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Vocational Interests in the United States: Sex, Age, Ethnicity, and Year Effects

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Vocational interests predict educational and career choices, job performance, and career success (Rounds & Su, 2014). Although sex differences in vocational interests have long been observed (Thorndike, 1911), an appropriate overall measure has been lacking from the literature. Using a cross-sectional sample of United States residents aged 14 to 63 who completed the Strong Interest Inventory assessment between 2005 and 2014 ($N = 1,283,110$), I examined sex, age, ethnicity, and year effects on work related interest levels using both multivariate and univariate effect size estimates of individual dimensions (Holland's Realistic, Investigative, Artistic, Social, Enterprising, and Conventional). Men scored higher on Realistic ($d = -1.14$), Investigative ($d = -.32$), Enterprising ($d = -.22$), and Conventional ($d = -.23$), while women scored higher on Artistic ($d = .19$) and Social ($d = .38$), mostly replicating previous univariate findings. Multivariate, overall sex differences were very large (disattenuated Mahalanobis' $D = 1.61$; 27% overlap). Interest levels were slightly lower and overall sex differences larger in younger samples. Overall sex differences have narrowed slightly for 18-22 year-olds in more recent samples. Generally very small ethnicity effects included relatively higher Investigative and Enterprising scores for Asians, Indians, and Middle Easterners, lower Realistic scores for Blacks and Native Americans, higher Realistic, Artistic, and Social scores for Pacific Islanders, and lower Conventional scores for Whites. Using Prediger's (1982) model, women were more interested in people ($d = 1.01$) and ideas ($d = .18$), while men were more interested in things and data. These results, consistent with previous reviews showing large sex differences and small year effects, suggest that large sex differences in work related interests will continue to be observed for decades.

Public Significance Statement
This study of a large, diverse sample of United States residents found that there were large sex differences in work-related interests for all age groups and all ethnicities, and that these differences are likely to persist. Because interests predict major and occupational choices, among other important outcomes, these findings suggest that men and women will continue to experience differing educational and career outcomes.

How similar are the work-related interests of men and women? Do interests change over the life span? Have interest patterns changed over the previous decade? How large are differences by ethnicity? Answers to these basic questions are important to many individuals and researchers, as vocational interests predict numerous important life outcomes, including occupational choices (Donnay & Borgen, 1999; Hansen & Dik, 2005; Lent, Brown, & Hackett, 1994) and college major selection (Gasser, Larson, & Borgen, 2007; Zafar, 2013), job satisfaction (Morris, 2003), job performance (Nye, Su, Rounds, & Drasgow, 2012), timely degree completion (Allen & Robbins, 2010), and subjective well-being (Harris & Rottinghaus, 2015). Occupational choices are also a critical factor in the male-female wage gap (Blau & Kahn, 2006), making recent vocational interest trends essential for a full understanding of this contentious public policy debate.

In the current study, I examine cross-sectional data from over 1.2 million United States residents aged 14–63 who completed the Strong Interest Inventory assessment (Donnay, Morris, Schaubhut, & Thompson, 2004) over the period 2005–2014. This is one of the largest samples of vocational interests ever reported and more than twice as large as the total sample size covered in a recent meta-analysis of vocational interest sex differences (Su, Rounds, & Armstrong, 2009). In addition to examining individual interest dimensions, this paper presents more appropriate multivariate effect size estimates than previous reviews. The rich dataset and new multivariate effect size estimates offer an opportunity to explore a variety of sex, age, ethnicity, and year effects on vocational interests.

Holland's Model of Vocational Interests

According to Nauta (2010), the most widely used and influential model of vocational interests is John Holland's (1959, 1973, 1997). Holland (1973) defined vocational interests as "the expression of personality in work, hobbies, recreational activities, and preferences" (p. 7). Vocational interests are central to one's identity (Su et al., 2009) and can be conceptualized as disposition-like attitudes (Low, Yoon, Roberts, & Rounds, 2005).

The structure of the six RIASEC interest areas (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional) is often represented as a hexagon, and can be represented in other ways as well. Prediger (1982) reasoned that, because Holland's model is a two-dimensional circumplex, there are very likely two fundamental dimensions (Data-Ideas and People-Things) that underlie the relations among the six Holland vocational types, a proposition that has received empirical support (Nauta, 2010; see Tay, Su, & Rounds, 2011 for a counterperspective). In this model, the Data-Ideas dimension runs between the Conventional and Enterprising dimensions (data pole) on one side of the hexagon and Investigative and Artistic on the opposite side (ideas pole). The People-Things dimension runs perpendicular to Data-Ideas, through Realistic on one side (things pole) and Social on the opposite side (people pole). Prediger scores can be derived from RIASEC scores and are examined in the current study.

Sex Differences in Vocational Interests

Sex differences[1] in vocational interests have been observed for over a century (Thorndike, 1911), and have been the subject of extensive study. The largest and most comprehensive review of sex differences in vocational interests, a meta-analysis of 47 vocational interest assessment technical manuals with a combined sample of over 500,000 people (Su et al., 2009), which included multiple versions of the Strong assessment, showed sex differences in five of six RIASEC areas. Men scored higher than women on Realistic and Investigative, while women scored higher than men on Artistic, Social, and Conventional (there was no difference on Enterprising). The magnitudes, and sometimes directions, of these differences across inventories were influenced primarily by whether or not sex differences were intentionally minimized as part of the assessment development process. Large sex differences have also been found on the People-Things dimension of Prediger's model.

Research on the most recent Strong assessment is mostly consistent with the larger literature, with men having higher scores than women on Realistic and Investigative, lower scores on Artistic and Social, and little to no difference on Enterprising (Donnay et al., 2004). On Conventional, in contrast to the findings of Su et al. (2009), men tend to score higher than women on the Strong assessment.

Overall Sex Differences

Su et al. (2009) reported overall sex differences for RIASEC interests by averaging the absolute value univariate effect sizes and found $|\bar{d}| = .45$, corresponding to 69.8% overlap of the male and female distributions. Su et al. (2009) describe sex differences in vocational interests as "substantial" (p. 873) and "an exception to the findings that sex differences are small to nonexistent" (p. 873), yet their effect size and overlap estimates might lead others to conclude that sex differences are roughly medium, based on prevailing interpretive standards of .2 for a small effect, .5 for a medium effect, and .8 for a large effect (Cohen, 1992). Indeed, Leuty and Hansen (2014), summarizing much of the same interest literature cited above concluded "overall the interests of women and men are more similar than different" (p. 291).

These conclusions may be misleading, however, because the measure of overall differences is flawed. Del Giudice and colleagues (Del Giudice, 2009a, 2013; Del Giudice, Booth, & Irwing, 2012) argue that the average absolute univariate difference is not a good measure for evaluating overall sex differences because many small differences can add up to a large overall difference, and correlations between the variables can strongly influence the result:

> When groups differ along many variables at once, the overall between-group difference is not accurately represented by the average of univariate effect sizes; in order to properly aggregate differences across variables while keeping correlation patterns into account, it is necessary to compute a multivariate effect size. The Mahalanobis distance D is the natural metric for such comparisons. Mahalanobis' D is the multivariate generalization of Cohen's d, and has the same substantive meaning. Specifically, D represents the standardized difference between two groups along the discriminant axis; for example, $D = 1.00$ means that the two group centroids are one standard deviation apart on the discriminant axis. A crucial (and convenient) property of D is that it can be translated to an overlap coefficient in exactly the same way as d. (Del Giudice et al., 2012, p.3)

D values cannot be negative and D does not indicate, for instance, whether male or female scores are higher or lower (or better or worse), rather it is a measure of distance in multidimensional space. Using observed score personality data to compute sex differences, Del Giudice et al. (2012) showed that $|\bar{d}| = .26$, while $D = 1.49$, leading to very different conclusions about the magnitude of overall sex differences in personality. Multivariate effect sizes can supplement univariate measures and "offer more realistic estimates of global patterns of similarity and dissimilarity" (Del Giudice, 2013, p. 1074).

Although there are critics of using D for measuring sex differences (see the Discussion section), it is clear that the mean univariate effect size is at best an incomplete measure of overall sex

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[1] As in Su et al. (2009), "sex differences" or "sex effects" are used throughout this article to refer to self-reported biological status.

differences. Multivariate effect size estimates, currently missing from the vocational interest literature, can add to the extensive accumulated knowledge of univariate effect sizes in vocational interests and can be used to evaluate questions about overall sex differences changing by age or over time.

Because all respondents in the current study completed the Strong assessment, univariate sex differences consistent with the Strong assessment literature were expected. Multivariate effect size estimates using D were expected to show larger differences than those previously reported in the literature using $|\bar{d}|$ (Del Giudice, 2009a).

Age Effects on Vocational Interests

Vocational interests are thought to be quite stable, particularly after the age of 25 to 30 (Campbell, 1971; Hansen, 1994; Strong, 1943, 1951; Swanson, 1999; each using previous forms of the Strong assessment). In their meta-analysis of longitudinal studies, which employed several interest assessments, Low et al. (2005) found vocational interests were stable within individuals and that interest levels increased over the college years, where they remained for the next two decades. There were no sex differences in stability. Subsequent research using the Kuder Occupational Interest Survey indicated that vocational interests are moderately stable within individuals over a 30-year period (Rottinghaus, Coon, Gaffey, & Zytowski, 2007; see also Hoyt, Smith, & Levy, 1957, which used the Strong Vocational Interest Blank assessment, and Swanson, 1999). Sex differences do not seem to vary much across age (Holland, Powell, & Fritzsche, 1994, using the Self-Directed Search assessment; Kuder & Zytowski, 1988, using the Kuder General Interest Survey), although Su et al. (2009) found that sex differences were smaller in older samples compared with younger samples. Results consistent with the accumulated age literature were expected, specifically that mean interest levels would be higher and sex differences would be similar or somewhat smaller in older samples compared with younger samples.

Year Effects on Vocational Interests

The decade of data covered here offered the opportunity to examine the influence of year on interests, independent of age and sex. In a sense, year effects can be considered an analysis of generational change for the period 2005–2014, although often when people discuss generational change they confound age and year effects. This time period may be of particular interest to those who have followed recent efforts to boost the interests of young people, particularly young women, with regard to science, technology, engineering, and math fields (e.g., https://ngcproject.org/engaging-girls-stem). To the extent that these efforts have been successful, later samples should show higher Investigative scores and smaller sex differences in Investigative than earlier samples.

Four reviews have examined year effects on vocational interests. In a review of 50 years of Strong assessment data, Hansen (1988) found interest levels were generally stable and that sex differences were resilient in many areas, especially Realistic and Artistic, but there were also small reductions of sex differences over time. Over 20 years later, in their meta-analysis of interest assessment technical manuals, Su et al. (2009) found sex differences in interests were very stable over the previous four decades, with some evi-

dence of smaller sex differences in Artistic and Enterprising areas in later samples, while Leuty and Hansen (2014) examined age and birth year effects in a sample of nearly 1,800 adults using data from 1974 through 1995 and three forms of the Strong assessment, finding small effects of both age and year. Together, these reviews suggest a slight narrowing of sex differences from the 1930s through the 2000s, but otherwise relatively little change.

Bubany and Hansen (2011), meanwhile, focused their meta-analysis on college students from 1976 to 2004 who took multiple forms of the Strong assessment, and found that for men, later samples had lower interests in Realistic, Investigative, and Artistic than earlier samples, while for women, later samples had higher scores on Enterprising than earlier samples. Sex differences on Investigative, Enterprising, and Conventional were all smaller in later samples. Although consistent with other reviews in showing a narrowing of sex differences over time, Bubany and Hansen (2011) found interest level changes not apparent in the other reviews.

Because the current study covers a shorter time period than previous reviews, and three of the four reviews showed little change by year, it was expected that any year effects in the current data would be small.

Ethnicity Effects on Vocational Interests

A number of studies have examined fit of the RIASEC model across ethnicities in the United States and found few differences. Some studies indicated relatively poor fit (Rounds & Tracey, 1996, using a variety of interest assessments), but subsequent research with larger samples generally concludes that fit is similar and at least adequate for all ethnic groups studied (Day & Rounds, 1998, and Day, Rounds, & Swaney, 1998, using the Unisex Edition of the ACT assessment; Gupta, Tracey, & Gore, 2008, using the UNIACT-R assessment; Kantamneni, 2014, and Oliver & Waehler, 2005, using the Strong assessment; Ryan, Tracey, & Rounds, 1996, using the Vocational Preference Inventory). Other work, all using the 1994 Strong assessment, found that consistency and differentiation do not differ (Fouad & Mohler, 2004), that interests predict job families similarly (Lattimore & Borgen, 1999), and that there is little evidence of differential test function (Fouad & Walker, 2005) across ethnic groups.

Similarly, studies measuring interest level differences by ethnicity have generally reported small effects. Although most studies conclude that there are small differences by ethnicity, many used now outdated interest assessments, small samples, and do not present data from ethnicities such as Indians and Middle Easterners, making the conclusion of small differences somewhat uncertain (see Carter & Swanson, 1990, for a review of studies involving previous forms of the Strong assessment with Blacks). For instance, Fouad and Mohler (2004) examined mean differences between men and women of five ethnicities, reporting that Asians scored higher than Native Americans on Investigative, and Blacks scored higher than Native Americans on Enterprising (both small effects), while Fouad (2002) reported that Asians scored higher than Native American, White, Black, and Hispanic groups on Investigative, and that overall sex and age differences were larger than ethnic differences. These latter two studies were well done but used outdated versions of the Strong assessment and the samples were overwhelmingly young.

Because the interest literature generally reports small differences by ethnicity, small differences were expected. In addition to examining interest level differences by ethnicity, each ethnicity was examined separately to explore for differences in sex, age, and year effects.

Summary of Research Questions

In brief, the current study aims to examine sex, age, year, and ethnicity effects on vocational interests in a very large sample of United States residents using the 2004 Strong Interest Inventory assessment. Prediger model scores are reported in addition to RIASEC scores. Specifically, the following questions were examined:

1. What predicts more variance in vocational interests among sex, age, year, and ethnicity?

2. What are the sizes of sex differences for each interest area and overall?

3. How do interest levels and sex differences vary with age?

4. Have interest levels or sex differences changed over the period 2005–2014?

5. How do these relationships vary by ethnicity?

Method

Participants

Participants were 511,814 men and 771,296 women ranging in age from 14 to 63, who completed the 2004 Strong Interest Inventory assessment online between January 2005 and December 2014. There were at least 1,265 participants at each age. Data were available from the assessment publisher.

Country of residence was available as an optional demographic item starting in 2008. Of those who responded, 95.7% reported residing in the United States, making it relatively safe to assume that those who did not respond to country of residence also resided in the United States. Accordingly, participants were included in the sample if they indicated that they resided in the United States (775,070), or if they did not respond (508,040). Those who indicated they resided in a country other than the United States were excluded.

Presented with a list of ethnicities[2] and the option to check any or none, and limiting analyses to those who selected at least one ethnicity ($N = 1,201,243$), 830,530 (69.1%) were White, 150,816 (12.6%) were Hispanic, 94,700 (7.9%) were Native American, 81,519 (6.8%) were Asian, 77,856 (6.5%) were Black, 14,917 (1.2%) were Middle Eastern, 11,406 (.9%) were Indian, and 25,346 (2.1%) were Other. Pacific Islander was added to the list of ethnicities in 2008 and was selected by 7,796 (.9% of those presented with the option).

Of those who selected any ethnicity, 81,392 (6.8%) selected more than one, slightly higher than the 2.9% rate reported by the United States Census (Jones & Bullock, 2012), although the census treats Hispanic origin as a separate question, suppressing their estimate. Rate of checking multiple ethnicities varied by ethnicity:

in the current data, Whites reported the lowest rate of multiple ethnicities (8%) while Pacific Islanders reported the highest rate (53%), which again parallels the findings of the census (Jones & Bullock, 2012). Those who checked more than one ethnicity were included in all ethnic groups checked.

Measures

The Strong Interest Inventory assessment is a 291-item vocational interest measure with a long history of use in education settings, primarily to assist students in making choices for majors and careers, but also in a variety of noneducation settings: social service agencies, outplacement consulting firms, employment offices, and many corporations seeking to encourage career development and assist displaced employees use the Strong assessment with adults across the life span (Donnay et al., 2004). For each item the respondent indicates how he or she feels about kinds of work (e.g., accountant), school subjects (e.g., agriculture), work (e.g., writing reports) leisure activities (e.g., experiencing other cultures), kinds of people (e.g., highway construction workers), and personal characteristics (e.g., prefer working alone rather than on committees). All responses are provided on a 5-point scale (anchored by *Strongly Like* and *Strongly Dislike* or *Strongly Like Me* and *Strongly Unlike Me*), and scales are standardized to have a mean of 50 and a standard deviation of 10 (*t*-scores), based on a sex balanced 2004 General Reference Sample (Donnay et al., 2004).

The measures of interest in the current study are the general occupational themes, which measure Holland's RIASEC dimensions. The six scales each have at least 21 items, internal consistencies of at least .90, retest reliabilities over intervals from 8–23 months of at least .80, and abundant validity evidence, including differences by academic majors and associations with empirically derived occupation scales (Donnay et al., 2004).

Prediger model scores were computed from RIASEC standard scores using the same formulas as in Tracey, Robbins, and Hofsess (2005): People-Things $= 2R + I - A - 2S - E + C$, where high scores indicate interest in things and low scores indicate interest in people, and Data-Ideas $= 1.73E + 1.73C - 1.73I - 1.73A$, where high scores indicate interest in data and low scores indicate interest in ideas. These are referred to hereafter as Prediger scores. Mahalanobis' D and all corrections for attenuation were calculated from raw data in R 3.1.2 (R Core Team, 2013) using a slightly modified[3] script by Del Giudice (2009b).

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[2] The list of options for ethnicity was: American Indian or Alaskan Native (origins of North America), African American/Black (origins of Africa), Asian (origins of Asia or Southeast Asia), Caucasian/White (origins of Europe), Indian (origins of Indian subcontinent), Latino/Latina/Hispanic (origins of Central or South America or culture of Spanish origin), Middle Easterner (origins of Middle East or North Africa), Native Hawaiian or other Pacific Islander, and Other. Terms (Native American, Black, Asian, White, Indian, Hispanic, Middle Eastern, and Pacific Islander, respectively) were chosen with the goal of balancing sensitivity, clarity, and parsimony.

[3] Two modifications were necessary. First, due to an update to R Version 3, means had to be replaced with colMeans. Second, nA and nB were wrapped in as.numeric commands to avoid integer overflow errors.

Results

Results are organized around the five research questions. Because sample sizes are large and even very small effects statistically significant, effect size estimates are emphasized.

Question 1: What Predicts More Variance in Vocational Interests Among Sex, Age, Year, and Ethnicity?

To assess the extent to which sex, age, year, and ethnicity predicted vocational interests, the six RIASEC measures were entered into a multivariate linear model. Sex and eight dummy variables representing the eight ethnicities were entered as fixed factors, with age and year entered as covariates. This approach considers the effect of each ethnicity separately. Partial eta squared results indicated sex accounted for more variance (.38) than age (.05) and year (.01). Among ethnicities, Asian and White had partial eta squared values of .01, while all others had values of 0. Multivariate tests and parameter estimates are available in the online supplement to this article.

Question 2: What Are the Sizes of Sex Differences?

For each RIASEC interest area and Prediger score, I calculated the means and standard deviations for each sex at each age, sex differences (Cohen's d, and d_c, corrected for attenuation) at each age, and the mean d and d_c, across all ages using all cases (see online supplement). This approach weights each age equally and controls for sample size differences across ages, providing a univariate effect size estimate for each interest area.

Using this approach, each of the six interest areas showed a sex difference. Women were more interested than men in Artistic (d = .19, d_c = .20) and Social (.38, .40), while men were more interested than women in Realistic (-1.14, -1.19), Investigative ($-.32$, $-.33$), Enterprising ($-.22$, $-.23$), and Conventional ($-.23$, $-.24$). Other than the magnitudes for Enterprising and Conventional, which are slightly larger in the current data, these results are similar to those reported in the Strong technical manual (RIASEC ds = -1.16, $-.29$, .26, .40, $-.08$, and $-.12$, respectively; Donnay et al., 2004). Using Prediger scores, women were much more interested in people on People-Things (d = 1.01) and somewhat more interested in ideas on Data-Ideas (.18).

To measure overall sex differences in vocational interests using all six RIASEC scores, I calculated Mahalanobis' D at each age (and D_c, corrected for attenuation, see online supplement). Averaging across all ages, results indicated a very large overall sex difference in vocational interests (D = 1.50, D_c = 1.61). This corresponds to 27% overlap[4] in the male and female distributions. Although not recommended as an overall measure of sex differences, $|\bar{d}|$ = .41 in the current data (averaging across all ages), nearly identical to a similar calculation reported by Su et al. (2009).

Question 3: How Do Interest Levels and Sex Differences Vary With Age?

Each of the RIASEC interest areas had a small to very small, but positive, correlation with age over the range 14 to 63 (Table 1).

Table 1
Correlations of Age and Interests

Dimension	Female	Male
Realistic	.17	.13
Investigative	.13	.17
Artistic	.18	.21
Social	.12	.23
Enterprising	.09	.09
Conventional	.17	.06
People-Things	.02	−.09
Data-Ideas	−.02	−.11
N	771,296	511,814

Note. Age range is 14–63 years; For People-Things and Data-Ideas, higher scores correspond to greater Interest in things and data, respectively.

Men had a stronger correlation between age and Social (r = .23) than women (.12), and women had a stronger correlation between age and Conventional (.17) than men (.06). Using Prediger scores, correlations for men indicated older samples were in the directions of people (r = −.09) and ideas (−.11) compared with younger samples, while for women correlations were practically zero (.02 and −.02, respectively).

There were very large sex differences at each age and a decrease in sex differences as samples got older, $r(48)$ = −.83, p < .001, from a high of D_c = 1.9 at age 14 to D_c = 1.6 around age 30. Overall sex differences were largest for younger samples, replicating the findings of Su et al. (2009).

Question 4: Have Interest Levels or Sex Differences Changed Over the Period 2005–2014?

Partial eta squared results indicated that year accounted for very little variance. To further explore year effects, I first calculated correlations between each interest area and year (2005–2014) separately for men and women for six age groups: 14–17, 18–22, 23–29, 30–39, 40–49, and 50–63, as shown in Table 2. All correlations were less than .10 in magnitude, again indicating very small to no year effects. These results suggest very slow changes in vocational interests over time, to the extent that there are any changes at all.

To examine sex differences by year, I computed effect sizes (Cohen's d) for all RIASEC areas and Prediger scores for each age group for each year, as well as D (based on RIASEC scores only; see online supplement). Examining individual interest areas, there were several significant[5] relationships between year and sex differences. On Realistic, 14–17 and 18–22-year-olds had smaller sex differences in later samples[6] than earlier samples (rs = .78 and .95, respectively), while on Enterprising (rs = −.88 and −.99) and Conventional (rs = −.89 and −.86) these same groups had larger sex differences in later samples. On Investigative, 18–22 and 23–29-year-olds had larger sex differences in later samples (rs = −.75 and −.92), while

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[4] $1 - U_1$, corrected for attenuation.

[5] For N = 10, correlations $r \geq .64$ are significant at p < .05, two tailed.

[6] Positive correlations in areas with sex differences favoring men indicate smaller sex differences in later samples; positive correlations in areas with differences favoring women indicate larger sex differences in later samples.

Table 2
Correlations of Year (2005–2014) and Interest Scores by Sex and Age Groups

	Female						Male					
Dimension	14–17	18–22	23–29	30–39	40–49	50–63	14–17	18–22	23–29	30–39	40–49	50–63
Realistic	.02	.00	.01	.01	.00	.05	−.02	−.02	.00	.01	.01	.05
Investigative	.05	.01	−.01	.01	−.01	.01	.07	.02	.02	.00	−.02	.00
Artistic	−.05	−.09	−.04	−.03	−.05	−.04	−.05	−.04	−.06	−.04	−.03	−.01
Social	−.01	−.04	.01	.02	.02	.03	.01	.00	−.02	.00	.01	.03
Enterprising	−.04	−.09	−.04	−.02	−.02	.01	.02	−.04	−.04	−.03	−.03	.01
Conventional	−.04	−.04	.00	−.01	.00	.02	.04	.01	.02	.00	.00	.02
People-Things	.05	.08	.02	.01	.01	.03	.03	.02	.05	.03	.01	.02
Data-Ideas	−.05	−.03	.00	−.01	.02	.03	.02	−.01	.01	.01	.01	.02
N	44,377	431,477	118,151	76,404	59,620	41,267	30,268	291,051	78,310	48,890	36,377	26,918

40–49-year-olds had smaller sex differences ($r = .69$). On Artistic, 18–22, 40–49, and 50–63-year-olds had smaller sex differences (rs = −.98, −.89, and −.88) in later samples. On Social, 18–22-year-olds had smaller sex differences in later samples ($r = -.99$) while 23–29-year-olds had larger sex differences ($r = .73$). On People-Things, 14–17 and 18–22-year-olds had smaller sex differences in later samples (rs = .66 and .98), while 23–29 year olds had larger sex differences ($r = -.80$). On Data-Ideas, 14–17 and 18–22-year-olds had larger sex differences in later samples (rs = −.91 and −.95).

Across all years and all age groups, there were very large overall sex differences in vocational interests. The only statistically significant year trend was for the 18–22 age group, which showed smaller sex differences in later samples, $r = -.97$, $p < .001$, from $D_c = 1.87$ in 2005 and 2006 to 1.69 in 2014.

Question 5: How Do These Relationships Vary by Ethnicity?

As mentioned, a multivariate linear model was conducted to compare the explanatory power of sex, age, ethnicity, and year. Inspection of b weights from this model, available in the online supplement, for each of the ethnicity dummy variables (the reference group checked Other or no ethnicity), and focusing on raw scale effects of at least 1 t-score point (all ps <.001), Asians and Indians had higher scores on Investigative (bs = 2.76 and 3.72), Artistic (1.59, 1.37), Enterprising (1.05, 1.03), and Conventional (2.52, 1.28), while Middle Easterners had higher scores on Investigative (1.40) and Enterprising (1.30). Blacks had lower scores on Realistic ($b = -1.15$) and Investigative (-1.00), while Native Americans had lower scores on Realistic (-1.20). Pacific Islanders had higher scores on Realistic ($b = 1.73$), Artistic (1.46), and Social (1.52). Whites had lower scores on Conventional ($b = -2.31$). Hispanics had no differences that met the 1-point threshold. Given

that the standard deviation of t-scores in the general population is 10, these differences are almost all small to very small. RIASEC and Prediger score means and standard deviations for men and women within each ethnicity and age group, d_c for sex differences, along with D, and D_c for overall sex differences, are presented in the online supplement.

Next, for each of the eight ethnicities separately, I conducted multivariate linear models with the RIASEC interests as dependent variables, and sex, age, and year as predictors. Partial eta squared results are presented in Table 3. These results show a great deal of consistency across ethnicities, with partial eta squared values between .33 and .39 for sex, .03 and .07 for age, and .01 for year for all ethnicities except Blacks (.04). For all ethnicities sex explained more variance than age, which, in turn, explained more variance than year.

To further explore age effects by ethnicity, I correlated age with the six RIASEC and two Prediger scores separately by sex and ethnicity, as shown in Table 4. Age correlations with RIASEC scales were positive and generally small (83 of 96 rs < .20) for men and women of all ethnicities. The minimum correlations for women (rs = .08) were on Enterprising for Asians, Middle Easterners, and Whites, while the maximums for women (rs = .23) were on Social and Conventional for Blacks. The minimum for men was on Conventional for Middle Easterners ($r = .03$) and the maximum was on Social for Blacks ($r = .31$).

Correlations of interests and year by sex and ethnicity for the 18–22-year-old age group are presented in Table 5; other age groups are presented in the online supplement. Correlations under .10 in magnitude or $p > .05$ (two-tailed) were considered practically insignificant. Of the 128 correlations in Table 5 only six met the thresholds: in later samples, interest in Realistic ($r = -.13$) and Artistic ($r = -.13$) were slightly lower and Data-Ideas was toward data ($r = .10$) for Black women, Enterprising was lower ($r = -.10$)

Table 3
Partial Eta Square Results by Ethnicity (Sex, Age, and Year Predicting RIASEC Interests)

Predictor	Asian	Black	Hispanic	Indian	Middle Eastern	Native American	Pacific Islander	White
Sex	.33	.34	.36	.36	.39	.35	.36	.39
Age	.04	.07	.03	.07	.04	.06	.04	.06
Year	.01	.04	.01	.01	.01	.01	.01	.01
N	81,519	77,856	150,816	11,406	14,917	94,700	7,796	830,530

Table 4
Correlations of Age and Interests by Sex and Ethnicity

Dimension	A	B	H	I	ME	NA	PI	W
Females								
Realistic	.14	.17	.12	.17	.15	.15	.18	.18
Investigative	.10	.11	.10	.09	.13	.10	.14	.15
Artistic	.13	.15	.13	.19	.16	.14	.11	.19
Social	.13	.23	.13	.18	.14	.19	.15	.11
Enterprising	.08	.17	.11	.13	.08	.13	.12	.08
Conventional	.14	.23	.15	.18	.12	.19	.22	.19
People-Things	.01	−.05	−.01	−.03	−.01	−.03	.05	.05
Data-Ideas	.01	.09	.02	.03	−.04	.06	.06	−.04
N	49,631	49,597	94,993	6,455	8,724	60,824	4,503	494,060
Males								
Realistic	.14	.19	.11	.16	.12	.17	.12	.13
Investigative	.13	.19	.13	.19	.16	.21	.14	.18
Artistic	.17	.20	.17	.27	.20	.20	.10	.22
Social	.19	.31	.20	.28	.20	.28	.14	.21
Enterprising	.10	.17	.12	.16	.08	.13	.07	.08
Conventional	.07	.15	.07	.12	.03	.11	.07	.07
People-Things	−.07	−.11	−.10	−.15	−.10	−.10	−.01	−.08
Data-Ideas	−.05	−.03	−.05	−.08	−.12	−.08	−.05	−.12
N	31,888	28,259	55,823	4,951	6,193	33,976	3,293	336,470

Note. Age range is 14–63 years. For People-Things and Data-Ideas, higher scores correspond to greater interest in things and data, respectively. A = Asian; B = Black; H = Hispanic; I = Indian; ME = Middle Eastern; NA = Native American; PI = Pacific Islander; W = White.

for Native American women, Realistic was lower ($r = −.13$) and Data-Ideas was toward data ($r = .13$) for Black men. For 14–17-year-olds, 23 of 128 correlations met the threshold, corresponding figures were 16 for 23–29-year-olds, 14 for 30–39-year-olds, 11 for 40–49-year-olds, and 15 for 50–63-year-olds. No year-interest correlations met the .10 threshold at for any age group for Hispanics or Whites. Together this indicates a pattern of almost universally small to nonexistent year effects, with some indication of relatively larger year effects for Blacks.

Finally, within each age group, I calculated D between each Sex × Ethnicity combination. This allows a comparison of overall RIASEC differences between, for instance, 18–22-year-old Black women and White men, or any other combination of sex and ethnicity. Median Ds across all age groups are presented in Table 6, results for individual age groups are presented in the online supplement.[7] Overall estimates of sex differences in vocational interests within each ethnicity are bolded, with the largest difference observed for Middle Easterners ($D = 1.56$) and the smallest for Asians ($D = 1.45$). Within ethnicity overall sex differences ($M = 1.51$, $SD = .03$) were not significantly different than cross ethnicity overall sex differences ($M = 1.54$, $SD = .19$), $t(62) = .54$. The magnitudes of D between women of two ethnicities and men of the same two ethnicities were highly correlated, $r(26) = .85$, suggesting that to the extent that two ethnicities differ in vocational interests, the relative magnitude of those differences is very similar for men and women.[8] Accordingly, the mean of the D for females of two ethnicities and males of the same ethnicities was computed as an estimate of overall between ethnicity differences. Using this metric, the smallest difference among the 28 possible comparisons was between Blacks and Native Americans ($D = .13$), while the largest was between Indians and Pacific Islanders ($D = .68$).

Discussion

Results from the current study support the following conclusions: First, multivariate sex differences in vocational interests are very large, and are largest in younger samples. Second, interest levels are higher in older samples, but these effects are generally small. Third, year effects over the period 2005–2014 were small to nonexistent, although there were larger year effects for Blacks compared with other ethnicities and smaller overall sex differences among 18–22-year-olds in later samples. Fourth, interest level differences by ethnicity tend to be very small.

Examining individual interest areas, the directions and magnitudes of sex differences in the current study are similar to those reported previously (Su et al., 2009). Among the points of agreement: Men having higher interest than women on Realistic, Investigative, and things on People-Things, and women having higher interest than men on Artistic and Social. Two interest areas where the current study diverges are Enterprising and Conventional. Enterprising shows no sex difference and Conventional shows a sex difference favoring women in Su et al. (2009), whereas the current study shows a small difference favoring men for both Enterprising and Conventional. The current study shows sex differences in both areas that are larger than those reported in the Strong technical manual (Donnay et al., 2004), and indeed for younger age groups sex differences in these areas got larger in later samples over the period 2005–2014. Despite some differences, there is a great deal

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[7] Correlations of paired Ds across consecutive age groups (e.g., 14–17 and 18–22) showed extremely high levels of consistency rs(118) > .96, indicating that the pattern of Ds Across Sex × Ethnicity Pairs is very stable over the observed age range.

[8] This pattern held for all age groups, rs(26) = .82, .85, .77, .75, .69, and .57 for age groups 14–17, 18–22, 23–29, 30–39, 40–49, and 50–63, respectively.

Table 5
Year (2005–2014) Correlations by Sex and Ethnicity For 18–22 Year Olds

Dimension	A	B	H	I	ME	NA	PI	W
Females								
Realistic	.01	−.13	.02	.01	.02	.05	.02	−.01
Investigative	.01	−.08	.03	.03	.04	.01	.01	.01
Artistic	−.07	−.13	−.08	−.09	−.08	−.03	−.08	−.09
Social	−.03	−.04	−.02	−.03	−.02	−.05	−.02	−.04
Enterprising	−.09	−.02	−.08	−.07	−.08	−.10	−.07	−.09
Conventional	−.04	−.01	−.05	−.02	−.02	−.07	−.05	−.05
People-Things	.07	−.03	.07	.08	.09	.09	.06	.07
Data-Ideas	−.04	.10	−.05	−.02	−.04	−.09	−.03	−.03
N	31,184	25,907	59,662	3,636	5,414	31,313	2,836	276,858
Males								
Realistic	−.01	−.13	.00	.03	.00	.02	.00	−.03
Investigative	.03	−.06	.04	.03	.01	.02	.04	.03
Artistic	−.04	−.07	−.04	.01	−.05	.00	−.03	−.05
Social	.00	.00	.01	.01	.00	−.01	.02	.00
Enterprising	−.07	.03	−.04	−.01	−.05	−.08	.01	−.03
Conventional	−.02	.06	.01	.01	.03	−.05	.04	.01
People-Things	.04	−.07	.04	.03	.05	.04	.02	.02
Data-Ideas	−.04	.13	−.02	−.02	.01	−.09	.02	.00
N	20,011	16,211	36,220	2,598	3,790	19,459	2,081	188,693

Note. A = Asian; B = Black; H = Hispanic; I = Indian; ME = Middle Eastern; NA = Native American; PI = Pacific Islander; W = White.

of consistency between the current results and other published findings.

Overall Sex Differences

As expected, the multivariate effect size estimate of overall sex differences ($D_c = 1.61$) was much larger than estimates based on averaging univariate effect sizes (Su et al., 2009; $|\bar{d}| = .45$). Put another way, the current study estimates that the male and female vocational interest distributions overlap by 27%, much lower than the 69.8% overlap reported by Su et al. (2009). Using this measure, the current study indicates that the vocational interests of men and women are more different than they are alike, and rather than a medium small overall effect, the

current study indicates that sex differences on vocational interests are very large, joining personality (Del Giudice et al., 2012) and mate preferences (Conroy-Beam, Buss, Pham, & Shackelford, 2015) as areas of psychology with large multivariate sex differences.

Although overall sex differences were smaller in later samples for 18–22-year-olds, the rate of decline is such that large overall differences appear likely to persist for decades. The multivariate sex difference for the 18–22 age group, for instance, is predicted to be $D = 1.14$ in 2040 if the rate of decline observed from 2005–2014 continues. Although this calculation is speculative and not to be taken too seriously, relatively consistent sex differences in interests have been observed for over a century (Thorndike,

Table 6
Sex Differences (Mahalanobis' D) Among Sex × Ethnicity Combinations (Median Across Age Groups)

Sex	Ethnicity	N	Female								Male						
			A	B	H	I	ME	NA	PI	W	A	B	H	I	ME	NA	PI
F	Black	49,597	.53														
F	Hispanic	94,993	.45	.30													
F	Indian	6,455	.30	.55	.55												
F	Middle Eastern	8,724	.43	.58	.53	.34											
F	Native American	60,824	.51	.13	.36	.53	.55										
F	Pacific Islander	4,503	.50	.44	.30	.62	.60	.51									
F	White	494,060	.54	.53	.32	.58	.55	.39	.48								
M	Asian	31,888	**1.45**	1.64	1.48	1.60	1.62	1.67	1.27	1.47							
M	Black	28,259	1.45	**1.49**	1.34	1.54	1.55	1.57	1.09	1.41	.49						
M	Hispanic	55,823	1.50	1.66	**1.54**	1.56	1.54	1.73	1.28	1.53	.36	.37					
M	Indian	4,951	1.41	1.65	1.50	**1.49**	1.55	1.69	1.33	1.50	.41	.64	.60				
M	Middle Eastern	6,193	1.53	1.69	1.55	1.60	**1.56**	1.74	1.36	1.47	.42	.49	.47	.39			
M	Native American	33,976	1.34	1.45	1.33	1.43	1.46	**1.52**	1.04	1.35	.43	.13	.33	.63	.48		
M	Pacific Islander	3,293	1.83	1.93	1.73	1.87	1.89	1.96	**1.49**	1.72	.50	.50	.31	.75	.60	.50	
M	White	336,470	1.52	1.72	1.55	1.61	1.56	1.77	1.38	**1.53**	.57	.61	.33	.71	.50	.54	.38

Note. Bolded diagonal indicates sex differences within each ethnicity. N for female Asians = 49,631. A = Asian; B = Black; H = Hispanic; I = Indian; ME = Middle Eastern; NA = Native American; PI = Pacific Islander; W = White.

1911), and previous reviews have generally found few differences due to year. Given this set of findings, psychologists and policy-makers should expect to continue finding large observable sex differences on vocational interests well into the 21st century.

Assuming large sex differences in interests continue, and the importance of interests in predicting a variety of educational and career outcomes, it is likely that men and women will continue to experience differing educational and career outcomes. This has clear implications for the male-female wage gap and related debates. Outcome differences primarily due to interest-driven choices suggest a much different policy response than differences primarily due to discrimination, for instance. Although the current study does not address the wage gap or the relative explanatory power of interests, discrimination, and other factors, the finding that men and women have very different work-related interests should be part of such discussions.

Critiques of *D*

Some argue against the use of *D* for studying sex differences, as it "produces results that are biased toward finding a large difference because of taking a linear combination that maximizes group differences, and it appears to yield results that are uninterpretable" (Hyde, 2014, p. 380). Others are critical because adding more dimensions can only increase *D*, making it possible to generate large multivariate differences just by adding more dimensions (Stewart-Williams & Thomas, 2013).

In response, Del Giudice (2013) argues that "maximization does not equal bias. In fact, the Mahalanobis *D* is simply the generalized form of the ordinary Euclidean distance when variables are correlated" (p. 1069) and that interpretation is typically straightforward. In the case of interests, "multivariate sex differences . . . can be interpreted as defining an axis of individual variation in [vocational interest] masculinity-femininity" (p. 1073). Furthermore, while it is true that *D* cannot be decreased by adding dimensions, any increase is dependent on the univariate difference on the new dimension and the pattern of correlations between the new dimension and all other dimensions. Adding dimensions "will increase *D* only insofar as they provide *unique additional information* about group differences" (p. 1070, emphasis original). Moreover, in the current study no attempt was made to increase *D* by adding novel new interest dimensions, as the RIASEC model has been a mainstay of vocational psychology for decades. In short, critiques of *D* are unpersuasive.

Age and Year Effects

In addition to the age and year effects on sex differences discussed above, interest levels were generally higher in older samples, which may be encouraging to both young people and their parents. Practitioners and individuals are encouraged to make use of the detailed normative information available by age in the online supplement. Such information may be especially informative for those making long-run career decisions.

Although very small, year effects help explain some differences in the current results compared with previously published findings, but also sometimes conflict with trends identified by previous researchers. For instance, the sex differences on Enterprising and Conventional are larger in the current data than those reported in

the Strong technical manual (Donnay et al., 2004), and examination of effect sizes by year show larger sex differences among younger age groups in later samples in these areas. These findings, however, as well as larger sex differences in Investigative in later samples, are at odds with those of Bubany and Hansen (2011), who found smaller sex differences in later samples in these three areas for college students over the period 1976 to 2004. Su et al.'s (2009) finding of smaller sex differences in later samples in Artistic was supported in the current study but the finding of larger sex differences in later samples in Enterprising was not. The simplest reconciliation is perhaps that the directions of interest change are not fixed and the current study compares people from more recent years than other reviews of year effects.

Ethnicity Effects

Ethnicity accounted for less variance in interest levels than sex and age. Within each ethnicity, sex effects were larger than age effects, which, in turn, were larger than year effects. Overall sex differences were close to $D = 1.5$ within all ethnicities. Age correlations with RIASEC interests were generally small and uniformly positive for men and women of all ethnicities. Together, these results add to the literature suggesting small differences in vocational interests by ethnicity.

Although generally very small, there were interest level differences. Compared with those who did not respond to ethnicity, Asians, Indians, and Middle Easterners scored higher on Investigative and Enterprising, while Blacks and Native Americans scored lower on Realistic and Investigative. Other differences included Whites scoring lower on Conventional, and Pacific Islanders scoring higher on Realistic, Artistic, and Social. The directions of these differences are generally consistent with prior research (e.g., Fouad & Mohler, 2004), and Investigative differences are generally consistent with the proportion of majors and bachelor's degrees awarded in science and engineering fields (Hinrichs, 2015; National Science Board, 2016).

There were larger year effects over the period 2005–2014 for Blacks than for other ethnicities, with both Black women and men showing slightly lower Realistic and more data-oriented scores in recent samples. This set of results was not predicted, and it is unclear why year effects should be larger for Blacks than other groups. They should be interpreted with caution until replicated.

Strengths and Limitations

This study has several unique strengths. The sample, with a total size of over 1.2M, is one of the largest ever in the study of vocational interests, and is diverse with regard to sex, age, and ethnicity. Eight ethnicities were examined, including rarely studied groups such as Middle Easterners, Pacific Islanders, and Indians. Accurately measuring multivariate, overall differences in vocational interests, and using such estimates to examine sex and ethnic differences, is a key contribution of this paper. Finally, this study focused on isolating age and year effects and their influence on sex differences, over a period in which sex differences and gender identity issues have received increasing attention.

Despite these strengths, there are some limitations, most notably the cross sectional design, the sample being one of convenience, the results being based on a single assessment of interests, and the

assumption of population equivalence for many analyses. Regarding the cross sectional design, some have argued that there is limited use to such designs for investigating age differences, with Tracey and Sodano (2008) claiming that cross sectional research "cannot reveal key aspects of development and change because there are too many confounds" (p. 52). For instance, although there were age effects in the current data, it is unknown exactly how much of the observed effects are due to large numbers of people changing a little or small numbers of people changing substantially, and longitudinal data indicate there are individual differences in likelihood to change interests (Rottinghaus et al., 2007).

That the data analyzed here are a convenience sample is another limitation. There is the question of whether observed differences are real or artifacts due to the kinds of people who are drawn to take this particular career assessment, or other systematic effects. Although it is true that the current study cannot reveal mechanisms for age-related change, the current study is helpful in measuring and describing the overall extent of change, and the results reported here are largely consistent with previous research, including longitudinal studies. Unfortunately, convenience samples are also common in much of the literature cited here.

Yet another limitation is that the data all come from a single assessment of interests. It is known, for instance, that sex differences vary by interest assessment, with the primary factor being whether or not sex differences were intentionally minimized as part of the assessment development process[9] (Su et al., 2009). Although the sex differences on the Strong assessment are similar to the averages across all inventories in the Su et al. (2009) meta-analysis, it must be acknowledged that results may be different with a different interest assessment.

Finally, population equivalence is assumed for many comparisons, which may or may not be warranted. For instance, business practices may change the kinds of people who respond over time, distorting findings by year.

Future Research

Future research should reexamine similar questions using other and more detailed measures of interests. It would be desirable to learn more about the vocational interests of people older than 63 and people who reside outside the United States. More research in the area of interest change would also be valuable, in particular, experimental studies of interventions to determine causal effects on interest change and genetically sensitive longitudinal studies to examine genetic effects and change over time simultaneously.

Summary and Conclusion

This paper opened with these questions: How similar are the work related interests of men and women? Do interests change over the life span? Have interest patterns changed over the previous decade? How large are differences by ethnicity? This paper aimed to provide the answers using the largest sample ever reported focusing on these questions, using appropriate multivariate effect size estimates.

The answers appear to be that (a) women and men have very different vocational interests, (b) interest levels are higher and sex differences smaller in older samples compared with younger samples, (c) there are very small year effects, most notably smaller sex differences among 18–22-year-olds in later samples compared with earlier samples, and (d) generally very small differences by ethnicity. Very large sex differences in vocational interests appear likely to persist for decades, and through their influence on educational and career choices, will continue to influence workplace outcomes.

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[9] Assessments designed to minimize sex differences have their uses, but accurate measurement of sex differences is better done using measures that were developed without regard to minimizing or maximizing sex differences. During development of the most recent Strong assessment, sex differences on the RIASEC measures were examined and deemed to be generally consistent with previous research. No intentional modifications were made to RIASEC measures based on sex differences.

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