set A items and was .73 for the Set B items. For the occupation-based scales, the VAF of the CUS model

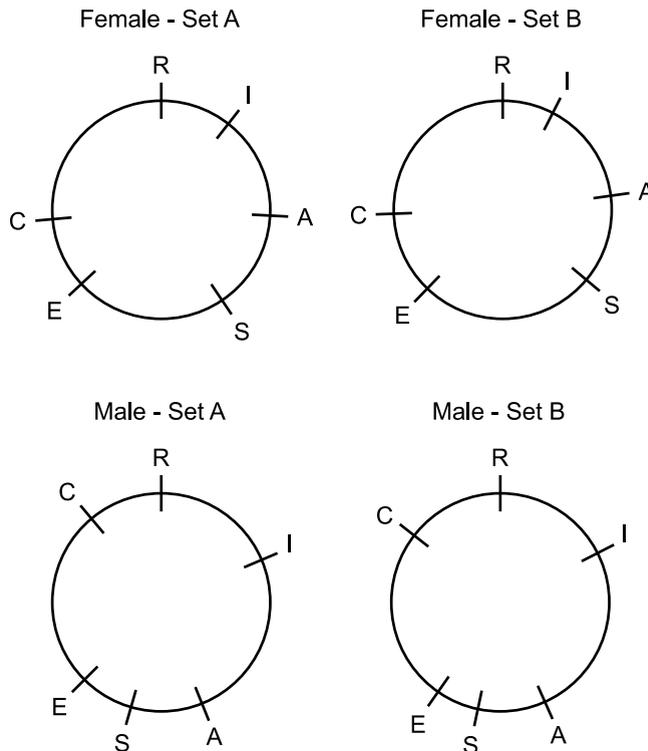


Fig. 1. Activity item short-form circular unidimensional scaling results for male and female students in sample 1.

Table 5
Reliability coefficients for occupation-based RIASEC scales from sample 2

Scale	Females			Males		
	30-Item scale	Set A	Set B	30-Item scale	Set A	Set B
<i>Occupations</i>						
Realistic	.94	.81	.84	.94	.84	.82
Investigative	.93	.88	.86	.94	.86	.86
Artistic	.95	.86	.84	.94	.87	.81
Social	.92	.78	.74	.95	.84	.84
Enterprising	.93	.82	.81	.82	.82	.79
Conventional	.95	.87	.88	.94	.84	.85

Note: Results obtained from 534 college students (328 female, 206 male).

was .90 or the Set A items and was .88 for the Set B items. The VAF results obtained in the CUS analysis are above the cutoff value of .60 from Armstrong et al. (2003). These results provide structural validity evidence by demonstrating that the brief scales produce inter-correlations that are consistent with the order predictions of Holland's (1959, 1997) model.

7. Discussion

Following Goldberg's (Goldberg's, 1999; Goldberg et al., 2006) and Liao et al.'s (2008) examples, the current paper outlines the development of a set of brief, alternate forms, activity- and occupation-based RIASEC measures that would be available in the public domain for research purposes. Two sets of 8-item activity-based RIASEC interest scales were developed from the 30-item Interest Profiler scales, and two sets of 8-item occupation-based RIASEC interest scales were developed from sets of 30 job titles, representing each RIASEC type selected from the O*NET database. Overall, the results obtained during the initial development and validation of these marker scales suggest that it is possible to produce brief RIASEC measures that retain acceptable levels of reliability and convergent validity with other interest measures. Structural analyses using the CUS technique demonstrate that the brief RIASEC marker scales produce orderings consistent with the predictions in Holland's (1959, 1997) model. These scales will be made available on a public domain website providing open access to the scales and items (<http://netfiles.uiuc.edu/jgrounds/IIP/home.htm>).

Table 6
Means and standard deviations for 8-item occupation RIASEC measures

Scale	Females		Males	
	Mean	SD	Mean	SD
<i>Set A occupations</i>				
Realistic	1.70	0.64	2.69	0.80
Investigative	2.52	0.97	2.71	0.85
Artistic	2.97	0.91	2.68	0.91
Social	3.11	0.79	2.63	0.77
Enterprising	2.26	0.75	2.45	0.73
Conventional	1.94	0.71	2.27	0.69
<i>Set B occupations</i>				
Realistic	1.74	0.66	2.84	0.78
Investigative	2.50	0.95	2.73	0.83
Artistic	2.80	0.91	2.61	0.78
Social	2.96	0.74	2.51	0.79
Enterprising	2.66	0.81	2.82	0.74
Conventional	1.76	0.69	2.29	0.71

Note: Results obtained from 534 college students (328 female, 206 male).

Table 7
Convergent validity for 8-item O*NET occupation-based RIASEC scales

Scale	Interest Profiler	
	Set A	Set B
<i>Set A occupations</i>		
Realistic	.75	.75
Investigative	.80	.83
Artistic	.86	.85
Social	.79	.82
Enterprising	.77	.75
Conventional	.79	.77
<i>Set B occupations</i>		
Realistic	.77	.78
Investigative	.85	.86
Artistic	.86	.86
Social	.77	.78
Enterprising	.74	.75
Conventional	.77	.73

Note: Results obtained from 534 college students (328 female, 206 male).

7.1. Implications for research

Goldberg (1999) proposed the IPIP to facilitate new research in the area of personality assessment. As noted by Liao et al. (2008), the continued growth of Goldberg's IPIP website and the increasing number of research studies conducted using its items suggests that the public domain approach to research can reinvigorate an area of inquiry dominated by well established commercial measures. More specifically, there are a number of areas of research identified by Goldberg (Goldberg, 1999; Goldberg et al., 2006) and Liao et al. that benefit from the increased use of public domain markers. First, because test publishers often have a bias towards the un-altered use of their measures, research that involved the manipulation of scales and items is discouraged, which limits investigations of new scoring methods or ways to develop new constructs. This is especially true with scales where the scoring keys are protected as proprietary information, and it may even be difficult to conceptualize research questions related to these scales. Second, researchers working with limited budgets may find it difficult to take full advantage of recently developed online tools for collecting data because publishers are reluctant to release their items on publicly accessible websites. And third, Goldberg argues that the test publishers have a vested interest in maintaining the status-quo, and a test publisher's interests are best served by offering measures that do not change dramatically across revisions and will appeal to a broad audience of test users.

Development of these public domain brief RIASEC measures should help address the issues raised by Goldberg (1999) and Liao et al. (2008) concerning the inhibiting effects of dominant commercial measures on research. In the area of vocational psychology, Holland's (1959, 1997) theory has emerged as a dominant model of interest assessment, and test publishers may be reluctant to experiment with the scoring and interpretation of their RIASEC scales. This limits the types of experimentation that researchers can do with a published measure that may involve new scoring methods or ways to develop new constructs. Researchers are also typically not allowed to post items online, aside from the controlled-access websites

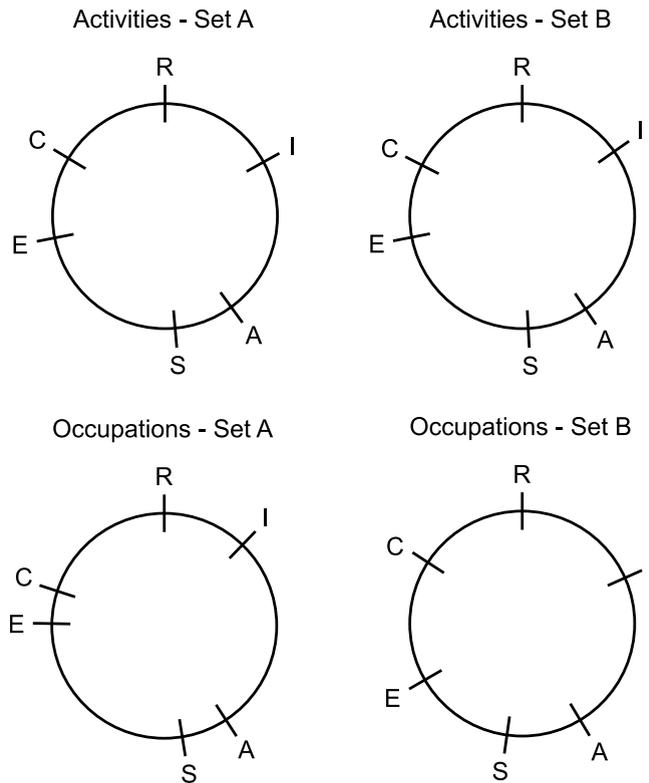


Fig. 2. Circular unidimensional results for activity and occupation based RIASEC scales for participants in sample 2.

run by some publishers for online assessments because this makes it difficult for the test publisher to collect royalties. By offering interest measures in the public domain, Liao et al. have created a potential alternative to commercial interest measures that should help expand the range of individuals who are able to conduct interest-based research using the RIASEC model. Additionally, these scales should help increase both the speed and flexibility of research by freeing researchers from the constraints imposed by copyrighted interest inventories.

The present study builds on the work of Liao et al. (2008) by adding sets of brief RIASEC scales to the list of basic interest markers developed for the public domain interest website. In particular, there are a number of potential research implications for these public domain RIASEC interest markers. In particular, the availability of shorter interest measures would facilitate the current call for integrative research across multiple individual domains (Lubinski, 2000), such as the Atlas of Individual Differences proposed by Armstrong et al. (2008), which uses Holland's RIASEC types as an organizational framework for combining work-related information from multiple sources in a visual form. Additionally, having alternative forms of the activity and occupation-based scales may help address limitations of previous research. Results obtained in research on career-related interventions (Whiston, Sexton, & Lasoff, 1998) using the Holland model and research on item response formats may be confounded by having participants take the same item repeatedly. Therefore, development of alternate forms of the activity and occupation-based scales may facilitate research where exposure or fatigue effects may be an issue because having different sets of items may help control for repeated-exposure effects. For example, the decision by Tracey (2002) to measure both interests and self-efficacy by having individuals rate each PGI item multiple times could be evaluated by comparing interest-efficacy correlations on the PGI's RIASEC scales to results obtained using the public domain alternate forms RIASEC scales developed in this paper.

7.2. Limitations and future directions

The brief RIASEC marker scales presented in this paper were designed for research purposes and, in their current form, are not intended for use in career counseling. Additional work would have to be done on the development of norm groups for diverse populations, and interpretive materials would have to be developed before these scales could be used effectively with clients. As noted by Liao et al. (2008), one of the key advantages of the assessment tools offered by commercial test publishers is the range of interpretive materials and resources typically provided with career-related measures. Therefore, the primary objective for developing public domain scales is not to compete with commercial test publishers in the areas where they are successful, but instead to augment commercial measures with a set of scales that are more suitable for a wide range of research purposes.

Although validity evidence is presented for the scales, this information is designed to show the relevance of the underlying constructs for research purposes. The continued development of these public domain interest markers would benefit from collecting additional validity evidence. In particular, empirical research on vocational interests is based on college students, and because of this, there is a need to recruit samples from a variety of settings and to link the current scales to measures of career-related outcomes, such as academic and career-related choices. Additionally, cross-cultural research using Goldberg's (1999) personality measures suggests that research working with diverse populations can provide new perspectives on important questions about the role of culture and social factors in the development of individual differences in personality, and the field of vocational psychology would likely benefit from similar insights into factors influencing career-related attitudes and behaviors.

Appendix A

Interest profile items selected for research forms A and B

Holland type	Interest Profiler Set A	Interest Profiler Set B
Realistic	<ul style="list-style-type: none"> Test the quality of parts before shipment Lay brick or tile Work on an offshore oil-drilling rig Assemble electronic parts Operate a grinding machine in a factory Fix a broken faucet Assemble products in a factory Install flooring in houses 	<ul style="list-style-type: none"> Perform lawn care services Repair household appliances Build kitchen cabinets Guard money in an armored car Operate a machine on a production line Repair and install locks Set up and operate machines to make products Build a brick walkway
Investigative	<ul style="list-style-type: none"> Study the structure of the human body Study animal behavior Do research on plants or animals Develop a new medical treatment or procedure Conduct biological research Study whales and other types of marine life Work in a biology lab Make a map of the bottom of an ocean 	<ul style="list-style-type: none"> Study ways to reduce water pollution Study the movement of planets Examine blood samples using a microscope Study genetics Determine the infection rate of a new disease Diagnose and treat sick animals Do laboratory tests to identify diseases Develop a new medicine
Artistic	<ul style="list-style-type: none"> Conduct a musical choir Direct a play Design artwork for magazines Write a song Write books or plays Play a musical instrument Perform stunts for a movie or television show Design sets for plays 	<ul style="list-style-type: none"> Paint sets for plays Sing in a band Act in a movie Conduct a symphony orchestra Create special effects for movies Compose or arrange music Write reviews of books or plays Draw pictures
Social	<ul style="list-style-type: none"> Give career guidance to people Do volunteer work at a non-profit organization Help people who have problems with drugs or alcohol Teach an individual an exercise routine Help people with family-related problems Supervise the activities of children at a camp Teach children how to read Help elderly people with their daily activities 	<ul style="list-style-type: none"> Work with juveniles on probation Take care of children at a day-care center Teach an elementary school class Work with mentally disabled children Teach disabled people work and living skills Organize field trips for disabled people Teach a high-school class Help conduct a group therapy session
Enterprising	<ul style="list-style-type: none"> Sell restaurant franchises to individuals Sell merchandise at a department store Manage the operations of a hotel Operate a beauty salon or barber shop Manage a department within a large company Manage a clothing store Sell houses Run a toy store 	<ul style="list-style-type: none"> Sell newspaper advertisements Sell a soft drink product line to stores and restaurants Give a presentation about a product you are selling Sell hair-care products to stores and salons Negotiate contracts for professional athletes Manage a retail store Start your own business Market a new line of clothing

Appendix A (continued)

Holland type	Interest Profiler Set A	Interest Profiler Set B
Conventional	Generate the monthly payroll checks for an office Inventory supplies using a hand-held computer Use a computer program to generate customer bills Maintain employee records Compute and record statistical and other numerical data Operate a calculator Handle customers' bank transactions Keep shipping and receiving records	Keep inventory records Keep accounts payable/receivable for an office Calculate the wages of employees Develop a spreadsheet using computer software Assist senior level accountants in performing bookkeeping tasks Transfer funds between banks using a computer Enter information into a database Keep records of financial transactions for an organization

Appendix B

O*NET occupations selected for research forms A and B

Holland type	O*NET occupations Set A	O*NET occupations Set B
Realistic	Farmers and Ranchers Electronics Engineering Technicians Fish and Game Wardens Chemical Technicians Nuclear Equipment Operation Technicians Fishery Workers Supervisor Petroleum Engineers Civil Engineers	Construction Carpenters Airline Pilots and Flight Engineers Welders, Production Commercial Pilots Forest Fire Fighters Mechanical Engineers Ship Pilots Geological Data Technicians
Investigative	Biochemists Dentists, General Veterinarians Biologists Epidemiologists Surgeons Orthodontists Animal Scientists	Optometrists Zoologists and Wildlife Biologists Obstetricians and Gynecologists Pediatricians, General Microbiologists Astronomers Medical Scientists Environmental Scientists
Artistic	Musicians, Instrumental Professional Photographers Singers English Language College Teachers Art, Drama, and Music College Teachers Set Designers Curators Music Directors	Painters and Illustrators Graphic Designers Composers Choreographers Librarians Foreign Language College Teachers Actors Creative Writers
Social	Physical Therapist Aides Mental Health Counselors Athletic Trainers Child Care Workers Secondary School Teachers Personal and Home Care Aides Speech-Language Pathologists Middle School Teachers	Occupational Therapists Fitness Trainers Tour Guides and Escorts Nursing Instructors Waiters and Waitresses Elementary School Teachers Substance Abuse Counselors Special Education Teachers
Enterprising	Purchasing Managers Sales Agents, Financial Services Food Service Managers	Law Clerks Coaches and Scouts Sales Managers

(continued on next page)

Appendix B (continued)

Holland type	O NET occupations Set A	O NET occupations Set B
Conventional	Telemarketers	Personnel Recruiters
	Retail Salespersons	Bartenders
	Insurance Sales Agents	Lodging Managers
	Lawyers	Public Relations Specialists
	Real Estate Sales Agents	Human Resources Managers
	Auditors	Credit Analysts
	Payroll and Timekeeping Clerks	Insurance Claims Clerks
	Shipping and Receiving Clerks	Tax Preparers
	Meter Readers, Utilities	Insurance Underwriters
	Accountants	Postal Service Clerks
Mail Clerks	Bookkeeping Clerks	
Actuaries	Cargo and Freight Agents	
Tellers	Construction and Building Inspectors	

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