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# Vocational Interests: The Road Less Traveled

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Beginning with E. K. Strong's introduction of the Strong Vocational Interest Bank in the 1920s, the study of vocational interests has been driven by practical measurement concerns (Dawis, 1991). In fact, much of what we know about vocational interests can be found in books and manuals written by the Big Three developers and promoters (E. K. Strong, F. Kuder, and J. L. Holland) of interest inventories (Borgen, 1986). The narrowness of the literature is compounded by the fact that these authors centered their writings on their own vocational interest inventories, and did not consider the larger domain of interest measures. For the Strong Interest Inventory, we have Strong's (1943) book on the *Interests of men and women*, Campbell's (1971) *Handbook for the strong vocational interest blank*, and the Strong Interest Inventory technical manual by Harmon, Hansen, Borgen, and Hammer (1994). For the Kuder General Interest Survey (Kuder, & Zytowski, 1988) and the Kuder Occupational Interest Survey (Kuder, & Zytowski, 1991), we have Kuder's (1977) *Activity interests and occupation choice*. The last of the Big Three—Holland (1997), *Making vocational choices: A theory of vocational personalities and work environments*, summarizes research on the Vocational Preference Inventory (Holland, 1985) and on the self-directed search (SDS; Holland, Fritzsche, & Powell, 1997). Within this almost exclusive focus on commercial interest inventories and their validities, a large body of literature has been established that is tied to predicting educational and vocational choice and occupational membership. This validity research, however, came at the expense of the development of interest theory and of the study of how vocational interests can contribute to the understanding of individual differences.

Savickas and Spokane (1999) attempted to remedy the narrow focus of interest scholarship on commercial measures through an edited book on interests. However, with a few exceptions, the edited chapters were on interest measurement and on the

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application of interest inventories in counseling practice. The present chapter breaks with this practical, psychometric tradition in two ways—we discuss research that is not inventory centered, and we highlight recent interest research that links interests to the broader domain of individual differences and psychology in general.

Interest literature since the 1970s has primarily used Holland's RIASEC model to organize research results. Therefore, the present chapter begins with a review of Holland's (1997) structural formulations of interests. Next, we discuss gender differences in interests. In particular, Hyde and her colleagues (Hyde, 2005; Hyde & Linn, 2006) have argued, on the basis of an impressive array of meta-analyses, that gender differences in psychology are small or non-existent. We discuss how gender differences in interests are an exception to Hyde's conclusion, supporting Lubinski's (2000) assertion that interests show the "largest sex differences on major psychological dimensions" (p. 421). We then discuss continuity and change of interests across the life span. The assumption that interests are stable dispositional attributes is central to all considerations of the construct, especially in its primary motivational purpose of directing the fit between people and their environments. Recently, researchers have begun to propose that interests can form the structure for integrated models of individual differences. We provide a rationale and a theoretical underpinning for the development of integrated models of individual differences. Finally, beginning with Ackerman and Heggestad (1997), we review recent research on building models that integrate cognitive and non-cognitive individual differences measures.

## Holland's Structural Formulations

Holland's (1959, 1997) theory of vocational personalities and work environments is premised on a match between individuals and environments. Central to Holland's (1997) theory is the assumption is that most individuals and environments can be categorized into one of six types: realistic (R), investigative (I), artistic (A), social (S), enterprising (E), and conventional (C), collectively referred to as RIASEC. In Holland's model, the person and the environment are described in commensurate ways. The link between the individual's personality and the environmental context is direct: for example, the individual's personality is manifested as preferences for work activities, and work environments are described in terms of the people who work in them and the activities they perform. Thus, it becomes possible to assess the environment in the same terms in which individuals are assessed. A simple way to do this is to describe the environment in terms of the percentage of the different RIASEC types. Holland's model, therefore, allows people and environments to be mapped in the same interest space. Both persons and educational–occupational settings have been described by using RIASEC codes. Typically, people and environments are described with three-letter codes, the first letter-code being most descriptive. For example, fish farmers are characterized as REI and comedians are characterized as AES. For the individual, the six types consist of clusters of personality and behavioral repertories and are defined by vocational and avocational preferences, personality traits, life goals and values, self-beliefs, problem solving styles, and competencies.

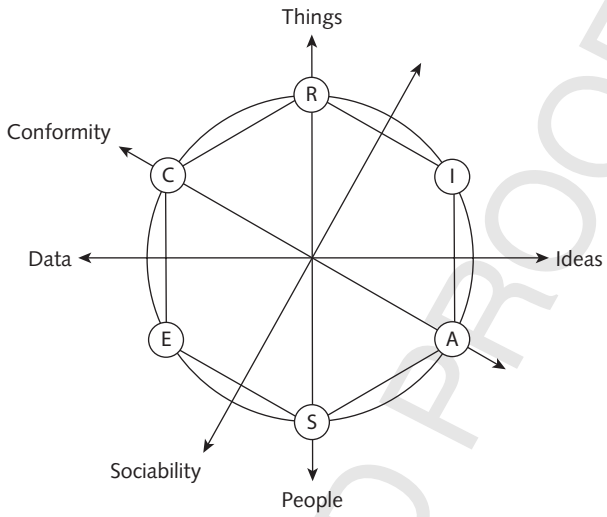


**Figure 23.1** Prediger's (1982) data–ideas and people–things dimensions and Hogan's (1983) sociability and conformity dimensions embedded in Holland's RIASEC model. Key: R = realistic, I = investigative, A = artistic, S = social, E = enterprising, C = conventional

Holland's structural hypothesis is the cornerstone of the way in which the types are interrelated. As shown in Figure 23.1, the personality types and environments are related to each other in a circular fashion (Holland calls his model a hexagon). As in circumplex models in personality—such as Wiggins's (1982) interpersonal circle or, more recently, Schwartz's (Schwartz & Bilsky, 1987) value circumplex—the spatial proximity between types reflects the closeness of their conceptual relationships. Because of the circular nature of Holland's R–I–A–S–E–C model, it is expected that the relations decrease as the types move further away from each other. In other words, it is expected the relation between adjacent types, for example, the realistic type and the investigative type, to be larger than the relation between the alternate types realistic and artistic, which would be larger than the relation between the opposite types realistic and social. Similarly, since the types theoretically comprise a circular structure, one would expect that the relation between the realistic type and the conventional type (adjacent types) would be similar to the relation between the realistic and the investigative type.

Also illustrated in Figure 23.1 are the dimensional interpretations of the RIASEC circumplex proposed by Prediger (1982) and by Hogan (1983). Prediger (1982) proposed that two bipolar work-task dimensions underlie the interrelations among the six Holland types: working with things versus people and working with data versus ideas. Prediger's structural hypothesis uses two factors rather than a circumplex arrangement of types to account for why the responses to the RIASEC interests organize themselves as Holland hypothesized. In comparison, Hogan (1983) proposed that two personality-based dimensions, sociability and conformity, underlie the interrelations among the six Holland types.

## Gender Differences in Interests

The discussion of gender differences in vocational interests traditionally subsumes the study of interest measurement on the basis of Holland's RIASEC structure. Validation research of the Holland model has in general supported the circular order of RIASEC interest types for both males and females and the invariance of interest structure across gender. Anderson, Tracey, and Rounds (1997), for example, found the fit of the RIASEC data to be similar for both males and females who completed the Strong Interest Inventory. Day, Rounds, and Swaney (1998) examined the fit of Holland's model with large representative samples of students who completed the ACT Interest Inventory (UNIACT: ACT, 1995), and they found a good fit for the model with both male and female samples representing different U.S. racial–ethnic groups. (It should be noted that racial–ethnic differences in model–data fit appear when circular unidimensional scaling, a more rigorous method to evaluate circumplex models, is applied to RIASEC matrices: Armstrong, Hubert, & Rounds, 2003). Darcy and Tracey (2007), using a variety of analytic methods such as structural equation modeling (SEM), randomization tests, multidimensional scaling, and circular unidimensional scaling, also demonstrated relatively few differences in the circumplex structure of the UNIACT RIASEC scores across gender and age (from Grades 8 through 12), despite some variation across methods.

In contrast to the similarity of interest structure across gender, the existence of mean level gender differences for interest items and for RIASEC interest scales is widely acknowledged among vocational psychologists (e.g. Betz & Fitzgerald, 1987; Hackett & Lonborg, 1993). It is believed that women are more likely than men to report interest in social and artistic activities, whereas men are more likely than women to report interest in scientific, technical, and mechanical activities (Betz & Fitzgerald, 1987). However, only recently have researchers begun to systematically review the magnitude and pattern of gender differences in RIASEC interests. Su, Rounds, & Armstrong (2009) conducted a meta-analysis using technical manuals of historical and current inventories of interests and found substantial gender differences in vocational interests. Their results from 503,188 respondents showed that men tend to prefer careers involving working with things and women tend to prefer people-oriented careers, producing a large effect size ($d = 0.93$) on the things–people interest dimension. This mean difference of 0.93 indicates that only 46.9 percent of the male and female distributions of interest on the things–people dimension overlaps, or that up to 82.4 percent of men have stronger interests in things-oriented careers than an average woman. More specifically, 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 (see Figure 23.2 for an illustration of gender differences in interests by RIASEC types). Gender differences favoring men were also found for measures of interests in engineering ($d = 1.11$), science ($d = 0.36$), and mathematics ($d = 0.34$). In other words, 74.9 percent of female respondents showed stronger social interests than an average male, whereas only 13.3 percent of women were more interested in engineering than an average man. Such large gender differences have rarely been found on major

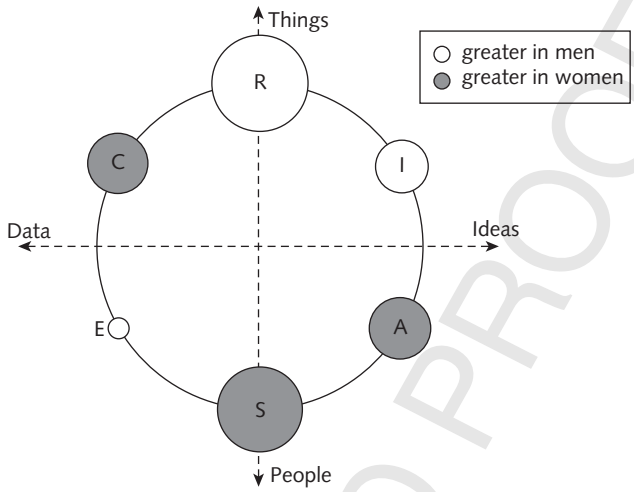


**Figure 23.2** Effect sizes of gender differences in RIASEC interests. Adapted with permission from Su et al., 2009, p. 871. Key: R = realistic, I = investigative, A = artistic, S = social, E = enterprising, C = conventional

psychological dimensions (Lubinski, 2000). After reviewing 124 effect sizes from 46 meta-analyses of gender differences including measures of cognitive abilities, communication, social and personality variables, psychological well-being, motor behaviors, and a miscellaneous category that included moral behavior and job performance, Hyde (2005) concluded that gender differences in most individual differences domains are small to non-existent. Evidence from Su and colleagues' meta-analysis suggested that vocational interests are one of the exceptions to the gender similarity hypothesis, and that they are worth further attention from individual differences researchers.

It is crucial to view these gender differences in vocational interests in the broader context of career choices. Under-representation of women in certain occupational areas, particularly the STEM (science, technology, engineering, and mathematics) fields, has received intensive attention and has generated heated controversy regarding its causation (e.g. Ceci & Williams, 2007; Gallagher & Kaufman, 2005; Watt & Eccles, 2008). Despite the increasing number of women obtaining graduate degrees across a wide arrange of scientific disciplines over the past five decades, women remain a minority in fields like engineering and the physical sciences, and a disproportionally high number of women were found to switch out of math and science careers as they advanced (Preston, 2004). Research has generally found little gender differences in mathematical abilities and standardized test performance (e.g. Else-Quest, Hyde, & Linn, 2010; Hyde & Linn, 2006; Spekle, 2005). Some studies supported the effect of differential life values on men's and women's work preferences (e.g. Ferriman, Lubinski, & Benbow, 2009; Lubinski & Benbow, 2007). Eccles and colleagues (Eccles, 1994; Parsons, Adler, & Meece, 1984) proposed the expectancy-value model, which explains how the subjective task value associated with different work

activities influences people's educational and occupational choices. Specifically, people-oriented careers are associated with higher subjective task value on the part of women, as these careers offer more opportunities of helping people and thus are preferred over things-oriented careers such as physical sciences and engineering. Vocational interests have been found to predict current occupation and future career aspirations very effectively (e.g. Donnay & Borgen, 1996; Hansen & Campbell, 1985), but interests have yet to receive the attention they deserve in the STEM gender debate. The gender differences in science, mathematics, and engineering interests were found to parallel the composition of men and women in corresponding educational programs and occupations (Su et al., 2009), suggesting the necessity for examining the role of vocational interests in occupational gender disparity.

The existence of large differences in interest scores between men and women unavoidably brings up the issue of the interpretation of these differences and of the consequential validity of interest measures (Messick, 1989). In particular, do these gender differences reflect sex-restrictiveness of interest inventories, and how does the development of sex-balanced interest inventories impact the validity of the measures? Traditionally, two opposing approaches have been taken to examining the validity of an interest inventory: an "opportunity approach to validation" (e.g. Prediger & Cole, 1975) and a "socialization approach to validation" (e.g. Gottfredson & Holland, 1978). The opportunity approach to validation argued that the primary purpose of using an interest inventory is occupational exploration. Its authors advocated removing gender differences from interest scores, in order to maximize career opportunities for individuals. In contrast, the socialization approach maintained that constructs measured by interest inventories are dependent on the differential socialization experiences of men and women. Its researchers argued against the removal of gender differences, in the belief that removing them would decrease the predictive validity of the measure.

Interest measures developed from these contrasting views tend to exhibit very different levels of gender differences in interest scores and have limited agreement in their career suggestions. Su et al. (2009) used interest item development strategy as a moderator for examining the magnitude of gender differences in interest scales and found that using sex-balanced item development techniques substantially reduced gender differences. A large proportion of variances across interest inventories was explained by the item development techniques, especially for scales traditionally favoring men such as realistic interest, interest in science, and interest in engineering. For instance, the UNIACT–R (ACT, 1995) developed from the "opportunity approach of validation" showed a small to moderate gender difference in realistic interests ($d = .40$), as compared to the huge realistic interest difference ($d = 1.70$) in the SDS–R (Holland et al., 1997) developed from the "socialization approach to validation." Other studies have provided evidence for unsatisfactory convergence among interest inventories (e.g. Russell, 2007; Savickas, Taber, & Spokane, 2002). Russell (2007), for example, showed that the hit rate in the cross-classification of Holland RIASEC codes between the SDS–R (Holland et al., 1997) and the UNIACT–R (ACT, 1995) is only 50.16 percent, which means that an individual receiving the same career suggestion from the two inventories is only at chance level. These results indicate that minimizing gender differences in interest measures may be associated

with change in the constructs being assessed. The consideration of social consequences of interest assessment needs to be addressed holistically, together with the achievement of construct and predictive validity.

More recently, under the impact of item response theory (IRT), research on gender differences in vocational interests has shifted focus from reducing the absolute level of gender differences to distinguishing gender bias from test impact (i.e. to reflect "true" gender differences in interest measures). Two studies have applied differential item functioning (DIF) techniques to examine item-level and scale-level gender bias, both using the Strong Interest Inventory (Harmon et al., 1994). In the first study, Aros, Henly, and Curtis (1998) used the Mantel–Haenszel log-odds ratios to examine differential responses to 28 occupational titles between males and females and detected gender-related DIF in most of the items, even after controlling for measured gender differences at scale level. The authors also found these gender-related DIF to be significantly correlated with occupational gender stereotypes, which indicated that sex-typing of occupations may contaminate interest measurement and may bias the magnitude of measured gender differences of interests.

In another study, Einarsdóttir and Rounds (2009) applied SIBTEST (Stout & Roussos, 1996) to examine DIF in the full range of interest items from the Strong Interest Inventory. They detected DIF in 70 percent of all the items used to construct the RIASEC scales (mean absolute $\beta = .163$) with 33 percent of the items showing a large amount of DIF (i.e. an absolute $\beta > .200$). Moreover, they recalculated the gender difference effect sizes for each RIASEC scale only with items that did not display DIF. Interestingly, only the realistic scale and the investigative scale had reduced scale-level gender differences after being "purified" ($d$ changed from to .86 to .64 and from .30 to .14, respectively); other scales all maintained the same amount of gender differences (recalculated gender differences for the artistic, social, enterprising, conventional scales were .44, .45, .11, and .29, respectively, as compared to .45, .45, .09, .24 before purification). Taken together, these results indicate that gender-related differential item functioning is prevalent and non-trivial; however, even after eliminating these biased items, a substantial amount of measured gender differences in interests at the scale level still persists.

The findings that gender differences in vocational interests are large and that they cannot be solely attributed to gender bias in measurement are important. They lead us beyond the traditional realm of interest measurement and bring up questions related to the broader domain of psychological research: Where do these differences come from? How are men's and women's interests developed? How much can interests change, and at what point of life do interests become stable? Future studies exploring these questions are necessary. In the following section, we provide a brief overview regarding the development and stability of interests, indicating that gender differences begin at an early age and are stable through the life course.

## Continuity and Change of Interests

The continuity and change of interests can be viewed from two theoretical perspectives: a situational perspective or a dispositional perspective (Silvia, 2006). Situational

interests, primarily studied in educational setting, are defined as the context-specific state of emotional experience, curiosity, and momentary motivation (see Hidi, 1990; Schraw & Lehman, 2001). Therefore, situational interests are fluid and malleable and are contingent on factors such as learning tasks and classroom techniques (Krapp, 1999; Renninger, Hidi, & Krapp, 1992). Conversely, dispositional interests, most frequently examined in vocational psychology, are 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). Dispositional interests are relatively stable, being involved with an individual's identity and choice of environment. These two perspectives on trait stability are not, however, incompatible. Research has found large within-person variability, as well as strong central tendency for the behavioral manifestation of traits, indicating that trait contents are like a density function of states and can be non-conditional or context-specific (Fleeson, 2001). Yet it is only meaningful to examine how interests develop and stabilize over the life course when interests are viewed as dispositional attributes.

Scholars have identified several kinds of trait stability (see De Fruyt et al., 2006; Low & Rounds, 2007): rank-order, profile, mean-level, and structural stability. These forms of interest stability represent different aspects of interest development and are not necessarily related to each other conceptually or statistically. Changes in one or more of these types of stability can be present while the others remain constant. Next, we review research evidence for each of these types of stability.

Rank-order stability, or relative stability, refers to correlations between scale scores at different time points. It is typically indexed by test–retest reliability of scale scores, and it provides information about the changes in the relative ranking of individuals within a group, on a particular interest dimension. In comparison, profile stability refers to the correlations between interest configurations (or profiles) at different time points. Instead of examining the stability of an individual interest scale score, profile stability focuses on changes in the full profile of multiple interest scales. Also, it provides information about the relative ordering of interest types within an individual rather than rank-order between individuals. The examination of rank-order stability and profile stability is important because, when individuals choose educational or work environments, 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. From an interindividual perspective, people may choose a field when they perceive themselves as having a relatively higher interest in that field by comparison to others; from an intra-individual perspective, people may choose a field in which they have the strongest interest among all interest types. Rank-order and profile stability have a direct impact on person–environment fit.

Evidence for rank-order stability is abundant in interest measurement literature. Studies using test–retest correlations generally lead to the conclusion that interests are highly stable during adulthood (e.g. Campbell, 1971; Hansen, 1984; Swanson, 1999). More recent research involving children in elementary school and children transitioning into middle school (Grades 4 to 6) have found moderate levels of rank-order stability, and these indices increase as children age (Tracey, 2002; Tracey & Ward, 1998). Similar findings were obtained for profile stability, and the results were consistent across gender and ethnicity.

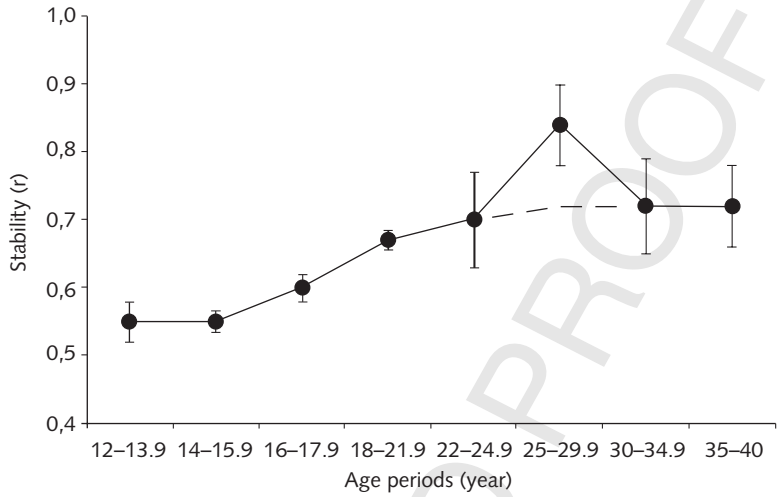


**Figure 23.3** Estimates of mean interest stability across age categories. Adapted with permission from Low and Rounds, 2007, p. 29. Error bars indicate 95% confidence intervals for each age group. Dashed line indicates hypothesized stability

In a meta-analysis, Low, Yoon, Roberts, and Rounds (2005) summarize results from 66 longitudinal studies in order to evaluate rank-order and profile stability of interests at different life stages. The authors found that, for both males and females, interests remained reasonably stable from age 12 to age 40 ($\rho$ = .55–.83). Stability estimates changed very little prior to graduation from high school (i.e. ages 12–13.9, ages 14–15.9 and ages 16–17.9; see Figure 23.3 for the development trend of interests across age periods). Interest stability increased dramatically during college years, peaked at ages 25–29.9, and subsequently plateaued for the remainder of adulthood with estimated stability above .70. Interestingly, the authors also compared meta-analytic estimates of rank-order stability between vocational interests and personality traits and showed that interests are constantly more stable than personality traits throughout the entire age period examined (see Figure 23.4). Overall, research examining rank-order stability indicates that interests are more stable than is commonly believed and that they stabilize at younger ages than was previously understood.

Mean-level stability, or absolute stability, refers to the absolute increase or decrease of a particular interest scale score over time. It can be measured at the individual level or at the group level. When a group of people shows consistent mean-level changes over a certain age period, we may infer that interests undergo normative growth which are consequences of maturational or historical processes shared by the group. Low (2009) conducted a meta-analytic review on the patterns of mean-level change in vocational interests, from early adolescence (age 12) to the end of emerging adulthood (age 24.9). Results showed that vocational interests exhibited a clear pattern of normative change, and this pattern of change was also moderated by gender. Specifically, investigative, artistic, social, and enterprising interests were found to increase across the studied period for both males and females, the greatest changes

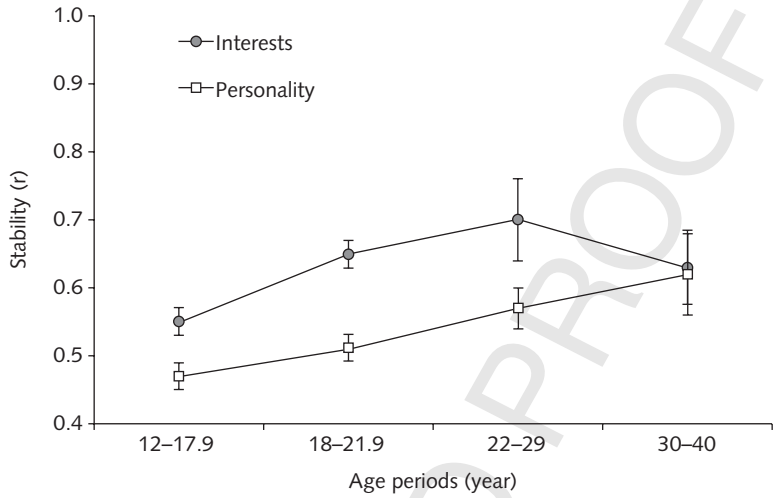


**Figure 23.4** Comparison between interest stability and personality consistency across age groups. Adapted with permission from Low and Rounds, 2007, p. 32. Error bars indicate 95% confidence intervals for each age group



of means occurring during middle through late adolescence into emerging adulthood. Conventional interests were found to increase for females and to decrease for males during the same period. Contrary to stereotypes, realistic interests increased in females and decreased in males. Longitudinal studies examining the mean-level change of vocational interests before middle school are scarce.

Structural stability refers to the change of RIASEC structure, that is, the interrelationship between interest types, at different time points. It is indicated by the extent to which interest scales relate to one another in a consistent manner and to which the theoretical circumplex structure holds. Tracey and Ward (1998) found that the structure of interests is different in young children (elementary) and that the adherence to the circumplex structure increases during early to middle adolescence (Swaney & Flojo, 2001). Several studies based on samples of middle school and high school students have consistently shown that interest structure changed very little through Grade 8 to Grade 12 (e.g. Darcy & Tracey, 2007).

Research evidence from these four perspectives on interest stability demonstrates notable stability. Such high stability can in part be attributed to genetic factors. Stability in interests can also be understood from the perspective of person–environment interaction. Interests, defined as preferences for certain activities and contexts, incentivize individuals to seek out environment and roles congruent with their predispositions. When they are not able to do so, individuals may try to change existing environments to better suit their preferences. In turn, experiences in the chosen environment, such as performing preferred tasks or interacting with similar people, further reinforce individuals' identity. It is through this iterative interaction process that increasing fit between person and environment is achieved. In other words, people "pick their niches" (Scarr & McCartney, 1983)—aligning their

environments with their interests such that the environmental press is in the direction of maintaining the direction of their interests.

When compared to the other trait domain—personality—interests are traditionally viewed as the less stable "developmentally downstream" and are situated closer to behavior and its social context than personality (McCrae & Costa, 1999; Roberts & Wood, 2006). Research evidence reviewed in the current chapter may suggest otherwise. Low and colleagues' (2005) meta-analysis showed higher stability for interests over personality across all age periods, casting doubt on the claim that personality is the antecedent of vocational interests. Counterevidence for the claim may also come from research in developmental psychology, where studies showed that children are able to articulate their aspirations and to develop occupational gender stereotypes from as young as age 4 (Trice & Rush, 1995), while the perception of personality traits is developed much later (Rholes, Ruble, & Newman, 1990). An alternative explanation was offered by Low et al. (2005), suggesting that personality and vocational interests have different functions in person–environment interaction. In contrast to interests' motivational function in the selection of environment, personality traits appear to affect how a person copes with, or adapts to, an environment. McCrae and Costa (1999), for instance, argued that personality traits are central to problem solving, influencing the ability to make strategic alliances and to compete with others for resources. In other words, personality traits influence individuals' behaviors toward adaptive functioning in an environment, after the environment has been selected, a role played by interests.

Setting aside the debate on the developmental sequence between personality and interests, it is worth noting that human functioning is a complex and inseparable process involving multiple individual difference traits, and these different aspects of individual identity are developed in a manner that interrelates them. In the next section we will present an integrative model of individual differences as a way to conceptualize traditionally separated domains of human dispositions.

Interests do change over time. Interests are shaped by environmental factors such as family, the school, and other aspects of the culture (Eccles, 1993). For example, Bandura, Barbaranelli, Caprara, and Pastorelli (2001) showed that, by controlling the type of activities to which their children are exposed, parents shape their children's interests. Helwig (1998) found that children's choices of occupations are influenced by parents' expectations and societal values. Presence of role models and availability of educational opportunities for female students were also shown to increase their non-traditional vocational interests (Betz & Schifano, 2000; Nauta, Epperson, & Kahn, 1998). The socialization process exerts a powerful influence on individuals' perception of self-identity, and occupations and plays an important role in interest development.

It is important to note, however, that changes in interests tend to occur very early. Previously reviewed empirical evidence showed that interests display a good deal of stability in childhood and early adolescence, and that crystallization of interests starts before middle school. Early stabilization of interests implies that any intervention on vocational interests needs to start at a much earlier age than the current focus (e.g. high school and college years), when interests are more malleable. In particular, efforts to increase girls' interests in the STEM fields, in order to bridge the gender

gap, must be initiated at formative years, as children are developing gender roles and perceptions of appropriate careers. Moreover, early stabilization of interests necessitates an appropriate method of interest measurement at an early age. Unfortunately, vocational psychologists rarely obtained samples from students younger than middle school , whereas developmental and educational psychologists working with younger samples usually focus on the study of situational interests without established interest measures. Future research bridging the gap between interest development and measurement for young children is needed to better understand the continuity and change of interests.

## Integrated Models

### Rationale

The call for the development of integrated models stems in part from the tendency for individual differences researchers to focus their research on a single domain. Research on the Holland model has focused on testing the structural model of the RIASEC types (Armstrong et al., 2003). Similarly, research on personality structure has focused on identifying the number and characteristics of broad personality traits (Goldberg, 1993), or on clarifying the nature of personality facets associated with each of the broad personality traits (Roberts, Bogg, Walton, Chernyshenko, & Stark, 2004). And research on intelligence structure has focused on testing alternative models of hierarchical structure (Carroll, 1993) and on the importance of general intelligence relative to domain-specific measures of intelligence (Carretta & Ree, 2000). In all three areas of individual differences research there is also an examination of the cross-cultural validity of measures. Most of the research that taps into more than one of these domains has focused primarily on the issue of incremental validity, that is, the extent to which individual differences measures from one domain can improve the prediction of an outcome over the established effectiveness of measures from another individual differences domain. For example, Roberts, Kuncel, Shiner, Caspi, and Goldberg (2007) found that personality traits had incremental validity over cognitive abilities and socioeconomic status for predicting mortality/longevity, divorce, and educational and occupational attainment.

With this tendency for researchers to focus on a single domain of individual differences, or on the incremental validity of using measures from multiple domains, the larger theoretical issue of how to conceptualize the interrelations among individual differences domains has received less attention. It should be noted that the tendency for researchers to focus their structural analyses on a single domain could be interpreted as assuming that the structural and theoretical conceptualizations of each domain are relatively independent. In other words, when developing a model of personality, the issue of interest or ability structure does not impact the identification of broad traits or their facets; or, when developing a hierarchical model of intelligence, Holland's circumplex structure of interests does not inform the number of domain-specific measures that are present or the magnitude of their loadings on a general factor of intelligence. When working within an individual differences domain, this

practice is quite understandable—measures of intelligence are designed to measure objective performance on a task, which is separate from the question of how much the individual likes to perform a particular task, or from the question of which task will be chosen from a range of alternatives. However, when using individual differences measures to understand and predict behavior, the interrelations among the domains becomes more of an issue. As noted by Lubinski (2000), "a much richer picture of humanity and psychological diversity is brought into focus when constellations of individual-differences variables are assembled for research and practice" (p. 407).

The issue of how to represent the interrelations among individual differences domains in an integrated model is tied to larger theoretical issues, related to understanding how individuals choose environments that reflect their personalities, interests, and capabilities, and also to understanding how the learning experiences individuals obtain when interacting in an environment shape the development of individual differences. For example, the socio-analytic model of identity development (Hogan, 1983; Hogan & Roberts, 2000, 2004) hypothesizes that both personality traits and abilities will have an effect on the development of interests because individual differences in both personality and ability impact how an individual responds to opportunities and experiences in an environment, and it is these experiences (both successful and unsuccessful) in environments that help shape preferences. Conversely, interests will also have an effect on the development of personality and abilities over time, because preferences for different environments will impact the range of experiences an individual has (Ickes, Snyder, & Garcia, 1997; Scarr, 1996). In other words, there is a reciprocal feedback loop between interests, personality, and abilities, with personality and abilities contributing to interests by influencing how individuals function in environments, and interest-based self-selection of educational and work environments influencing which personality traits and abilities are developed and refined by new experiences (Roberts, Caspi, & Moffitt, 2003; Schooler, 2001).

This reciprocal feedback loop contributes to what Armstrong, Day, McVay, and Rounds, (2008) refer to as "contextual convergence"—the finding that the distinct sets of constructs measured by personality, ability, and interest-based individual differences form a cohesive picture when examined from the perspective of educational and work environments. This tendency for educational and work environments to influence individual differences traits has also been referred to as "the gravitational hypothesis" (McCormick, DeNisi, & Shaw, 1979), which states that individuals will be pulled towards occupations that are matched to their level of cognitive ability. In this model, the source of gravity is the different levels of cognitive demands placed on individuals in various occupations. Individuals with relatively high levels of mental ability are pulled towards occupations with relatively high levels of cognitive demands, and are pulled away from occupations that lack sufficient levels of challenge. Conversely, individuals with less cognitive ability will be pulled away from occupations that are too challenging and towards occupations with cognitive demands that are commensurate with their level of ability. In addition to cognitive demands, the gravitational hypothesis has been implicated in other dimensions of the person–environment fit, including interests (Reeve & Heggestad, 2004). In other words, there is more than one gravitational field operating in the world of work: cognitive

demands pull individuals towards occupations that are a good match for their mental abilities, personality traits pull individuals towards occupations where they can effectively express their personalities, and interests pull individuals towards occupations that reflect activity preferences.

One of the best known examinations of individual differences constellations is the meta-analysis by Ackerman and Heggestad (1997), which reported estimates of correlations between intelligence, personality, and Holland's model of interests. On the basis of their analysis, Ackerman and Heggestad identified four trait complexes. The first trait complex, social, combined interest in working with people from the social and enterprising Holland types with personality measures of extraversion and social potency, and also included measures of subjective well-being. The second trait complex, clerical/conventional, combined interest in the conventional interest types with personality measures of control, traditionalism, and conscientiousness, and with the ability measure of perceptual speed. The third trait complex, science/math, combined interest in working with things from the realistic and investigative interest types with the abilities of visual perception and math reasoning. And the fourth trait complex, intellectual/cultural, combined interest in the investigative and artistic types with the personality traits of openness to experience, typical intellectual engagement, and absorption and ability measures of ideational fluency and general cognitive ability.

Ackerman and Heggestad's (1997) results included two key contributions that have been continued in subsequent work on integrated models by Armstrong et al. (2008). The utility of Holland's theory as an organizational framework for trait complexes is established, and subsequent research has build on these findings by more explicitly testing the structural model of Holland's theory when identifying links between individual differences domains. Additionally, these results demonstrate that not all trait complexes combine the three domains of interest, personality, and abilities. Indeed, for two of the four complexes there is a missing element, as the social complex does not include any ability measures and the science/math complex does not include any personality measures. These results may reflect the limitations of current individual differences measures: namely the lack of personality measures associated with the science/math trait complex may indicate that the distinct personality traits of individuals who are interested in careers in math and science are not well represented by current measures. However, the lack of personality traits associated with the science/math complex may also reflect that multiple personality traits are compatible with this work environment, or that personality traits are not a critical factor for effective functioning in work environments that place an emphasis on math and science. Similarly, the lack of cognitive ability measures tied to the social trait complex may reflect a deficit in current ability measures: either the abilities used to work effectively with people are not captured by traditional cognitive ability measures, or cognitive abilities are not a critical factor for effective functioning in work environments that place an emphasis on interpersonal interactions.

## Using holland as a framework

With the Atlas model of individual differences, Armstrong et al. (2008) proposed using interest-based structures, and Holland's (1997) model of interest structure in

particular, as a template for developing integrated models of individual differences. In particular, they hypothesized that interests may provide an effective starting point for integrated models because, at the individual level, the process of interest development reflects the integration of personality traits and abilities with preferences for different educational and work environments. Holland's (1997) theory, which can be used to classify both individuals and work environments, provides a structure that can be used as a template for combining information from different sources. This approach builds on Ackerman and Heggestad's (1997) work by explicitly testing Holland's structural hypothesis when examining correlations between individual differences measures. In addition to statistical considerations, Holland's theory also has the advantage of being a well-established model in applied settings. In consequence, using the RIASEC model as an integrative framework provides information linking abilities and personality to career choices that may be useful when working with individuals who are making career-related decisions.

Armstrong et al. (2008) used the linear multiple regression-based technique of property vector fitting (Jones & Koehly, 1993; Kruskal & Wish, 1978) to model statistically the integration of individual differences variables into Holland's model. As illustrated in Figure 23.5, this technique allows for the placement of a variable into the RIASEC circumplex as a line, or property vector, emerging from the center point. The angle of the property vector is calculated from the regression coefficients

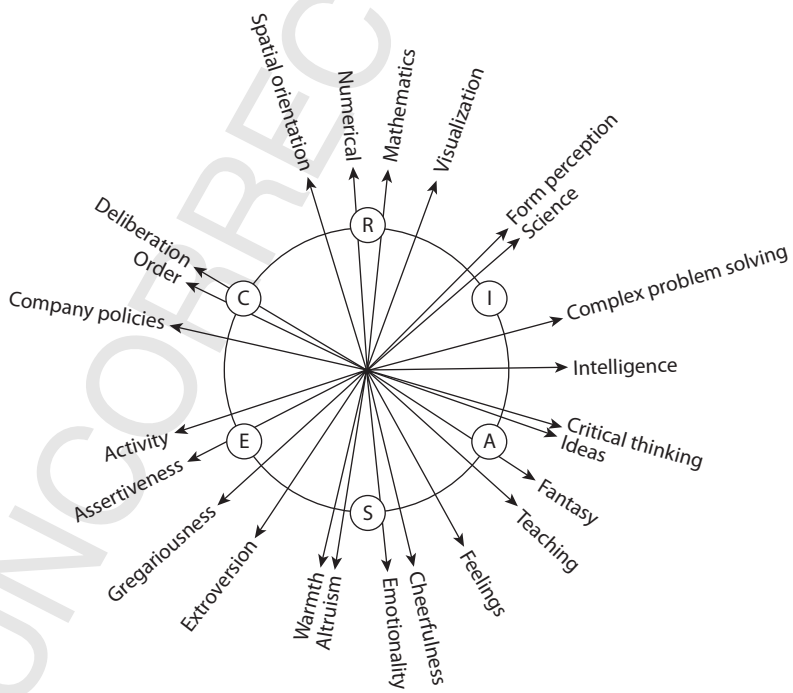


**Figure 23.5** Illustrative results of property vector fitting analyses from Armstrong et al. (2008). Adapted with permission from Armstrong et al., 2008. Key: R = realistic, I = investigative, A = artistic, S = social, E = enterprising, C = conventional

obtained by regressing variable scores for each RIASEC type on the structural coordinates representing the interest structure. That is, when analyzing the relations between the individual differences measures and the Holland model, the property vector fitting technique examines the relative magnitude of relations across all six RIASEC types. In this approach, goodness of fit to the model reflects the extent to which the relative magnitude of the relations between a measure and all six types is consistent with the order-predictions in the Holland model. This builds on previous research, such as that of Ackerman and Heggestad (1997), which primarily focused on bivariate correlations. In other words, the integration process used in the Atlas model considers more than just the question of which ability or personality trait has the highest correlation with a particular RIASEC type. Property vector fitting results illustrate the structural relations among interests and other individual differences characteristics by indicating the orientation of characteristics in the interest structure and by comparing the relative orientations of different characteristics. Instead of focusing on the absolute magnitude of a particular bivariate relationship, this type of structural analysis systematically models the relative strength of associations between characteristics and the underlying interest structure. Subsequent research (Anthoney & Armstrong, 2010; Armstrong & Anthoney, 2009) has refined this approach by using a bootstrapping technique to develop confidence intervals for the magnitude of fit and orientation of property vectors in the RIASEC circumplex.

## Atlas-based studies

*People–things dimension* Research fitting personality and ability measures into the RIASEC model have consistently supported the people–things dimension of interest proposed by Prediger (1982) as underlying the inter-relations among the six types. This distinction between individuals who prefer involvement with other people and those who prefer involvement with things is, in fact, a recurrent theme in the interest literature dating back to Thorndike (1911), first demonstrated empirically by Thurstone (1931). Armstrong and colleagues (2008) found that a number of personality characteristics fit into the RIASEC structure in an arc encompassing the social type, which is the anchor for the people end of this dimension, and also encompassing the enterprising type. Personality measures of extraversion both from the five-factor model of personality and from the Myers–Briggs Type Indicator (MBTI; Myers, & McCaulley, 1985) extravert–introvert scale were fit into the model, as were two measures of interpersonal confidence. Consistent with Ackerman and Heggestad (1997), Armstrong et al. (2008) found that results that fit ability requirements into the integrated model tended to be oriented toward the "things" end of the interest continuum, whereas the personality measures tend to emphasize the "people" end of the continuum.

At the facet level, Armstrong and Anthoney (2009) found that extraversion facets were oriented both towards the social and towards the enterprising type. When this analysis was done with NEO–PI–R (Costa & McCrae, 1992) extraversion facets, the range of the circumplex covered included both the extravert and the social type. However, when a second set of facets from the International Personality Item Pool (IPIP; Goldberg et al., 2006) was analyzed, the extraversion facets were more closely

grouped around the social type. When comparisons were made between the two sets of results, Armstrong and Anthoney found that five of the six extraversion facets were embedded for both measures, with an average angle difference of 36°, suggesting a similar interpretation of the links between extraversion facets and interests across measures. These results were interpreted as supporting previous research, which linked extraversion with social and enterprising interests. However, the finding that extraversion is linked to both types raises potential problems with the dimensional interpretation of the RIASEC circumplex. In particular, Prediger's interpretation of people–things is anchored by the social and realistic types, which suggests that the social type has a stronger relation with people-oriented interests than the enterprising type. In comparison, Hogan (1983) has suggested that there is a sociability dimension that underlies the RIASEC circumplex and is oriented in-between the enterprising and the social type. As such, Armstrong and Anthoney's results tend to support Hogan's (1983) interpretation over that of Prediger (1982), in that the ordination of extraversion facets tended to fall in-between the enterprising and the social type, but there were no extraversion facets oriented towards the artistic type.

When comparing individual self-ratings and occupational requirements along the people–things dimension, Anthoney and Armstrong (2010) found that measures of mathematics, systems analysis, and technical skills were associated with working with things for individual self-ratings and for occupational requirements. However, for some things-oriented measures, the results were not consistent across individual self-ratings and occupational ratings. Spatial orientation and perceptual abilities were also related to the realistic area of the circumplex for women and for the occupational ratings. Visualization and selective attention abilities were linked to the realistic type by occupational ratings, but not by individual ratings. Quantitative ability and material resources management skills were significant for individual self-ratings, but not for occupational ratings. Despite this information on abilities required for environments that place an emphasis on interacting with things, there is comparatively little in the way of personality measures for things-oriented individuals.

In comparison, the range of environmental information for people-oriented work environments is smaller, but there is a number of personality measures reflecting an orientation towards people. For example, Anthoney and Armstrong (2010) found that service orientation, personnel resources management, and influencing skills are linked with the people dimension. Additionally, some verbal abilities and communication skills spanned the region between the artistic and social types, falling in the area between the people and the idea dimension-anchor in Prediger's model. Holland's theory associates verbal abilities with the A type, but also links speaking ability with E, which may result in an orientation of verbal abilities and communication skills between A and S when one is using property vector fitting. Teaching skills are associated with the S type for individuals and linked with the A type for occupations, suggesting dynamic work with people. Time management skill is people-oriented for occupations, yet did not fit the model for individual self-ratings. Overall, the differences between the individual self-ratings and the occupational ratings found by Anthoney and Armstrong suggest that there may be discrepancies between how individuals conceptualize working with people and more objective measures of workplace activities and ability requirements.

*The structured–dynamic dimension* Consistent with Ackerman and Heggestad's (1997) clerical/conventional and intellectual/cultural trait complexes, Armstrong et al. (2008) found that one of the dominant organizational dimensions that emerged when integrating individual differences measures into the RIASEC circumplex was a contrast between those individuals who prefer structured environments, where activities are regimented and tasks are clearly defined in advance, and those who prefer more dynamic environments, where specific tasks are not defined as clearly and an emphasis is placed on creative activities. For example, the five-factor model-based measure of openness to experience contrasted the artistic and the conventional type. The dynamic end of this dimension also included measures of independence, imagination, originality, creativity, and fluency of ideas.

At the facet level, Armstrong and Anthoney (2009) found that the most consistent pattern of relations between personality and interest across the two sets of facet measures emerged with the openness to experience facets, with an average angle difference of 24° between NEO–PI–R (Costa & McCrae, 1992) and IPIP (Goldberg et al., 2006) scales. The overall pattern of these results was consistent with that of previous studies, which examined these relations by using broader measures of the openness trait (e.g. Larson, Rottinghaus, & Borgen, 2002). However, Armstrong and Anthoney interpreted their findings as providing new information on links between personality and interests though the examination of the relative position of different facets of openness. For example, the feelings/emotionality facets were oriented more towards the social type, whereas the intellect/ideas facets were oriented more towards the investigative and artistic types. These results suggest that emotional openness may be tied more to social interests, and that intellectual openness may be tied to scientific and creative interests. Overall, measures of the broad personality trait of openness to experience are linked to the artistic type, but the various facets of openness span the investigative, artistic, and social types, reflecting the different ways individuals are open to experiences and to the work environments that best fit their openness.

In comparison, the structured end of this same dimension is oriented towards the conventional type. Armstrong et al. (2008) found that measures of conscientiousness, sensing, conformity, clerical ability, and need for supervision were oriented in that direction. At the personality facet level, Armstrong and Anthoney (2009) found that the NEO–PI–R (Costa & McCrae, 1992) conscientiousness facets were consistently linked with business-related interests, being oriented towards the C type and to the area in-between the E and C types. However, the results were less consistent with the IPIP (Goldberg et al., 2006) facet scales, where dutifulness and achievement were oriented towards the social type, and orderliness was oriented towards the enterprising type. Anthoney and Armstrong (2010) found that, when they compared individual self-ratings and occupational ratings, fewer property vectors were integrated consistently for the structured–dynamic dimension. Although there were skill vectors oriented towards individual self-ratings of the E and C types, there were no significant results for the occupational ratings.

Anthoney and Armstrong (2010) found that written communication skill is oriented in the dynamic direction for individuals and occupations, and that the generation of ideas (or, in the jargon, "idea generation") is linked with the dynamic

dimension for men and occupations. Science skill is located between the I type and the R type, suggesting dynamic work with things. Additionally, there are several differences in the integration of individual and environmental ratings in the dynamic direction. Critical thinking and complex problem solving skills are oriented in the dynamic dimension on the basis of environmental demands. Critical thinking is linked with working with things for women, and complex problem solving is oriented in the structured dimension for men. Perceptual abilities are linked with the dynamic region for men, but they are linked with things for occupations, which suggests that, for men, perceptual abilities are viewed at a higher level of abstraction but are conceptualized more concretely in the occupational ratings. For women, perceptual abilities span the region between things and ideas.

## Conclusion

Vocational interests are more than just educational–occupational preferences. Interests are the affective and cognitive responses to critical features of environments and of the behaviors imposed or suggested by those environments. Interests are the perceived environmental affordances that constitute the means of attaining values and goals. Interests energize and direct action toward attaining and maintaining environments best suited to fulfill the individuals' needs. In that sense, interests describe the means by which and the environments in which people can function optimally.

Interests are important for the multiple decisions that are made prior to initial career choices, and they affect an individual's success and satisfaction with each of these choices. Since interests become stable early on in the life course, community support is necessary for the kinds of interests and early experiences that lead to educational choices in the STEM fields. Interests are an ideal candidate for classifying and understanding values, abilities, and personality characteristics. The interest foundation for integrative models of trait complexes may be different from the current circumplex models. For the development of new interest models, researchers need to continue to develop public-domain interest-measures (Liao, Armstrong, & Rounds, 2008) rather than to rely on the liabilities of commercial interest inventories.

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