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Men and Things, Women and People: A Meta-Analysis of Sex Differences in Interests

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The magnitude and variability of sex differences in vocational interests were examined in the present meta-analysis for Holland's (1959, 1997) categories (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional), Prediger's (1982) Things–People and Data–Ideas dimensions, and the STEM (science, technology, engineering, and mathematics) interest areas. Technical manuals for 47 interest inventories were used, yielding 503,188 respondents. Results showed that men prefer working with things and women prefer working with people, producing a large effect size ($d = 0.93$) on the Things–People dimension. Men showed stronger Realistic ($d = 0.84$) and Investigative ($d = 0.26$) interests, and women showed stronger Artistic ($d = -0.35$), Social ($d = -0.68$), and Conventional ($d = -0.33$) interests. Sex differences favoring men were also found for more specific measures of engineering ($d = 1.11$), science ($d = 0.36$), and mathematics ($d = 0.34$) interests. Average effect sizes varied across interest inventories, ranging from 0.08 to 0.79. The quality of interest inventories, based on professional reputation, was not differentially related to the magnitude of sex differences. Moderators of the effect sizes included interest inventory item development strategy, scoring method, theoretical framework, and sample variables of age and cohort. Application of some item development strategies can substantially reduce sex differences. The present study suggests that interests may play a critical role in gendered occupational choices and gender disparity in the STEM fields.

Keywords: vocational interests, RIASEC interests, sex differences, gender disparity in STEM, construct validity

Since the 1970s, researchers have been debating why women are underrepresented in the STEM (science, technology, engineering, and mathematics) fields (e.g., Ceci & Williams, 2007; Ceci, Williams, & Barnett, 2009; Gallagher & Kaufman, 2005; Watt & Eccles, 2008). The number of women completing a degree and being employed in mathematics is less than half the number of men. This female–male ratio is approximately two fifths for physical sciences, one fourth for computer sciences, and barely one fifth for engineering (National Science Foundation [NSF], 2007). However, the number of women obtaining graduate degrees has significantly increased across a wide range of scientific disciplines over the past four decades. In the 1960s, all scientific disciplines were male dominated, but the majority of students currently receiving master's degrees in the social sciences, biological sciences, and psychology are female as are the majority of those with doctoral degrees in psychology (NSF, 2007). Nevertheless, women remain a minority in the fields of engineering and the physical sciences. This raises the question: Why do large sex differences continue to exist in these areas? Why are more women not represented in science and engineering fields? Debate over these STEM sex differences has been frequently highlighted in the media and has led to public debate (e.g., Dillon & Rimer, 2005; Pinker, 2008; Tierney, 2008).

Among the reasons put forward as potential contributors to gender disparity in the STEM fields, interest is often identified as a critical factor that may lead to the low number of women entering these fields. Interest is a central predictor of educational choices (e.g., Benbow & Minor, 1986; Hansen & Sackett, 1993; Lapan, Shaughnessy, & Boggs, 1996), degree completion (e.g., Webb, Lubinski, & Benbow, 2002), occupational choices both within and outside of the STEM areas (e.g., Fouad, 1999; Parsons, Adler, & Meece, 1984; Strong, 1943), and job satisfaction (e.g., Barge & Hough, 1988; Morris, 2003). Lack of interest in the STEM fields or finding other fields to be more interesting is also the top reason given for women switching out of the STEM majors and jobs (Preston, 2004; Seymour & Hewitt, 1997). For decades, results obtained from developing revisions of the Strong Interest Inventory (Campbell, 1974; Hansen & Campbell, 1985; Harmon, Hansen, Borgen, & Hammer, 1994; Donnay, Morris, Schaubhut, & Thompson, 2005), as well as other interest inventories, have documented sex differences in vocational interests. These sex differences in interests have not lessened appreciably since the 1930s

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(Hansen & Campbell, 1985; see also Donnay et al., 2005; Einarsdóttir & Rounds, 2009; Fouad, 1999). Despite the importance of interests in educational–occupational choices and the widespread belief that substantial sex differences exist, there has been no comprehensive review quantifying the magnitude and examining the nature of sex differences in interests (Hyde, 2005; Hyde & Linn, 2006). The present study is a meta-analysis of sex differences in vocational interests.[1]

Interest and Career Development

Interest can be conceptualized from either a situational perspective or a dispositional perspective (Silvia, 2006). *Situational interest* is defined as the context-specific state of emotional experience, curiosity, and momentary motivation (see Hidi, 1990; Schraw & Lehman, 2001). In comparison, *dispositional interest* is trait-like, reflecting a person's preferences for behaviors, situations, contexts in which activities occur, and/or the outcomes associated with the preferred activities (Rounds, 1995). From the dispositional perspective, interests are associated with attention, positive emotional states, and direction toward or away from an object, as well as actual function of behavior (Savickas, 1999). The situational and dispositional perspectives are most closely identified with the disciplines of educational and vocational psychology, respectively. The two perspectives on interests can be traced to the early 20th century (Arnold, 1910; Parson, 1909) and parallel the emergence of educational and vocational psychology as separate disciplines of scientific inquiry (Cronbach, 1956). The educational psychology tradition of interest research focuses on the relationship between interest and attention/motivation, primarily examining the function of interest in learning and academic achievement in classroom settings with children (Krapp, 1999; Renninger, Hidi, & Krapp, 1992). In comparison, the vocational psychology tradition of interest research focuses on the construction, validation, and interpretation of interest-based measures to address career development issues with adolescents, college students, and adults (Low & Rounds, 2006; Walsh & Osipow, 1986).

The present study examines interests from the dispositional perspective, because it is dispositional measures of interest that are frequently used in applied settings when working with individuals who are making career-related decisions. Holland (1966) has defined *vocational interests* as "the expression of personality in work, hobbies, recreational activities, and preferences" (p. 3). An individual's interests are fundamental to the process of career development because individuals tend to seek environments in which they can express their interests (Holland, 1997). Another view of interests, put forward by Hogan (Hogan & Blake, 1999), is that vocational interests are, rather than outgrowths of personality development, a direct reflection of an individual's identity (i.e., the way we think of ourselves) that is best conceptualized in terms of a person's motives, goals, values, and aspirations (Hogan & Roberts, 2000). Hogan proposed that, compared with personality measures, which tend to reflect an individual's reputation (i.e., the way others see us), interest measures are a more direct expression of an individual's identity. Alternatively, Eccles-Parsons (1983; see also Meece, Parsons, Kaczala, Goff, & Futterman, 1982) proposed the concepts of attainment value and intrinsic/interest value, which are closely related to the concept of interest, as important determinants of individuals' achievement motivation and career choices. Eccles-Parsons (1983) suggested that these subjective values that individuals attach to different achievement tasks are a stable part of identity and are influenced by the socialization process. Despite the conceptual and terminological differences of these theories, interests are integral to one's identity and are an expression of an individual's attempts to adjust to the academic and work environment by finding opportunities that match their identity.

The development of "trait complexes" (Ackerman, 2003; Armstrong, Day, McVay, & Rounds, 2008) can be an approach to identity formulation. Ackerman and Heggestad (1997) suggested that there are substantial commonalities among families of nonability traits (e.g., personality, interests, motivation, self-concept) as well as between ability traits and nonability traits, making it possible to form meaningful clusters of trait complexes that may enhance our understanding of the nature of individual differences in each of these traditionally separated domains. Armstrong et al. (2008) used interests as a structural framework for identifying trait complexes and interpreted the emergence of trait complexes as a process of contextual convergence, that is, individuals tend to seek out environments that allow for their various individual differences to function effectively and complement each other. Over the life span, individuals form interests that are consistent with their existing identity, including personality (e.g., Darley, 1941; Holland, 1966), self-perception of abilities (e.g., Danissen, Zarret, & Eccles, 2007; Lent, Brown, & Hackett, 1994; Thorndike, 1915), and gender role (e.g., Eccles-Parsons, 1983; L. S. Gottfredson, 1981; Tyler, 1955). As an inseparable part of self-identity, interests serve as the impetus for individuals to navigate through and function effectively in their environments.

Sex Differences in Interest

The issue of how sex differences in interest influence outcomes is central to both the educational and the vocational traditions of interest research, despite their different emphases on the contextual and dispositional aspects of interest. In educational psychology, researchers are concerned about how these sex differences in interests develop and how they impact individuals'—particularly girls' and women's—educational choices, career decisions, and achievement. For example, Marsh and Yeung (1998) studied the bidirectional relationship of interest and achievement and used an internal–external framework of reference model to explain why boys develop stronger mathematics self-concepts and girls develop stronger English self-concepts (see also Marsh, 1986). Eccles and her colleagues (Eccles, 1994; Parsons et al., 1984) applied an expectancy–value model to understand the different patterns of men's and women's educational and occupational choices and considered interest (part of the subjective task value) an important reason why women do not select the same occupational fields—particularly physical sciences, engineering, and applied mathematics—as men. Other studies (e.g., Betz & Schifano, 2000; Cook et

[1] The phrase "sex differences" is used throughout this article because we compared the vocational interests of men and women on the basis of their self-reported biological status. In several cases, we used the term "gender" to refer to the psychosocial characteristics of males and females, such as gender role identity, and when the accepted usage is gender, for example, gender disparity in STEM fields.

al., 1996; Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005) shed light on the influence of socialization process (e.g., role modeling, parents' expectations, educational experiences) on the interest levels, as well as the changing trajectories of interests, of boys and girls.

In the vocational psychology field, researchers have widely acknowledged that sex differences of interests appear at both the item level and the scale level (e.g., Betz & Fitzgerald, 1987; Fouad, 1999; Hackett & Lonborg, 1993; Johansson, 2003). Generally, women are more likely than men to indicate interest in social and artistic activities, whereas men are more likely than women to indicate interest in scientific, technical, and mechanical activities (Betz & Fitzgerald, 1987). As early as one century ago, Thorndike (1911) wrote that the greatest difference between men and women is "in the relative strength of the interest in things and their mechanisms (stronger in men) and the interest in persons and their feelings (stronger in women)" (p. 32). On the basis of a review of studies on masculinity and femininity, Lippa (2001) proposed that masculinity–femininity as a bipolar trait overlaps substantially with the People–Things dimension of vocational interests. Lippa (1998) computed the effect sizes (female minus male) from his multistudy article on the People versus Things dimension and found effect sizes (Cohen's *d*) larger than 1.20 for all three studies. Lubinski (2000) cited this effect size as the largest sex difference in the field of individual differences. Furthermore, these sex differences do not seem to vary much across age (Holland, Fritzsche, & Powell, 1994; F. Kuder & Zytowski, 1988) or over decades (Fouad, 1999; Hansen, 1988). However, the literature has yet to include a systematic meta-analysis examining the pattern and size of sex differences in vocational interests.

Much of the debate on sex differences in vocational interest assessment concerns how to interpret differences in interest scores between men and women. In particular, these sex differences may reflect the sex restrictiveness of interest inventories; if this is the case, the question then becomes how to revise interest inventory scales to be more sex-balanced. In the early 1970s, Lois-Ellin Datta from the National Institute of Education brought together staff from that institution, a senior consultant (Esther E. Diamond), and researchers to study sex bias and sex fairness in career interest inventories. The National Institute of Education planning group was formed to determine what constitutes sex fairness or sex bias in interest inventories. From this examination, the National Institute of Education planning group produced *Guidelines for Assessment for Sex Bias and Sex Fairness in Career Interest Inventories* (National Institute of Education, 1974) and two edited books (Diamond, 1975; Tittle & Zytowski, 1978) that had considerable impact on the development and interpretation of interest inventories.

The *Guidelines* (National Institute of Education, 1974) are reflected in the current *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999) and form the basis for interest inventory construction and revision. Probably the most controversial recommendation in the *Guidelines* was the proposal that interest inventories contain sex-balanced interest scales within the limitations imposed by validity considerations. This guideline in particular led to two sharply divided positions: American College Testing Program (ACT) researchers argued for sex-balanced inventories, and John Holland and colleagues argued that sex-balanced scales would reduce the validity of vocational interest inventories. Both sides of the debate had developed their respective interest inventories: the ACT Interest Inventory (American College Testing Program, 1974) and the Self-Directed Search (Holland, 1972).

Underlying the debate on sex-balanced inventories were two different approaches to examining the validity of an interest inventory—an "opportunity approach to validation" and a "socialization approach to validation" (Cole & Hanson, 1975; see also G. D. Gottfredson & Holland, 1978; Holland, 1976; Lamb & Prediger, 1979; Prediger & Cole, 1975; Prediger & Hanson, 1976). Prediger and Cole (1975) argued that the primary purpose of using an interest inventory is occupational exploration. These authors advocated for removing sex differences from interest scores to maximize career opportunities for individuals. In contrast, G. D. Gottfredson and Holland (1978) stated that constructs measured by interest inventories are dependent on differential socialization experiences of men and women. These researchers argued against the removal of sex differences in the belief that doing so would decrease the predictive validity of the measure. These contrasting positions regarding how to interpret the sex differences foreshadowed the wider debate in psychology over whether test consequences fall within the realm of validity (e.g., Linn, 1997; Messick, 1989; Popham, 1997; Shepard, 1997).

The opportunity approach to validation and the *Guidelines* led to strategies for reducing sex differences in the scaling and scoring of many interest inventories, including eliminating or revising items with largely discrepant endorsement rates for men and women and using combined-sex norm scores instead of raw scores. New measures, such as the Vocational Interest Inventory (Lunneborg, 1981) and the Unisex Edition of the ACT Interest Inventory (UNIACT; American College Testing Program, 1981), were developed during this period of debate using the techniques proposed for reducing sex differences. It is also during the course of this debate that validity of the sex-balanced inventories became a focus of study: Does item selection based on sex differences affect vocational interest scale validity?

A common validity procedure is to use a classification system to group people on the basis of their interest scores and a criterion (e.g., vocational choice, college major, occupation) and then to calculate the percentage of agreement. Vocational researchers have conducted validity studies (e.g., G. D. Gottfredson & Holland, 1975; Hanson, Noeth, & Prediger, 1977), leading to a variety of conclusions depending on how percentage agreement between interest score and criterion was assessed. For example, G. D. Gottfredson and Holland (1978) showed that overall hit rate across all interest categories compared with unweighted average hit rates across categories can suggest divergent interpretations, with overall hit rate favoring the position of Holland and colleagues and unweighted average hit rates favoring the position of the American College Testing Program. Because these studies focused on the Self-Directed Search and early forms of the UNIACT and rarely involved other interest inventories, the results had limited generalizability. The answer to a seemingly straightforward validity issue became overly complicated. The controversy eventually disappeared, but the issues of how to develop and score interest inventories remain. In the present study, we examined the effectiveness of the "sex-balanced" techniques and document the extent to which they minimize sex differences in interest inventory scores.

Types of Interests and Interest Measurement

Interest measures are typically classified into three levels of generality (Hansen, 1984; Rounds, 1995): occupational interest scales, basic interest scales, and general interest scales. Occupational scales are empirically keyed scales measuring similarity of interest between an individual and incumbents employed in different occupations. Basic interest scales measure interests at the level of generality between interest in a certain occupation and interest in a broad area. These scales characterize shared properties of activities (e.g., teaching, selling, and writing) and are often implied in the object of interest (e.g., mathematics, physical science, and engineering). General interest scales measure broad interest areas that encompass a heterogeneous group of occupations and activities. Items in general interest scales share some content and are often grouped on the basis of theoretical models, such as Holland's (1959, 1997) interest types. In the current study, we examined sex differences in responses on general interest (scales) and basic interest scales, because these scales are used most frequently when developing vocational interest measures and provide the best understanding of the nature of sex differences.

The interest model developed by Holland (1959, 1997) is the most widely adopted theoretical framework for interest measurement. Holland organized vocational interests into six types, forming a circular structure referred to collectively as RIASEC: *Realistic* interest in working with things and gadgets or working outdoors; *Investigative* interest in science, including mathematics, physical and social sciences, and biological and medical sciences; *Artistic* interest in creative expression, including writing and the visual and performing arts; *Social* interest in helping people; *Enterprising* interest in working in leadership or persuasive roles directed toward achieving economic objectives; and *Conventional* interest in working in well-structured environments, especially business settings. Prediger (1982) proposed two bipolar work task dimensions underlying Holland's hexagon: working with things versus people and working with data versus ideas.

Holland's (1959, 1997) interest model has received robust empirical support (Armstrong, Hubert, & Rounds, 2003; Day & Rounds, 1998; Tracey & Rounds, 1993). Interest inventories used most frequently to assist individuals in making educational and career-related plans, such as the Strong Interest Inventory (Donnay et al., 2005) and the UNIACT Interest Inventory (American College Testing Program, 1995) have either explicit scales to assess RIASEC types or methods to convert interest scale scores to Holland's system. The U.S. Department of Labor O*NET occupation classification (Rounds, Smith, Hubert, Lewis, & Rivkin, 1999) is also linked to the RIASEC constructs. Given its wide use and far-reaching influence on interest assessment, we use the RIASEC model in the present study to examine sex differences by interest type. As previously noted, the greatest differences between men and women are in the relative strength of the interest in working with things versus the interest in working with people (Lippa, 1998; Thorndike, 1911). Thus, we also examined sex differences in Prediger's (1982) Things–People and Data–Ideas dimensions.

The Present Study

The purpose of the present study was to examine the size of sex differences in RIASEC interests and work task dimensions using a meta-analytic review. We used technical manuals of vocational interest inventories as our data source because such manuals generally include results from large samples that are representative of different ages and ethnic groups, thus controlling sampling error. Hedges and Nowell (1995; see also Hyde, 2005) recommended the use of large well-sampled data sets as an alternative to traditional meta-analysis. Additionally, the data obtained from these technical manuals represent the empirical foundation of the interest measures that are used most frequently in applied settings when working with individuals who are making career-related decisions. Therefore, in addition to providing insight into the nature and magnitude of sex differences in interests, the results obtained from this meta-analysis have important practical implications for career guidance and interest inventory development.

We expected sex differences in most of the RIASEC domains, especially in the Realistic and Social interests that anchor the Things–People dimension. Specifically, we expected to find a greater tendency for men to prefer working with things and women to prefer working with people and for men to have more interest in the Realistic category and women to have more interest in the Social and Artistic categories. Because our intention in undertaking the present study was to inform the ongoing debate about women's underrepresentation in the STEM fields, we also investigated basic interest scales related to the STEM fields. We expected to find men to be more interested in engineering, science, and mathematics (mathematics referring restrictively here to the mathematician profession that is linked to the Investigative interest type). We also examined the homogeneity of effect sizes across interest measures and samples. When the results were heterogeneous, we evaluated potential moderators that could account for the variability in sex differences.

Potential Moderators

Moderators were classified into two groups. The first set of moderators involved the interest inventory per se, including (a) item development to remove sex differences; (b) scoring (raw scores vs. combined-sex norm scores); and (c) theoretical framework of the interest inventories (Holland's RIASEC vs. other frameworks). Constructing interest inventories using only those items with little or no response disparity between men and women is one strategy that has been recommended for reducing sex differences in inventory scores (e.g., Lamb & Prediger, 1979). For example, the items of the UNIACT (American College Testing Program, 1981) were selected so that male and female score overlap for every scale was larger than 85%; the items of the Vocational Interest Inventory (Lunneborg, 1981) were thoroughly inspected and revised until the correlation between every item and participants' sex was within the range of $\pm.15$; and the items of the Career Occupational Preference System Interest Inventory were selected in its Revised Edition (R. R. Knapp & Knapp, 1979) only if response differences for male and female respondents were smaller than 15%. Selecting items that minimize sex differences potentially reduces the differences on interest scales. The present analysis focused on the effects of item selection on sex differences across the RIASEC scales and inventories. We expected the majority of the heterogeneity in effect sizes across interest inventories to be explained by the kinds of items in interest inventories.

The use of raw scores in interest inventories has been criticized for producing dramatically different score distributions for male and female respondents and leading to divergent, sex-stereotypic occupational guidance (e.g., Prediger & Cole, 1975). Little research has been conducted, however, on the degree to which norm scores can reduce sex differences. We examined the extent to which raw scores, as compared with combined-sex norm scores, influenced the size of sex differences in interest inventories. Interest framework refers to whether an interest inventory uses the RIASEC model (Holland, 1959, 1997) or other interest models, such as G. F. Kuder's (1977) 10 preference areas, Roe's (1956) eight interest groups, or basic interest scales. Because of differences in the constructs and the specificity of interest level measured by the scales, theoretical framework may have had an impact on the size of sex differences in interest inventory scores.

The second set of moderators focused on sample characteristics, including (a) age of the sample and (b) cohort. Low (2009) showed that the mean level of men's and women's interests change before mid-adulthood and follow different trajectories. Different trajectories of mean-level interest change for men and women may lead to observable age effects on sex differences. Cohort effects may come about because the work tasks and environments have changed dramatically since the late 1960s (Betz & Fitzgerald, 1987; Savickas, 2002). Changing work environment has led to shifts in the cultural values shared by different cohorts as well as shifts in access to educational and occupational opportunities, especially for women. These sociocultural changes may correspond to changes in sex differences in vocational interests across cohorts. We expected the effect of the sample moderators to be much weaker than the inventory-related moderators that directly affect sex differences.

Highly Regarded Inventories

A common criticism about meta-analyses is that the good and the not so good studies get combined, diluting the accuracy of effect size estimates. A number of interest inventories are generally held in high regard by the professional testing community of test developers, teachers, researchers, and practitioners. Although we are aware of no evidence that the quality of interest inventories is differentially related to the size of sex differences obtained with them, estimating the effect sizes for these highly regarded interest inventories and comparing them with overall effect sizes can provide additional confidence in the present meta-analytic results. We propose using the professional reputation of interest inventories as a proxy for their overall quality (this procedure is described in more detail in the Method section) rather than any single psychometric characteristic of the inventory (e.g., validity) because it is based on a broad set of criteria, such as inventory development, reliability, validity, norms, usefulness in practice, and so forth.

Sex differences in the interest inventories that are highly regarded by the professional testing community should be of particular interest to applied researchers and practitioners. Inventories selected on the basis of their professional reputations are the interest measures with which practitioners are most likely to have received training in administration and interpretation. Therefore, interest inventories with the strongest reputations are more likely to be used in applied settings and will possibly have the greatest impact on the career choices of individuals. In the present study, we calculated effect sizes of sex differences for most recent editions of all interest inventories that are currently in print and also examined effect sizes for inventories that are highly regarded in the field of vocational assessment. Our purpose was twofold: First, the results will enhance understanding about all of the vocational interest measures commercially available and currently being used in practice. This information can assist practitioners in selecting assessments and interpreting interest scores. Second, the effect sizes for the most highly regarded interest inventories can be used as a benchmark for comparison purposes. We expected the magnitude and pattern of sex differences for highly regarded interest inventories to be similar to the results based on all inventories.

Method

Literature Search Procedures

Technical manuals of vocational interest inventories constituted the data source. We went through the first through the 17th editions of the *Mental Measurements Yearbook* (Buros, 1938, 1941, 1949, 1953, 1959, 1965, 1972, 1978; Conoley & Impara, 1995; Conoley & Kramer, 1989; Geisinger, Spies, Carlson, & Plake, 2007; Impara & Plake, 1998; Kramer & Conoley, 1992; Mitchell, 1985; Plake & Impara, 2001; Plake, Impara, & Spies, 2003; Spies & Plake, 2005) to identify interest inventories published through 2007. We then searched the publishers' websites or contacted the publishers directly to determine whether any new edition of a test had been published or any new norm sample had been used since 2007. James Rounds identified interest inventories from governmental/military sources. Inventories were obtained either through the library system or from the publishers. In addition, Rong Su visited the Buros Institute of Mental Measurements to retrieve data from the institute's archives. The literature search resulted in 108 inventories.

Inclusion Criteria

Inventories were evaluated for inclusion in the current meta-analysis on the basis of the following criteria: First, the inventories were published in English with norm samples from the United States or combined norm samples from both the United States and Canada. Second, the inventories were intended to measure vocational interests. Tests intended to measure educational interests, such as the College Major Interest Inventory (Whetstone & Taylor, 1990) were excluded. Form AH (hand scored) of the Kuder Preference Record (G. F. Kuder, 1948), which measures personality, was also excluded. Third, the inventories used the same form for male and female respondents. Fourth, and finally, means and standard deviations for both male and female respondents were reported in the technical manuals, making it possible to calculate effect sizes of sex differences. Different editions of an inventory were counted as separate studies if item changes had occurred between editions. If a new edition of an inventory contained only new norms and had not yet gone through any revision, we weighted its sample and combined it with the sample from the older edition to avoid statistical dependence. If one sample was used by multiple inventories (e.g., the Career Assessment Inventory—Enhanced Version, Johansson, 2003, in which an adult sample was also used to develop adult norms for the Interest Determination, Exploration and Assessment System, Johansson, 1996), we included only one set of data. Application of these inclusion criteria resulted in 47 inventories, published between 1964 and 2007, and a total of 81 samples consisting of 243,670 men and 259,518 women. The mean ages of the samples ranged from 12.50 to 42.55 years. The oldest cohort of the samples was born in 1939, and the youngest in 1987.

Coding of Study Variables

Each sample meeting the inclusion criteria was coded for study variables, including item development (1 = overlap of male and female scores was less than 75% or more than 33% of the items had response differences larger than 15%; 2 = overlap of male and female scores was between 75% and 85% or 10% to 33% of the items had response differences larger than 15%; 3 = overlap of male and female scores was larger than 85% or no more than 10% of the items had response differences larger than 15%), scoring (1 = raw score; 2 = combined-sex norm), theoretical framework (0 = RIASEC interests; 1 = other theoretical models), mean age of the sample, and year when the sample was collected. For each sample, we calculated an index for cohort by subtracting mean age from (year of the sample minus 1900).

Interest inventory scales that were not RIASEC scales were categorized into the RIASEC types independently by James Rounds and Rong Su on the basis of the following criteria supported by construct validity evidence from previous studies: First, if an interest inventory follows Holland's theoretical framework but uses different names for the RIASEC scales, the inventory scales were assigned to the corresponding Holland scales (e.g., UNIACT–Revised; American College Testing Program, 1995, p. 2). Second, if an interest inventory has basic interest scales, we assigned such scales into Holland types on the basis of the scales' link to a RIASEC type identified from the inventory manual (e.g., Interest Determination, Exploration and Assessment System, Johansson, 1996, pp. 63–65). Third, if an interest inventory follows Roe's (1956) model, G. F. Kuder's (1948) classification, L. Knapp and Knapp's (1982) system, or J. P. Guilford, Christensen, Bond, & Sutton's (1954) interest categories, we assigned its scales to RIASEC types on the basis of previous factor analytic results (e.g., R. R. Knapp, Knapp, & Knapp-Lee, 1990, p. 30) establishing the link between these theoretical frameworks and Holland's (1959, 1997) model. Fourth, for interest inventories following the United States Employment Service occupational interest classification (e.g., Chronicle Career Quest; Chronicle Guidance Publications, 1992), we classified the 12 occupational interest areas of this system into the Holland types on the basis of criteria well recognized among researchers (G. D. Gottfredson & Holland, 1996, p. 708). Fifth, for interest inventories that do not contain the information described above (e.g., Jackson Vocational Interest Survey; Jackson, 2000), we compared the content of the scales with the description of the Holland personality/environment typology (G. D. Gottfredson & Holland, 1996; Holland, 1997) and classified the scales into the RIASEC types. Agreement rate on classification of interest scales into the RIASEC types was 96.6% (see Table 1 for the list of interest inventory scales categorized by RIASEC type).

Rong Su coded all of the inventories; Patrick Ian Armstrong coded 63% of the inventories. The interrater agreement was 96.4% on item development, 89.3% on scoring, 100.0% on theoretical framework, 100.0% on age, and 96.4% on cohort. Differences between raters were resolved by discussion. A complete list of coding classifications on study variables is presented in Table 2.

To identify highly regarded interest inventories, we perused professional test and measurement books and selected the inventories that were most endorsed. We first conducted a literature search for test and measurement books published in the past 15 years (1994–2009) using all possible combinations of the following words: *interest(s), career, vocational, occupational, test, assessment*, and *measurement.* We then checked the retrieved books for cross-referenced books and reviewed the content of the books. Only books including a chapter on interests/values and containing detailed reviews of selected interest inventories (e.g., a presentation of the scales of an inventory and interpretation of its scores) were included. This procedure resulted in a total of 28 books. For books that have multiple editions, we used only the most recent edition. If one scholar had edited, authored, or coauthored several different books, we included only the most recent book by that author to ensure that information from different sources was independent and was not duplicated. Applying these further inclusion criteria led to 14 books. We then tallied the number of times interest inventories were highlighted in these books.

Analytical Procedures

We calculated sex difference effect sizes for the six RIASEC types and Prediger's two dimensions using Cohen's (1988) *d*. The absolute values of the RIASEC effect sizes were then averaged to obtain an average effect size representing the magnitude of sex difference for each sample. A positive effect size indicated stronger interest for men than for women. We calculated effect sizes for the Things–People and Data–Ideas dimensions using the formulas in the UNIACT–Revised Edition manual (American College Testing Program, 1995, p. 126), with a larger score indicating stronger interest in working with things or data. Effect sizes for the RIASEC scales and the Things–People and Data–Ideas dimensions, as well as the average effect sizes, were then weighted by their inverse variance and averaged to generate mean effect sizes according to a random-effects model of error estimation. We calculated the 95% confidence intervals and 90% credibility values. We followed the same procedure to compute the mean effect sizes for the latest editions of 29 in-print interest inventories and highly regarded interest inventories.

For variables with heterogeneous effect sizes, we conducted moderator analyses to examine the source of heterogeneity using a mixed-effects model. We chose the mixed-effects model because use of this model has been suggested to be the best practice for meta-analysis involving the examination of systematic influence from moderators (Viechtbauer, 2008; see also Hedges & Vevea, 1998; Lau, Ioannidis, & Schmid, 1998). This model allowed us to examine the influence of moderators without making the untenable assumption that all variance in effect sizes could be accounted for by systematic factors or that all variance was due to random error.

As a first step, we examined item development, scoring (raw scores vs. combined-sex norm scores), and interest framework using weighted analysis of variance (ANOVA) and weighted regression by inventory. Second, we evaluated age and cohort using weighted regression by sample. We performed both effect size calculation and moderator analyses in SPSS 13.0 using the modules given by Lipsey and Wilson (2001, pp. 208–220).

To detect the likelihood and possible influence of publication bias, we conducted a trim-and-fill procedure (Duval & Tweedie, 2000), a nonparametric statistical technique of examining the symmetry and distribution of effect sizes plotted by inverse of standard error. This technique first estimates the number of studies that may be missing as a result of publication bias and then allows a new, attenuated effect size to be calculated on the basis of the influence such studies would have if they were included in the analysis. We performed this procedure on the average effect sizes by inventory and by sample with the statistical computing program R (Schwarzer, 2008). Two estimators of the number of missing studies, L_0 and R_0, were generated and used to evaluate the potential influence of publication bias.

Results

RIASEC Interests

We began our examination of sex differences with the two broad RIASEC dimensions of Things–People and Data–Ideas and then focused on the six RIASEC types. Table 3 shows the effect sizes for the RIASEC interests. To further illustrate the implication of these effects sizes, we calculated the percentages that male and female interest distributions overlap given the effect sizes, using a statistic called percentage overlap proposed by Tilton (1937). As hypothesized, the mean effect size for the Things–People dimension (d = 0.93) favored men and was the largest effect size observed. In contrast, a very small sex difference was found for the Data–Ideas dimension ($d = -0.10$). The RIASEC interest scales, with the exception of Enterprising, showed statistically significant sex differences. As expected, men showed stronger Realistic and Investigative interests, whereas women showed stronger Artistic, Social, and Conventional interests. Most of the Things–People sex difference could be accounted for by the large Realistic interest effect size (d = 0.84) and the moderate Social interest effect size ($d = -0.68$). The effect sizes for the Investigative (d = 0.26), Artistic ($d = -0.35$), and Conventional ($d = -0.33$) interests were small. Figure 1 illustrates the sex differences in RIASEC interests.

Table 4 shows sex differences for the latest editions of 29 in-print interest inventories. The interest inventories are ordered by the magnitude of their average effect size. Large variability was evident across inventories. The inventory having the smallest sex differences was the Career Occupational Preference System Interest Inventory—Revised Edition (R. R. Knapp & Knapp, 1979), with an average effect size of 0.08; all of the other effect sizes were within ±0.20. The Vocational Interest Inventory–Revised (Lunneborg, 1993), the Career Assessment Inventory—Enhanced Version (Johansson, 2003), the UNIACT-R (American College Testing Program, 1995), and the O*NET Interest Profiler (U.S. Department of Labor, 2000) also showed relatively small sex differences. In comparison, the Occupational Aptitude Survey and Interest Schedule—Third Edition: Interest Schedule (Parker, 2002) had an average effect size of 0.79. The Self-Directed Search (Holland et al., 1994) showed large sex differences, particularly for Realistic interests and the Things–People dimension. We highlight the results for the seven most highly regarded interest inventories (cited by at least one third of the 14 most currently published professional test and measurement textbooks: the Strong Interest Inventory, cited 13 times; the Self-Directed Search, cited 13 times; the Kuder Occupational Interest Survey, cited 10 times; the Campbell Interest and Skill Survey, cited 10 times; the Career Assessment Inventory—Vocational Version, cited eight times; the Jackson Vocational Interest Survey, cited eight times; the UNIACT, cited five times) and calculated their mean effect sizes. Table 4 also displays the mean effect sizes for these highly regarded inventories as well as for all 29 in-print interest inventories. Except for Conventional interests, the magnitude and pattern of sex differences from highly regarded inventories were very similar to the overall results, indicating that professional reputation of an interest inventory had very little impact on the meta-analytic results of sex differences.

Figure 2 illustrates the sex differences in the Things–People and Data–Ideas dimensions for the interest inventories. All of the inventories had positive effect sizes, ranging from 0.14 to 1.65, on the Things–People dimension, indicating men's predominant interest in things-oriented activities and occupations rather than people-oriented activities and occupations. In contrast, the effect sizes were distributed evenly on the Data end and the Ideas end, with less extreme values, suggesting that men and women differed very little in their preference for working with data or working with ideas.

We next evaluated the homogeneity of the effect sizes. The Q statistic (Hedges & Olkin, 1985) showed that the effect sizes for all interest variables were heterogeneous, indicating the possibility of moderator variables to account for this heterogeneity. Tables 5 and 6 show the results of the moderator analyses. Item development had the greatest moderating effect on sex differences. An inverse variance weighted one-way ANOVA followed by an inverse variance regression showed that item development had a significant negative impact on the size of sex differences for the Things–People dimension ($\beta = -.42$, $p < .01$, $R^2 = 21.8\%$), the Realistic type ($\beta = -.46$, $p < .01$, $R^2 = 26.6\%$), the Investigative type ($\beta = -.37$, $p < .05$, $R^2 = 13.3\%$), the Enterprising type ($\beta = -.47$, $p < .01$, $R^2 = 13.7\%$), and the average effect size ($\beta = -.32$, $p < .05$, $R^2 = 12.6\%$). The sex differences were reduced for Realistic interests, from a d of 0.91 to a value of 0.35, and for Investigative and Enterprising interests, item selection reduced statistically significant effect sizes (d = 0.29 for Investigative and d = 0.09 for Enterprising) to nonsignificant effect sizes (d = 0.05 for Investigative and $d = -0.07$ for Enterprising). When inventory developers used a variety of methods to select items that showed small or no sex differences, smaller response differences between men and women were found.

Scoring did not significantly influence the average effect sizes and had mixed moderating effects for different interest types and dimensions. The use of combined-sex norm scores compared with raw scores led to smaller sex differences for the Realistic type (d = 0.88 for raw scores; d = 0.69 for combined-sex norm scores, $p < .01$). Raw scores reduced sex differences for the Artistic type ($d = -0.32$ for raw scores; $d = -0.47$ for combined-sex norm scores,

Table 1
List of Interest Inventory Scales by RIASEC Type

Inventory	Scales classified into RIASEC type					
	Realistic	Investigative	Artistic	Social	Enterprising	Conventional
CCQ	Plants and Animals, Protective, Mechanical, Industrial, Physical Performing	Scientific	Artistic	Accommodating, Humanitarian	Leading–Influencing, Selling	Business Detail
CDI	Outdoors, Industrial Arts	Science and Technology	Art, Writing	Health Service, Teaching and Social Service, Personal Service	Administration, Sales	Clerical, Food Service
CII	Agriculture, Building Trades, Transportation, Benchwork, Machine Operation	Social Science, Mathematics/ Science	Fine Arts	Health Services, Educational Services	Legal Services, Sales, Management	Clerical Services, Customer Services
CISS	Producing, Adventuring	Analyzing	Creating	Helping	Influencing	Organizing
COPS	Technology–Professional, Technology–Skilled, Outdoor	Science–Professional, Science–Skilled	Communication, Arts–Professional, Arts–Skilled	Service–Professional, Service–Skilled	Business–Professional, Business–Skilled	Clerical, Consumer Economics
GOCL II	Technology–Mechanical, Technology–Industrial, Mechanical, Outdoor		Arts	Service	Business	
GZII	Natural, Mechanical	Scientific	Literary, Artistic, Creative	Service	Enterprising, Leadership	Clerical
IDEAS	Mechanical/Fixing, Protective Services, Nature/Outdoors	Mathematics, Science, Medical	Creative Arts, Writing	Community Service, Education, Child Care	Public Speaking, Business, Sales	Office Practices, Food Service
JVIS	Adventure, Engineering, Nature-Agriculture, Skilled Trades	Math, Physical Science, Life Science, Medical Services, Social Science	Creative Arts, Performing Arts, Author Journalism, Technical Writing	Personal Services, Family Activity, Teaching, Social Service, Elementary Education	Professional Advising, Business, Sales, Supervision, HR Management, Law	Finance, Office Work
KCS	Outdoor, Mechanical	Scientific	Communications, Fine and Performing Arts	Social Service	Persuasive, Managerial	Computational, Clerical
KGIS	Outdoor, Mechanical	Scientific	Artistic, Literary, Musical	Social Service	Persuasive	Computational, Clerical
KOIS	Outdoor, Mechanical	Scientific	Artistic, Literary, Musical	Social Service	Persuasive	Computational, Clerical
OASIS: IS	Nature, Protective, Mechanical, Industrial, Physical Performing	Scientific	Artistic	Accommodating, Humanitarian	Selling, Leading-Influencing	Business Detail
OVIS	Manual Work, Machine Work, Inspecting and Testing, Crafts and Precise Operation, Agriculture, Applied Technology	Medical	Literary, Artistic, Music, Entertainment and Performing Arts	Personal Services, Skilled Personal Services, Training, Care People-Animals, Teaching/ Counseling/and Social Work, Nursing and Related Technical Services	Management and Supervision, Sales Representative, Promotion and Communication, Appraisal	Clerical Work, Customer Services, Numerical
OVIS-II	Manual Work, Machine Operation, Crafts and Precise Operations, Engineering and Physical Sciences, Agriculture and Life Sciences	Medical Services	Communications, Visual Arts, Performing Arts, Music, Sport and Recreation	Health Services, Basic Services, Skilled Personal Services, Education and Social Work	Management, Marketing, Legal Services, Customer Services	Clerical, Numerical

(*table continues*)

Table 1 (*continued*)

Inventory	Realistic	Investigative	Artistic	Social	Enterprising	Conventional
	Scales classified into RIASEC type					
VII	Outdoor, Technology	Science	Art and Entertainment, General Culture	Service	Business Contact	Organization
VRII	Plants and Animals, Protective, Mechanical, Industrial, Physical Performing	Science	Artistic	Accommodating, Humanitarian	Leading-Influence, Selling	Business Detail
WOWI	Primary Outdoor, Machine Work, Structural Work, Mechanical & Electrical Work, Mining, Processing, Engineering	Sciences	Arts, Graphic Arts	Service, Public Service	Managerial, Sales, Business Relations	Benchwork, Clerical

Note. CCQ = Chronicle Career Quest; CDI = Career Decision Inventory; CII = Career Interest Inventory; CISS = Campbell Interest and Skill Survey; COPS = Career Occupational Preference System Interest Inventory; GOCL = Gordon Occupational Check List; GZII = Guilford-Zimmerman Interest Inventory; IDEAS = Interest Determination, Exploration and Assessment System; JVIS = Jackson Vocational Interest Survey; KCS = Kuder Career Search with Person Match; KGIS = Kuder General Interest Survey; KOIS = Kuder Occupational Interest Survey; OASIS: IS = Occupational Aptitude Survey and Interest Schedule: Interest Schedule; OVIS = Ohio Vocational Interest Survey; VII = Vocational Interest Inventory; VRII = Vocational Research Interest Inventory; WOWI = World of Work Inventory; HR = Human Resources.

$p < .01$). In comparison with item development, scoring had a much weaker moderating effect and generally accounted for no more than 10% of the variance.

Finally, we examined the moderating effect of the theoretical framework used in interest inventories. The results showed that different interest frameworks had a significant impact on sex differences only for Realistic and Conventional interests, indicating that inventories using other theoretical frameworks might include scales measuring constructs that differ from the Realistic and Conventional interests measured by the Holland model. Inventories including RIASEC scales showed larger sex difference in Realistic interests ($d = 0.96$) than did inventories using other frameworks ($d = 0.70$, $p < .01$). The reverse is true for Conventional interests ($d = -0.22$ for inventories containing RIASEC scales and $d = -0.43$ for inventories using other frameworks, $p < .05$).

In all, inventory-related moderators accounted for 28.5% of the variance in the Things–People dimension, 18.2% of the variance in the Data–Ideas dimension, 48.1% in the Realistic type, 13.4% in Investigative type, 15.5% in the Artistic type, 11.1% in the Social type, 22.2% in the Enterprising type, 9.9% in the Conventional type, and 13.2% for the average effect sizes. Among the inventory-related moderators coded in the meta-analysis, item development accounted for the majority of this variance.

Sample-related moderators, as hypothesized, showed a weaker moderating effect than did inventory-related moderators. Results indicated that, on average, sex differences were smaller for older group ($\beta = -.36$, $p < .01$) and younger cohort ($\beta = -.29$, $p < .05$). As age increases, effect size of the sex differences on the Things–People dimension ($\beta = -.24$, $p < .05$) and Social interest ($\beta = .45$, $p < .01$) decreases. Younger cohort showed smaller sex differences in the Data–Ideas dimension ($\beta = -.50$, $p < .01$) and in the Artistic ($\beta = .58$, $p < .01$) and Enterprising ($\beta = -.54$, $p < .01$) interests.

Taken together, sample variables accounted for 24.1% of the variance in the Data–Ideas dimension (5.4% by age and 24.0% by cohort, separately), 25.7% in the Artistic type (0.4% by age and 22.7% by cohort), 23.8% in the Social type (23.8% by age and 8.5% by cohort), 28.1% in the Enterprising type (6.9% by age and 28.0% by cohort), and 10.9% for the average effect sizes (5.0% by age and 1.1% by cohort). In comparison with inventory variables, sample variables showed significant moderating effects for fewer interest types: We found that sex differences in Artistic and Enterprising interests were smaller for younger generations and that sex differences in Social interests decreased as people aged. Age and cohort seemed to impact different interest types: Age influenced the Things–People dimension, yet cohort had an effect on interest types that anchor the Data–Ideas dimension.

We performed the trim-and-fill procedure on average effect sizes by inventory and by sample. The funnel plot of average effect sizes by sample is presented in Figure 3. Analyses based on both the L_0 and the R_0 estimators indicated no missing studies, suggesting that the current study was not threatened by publication bias.

STEM Interests

We conducted three supplementary analyses using basic interest scales in science, mathematics, and engineering-related areas to examine sex differences in the STEM fields. In these analyses, we not only considered the size of sex differences and relevant moderators but also examined the variance ratio of male and female interests and the comparative size of differences within male and female respondents in comparison with the differences between male and female respondents.

Method. We used the same pool of interest inventory manuals as in the previous analyses for these analyses. We selected scales on the basis of the content of their items to represent the three fields. To calculate effect sizes of sex differences in interests for the science field, we included all science basic interest scales (including scales with the names Physical Science and Research); to calculate effect sizes for the mathematics field, we included all mathematics, numerical, and computational scales; to calculate

Table 2
Overview of the Meta-Analysis Database: Average Effect Size and Moderator Variables by Sample

			Moderator					Sample size		
Inventory	Reference	*d*	Item development	Scoring	Theoretical framework	Age (years)	Cohort	*N*	Male	Female
ACT-IV	Hanson, 1974	0.57	1	1	0	17.50	56.50	2,971	1,233	1,738
ACT-IV	Hanson, 1974	0.43	1	1	0	20.50	53.50	1,218	666	552
ASVAB	U.S. Department of Defense, 2005	0.59	2	2	0	13.37	83.63	1,958	945	1,013
CAI-E	Johansson, 2003	0.25	2	2	0	40.35	45.65	900	450	450
CAI-V	Johansson, 1984	0.50	1	2	0	36.60	39.40	1,500	750	750
CCQ-Form L	Chronicle Guidance Publications, 1992	0.48	2	1	1	16.00	74.00	1,311	661	650
CCQ-Form S	Chronicle Guidance Publications, 1992	0.58	2	1	1	14.00	76.00	1,536	797	739
CDI	Jackson, 1986	0.62	1	1	1			1,000	500	500
CDI	Jackson, 2003	0.84	1	1	1			212	114	98
CDI	Jackson, 2003	0.64	1	1	1	16.50	86.50	737	385	352
CDI	Jackson, 2003	0.55	1	1	1	18.50	84.50	386	206	180
CDI	Jackson, 2003	0.53	1	1	1	25.00	78.00	392	171	221
CDI	Jackson, 2003	0.56	1	1	1	35.00	68.00	317	148	169
CDI	Jackson, 2003	0.58	1	1	1			276	145	131
CDM	Harrington & O'Shea, 1981	0.12	1	1	0	20.00	71.00	1,089	577	512
CDM	Harrington & O'Shea, 1981	0.32	1	1	0			1,246	567	679
CDM	Harrington & O'Shea, 1981	0.57	1	1	0	13.50	67.50	4,004	2,045	1,959
CDM	Harrington & O'Shea, 1981	0.61	1	1	0	16.50	64.50	5,646	3,083	2,563
CDM	Harrington & O'Shea, 1981	0.45	1	1	0	18.50	62.50	2,925	1,130	1,795
CDM-Revised	Harrington & O'Shea, 2001	0.45	1	1	0	13.47	77.53	965	483	482
CDM-Revised	Harrington & O'Shea, 2001	0.42	1	1	0	16.29	74.71	996	496	500
CDM-Spanish	Harrington & O'Shea, 1981	0.46	1	1	0			648	288	360
CDM-Spanish	Harrington & O'Shea, 2001	0.47	1	1	0	16.10	73.90	966	420	546
CII-Level 1	Psychological Corporation, 1991	0.38	1	1	1	12.50	76.50	13,733	6,901	6,832
CII-Level 1	Psychological Corporation, 1991	0.41	1	1	1	13.50	75.50	20,025	10,054	9,971
CII-Level 1	Psychological Corporation, 1991	0.42	1	1	1	14.50	74.50	26,361	13,048	13,313
CII-Level 2	Psychological Corporation, 1991	0.40	1	1	1	15.50	73.50	14,708	7,362	7,346
CII-Level 2	Psychological Corporation, 1991	0.37	1	1	1	16.50	72.50	8,793	4,401	4,392
CII-Level 2	Psychological Corporation, 1991	0.38	1	1	1	17.50	71.50	8,679	4,438	4,241
CISS	Campbell et al., 1992	0.49	1	2	1			5,241	3,442	1,799
COPS	R. R. Knapp et al., 1990	0.48	1	1	1	15.50	66.50	4,145	2,034	2,111
COPS	R. R. Knapp et al., 1990	0.40	1	1	1	20.00	62.00	1,445	773	672

(*table continues*)

Table 2 (*continued*)

Inventory	Reference	*d*	Moderator: Item development	Scoring	Theoretical framework	Age (years)	Cohort	Sample size: *N*	Male	Female
COPS	R. R. Knapp et al., 1990	0.40	1	1	1	15.00	73.00	14,619	7,565	7,054
COPS	R. R. Knapp et al., 1990	0.42	1	1	1	20.00	68.00	3,237	1,379	1,858
COPS-Revised	R. R. Knapp & Knapp, 1979	0.08	3	1	1	15.00	64.00	400	200	200
GOCL II	Gordon, 1981	0.33	1	1	1	17.00	64.00	359	168	191
GZII	Guilford & Zimmerman, 1989	0.56	1	1	1			215	97	118
IDEAS	Johansson, 1978	0.64	1	2	1	16.00	61.00	3,436	1,755	1,681
IDEAS	Johansson, 1978	0.59	1	2	1	12.50	64.50	598	292	306
IDEAS	Johansson, 1996	0.55	2	2	1	13.50	75.50	1,770	820	950
IDEAS	Johansson, 1996	0.57	2	2	1	16.50	72.50	2,891	1,208	1,683
IF	Wall et al., 1996	0.34	2	1	0	16.40	77.60	1,313	591	722
JVIS	Jackson, 1977	0.33	1	1	1	17.40	59.60	1,000	500	500
JVIS	Jackson, 2000	0.37	1	1	1	15.00	84.00	2,380	1,190	1,190
JVIS	Jackson, 2000	0.26	1	1	1			1,120	560	560
KGIS (Form E)	Kuder & Zytowski, 1988	0.72	1	1	1	12.50	50.50	4,109	2,080	2,029
KGIS (Form E)	Kuder & Zytowski, 1988	0.71	1	1	1	16.00	47.00	5,704	2,766	2,938
KGIS (Form E)	Kuder & Zytowski, 1988	0.67	1	1	1	12.50	74.50	5,894	2,714	3,180
KGIS (Form E)	Kuder & Zytowski, 1988	0.68	1	1	1	16.00	71.00	7,113	3,402	3,711
KOIS (Form DD)	Kuder & Zytowski, 1991	0.34	1	1	1			3,214	1,583	1,631
KCS	Zytowski, 2007	0.34	1	2	1	23.60	83.40	3,619	1,663	1,956
OASIS-3: IS	Parker, 2002	0.79	2	1	1	15.50		1,091	551	540
O*NET IP	U.S. Department of Labor, 2000	0.30	2	1	0	32.46	63.54	1,123	529	594
OVIS	D'Costa et al., 1970	0.42	1	1	1	15.50	53.50	46,181	23,272	22,909
OVIS-II	Winefordner, 1983	0.31	2	1	1	13.50	66.50	9,800	4,915	4,885
OVIS-II	Winefordner, 1983	0.36	2	1	1	16.50	63.50	6,672	3,308	3,364
OVIS-II	Winefordner, 1983	0.31	2	1	1	20.00	60.00	2,800	1,057	1,743
SDS-E	Holland et al., 1994	0.63	1	1	0	24.50	71.50	717	313	404
SDS-R	Holland, 1972	0.77	1	1	0	16.50	53.50	4,961	2,384	2,577
SDS-R	Holland, 1972	0.65	1	1	0	20.00	50.00	1,438	578	860
SDS-R	Holland, 1979	0.43	1	1	0			600	235	365
SDS-R	Holland, 1985	0.45	1	1	0			768	297	471
SDS-R	Holland et al., 1994	0.52	1	1	0	16.50	77.50	819	344	475
SDS-R	Holland et al., 1994	0.48	1	1	0	20.00	74.00	1,114	399	715
SDS-R	Holland et al., 1994	0.51	1	1	0	38.65	55.35	656	251	405
SII	Campbell, 1974	0.42	1	2	0	34.30	39.70	600	300	300
SII	Hansen & Campbell, 1985	0.30	1	2	0	38.20	46.80	600	300	300
SII	Harmon et al., 1994	0.32	1	2	0	42.55	51.45	18,951	9,484	9,467
SII	Donnay et al., 2005	0.38	1	2	0	35.46	66.54	2,250	1,125	1,125
UNIACT	American College Testing Program, 1981	0.21	3	2	0	17.50	63.50	4,631	1,247	1,693
UNIACT-R	American College Testing Program, 1995	0.30	3	2	0	13.50	78.50	4,631	2,294	2,307
UNIACT-R	American College Testing Program, 1995	0.30	3	2	0	15.50	76.50	4,133	1,979	2,132
UNIACT-R	American College Testing Program, 1995	0.27	3	2	0	17.50	75.50	4,679	2,219	2,426

(*table continues*)

Table 2 (*continued*)

Inventory	Reference	*d*	Moderator: Item development	Scoring	Theoretical framework	Age (years)	Cohort	Sample size: *N*	Male	Female
VII	Lunneborg, 1981	0.36	3	2	1	16.50	59.50	600	300	300
VII-R	Lunneborg, 1993	0.23	3	2	1	16.50	68.50	1,562	748	814
VPI	Holland, 1965	0.55	1	1	0	20.00	45.00	12,433	6,290	6,143
VPI	Holland, 1977	0.38	1	1	0	28.93	48.07	732	354	378
VRII	Vocational Research Institute, 1988	0.45	1	1	1	16.60	68.40	856	429	427
VRII	Vocational Research Institute, 1988	0.49	1	1	1	28.10	56.90	525	198	327
WOWI	Ripley et al., 2001	0.38	1	1	1	28.88	68.12	169,436	78,564	90,872

Note. *d* = inverse variance weighted effect size; ACT-IV = ACT Interest Inventory; ASVAB = Armed Services Vocational Aptitude Battery; CAI-E = Career Assessment Inventory–Enhanced Version; CAI-V = Career Assessment Inventory—Vocational Version; CCQ = Chronicle Career Quest; CDI = Career Decision Inventory; CDM = Harrington–O'Shea Career Decision-Making System; CII = Career Interest Inventory; CISS = Campbell Interest and Skill Survey; COPS = Career Occupational Preference System Interest Inventory; GOCL = Gordon Occupational Check List; GZII = Guilford–Zimmerman Interest Inventory; IDEAS = Interest Determination, Exploration and Assessment System; IF = Interest Finder; JVIS = Jackson Vocational Interest Survey; KGIS = Kuder General Interest Survey; KOIS = Kuder Occupational Interest Survey; KCS = Kuder Career Search with Person Match; OASIS-3: IS = Occupational Aptitude Survey and Interest Schedule— Third Edition: Interest Schedule; O*NET IP = O*NET Interest Profiler; OVIS = Ohio Vocational Interest Survey; SDS-E = Self Directed Search (Form E); SDS-R = Self Directed Search (Form R); SII = Strong Interest Inventory; UNIACT = Unisex Edition of ACT Interest Inventory; UNIACT-R = Unisex Edition of ACT Interest Inventory–Revised Edition; VII = Vocational Interest Inventory; VII-R = Vocational Interest Inventory—Revised; VPI = Vocational Preference Inventory; VRII = Vocational Research Interest Inventory; WOWI = World of Work Inventory. In the coding for item development, 1 represents an overlap of male and female scores of less than 75% or cases in which more than 33% of the items have response differences larger than 15%; 2 represents an overlap of male and female scores from 75% to 85% or 10% to 33% of the items have response differences larger than 15%; 3 represents an overlap of male and female scores larger than 85% or in which no more than 10% of the items have response differences larger than 15%. For scoring, 1 = raw score and 2 = combined-sex norm. Theoretical framework was coded as 0 = RIASEC model; 1 = other interest models.

effect size for the engineering and related fields, we used engineering, mechanical, electronics, machine work, and technology scales. The Engineering and Physical Sciences scale in the Ohio Vocational Interest Survey II (Winefordner, 1983) was classified as an engineering scale. The Math/Science scale in the Career Interest Inventory (Psychological Corporation, 1991) was classified as a mathematics scale. Effect size calculations and moderator analyses followed the same procedures as were used with RIASEC interests. The differences between the first quartile and the third quartile of the male and female groups were used as an indicator for intragroup differences and were divided by the intergroup mean differences for each inventory. The ratios formed were denoted as the male ratio and the female ratio. We calculated variance ratios by dividing female variance by male variance. A log transformation was performed on each ratio while aggregating the male and female ratios and the variance ratios. When $d = 0$, and the male ratio and female ratio were infinite, they were set to the next largest value.

Results. For the science field, we computed and aggregated 34 effect sizes. The mean effect size for sex differences in science was .36 ($p < .01$, -95% $CI = 0.27$, $+95\%$ $CI = 0.46$). Because the effect sizes showed heterogeneity, we again examined moderating effects of two inventory variables (item development and scoring) and two sample variables (age and cohort). Only item development had a significant impact, reducing the effect size from $d = 0.43$ to $d = -0.05$ ($\beta = -.43$, $p < .01$), accounting for 20.2% of the variance. Within each level of item development, effect sizes were homogeneous. The four moderator variables accounted for 35.9% of the variance of sex differences in the science area.

For the mathematics field, we computed and aggregated 30 effect sizes. Mean effect size for sex differences in mathematics was 0.34 ($p < .01$, -95% $CI = 0.27$, $+95\%$ $CI = 0.40$). Moderator analysis showed that scoring had a substantial effect on the effect size ($\beta = -.63$, $p < .01$). Inventories with combined-sex norm scores had smaller effect sizes ($d = 0.19$) than inventories with raw scores ($d = 0.44$). Scoring accounted for 41.7% of the variance. Other moderators were not significant. The four moderator variables accounted for 64.1% of the variance of sex differences in mathematics areas.

For the engineering field, we computed and aggregated 45 effect sizes. Mean effect size for sex differences in engineering was 1.11 ($p < .01$, -95% $CI = 1.01$, $+95\%$ $CI = 1.20$). Item development, age, and cohort showed significant moderating effects on the effect size. Item development significantly reduced the effect size from $d = 1.18$ to $d = 0.58$ ($\beta = -.37$, $p < .01$) and accounted for 17.3% of the variance. Effect sizes within each level of item development were homogeneous. Older samples had a smaller effect size than younger samples ($\beta = -.62$, $p < .01$). Over the decades, there was a trend for younger cohort to have smaller sex differences in engineering ($\beta = -.30$, $p < .05$). Age and cohort accounted for 25.1% of the variance. These four moderator variables accounted for 57.4% of the variance in sex differences in engineering areas. In summary, engineering stood out by having a very large effect size and science and mathematics had small effect sizes, all favoring men. Only engineering interests were impacted by sample variables of age and cohort; sex differences in science and mathematics fields were moderated only by inventory variables, not sample variables.

Table 3
Weighted Mean Effect Sizes for Things–People and Data–Ideas Dimensions, RIASEC Types, and Science, Technology, Engineering, and Mathematics (STEM) Interests

Interest	*k*	*d*	*SD*	Lower 95% *CI*	Upper 95% *CI*	Lower 90% *CV*	Upper 90% *CV*	Male–female overlap	Female–male ratio among top 25%
Dimension									
Things–People	79	**0.93**	0.242	**0.87**	**0.99**	**0.52**	**1.33**	46.9%	0.287
Data–Ideas	79	**−0.10**	0.217	**−0.15**	**−0.05**	−0.46	0.27	92.3%	1.134
RIASEC interests									
Realistic	80	**0.84**	0.207	**0.79**	**0.89**	**0.49**	**1.19**	50.9%	0.327
Investigative	79	**0.26**	0.217	**0.20**	**0.31**	−0.11	0.62	81.9%	0.720
Artistic	80	**−0.35**	0.154	**−0.39**	**−0.31**	**−0.61**	**−0.09**	75.0%	1.556
Social	80	**−0.68**	0.236	**−0.74**	**−0.62**	**−1.08**	**−0.28**	58.4%	2.426
Enterprising	79	0.04	0.182	−0.01	0.08	−0.27	0.34	96.9%	0.963
Conventional	80	**−0.33**	0.272	**−0.39**	**−0.26**	−0.78	0.13	76.8%	1.478
Average *d*	80	**0.45**	0.101	**0.43**	**0.48**	**0.28**	**0.62**	69.8%	
STEM interests									
Science	34	**0.36**	0.221	**0.27**	**0.46**	−0.01	0.74	75.0%	0.602
Mathematics	30	**0.34**	0.169	**0.27**	**0.40**	**0.06**	**0.62**	76.2%	0.638
Engineering	45	**1.11**	0.279	**1.01**	**1.20**	**0.64**	**1.57**	40.7%	0.195

Note. k = number of effect sizes; d = inverse variance weighted effect sizes; *CI* = confidence interval; *CV* = credibility value; Male–female overlap represents the overlap of male and female distribution of interests; Female–male ratio among top 25% = percentage of male participants divided by the percentage of female participants among the top 25% in overall population distribution of interests. Significant effect sizes (ds) are presented in boldface. Similarly, confidence intervals (*CI*s) and credibility values (*CV*s) in boldface represent significant values not including 0 within the interval.

Analysis of variance ratios (*VR*s) showed that men had larger variability than women in their interests in the engineering areas (mean $VR = 1.51$, $-95\%\ CI = 1.32$, $+95\%\ CI = 1.74$). For male respondents, intragroup variances were larger than intergroup variances. The mean ratio of intra- versus intergroup differences was 1.35 ($p < .01$). For female respondents, the mean ratio was 1.10 (*ns*). In contrast, men and women had about equal variability in their science interests and their mathematics interests (mean $VR =$ 1.03 for science, *ns*; mean $VR = 1.06$ for mathematics, $p < .05$). In both science and mathematics, intragroup variances were much larger than intergroup variances. The mean ratio of intra- versus intergroup difference was 5.00 for men ($p < .01$) and 4.95 for women ($p < .01$) in science. The mean ratio was 4.91 for men ($p < .01$) and 4.78 for women ($p < .01$) in mathematics. These results showed that intragroup differences were substantially larger than intergroup differences in the STEM fields, both for men and for women, indicating the importance of considering individual differences in vocational interests.

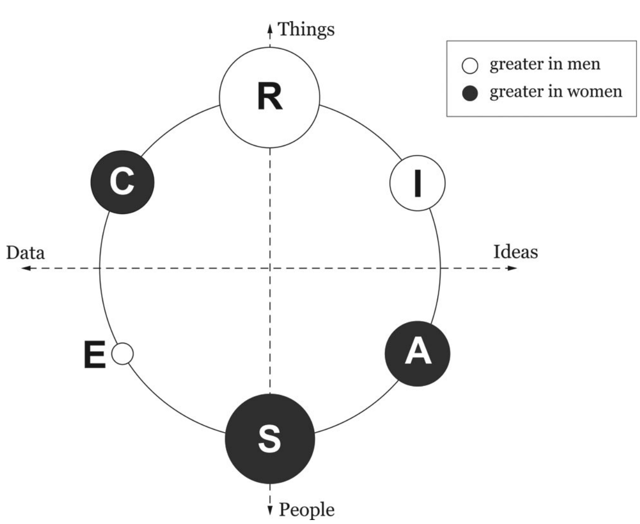

Figure 1. Effect size of RIASEC interests. R = Realistic; I = Investigative; A = Artistic; S = Social; E = Enterprising; C = Conventional.

Discussion

Despite improvement over the past four decades in the number of women pursuing careers in the STEM fields, the continued underrepresentation of women in these fields is an issue of great concern to researchers and policy makers. Sex differences in career preferences are often cited as among the most important underlying reasons for gender disparity in the STEM fields (e.g., Lubinski & Benbow, 1992, 2006, 2007). Researchers and policy makers, however, have little information on the size and pattern of sex differences in interests. The present study provides a systematic review of sex differences in interests that can inform the ongoing debate and can lay the ground for future research on gender disparity in the STEM areas.

Except for a few variables, such as quantitative reasoning and spatial ability (Austin & Hanisch, 1990; Wai, Lubinski, & Benbow, in press), past research on individual differences domains other than interests has generally suggested that sex differences are small (Hyde, 2005; Maccoby, 1990). The present study, however, revealed substantial sex differences in vocational interests. The largest difference between men and women was found along the Things–People dimension, with men gravitated toward things-oriented careers and women gravitated toward people-oriented careers. Men generally showed more Realistic and Investigative interests as well as stronger interests in the STEM areas; in comparison, women tend to have more Artistic, Social, and Conventional interests and to express less interest in the STEM fields.

Table 4
Weighted Mean Effect Sizes for the Work–Task Dimensions and RIASEC Interests for the Latest Edition of an Inventory by Magnitude of Average Effect Size

	Sample size			Dimension		RIASEC type						
Inventory	*N*	Male	Female	Things–People	Data–Ideas	Realistic	Investigative	Artistic	Social	Enterprising	Conventional	Average *d*
COPS-R	400	200	200	0.14	−0.06	0.16	0.04	−0.09	−0.01	−0.09	−0.06	0.08
VII-R	1,562	748	814	0.36	−0.11	0.49	−0.03	−0.11	−0.31	0.04	−0.40	0.23
CAI-E	900	450	450	0.41	0.27	0.49	0.13	−0.49	−0.08	0.25	−0.06	0.25
UNIACT-R	**13,443**	**6,492**	**6,865**	**0.67**	**−0.15**	**0.40**	**0.06**	**−0.20**	**−0.62**	**−0.29**	**−0.17**	**0.29**
O*NET IP	1,123	529	594	0.55	−0.25	0.81	0.24	−0.02	−0.30	0.07	−0.34	0.30
OVIS-II	19,272	9,280	9,992	0.75	0.34	0.68	−0.20	−0.26	−0.52	−0.02	0.21	0.32
JVIS	**3,500**	**1,750**	**1,750**	**0.98**	**−0.06**	**0.62**	**0.28**	**−0.20**	**−0.72**	**−0.09**	**0.06**	**0.33**
KCS	3,619	1,663	1,956	0.78	0.17	0.35	0.33	−0.24	−0.71	0.27	0.11	0.34
KOIS (Form DD)	**3,214**	**1,583**	**1,631**	**0.94**	**0.02**	**0.66**	**0.23**	**−0.19**	**−0.81**	**0.17**	**0.00**	**0.34**
WOWI	169,436	78,564	90,872	0.89	−0.20	0.90	0.19	−0.24	−0.47	−0.15	−0.32	0.38
VPI	732	354	378	0.80	0.50	0.69	0.05	−0.40	−0.52	0.33	0.30	0.38
SII	**2,250**	**1,125**	**1,125**	**1.03**	**0.08**	**1.16**	**0.29**	**−0.26**	**−0.40**	**0.08**	**0.11**	**0.38**
CII–Level 2	60,119	30,003	30,116	0.73	−0.22	0.81	0.03	−0.21	−0.60	−0.08	−0.57	0.38
COPS	17,856	8,944	8,912	0.83	−0.10	0.81	0.18	−0.38	−0.54	0.00	−0.43	0.39
CII–Level 1	32,180	16,201	15,979	0.66	−0.36	0.74	0.05	−0.13	−0.71	−0.07	−0.77	0.41
CDM-R	1,961	979	982	1.17	0.08	1.14	0.00	−0.39	−0.81	−0.06	−0.17	0.43
VRII	1,381	627	754	0.30	−0.78	0.49	0.08	−0.18	−0.53	−0.30	−1.20	0.46
CDM–Spanish	966	420	546	1.04	−0.43	1.20	0.37	−0.10	−0.60	−0.21	−0.36	0.47
CCQ–Form L	1,311	661	650	0.87	−0.16	0.59	0.00	−0.60	−0.78	−0.23	−0.70	0.48
CISS	**5,241**	**3,442**	**1,799**	**0.88**	**0.54**	**0.72**	**0.39**	**−0.85**	**−0.29**	**0.41**	**0.26**	**0.49**
CAI-V	**1,500**	**750**	**750**	**0.83**	**−0.12**	**0.97**	**0.25**	**−0.58**	**−0.46**	**0.07**	**−0.66**	**0.50**
CDI	2,320	1,169	1,151	1.06	−0.48	1.09	0.78	−0.21	−0.47	0.03	−0.42	0.50
KGIS (Form E)	13,007	6,116	6,891	1.16	−0.12	0.89	0.67	−0.38	−0.86	0.31	−0.12	0.54
IDEAS	4,661	2,028	2,633	0.86	−0.22	0.75	−0.08	−0.56	−0.77	−0.26	−0.83	0.54
CCQ–Form S	1,536	797	739	0.73	−0.57	0.52	0.00	−0.60	−0.77	−0.47	−1.14	0.58
ASVAB	1,958	945	1,013	1.58	−0.03	1.07	0.25	−0.55	−1.28	−0.12	−0.26	0.59
SDS-E	717	313	404	1.11	−0.27	1.40	−0.11	−0.31	−0.97	0.01	−0.96	0.63
SDS-R	**6,399**	**2,962**	**3,437**	**1.65**	**0.00**	**1.70**	**0.42**	**−0.60**	**−1.02**	**0.25**	**−0.42**	**0.74**
OASIS-3: IS	1,091	551	540	1.20	−0.59	0.78	0.37	−0.80	−1.14	−0.45	−1.18	0.79
Mean effect size	**373,655**	**179,646**	**193,923**	**0.86**	**−0.12**	**0.78**	**0.19**	**−0.34**	**−0.63**	**−0.03**	**−0.35**	**0.43**
Mean effect size of highly regarded interest inventories	**35,547**	**18,104**	**17,357**	**0.89**	**−0.01**	**0.80**	**0.23**	**−0.30**	**−0.60**	**0.03**	**−0.12**	**0.38**

Note. *d* = inverse variance weighted effect size; COPS-R = Career Occupational Preference System Interest Inventory—Revised; VII-R = Vocational Interest Inventory—Revised; CAI-E = Career Assessment Inventory—Enhanced Version; UNIACT-R = Unisex Edition of ACT Interest Inventory—Revised Edition; O*NET IP = O*NET Interest Profiler; OVIS-II = Ohio Vocational Interest Survey—Second Edition; JVIS = Jackson Vocational Interest Survey; KCS = Kuder Career Search with Person Match; KOIS = Kuder Occupational Interest Survey; WOWI = World of Work Inventory; VPI = Vocational Preference Inventory; SII = Strong Interest Inventory; CII = Career Interest Inventory; COPS = Career Occupational Preference System Interest Inventory; CDM = Harrington-O'Shea Career Decision-Making System (R = Revised Version); VRII = Vocational Research Interest Inventory; CCQ = Chronicle Career Quest; CISS = Campbell Interest and Skill Survey; CAI-V = Career Assessment Inventory—Vocational Version; CDI = Career Decision Inventory; KGIS = Kuder General Interest Survey; IDEAS = Interest Determination, Exploration and Assessment System; ASVAB = Armed Services Vocational Aptitude Battery; SDS-E = Self Directed Search (Form E); SDS-R = Self-Directed Search (Form R); OASIS-3: IS = Occupational Aptitude Survey and Interest Schedule—Third Edition: Interest Schedule. Boldface represents highly regarded interest inventories.

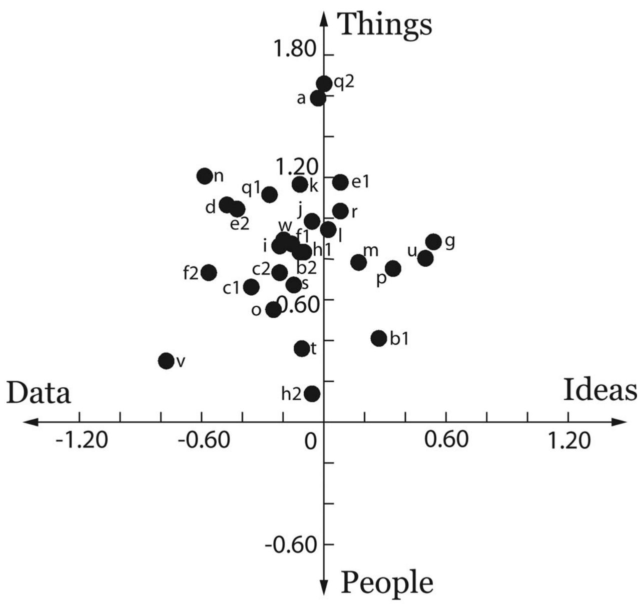

Figure 2. Effect size of interest inventories plotted by Data–Ideas and Things–People dimensions: a = Armed Services Vocational Aptitude Battery; b1 = Career Assessment Inventory—Enhanced Version; b2 = Career Assessment Inventory—Vocational Version; c1 = Career Interest Inventory—Level 1; c2 = Career Interest Inventory—Level 2; d = Career Decision Inventory; e1 = Harrington–O'Shea Career Decision-Making System—Revised; e2 = Harrington–O'Shea Career Decision-Making System—Spanish; f1 = Chronicle Career Quest—Form L; f2 = Chronicle Career Quest—Form S; g = Campbell Interest and Skill Survey; h1 = Career Occupational Preference System Interest Inventory; h2 = Career Occupational Preference System Interest Inventory—Revised; i = Interest Determination, Exploration and Assessment System; j = Jackson Vocational Interest Survey; k = Kuder General Interest Survey; l = Kuder Occupational Interest Survey; m = Kuder Career Search with Person Match; n = Occupational Aptitude Survey and Interest Schedule–Third Edition: Interest Schedule; o = O*NET Interest Profiler; p = Ohio Vocational Interest Survey–II; q1 = Self-Directed Search (Form E); q2 = Self Directed Search (Form R); r = Strong Interest Inventory; s = Unisex Edition of ACT Interest Inventory–Revised; t = Vocational Interest Inventory; u = Vocational Preference Inventory; v = Vocational Research Interest Inventory; w = World of Work Inventory.

Effect sizes from highly regarded interest inventories displayed a very similar pattern to the overall meta-analytic results. The present study also showed considerable variability in the effect sizes of sex differences across inventories. Item development stood out as a crucial moderator. Weaker moderating effects were found for age and cohort for several interest types. These results indicate the important role of interests in gendered occupational choices and gender disparity in the STEM fields and have implications for how future interest measures are developed and used in applied settings.

Sex Differences in RIASEC and STEM Interests

Our study revealed substantial sex differences in vocational interests that parallel the composition of males and females in educational programs and occupations. Men and women differed by almost a full standard deviation in the Things–People dimension. This mean difference of 0.93 indicates that only 46.9% of the male and female distributions of interest on the Things–People dimension overlaps or that up to 82.4% of male respondents have stronger interests in things-oriented careers than an average female. Men have stronger Realistic, Investigative, and STEM interests, and women have stronger Artistic and Social interests that parallel the Things–People sex difference. These differences were large, with the mean effect size of .84 for Realistic interests and 1.11 for engineering interests, equal to a 50.9% and 40.7% overlap of male and female distributions, respectively. The mean effect size for Social interest ($d = -0.68$) was moderate, equal to a 58.4% overlap of distributions. In other words, only 13.3% of female respondents were more interested in engineering than an average man, whereas 74.9% of female respondents showed stronger Social interests than an average man. These findings echo Thorndike's (1911) statement that the greatest differences between men and women are in the relative strength of the interest in working with things (stronger in men) and the interest in working with people (stronger in women).

Vocational interests seem to be an exception to the findings that sex differences are small to nonexistent on most psychological variables (Hyde, 2005). These large sex differences along the Things–People dimension need to be taken into account in understanding men's and women's educational and occupational choices. The effect size found in the present study for the Investigative scale ($d = .26$), as well as for science ($d = .36$) and mathematics ($d = .34$) basic interest scales, were within the small to moderate range according to Cohen's (1988) benchmarks. Theoretically, the small effect size shows that distribution of men's and women's interests in science and mathematics mostly overlap with each other (81.9% for Investigative, 75.0% for science, and 76.2% for mathematics). Although these effects sizes may appear to be less important than the Things–People sex difference, in applied settings an effect size of .30 may have considerable effects on an individual's career decisions.

When individuals make educational or occupational choices, they tend to compare their interest in a certain area both with other people's interest in this area and with their own interests in other areas. Thus, when comparing results across individuals, or from the *inter*-individual comparison perspective, only people in the upper tail of the STEM interest distribution, who have strong interest in this field relative to the larger population, may choose to enter these areas. That is, individuals who have high interest in the STEM fields relative to others are the individuals most likely to consider careers in the STEM fields. It is in the upper tail of the STEM interest distribution where female and male distributions overlap less. Therefore, from the inter-individual perspective, the individuals who pursue STEM careers are more likely to be male than female. For example, assuming that individuals within the highest 25% of a population interest distribution are likely to make occupational choices consistent with an interest type, the number of women entering the engineering occupation, then, is only 19.5% of the number of men entering the field. This percentage is very similar to the actual female–male ratio of individuals employed in engineering. In science and mathematics interest distributions, the female–male ratios in the upper 25% asymptote are 0.60 and 0.64, respectively. However, the actual female–male ratio of individuals employed in the field of physical sciences is only about 0.40 and, in mathematics, it is about 0.45. This dis-

Table 5
Weighted Effect Sizes and Moderator Analysis on Inventory Variables by Interest

Interest/Moderator value	*k*	Mean *d*	*SE*	95% *CI*		Q_W	β	R^2
			Item development					
Things–People dimension							−0.42**	21.84%
1	31	0.99	0.046	0.90	1.08	33.63		
2	10	0.85	0.082	0.69	1.01	14.48		
3	4	0.44	0.130	0.19	0.70	2.10		
Data–Ideas dimension							−0.15	0.01%
1	31	−0.08	0.042	−0.16	0.00	48.14*		
2	10	−0.14	0.074	−0.28	0.01	15.28		
3	4	−0.03	0.117	−0.26	0.19	0.46		
Realistic							−0.46**	26.59%
1	32	0.91	0.033	0.85	0.98	79.77**		
2	10	0.74	0.058	0.62	0.85	8.95		
3	4	0.35	0.093	0.17	0.53	1.93		
Investigative							−0.37*	13.32%
1	31	0.29	0.042	0.21	0.38	38.55		
2	10	0.11	0.074	−0.04	0.25	5.19		
3	4	0.05	0.118	−0.18	0.28	0.54		
Artistic							0.20	0.18%
1	32	−0.35	0.030	−0.41	−0.29	40.59		
2	10	−0.47	0.054	−0.58	−0.36	15.69		
3	4	−0.20	0.086	−0.37	−0.03	0.78		
Social							0.15	5.97%
1	32	−0.67	0.046	−0.76	−0.58	27.96		
2	10	−0.68	0.082	−0.84	−0.52	17.41*		
3	4	−0.36	0.130	−0.61	−0.10	2.73		
Enterprising							−0.47**	13.68%
1	31	0.09	0.035	0.02	0.16	24.99		
2	10	−0.11	0.063	−0.24	0.01	12.70		
3	4	−0.07	0.100	−0.27	0.12	2.49		
Conventional							−0.12	0.20%
1	32	−0.29	0.052	−0.39	−0.19	48.35*		
2	10	−0.52	0.092	−0.70	−0.34	22.21**		
3	4	−0.15	0.147	−0.44	0.14	0.43		
Average RIASEC *d*							−0.32*	12.61%
1	32	0.46	0.020	0.42	0.50	32.74		
2	10	0.47	0.035	0.40	0.54	19.43*		
3	4	0.23	0.056	0.12	0.34	1.74		
Science							−0.43*	20.19%
1	25	0.43	0.056	0.32	0.54	24.78		
2	6	0.29	0.114	0.07	0.52	4.52		
3	3	−0.05	0.165	−0.38	0.27	0.27		
Mathematics							−0.20	6.57%
1	24	0.36	0.035	0.30	0.43	25.34		
2	6	0.24	0.070	0.11	0.38	8.24		
3								
Engineering							−0.37**	17.29%
1	32	1.18	0.055	1.07	1.29	41.91		
2	10	1.01	0.104	0.80	1.21	3.14		
3	3	0.58	0.184	0.21	0.94	2.41		
			Scoring					
Things–People dimension							−0.12	5.59%
1	32	0.96	0.046	0.87	1.05	46.06*		
2	13	0.79	0.071	0.65	0.93	16.41		
Data–Ideas dimension							0.38**	12.33%
1	32	−0.15	0.041	−0.23	−0.07	46.58*		
2	13	0.06	0.064	−0.06	0.19	10.39		
Realistic							−0.19*	8.20%
1	33	0.88	0.034	0.82	0.95	81.61**		
2	13	0.69	0.053	0.59	0.79	24.74*		
Investigative							0.02	1.56%
1	32	0.25	0.043	0.17	0.33	43.22		
2	13	0.18	0.067	0.05	0.31	4.21		

(*table continues*)

Table 5 (*continued*)

Interest/Moderator value	*k*	Mean *d*	*SE*	95% *CI*		Q_W	β	R^2
Artistic							−0.43**	11.35%
1	33	−0.32	0.028	−0.38	−0.27	41.98		
2	13	−0.47	0.043	−0.56	−0.39	23.93*		
Social							0.25	9.02%
1	33	−0.70	0.044	−0.79	−0.61	29.35		
2	13	−0.52	0.070	−0.65	−0.38	21.15*		
Enterprising							0.27	1.21%
1	32	0.01	0.036	−0.06	0.08	33.13		
2	13	0.06	0.055	−0.04	0.17	14.26		
Conventional							0.17	2.78%
1	33	−0.37	0.051	−0.47	−0.27	54.69**		
2	13	−0.23	0.080	−0.39	−0.07	21.06*		
Average RIASEC *d*							−0.08	4.37%
1	33	0.46	0.020	0.42	0.50	45.22		
2	13	0.40	0.030	0.34	0.46	19.44		
Science							−0.11	3.86%
1	20	0.41	0.067	0.28	0.54	25.97		
2	14	0.29	0.080	0.14	0.45	5.99		
Mathematics							−0.63**	41.73%
1	18	0.44	0.034	0.37	0.50	17.47		
2	12	0.19	0.043	0.10	0.27	11.99		
Engineering							−0.24	9.89%
1	31	1.18	0.055	1.07	1.29	47.76*		
2	14	0.94	0.082	0.78	1.10	7.22		
Theoretical framework								
Things–People dimension							−0.25*	4.98%
0	22	0.98	0.054	0.87	1.09	35.27*		
1	23	0.84	0.053	0.74	0.94	29.80		
Data–Ideas dimension							−0.19	6.18%
0	22	−0.02	0.050	−0.11	0.08	18.15		
1	23	−0.15	0.049	−0.25	−0.06	41.66**		
Realistic							−0.46**	17.08%
0	22	0.96	0.047	0.87	1.05	47.83**		
1	24	0.70	0.045	0.62	0.79	26.92		
Investigative							0.02	0.09%
0	22	0.22	0.052	0.12	0.32	6.91		
1	23	0.24	0.050	0.14	0.34	41.65**		
Artistic							−0.08	0.05%
0	22	−0.36	0.035	−0.43	−0.29	27.41		
1	24	−0.37	0.033	−0.43	−0.30	43.55**		
Social							0.02	0.07%
0	22	−0.64	0.054	−0.75	−0.53	30.41		
1	24	−0.65	0.052	−0.76	−0.55	25.13		
Enterprising							−0.12	2.17%
0	22	0.06	0.043	−0.02	0.14	13.77		
1	23	0.00	0.042	−0.08	0.08	32.68		
Conventional							−0.25*	7.29%
0	22	−0.22	0.061	−0.34	−0.10	19.11		
1	24	−0.43	0.059	−0.54	−0.31	55.21**		
Average RIASEC *d*							0.01	0.20%
0	22	0.43	0.025	0.39	0.48	27.14		
1	24	0.45	0.023	0.40	0.49	38.01*		

Note. k = number of effect sizes; d = weighted mean effect sizes; *SE* = standard error; *CI* = confidence interval; Q_W = within-category residual variability statistic; β = standardized regression coefficient, controlled for the other inventory variables; R^2 = percentage of variance accounted for. In the coding for item development, 1 represents an overlap of male and female scores of less than 75% or cases in which more than 33% of the items have response differences larger than 15%; 2 represents an overlap of male and female scores from 75% to 85% or 10% to 33% of the items have response differences larger than 15%; 3 represents an overlap of male and female scores larger than 85% or in which no more than 10% of the items have response differences larger than 15%. For scoring, 1 = raw score and 2 = combined-sex norm. Theoretical framework was coded as 0 = RIASEC model; 1 = other interest models.

* $p < .05$. ** $p < .01$.

Table 6
Moderator Analysis on Sample Variables by Interest

Interest	k	Q_W	β_{AGE}	R^2_{AGE}	β_{COHORT}	R^2_{COHORT}	R^2_{TOTAL}
Things–People dimension	67	88.51*	−0.24*	3.44%	−0.12	0.00%	4.31%
Data–Ideas dimension	67	108.00**	−0.03	5.40%	−0.50**	24.00%	24.14%
Realistic	68	131.45**	−0.10	0.02%	−0.16	1.37%	2.00%
Investigative	67	75.51	0.12	1.20%	0.01	0.33%	1.34%
Artistic	68	111.26**	0.20	0.41%	0.58**	22.70%	25.65%
Social	68	61.38	0.45**	23.81%	−0.06	8.45%	23.81%
Enterprising	67	105.45**	−0.02	6.86%	−0.54**	27.95%	28.12%
Conventional	68	99.93**	0.12	5.49%	−0.20	6.79%	7.94%
Average RIASEC *d*	68	94.75**	−0.36**	5.00%	−0.29*	1.14%	10.85%
Science	29	37.12	−0.34	5.67%	−0.17	0.07%	7.67%
Mathematics	27	29.48	−0.12	3.38%	0.11	3.23%	4.13%
Engineering	39	67.54**	−0.62**	19.26%	−0.30*	0.45%	25.11%

Note. k = number of effect sizes; Q_W = residual variability statistic; β_{AGE} = standardized regression coefficient for age, controlled for cohort; β_{COHORT} = standardized regression coefficient for cohort, controlled for age; R^2_{AGE} = percentage of variance accounted for by age alone; R^2_{COHORT} = percentage of variance accounted for by cohort alone; R^2_{TOTAL} = percentage of variance accounted for by age and cohort.
* $p < .05$. ** $p < .01$.

crepancy between interest data and real employment composition indicates that there may be reasons other than sex differences in interests that can account for gender disparity in science and mathematics.

In addition to the inter-individual perspective, interest scores for different types of careers can also be examined within an individual to determine the career area with the highest interest. From this *intra*-individual comparison perspective, it is expected that individuals will choose the field in which they have the strongest interest, creating the possibility that individuals with high levels of STEM interests may still pursue careers in other fields because they have even greater interests in other areas. These intra-individual differences in interests may also contribute to gender disparity in the STEM fields, because the STEM areas are often perceived as a better match for individuals with things-oriented interests, and our results suggest that women are more likely than men to prefer working with people over working with things, and men are more likely than women to prefer working with things over working with people. Therefore, although an individual female may have high levels of STEM interests, she may still leave STEM areas because she has stronger interests in other people-oriented areas.

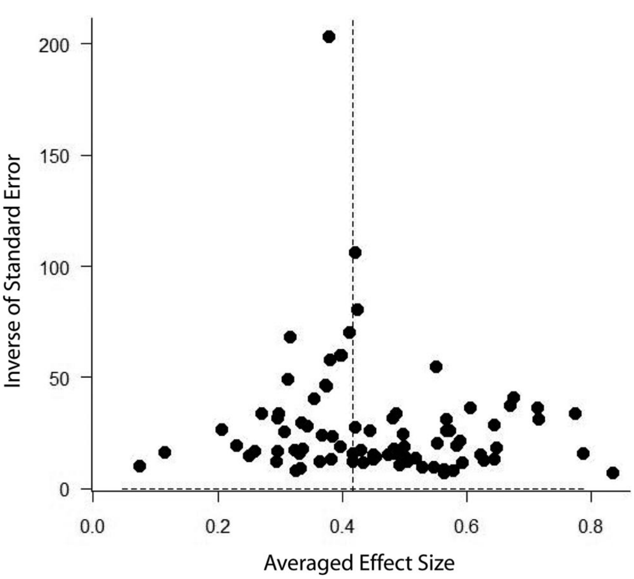

Figure 3. Funnel plot from trim-and-fill analysis.

The hypothesis that intra-individual effects may be a factor contributing to women leaving scientific fields is somewhat supported by previous research. For example, in their 3-year interview study, Seymour and Hewitt (1997) found that perceptions that non-STEM academic majors offered better education options and better matched their interests was the most common (46%) reason provided by female students for switching majors from STEM areas to non-STEM areas. The second most frequently cited reason given for switching to non-STEM areas was a reported loss of interest in the women's chosen STEM majors. Additionally, 38% of female students who remained in STEM majors expressed concerns that there were other academic areas that might be a better fit for their interests. Preston's (2004) survey of 1,688 individuals who had left sciences also showed that 30% of the women endorsed "other fields more interesting" as their reason for leaving. On the basis of findings from previous research and the present study, we suggest that interest may be a key factor in understanding individuals' occupational choices as well as the gender disparity in the STEM fields.

Issues of Construct Validity

Our study showed that the application of some item development strategies can substantially reduce sex differences in vocational interests. This result is not surprising, given that the most frequently used procedure for reducing gender disparity was based on analyzing male and female item response rates and removing items with large sex differences. However, not all RIASEC interests were impacted in the same way by using this approach. Obtained results showed that item development moderated only the effect sizes of Realistic, Investigative, and Enterprising interests and the basic interests of engineering and science, indicating that efforts to reduce sex differences in vocational interest inventories have been made primarily with scales traditionally favoring male respondents. In comparison, the reduction of sex differences has been minimal for the Artistic, Social, and Conventional interests. The implications of using these criteria to develop more sex-balanced interest measures are double-edged. Implementing sex-balanced techniques was found to be effective in reducing sex differences observed in vocational interest measures. Interest inventories applying these techniques with the resulting report of scale scores encourage women to explore opportunities in nontraditional fields such as engineering and science. Conversely, eliminating items with large differences in response rates between men and women might result in changes in the construct that an inventory is intended to measure.

Inventory authors have taken different perspectives regarding eliminating items that show sex differences. For example, in the development of the Career Occupational Preference System Interest Inventory—Revised Edition, R. R. Knapp and Knapp (1979) removed all items with a response difference larger than 15%. This strategy led to an effect size of .15 for Realistic interests (averaged from Technology–Professional, Technology–Skilled, and Outdoor scale scores). In contrast, about one third of the items in the Strong Interest Inventory had response differences of 16% or larger, yet these items were retained through revisions (see Hansen & Campbell, 1985; Harmon et al., 1994). As a result, the Strong Interest Inventory (Campbell, 1974; Donnay et al., 2005; Hansen & Campbell, 1985; Harmon et al., 1994) has an average effect size of .75 for Realistic interests, and the most recent edition of the measure (Donnay et al., 2005) has an effect size of 1.16 on the Realistic scale. Such a large discrepancy between inventories is of concern: If an inventory shows a trivial sex difference for Realistic interest, is it still measuring the Realistic construct? Do the inventory results necessarily reflect individuals' expressed interests? Should inventory respondents be informed that their interest scores could vary depending on which inventory they take? Do individuals have the right to know how their suggested career options may be influenced by different strategies in item development? Researchers and interest inventory authors need to be aware of these important issues of construct validity when using sex-balanced techniques in item development.

Because inventory authors have taken different perspectives on test validation and have used different strategies for item development, the constructs measured by scales with the same name from different inventories may not converge, and individuals' interest scores from different inventories may vary. Several studies have provided evidence for unsatisfactory agreement among interest inventories (e.g., Russell, 2007; Savickas, Taber, & Spokane, 2002). For example, Russell (2007) showed that the hit rate in the cross-classification of Holland RIASEC codes between the Self-Directed Search (Holland et al., 1994) and the UNIACT-R (American College Testing Program, 1995) is only 50.16%. That means that if an individual takes the Self-Directed Search and the UNIACT-R, his or her chance of being identified as two different Holland interest types is almost as large as that of being assigned the same type, and he or she is very likely to receive different suggestions for occupational options. As noted previously, the Self-Directed Search and the UNIACT were developed on the basis of two different approaches to test validation (G. D. Gottfredson & Holland, 1978; Prediger & Cole, 1975). It appears that the attempt to remove sex differences from interest scores in the UNIACT-R has resulted in scales that do not mirror the original RIASEC constructs but instead measure a narrower range of interests than the construct domains because of the removal of items with large sex differences.

It is important that information about the construct validity of an inventory and the procedure, justification, and potential impact of the test validation approach used by an inventory be available to test takers. Individuals can then use such information to make choices about interest inventories and to assist in interpreting their own interest scores. The *Standards for Educational and Psychological Testing* (American Educational Research Association et al., 1999) has recommended that test developers clearly describe and justify the construct the test is intended to measure and document the extent to which the content domain of a test represents the defined construct. With regard to the relationship between validity and test consequences (e.g., sex differences and other subgroup differences), the standards state the importance of distinguishing between issues of validity and issues of social policy and clarify that unequal outcomes at the group level do not necessarily have direct bearing on questions of test fairness; however, the standards also recommend using a testing alternative that minimizes outcomes differences across relevant subgroups with "other things being equal."

Multidimensionality of RIASEC Interests

The present study showed that inventories using interest models different from Holland's RIASEC model had smaller sex differences in Realistic interests. The primary difference between other interest frameworks and the RIASEC model is the number of interest categories. Interest frameworks other than the RIASEC model include multiple interest categories or basic interest scales that can be indirectly mapped onto the RIASEC types. The content of these interest categories is usually fairly homogeneous compared with the broad RIASEC types. For example, the Kuder Occupational Interest Survey (F. Kuder & Zytowski, 1991) Vocational Interest Estimation contains two scales that were classified into the Realistic type: Outdoor and Mechanical. For the Mechanical scale, the effect size was 1.14; the Outdoor Scale, however, had a much smaller effect size of 0.18. When averaged, it produced a smaller effect size than that typically found in inventories using the RIASEC model because mechanical and technical items are usually more heavily weighted than outdoor items in Realistic scales. The range of constructs covered by multiple interest categories that are classified into a single RIASEC scale could be understood as narrower facets within a broad interest type.

The concept of facet has been widely adopted in personality psychology to refer to subdomains of the Big Five personality traits. Studies have shown that, compared with broad personality factors, personality facets are more useful for understanding subgroup differences and for predicting certain behaviors (e.g., Connor-Smith & Flachsbart, 2007; Foldes, Duehr, & Ones, 2008; Kamp & Hough, 1986; Mount & Barrick, 1995). Similar to the broad personality factors in the five-factor model, Holland's (1997) RIASEC interest types are multidimensional (e.g., Einarsdóttir & Rounds, 2009; Fouad & Walker, 2005). Each RIASEC type is likely to include several facets that cover different parts of the whole content domain, and these facets can reveal substantial group differences that are not visible at the scale level (Fouad &

Walker, 2005). Therefore, examining sex differences at the facet level may clarify the extent to which men and women differ in interests. For example, outdoor and mechanic are two facets of Realistic interests that are different in nature and show very different effect sizes. Examining sex differences at the facet level revealed the extreme difference in mechanic that is covered up when combined with the outdoor items. This facet perspective provides a further explanation for the moderating effect of item development. When items with large response differences are deleted from interest inventories to reduce sex difference, they are more likely to be mechanic items than outdoor items. This strategy could lead to a much smaller effect size for the Realistic scale. However, if most of the Mechanic items are taken out, the remaining items actually measure the outdoor facet instead of the full range of interests in the Realistic type that encompasses both facets.

From another perspective, examining interests at the facet level can provide finer differentiation of the interest profile of an individual or a group, a practice suggested for interpreting the Strong Interest Inventory (Donnay et al., 2005). For example, when a woman receives a relatively low score on the Realistic scale, it does not mean that she does not have any of the Realistic interests. It is possible that she is highly interested in outdoor activities and occupations. A closer look at the facets of Realistic interests could help more accurately identify her vocational interests and reveal a broader range of options for career exploration. Therefore, additional research is needed at the facet level of interests to examine the potential utility of these measures for identifying career choices while reducing the impact of sex differences observed with broad RIASEC measures of interest.

Although theoretical framework of the interest measure was not a significant moderator for the Investigative type, it is worth noting that the effect size for Investigative interests was significantly smaller than that for Science and Mathematics. This result implies that the Investigative type also encompasses diverse facets, including some facets with greater sex differences favoring men, such as physical sciences and mathematics, as well as others with smaller sex differences or sex differences favoring women, such as biological/medical sciences and social sciences. Given women's preference for people-oriented careers over things-oriented careers, women who pursue scientific careers tend to gravitate toward fields that allow for more opportunities to work with people, such as the biological and medical sciences, psychology, and other social sciences (Lubinski & Benbow, 2007). Therefore, the effect size for the Investigative type could favor men or women depending on how the items are weighted. For example, the Vocational Interest Inventory (Lunneborg, 1981) has an effect size of $-.17$ for the Science scale, with women scoring higher. The negative effect size is not surprising given that many physical sciences items were replaced by social, medical, and biological sciences items in an effort to reduce gender disparity when constructing the instrument.

The present study examined only the facets of Realistic and Investigative interests that are related to the STEM fields. Interest types other than Realistic and Investigative could be multidimensional as well. For example, G. F. Kuder (1977) believed that Literacy and Musical interests are different from the Artistic interests and include all three scales in the Kuder Occupational Interest Survey (F. Kuder & Zytowski, 1991) instead of a general Artistic theme. These three areas could be facets of Artistic interests. Future research on the multidimensionality of interests and sex differences at the facet level will greatly advance understanding of vocational interests and will increase the accuracy of test interpretation and career guidance for individuals.

Age Cohort Change in Sex Differences

Interest is shaped by environmental factors such as family, the school, and other aspects of the culture (Eccles, 1993). For example, Helwig (1998) showed that children's choices of occupations are influenced by parents' expectations and societal values. Bandura, Barbaranelli, Caprara, and Pastorelli (2001) showed that by controlling the type of activities to which their children are exposed, parents shape children's interests. Educational opportunities for female students also increase their nontraditional vocational interests (Betz & Schifano, 2000). Nevertheless, previous research has revealed that interests are fairly stable (Campbell, 1971; Hansen, 1984; Swanson, 1999; Tracey & Sodano, 2008). Several longitudinal studies showed that interests have significant covariation over Grades 8 through 12 and tend to crystallize over time (e.g., Tracey & Robbins, 2005; Tracey, Robbins, & Hofsess, 2005). This pattern was found to be similar across all ethnic groups and for males and females. Recently, Low, Yoon, Roberts, and Rounds (2005) conducted a meta-analysis examining the stability of interests from early adolescence to middle adulthood. These authors found that vocational interests remained reasonably stable from age 12 to age 40 for both males and females ($\rho = .55–.83$). The stability of interests had a major increase by the end of high school and peaked in college years, earlier than was previously believed to occur. Low et al. (2005) also showed that interests are more stable than personality traits. These results suggest that it is important to attend to both change and stability of interests.

The present study, covering interest inventories from the 1960s to the present and generations born in the 1930s to the 1980s, again showed consistency of sex differences in interests, with a few interest types being subject to the influence of age. The age effect was generally small. The only noteworthy impact of age on vocational interests was that for older samples, sex differences were smaller for Social interests and engineering interests, which contributes overall to a smaller sex difference in the Things–People dimension, although the general tendency of men to prefer working with things and women to favor working with people never becomes trivial in the older samples. Readers need to be cautious when interpreting the results of these changes in interests because they are cross-sectional. However, because we conducted moderator analysis on age with cohort effect controlled for, we have eliminated the alternative explanation that these changes happened because of sociocultural shift and, thus, we can have more confidence that these changes can be attributed to age differences.

With regard to cohort effect for interests, past research has demonstrated considerable stability of interests over time. For example, Hansen (1988) examined the Strong Vocational Interest Blank scores for general samples of women and men from the 1930s to the 1980s and illustrated tenacious stability of occupational interests for both women and men and "resilience" of sex differences over time. Using cohort as a moderator, the present study again showed that interests generally have been very stable over the past four decades. Three exceptions were notable: Younger cohorts had smaller sex differences in Artistic interests and engineering interests, and effect sizes of sex differences in Enterprising interests actually changed from positive (stronger in men) to nonsignificant over time. Betz and Fitzgerald (1987) identified a typically found sex difference favoring men for Enterprising scales. Developing meta-analytic evidence appears to no longer support this observation. The decrease of sex differences in Enterprising interests over time may be explained by the concomitant people element of Enterprising interests with the significant increase in women's opportunities in Enterprising occupations. Twenge's (2001) cross-temporal meta-analysis has shown that women's assertiveness or dominance, a personality trait that is closely related to Enterprising interests, has been increasing steadily since the late 1960s and is predicted by social statistics, such as women's educational attainment, labor-force participation, and median age at first marriage. These results from past studies and the present study indicate that the changes in working environment and women's status and roles may have helped the expression of women's Enterprising interests. In comparison, Realistic and Investigative interests (including more specific STEM interests in science and mathematics) were relatively stable to age and cohort and were not affected by these sample variables.

Practical and Policy Implications

Findings from the present study on sex differences of interests not only constitute important knowledge in their own right but also hold implications for assessment policy and practice. Because RIASEC interests are multidimensional, it is important for inventory developers to select items proportionally from all facets of one interest type to reflect the breadth of the defined construct domain. Attention to social consequences of interest assessment and the application of technologies to remove sex differences from interest inventory should be considered under the overarching issue of construct validity (Messick, 1989).

As suggested by previous literature and the present study, interests stabilize at an early age. Given the essential role of family and other environmental influences in the socialization process of children and their interest development, it may be important for parents, educators, and counselors to be involved early on, when interests seem more malleable. Efforts to increase girls' interests in the STEM fields to bridge the gender gap may also need to be initiated at formative years when children are developing gender roles and perceptions of appropriate careers.

The sex difference information provided for inventories that are currently in print can be used to guide selection of inventories. Practitioners and administrators who wish to choose interest inventories showing small sex differences or who wish to encourage female students to explore nontraditional areas, including the STEM fields may, consider inventories such as the Career Assessment Inventory—Enhanced Version (Johansson, 2003) and the UNIACT-R (American College Testing Program, 1995). The present study also suggests that caution needs to be exercised in interpretation of inventory results: Both sex differences in vocational interests and individual differences within the same sex should be taken into consideration to assist individuals in making the most suitable career decisions.

Limitations and Future Directions

In the present study, we examined the magnitude and pattern of sex differences in vocational interests. It is important to note that group differences do not speak for every individual within a group, and it is not the purpose of the present study to reify the stereotypes that men and women are interested in their "traditional" areas. The present study provided evidence that intragroup differences were substantially larger than intergroup differences.

Although it is beyond the scope of the present study to provide a detailed exploration of the environmental, social, and biological factors that have contributed to the development of these sex differences, the findings presented here highlight the importance of understanding how sex differences in interests develop. Interested readers are referred to reviews such as those by Watt and Eccles (2008), Ceci and Williams (2007), and Ceci et al. (2009) for a discussion on the biological, psychological, and social processes and gendered vocational interests or career choices. It is crucial for researchers, practitioners, and policy makers to better understand the course of vocational interest development and the factors contributing to individual differences in interests within the same sex. Why do some women become more interested in the STEM fields than others? Which stage in the developmental process is critical for the development of science and engineering interests? What factors may thwart or promote the development of science and engineering interests? To the extent that future research can answer these questions, it becomes possible to provide appropriate intervention for increasing girls' interest in the STEM areas or attracting women to work in the STEM fields.

Another limitation of the present study is that we did not examine possible variation in the sex differences between different racial/ethnic groups. Few interest inventories report results separately for racial/ethnic groups by sex. Available information about any specific racial/ethnic group was too limited to warrant a moderator analysis. Future research conducted with samples from specific racial/ethnic groups and other cultures can further contribute to the scientific knowledge about sex differences in interests and may promote understanding about how these sex differences are developed from a cultural perspective.

Additionally, because of the nature of the available database, the cell sizes for our moderator analysis on item development were unequal. Many more inventories that have undergone minimal or slight item selection and revision were included than inventories that have had major item revisions to reduce sex differences. Unequal cell sizes may render the significance testing results from moderator analysis on item development nonrobust. When reading the results, readers should note this fact and attend to the actual magnitude of effect sizes and their trend of change.

Although we have identified a number of important moderators in the assessment process that influence the magnitude of sex differences, in future studies, researchers may also wish to consider additional moderators for sex differences in vocational interests. Although moderators in the present study accounted for a fair amount of variance in the effect sizes, there was still nontrivial variance left unexplained. In particular, the two sample variables, age and cohort, explained only a limited proportion of the variance. Given the large individual differences within the same sex, it is important to examine other variables (e.g., education, gender role identity) that influence the development and level of interests.

Summary and Conclusions

The present study makes several important contributions to the literature. First, it is the first comprehensive meta-analysis on sex differences in vocational interests. We synthesized evidence from interest inventories over four decades and found large sex differences in vocational interests, with men preferring working with things and women preferring working with people. These sex differences are remarkably consistent across age and over time, providing an exception to the generalization that only small sex differences exist. Second, this study provides a systematic review of the sex differences in the STEM interests that has not previously appeared in the literature. The pattern of sex differences in the STEM interests revealed by the present study closely resembles the composition of men and women in corresponding occupations and contributes to the understanding of the gender disparity in the STEM fields. The results suggest that the relatively low numbers of women in some fields of science and engineering may result from women's preference for people-oriented careers over things-oriented careers.

Finally, we found that effect size of sex differences varied widely among interest inventories. The sex differences were found to be moderated by the item development process, suggesting that interest inventories can be designed either to reduce or to magnify the estimates of the magnitude of these sex differences in interests. Educators and counselors need to be aware of which inventories produce the largest and smallest differences, given the crucial role of vocational interests in people's career development and the wide use of interest inventories in helping people identify their interests and choose their careers. Educators and counselors also need to be careful in choosing assessment tools and in interpreting the results of such measures so as not to restrict the occupational choice of individuals—for both men and women.

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