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Normative Changes in Interests from Adolescence to Adulthood: A Meta-Analysis of Longitudinal Studies

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Abstract

Vocational interests predict a variety of important outcomes, and are among the most widely applied individual difference constructs in psychology and education. Despite over 90 years of research, little is known about the longitudinal development of interests. In this meta-analysis, we investigate normative changes in interests through adolescence and young adulthood. Effect sizes were aggregated from 49 longitudinal studies reporting mean-level changes in vocational interests, containing 98 total samples and 20,639 participants. Random effects meta-analytic regression models were used to assess age-related changes and gender differences across Holland's (1959, 1997) RIASEC categories and composite dimensions (People, Things, Data, and Ideas). Results showed that mean-level interest scores generally increase with age, but effect sizes varied across interest categories and developmental periods. Adolescence was defined by two broad patterns of change: interest scores generally decreased during early adolescence, but then increased during late adolescence. During young adulthood, the most striking changes were found across the People and Things orientations. Interests involving People tended to increase (Artistic, Social, and Enterprising), whereas interests involving Things either decreased (Conventional) or remained constant (Realistic and Investigative). Gender differences associated with occupational stereotypes reached a lifetime peak during early adolescence, then tended to decrease in all subsequent age periods. Overall findings suggest there are normative changes in vocational interests from adolescence to adulthood, with important implications for developmental theories and the applied use of interests.

Public Significance Statement: This meta-analysis integrates longitudinal research on mean-level changes in vocational interests. Results suggest there are normative changes in interests from adolescence to adulthood, with implications for lifespan development theories and the applied use of interests.

Normative Changes in Interests from Adolescence to Adulthood: A Meta-Analysis of Longitudinal Studies

Interests are among the most widely applied individual difference constructs in education and psychology (Chamorro-Premuzic, von Stumm, & Furnham, 2011; Dawis, 1992; Lubinski, 2000; Renninger & Hidi, 2016; Sackett, Lievens, Van Iddekinge, & Kuncel, 2017). Interests are used extensively in career counseling to guide individuals making educational and career-related decisions, and there is a long history of research linking vocational interests to occupational choice (Campbell, 1971; Clark, 1961; Holland, 1997; Kuder, 1977; Strong, 1943). Interests are also widely used for prediction; a substantial body of research has shown that *interest fit* predicts employment outcomes, such as job satisfaction and job performance (Nye, Su, Rounds & Drasgow, 2012, 2017; Spokane, Meir, & Catalano, 2000; Van Iddekinge, Roth, Putka, & Lanivich, 2011). In combination with abilities, interests explain a great deal of variability in the choices people make throughout their careers, and whether they are successful (Austin & Hanish, 1990; Gottfredson, 2003; Rounds & Su, 2014; Stoll et al., 2016). Because of their powerful influence on human development, it is critical to understand how interests change through the lifespan.

To date, there has only been one published meta-analysis of longitudinal interest research (Low, Yoon, Roberts, & Rounds, 2005). Low et al's meta-analysis focused on rank-order stability, revealing that individual differences in vocational interests are among the most stable of all psychological constructs. Yet rank-order stability is only one way to examine change (De Fruyt et al., 2006). A complementary perspective, *mean-level change*, describes normative variations in interest intensity levels. Mean-level change provides information critical to developmental theories. Identifying normative patterns of development can guide theory

selection and lead to a more complete understanding of how and when people change across the lifespan. For example, several integrative theories propose frameworks that organize the development of key individual differences, such as interests, abilities, and personality traits (Ackerman, 1996; Corno, Cronbach et al., 2002; Gottfredson, 1981, 2005; Schmidt, 2014; Snow, Corno, & Jackson, 1996; von Stumm, & Ackerman, 2013; Wrzus & Roberts, 2016). These theories could benefit from an increased understanding of how interests change through the lifespan in relation to abilities (e.g., Carroll, 1993; Cattell, 1987; Schmidt & Hunter, 1998) and personality traits (e.g., Roberts & Mroczek, 2008; Roberts, Walton, & Viechtbauer, 2006; Soto & Tackett, 2015). However, as it stands, little is known about normative patterns of change in interest intensity levels (Nauta, 2010; Silvia, 2008; Swanson, 1999).

In this meta-analysis, we advance this critical area of study by aggregating longitudinal research on mean-level changes in vocational interests from adolescence to adulthood. We examine normative changes in interest traits across different domains and developmental age periods. The present study investigates three core questions: (1) Do mean-levels of vocational interests change over time? If so, in what direction? (2) Do the size and direction of changes vary across age-graded developmental periods? (3) Are there gender differences in developmental trends?

Identifying normative changes in interests also has important implications for their applied use. For example, each year roughly four million high school students take the ACT Interest Inventory (American College Testing Program, 2009), which is just one of several popular interest measures (e.g., Strong Interest Inventory: Donnay, Morris, Schaubhut, & Thompson, 2005; Self-Directed Search: Holland, Fritzsche, & Powell, 1994). Without accounting for age-related changes, the implicit assumption has been that interests either do not

change normatively, or that changes are inconsequential. Yet there is little data to support this assumption. In practice, incorporating knowledge about mean-level changes could help improve the predictive utility of interest assessments. Practitioners could use this information to provide context for clients' interest scores based on their age group, and anticipate future changes in interest levels. Identifying normative changes can also inform interventions targeting interests and other motivational variables. A previous meta-analysis identified large gender differences in vocational interests (Su, Rounds, & Armstrong 2009), which have been linked to disparities in STEM fields (Ceci & Williams, 2011; Su & Rounds, 2015). An intervention designed to increase female students' interest in STEM careers could benefit from knowing when gendered interests emerge and how they change over the course of development (e.g., Karabenick & Urdan, 2014).

The Concept and Measurement of Interests

Interests are studied from both a state and a trait perspective (Savickas, 1999). Educational psychologists study interest as a state, "characterized by increased attention, effort, concentration, and affect" (Renninger & Hidi, 2016, p. 9). In contrast, researchers in organizational and vocational psychology study interest as a trait-like disposition, focusing on the application of interest traits to employment settings (Low et al., 2005). In this paper we focus on vocational interests, defined as "trait-like preferences to engage in activities, contexts in which activities occur, or outcomes associated with preferred activities that motivate goal-oriented behaviors" (Rounds & Su, 2014, p. 98). More simply, vocational interests reflect enduring patterns of motivation for pursuing context-specific activities, outcomes, and environments. Because interests capture motivation—including goals and plans—they are powerful predictors of behavior contextualized to specific environments (Rounds & Su, 2014; Su & Nye, 2015).

The vocational interest typology developed by Holland (1959, 1997) is the most widely adopted theoretical framework for interest measurement. Most modern vocational interest scales, beginning with the Strong (Campbell & Holland, 1972), have been developed to assess Holland's typology. Holland's typology describes people according to their resemblance to six vocational personalities and environments collectively known as RIASEC: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). *Realistic* interests involve working with hands, tools, and materials. *Investigative* interests involve scientific and research activities. *Artistic* interests involve self-expression and creativity typically associated with the performing, written, and visual arts. *Social* interests are activities that involve helping and nurturing. *Enterprising* interests involve selling, managing, and social influence typically in a business context. *Conventional* interests involve the ordered and systematic manipulation of data with clear standards.

A key assumption of Holland's (1958, 1959, 1997) theory is that interest inventories are personality inventories. Accordingly, Holland described the RIASEC interests as *personality types* that are not only interpreted as interest dimensions but also provide information on interrelated preferences, traits, self-attitudes, values, and competencies. In a sense, the surplus meaning given to the RIASEC types derives from Holland's (1958) initial proposal that "the choice of an occupation is an expressive act which reflects the person's motivation, knowledge, personality, and ability" (p. 336). This idea has been supported by correlates of the RIASEC scales gathered over some 40 years of research (Holland, 1997)[1].

[1] Holland's (1959) approach is consistent with integrative theories of human development that jointly examine individual difference variables, such as Ackerman's PPIK model (1996; von Stumm, & Ackerman, 2013), Gottfredson's (1981, 2005) Theory of Circumscription and Compromise, and Snow's Aptitude Complexes (Corno, Cronbach et al., 2002; Snow et al., 1996). In these theories, interests, abilities, and personality traits are organized into clusters based on their shared variance (for reviews of interest-ability-personality associations, see Ackerman & Heggestad, 1997; Armstrong, Day, McVay, & Rounds, 2008; and Mount, Barrick, Scullen, & Rounds 2005). These integrative frameworks allow for better predictions of outcomes than models that examine variables in isolation

Another classification system that relies on Holland's typology is Prediger's (1982) two-dimensional model of *People-Things* and *Data-Ideas*. These dimensions have been used frequently to represent the interrelations among RIASEC interest scales (Rounds & Tracey, 1993). The present meta-analysis uses Holland's (1997) and Prediger's (1982) dimensions to organize the variety of vocational interest inventory scales. Throughout the paper, we refer to these dimensions as "interest traits" to emphasize the dispositional nature of vocational interests. In addition, this term helps clarify our focus on interests, rather than the broader interpretation implied by the term "personality types".

There are large gender differences in vocational interests. In a meta-analysis of mean-level gender differences, Su et al. (2009) reported that men have stronger Realistic and Investigative interests, while women have stronger Social, Artistic, and Conventional interests. The disparities in Realistic and Social interests are particularly noteworthy because of their magnitude and correspondence to the gender disparity in STEM fields (Ceci & Williams, 2011; Su & Rounds, 2015). Unlike past research showing small gender differences in most psychological constructs (Hyde, 2005), the disparities in Realistic (d = 0.84) favoring men and Social (d = 0.68) favoring women are large. Researchers, however, have yet to study longitudinal trends in the size of these gender differences. Several open questions remain. When in the life course do gender differences in vocational interests emerge? Do they increase or decrease with age as individuals enter the workforce and potentially encounter gender disparities?

Interest Development

Continuity and Change in Interests

(Asbury & Plomin, 2014; Austin & Hanisch, 1990; Gottfredson, 2003; Revelle, Wilt, & Condon, 2011; Rounds & Tracy, 1990; Scarr, 1996).

The two most common ways of studying continuity and change are *mean-level change* and *rank-order consistency*. Both approaches reflect continuity and change at the group-level, but they are independent statistical measures with distinct implications for behavior (Funder & Colvin, 1991). The only published meta-analysis on continuity and change in vocational interests focused on rank-order stability. Low et al. (2005) quantitatively reviewed 66 longitudinal studies spanning various ages from early adolescence through middle adulthood. Vocational interests were notably stable throughout all age periods, displaying higher rank-order stability than personality traits (Roberts & Delvecchio, 2000). The rank-order consistency of interests was least stable during adolescence (ages 12-18), then increased substantially during the college years (ages 18-22). Interest stability continued to increase during young adulthood, hitting a peak from ages 25-30. These findings suggest that the relative ranking of individuals' interests within a group shift more during adolescence, when many students begin working part-time jobs and taking career-oriented courses, than during young adulthood. Nevertheless, Low et al.'s results do not provide information on the direction in which interests change, the magnitude of changes, or gender differences in mean-level trends. This knowledge is critical to expand theories and research on the longitudinal development of vocational interests.

Developmental Theories

Existing theories of interest development do not address normative, age-related changes. However, three theories provide frameworks that describe how new experiences transform into enduring interests: Holland's (1997) Theory of Vocational Personalities and Work Environments, the Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994), and the Four-Phase Model of Interest Development (Hidi & Renninger, 2006; Renninger & Hidi, 2016). These three theories differ in their emphases. Holland's theory is the most general; it broadly describes the

process by which RIASEC types become more differentiated through exposure to and reinforcement from different environments (Holland, 1997). The SCCT, based on Bandura's (1982) self-efficacy theory, focuses more narrowly on the role of self-efficacy beliefs and outcome expectations. According to the SCCT, interests are more likely to develop and flourish when people view themselves as competent in activities and anticipate positive outcomes from performing them (Lent et al., 1994).

Whereas Holland's theory and the SCCT describe the mechanisms guiding development at a relatively general level, Hidi & Renninger's (2006; 2016) Four-Phase Model of Interest Development breaks down the process into specific, sequential phases. According to the four-phase model, interest begins as a psychological state triggered by situational changes. Interest is maintained over time through sustained attention in recurring situations, eventually emerging into a predisposition to seek reengagement. In the final phase, interest becomes well-developed and self-regulated, and can persist through frustration and other obstacles.

Importantly, all three theories highlight the importance of exposure and reinforcement in triggering interest development. Triggering refers to the process by which interest is directed towards a new object of attention (Renninger & Hidi, 2016). Research on interest triggers has primarily been conducted in school settings. Studies have revealed that different triggers are needed to impact interest at varying stages of development. For example, classroom activities that increase the relevancy or novelty of content can trigger situational interest, but have less of an impact on interest that is already well-developed (Harackiewicz, Tibbetts, Canning, & Hyde 2014; Hulleman & Harackiewicz, 2009). Well-developed interests are more likely to be impacted by triggers that help integrate personal identities, needs, and values, such as social experiences that promote a sense of belonging (Bergin, 2016; Eccles, Fredricks, & Epstein, 2015; Krapp,

2005). However, researchers have yet to apply these findings to the study of trait-like vocational interests. In sum, existing theory and research on interest development do not lead to clear expectations about normative changes.

Research on personality trait and cognitive development, however, may inform mean-level changes in interests. Vocational interests, cognitive abilities, and personality traits are similar in that they reflect relatively enduring attributes that can develop and mature over time (Briley & Tucker-Drob, 2017; Roberts et al., 2006; Rounds & Su, 2014). Key findings from research on the development of these individual differences may also apply to interests, such as the maturity principle (Roberts et al., 2006; Roberts & Mroczek, 2008) and social investment principle (Lodi-Smith & Roberts, 2007).

The maturity principle was one of the main conclusions of a seminal meta-analysis on mean-level changes in personality traits (Roberts et al., 2006). The authors found that during late adolescence and young adulthood, people become more agreeable, conscientious, and emotionally stable—traits associated with social maturity (Roberts & Mroczek, 2008). These normative changes occur rapidly during the transition from late adolescence to emerging adulthood and are associated with social role transitions outlined by the social investment principle (Lodi-Smith & Roberts, 2007). Similarly, cognitive ability displays massive mean-level gains over childhood and adolescence as individuals move through the educational system (Tucker-Drob, 2009). During this time, investments in academic achievement and social capital are made.

Social investment refers to a commitment to adult roles, in work, education, family, and community contexts. Social investments, such as starting a full-time job (e.g., Bleidorn et al., 2013) or gaining additional years of schooling (Brinch & Galloway, 2012), may play a role in

motivating psychological maturation. For example, research has shown that becoming more invested in work is associated with increases in conscientiousness and agreeableness—traits that are typically rewarded in work settings (Hudson, Roberts, & Lodi-Smith, 2012; Lodi-Smith & Roberts, 2007; Nye & Roberts, 2013). In contrast, becoming less invested in work is associated with work withdrawal (Griffeth, Hom, & Gaertner, 2000) and decreases in personality maturity (Roberts, Walton, Bogg, & Caspi, 2006). Work-related experiences may also contribute to cognitive development through mechanisms such as adapting to the complexity of occupational environments (Gottfredson, 1997; Schooler, 1984). The impact of a social investment depends largely on the reward structures associated with the new role.

Social role transitions may also motivate normative changes in vocational interests. Educational changes may be particularly impactful because they occur at similar developmental periods in the United States (e.g., students typically attend middle school during early adolescence, and high school during late adolescence). For example, in middle school students may be exposed to certain topics in science for the first time. Or, similarly, high school students may be finally granted the autonomy to seriously pursue artistic ambitions, initiating an increase in these kinds of interests. As it currently stands, the literature on mean-level changes in vocational interests has never been systematically studied to test these sorts of changes.

Research Questions

Research Question 1: Overall Direction of Changes

Vocational interests represent broad categories of interest in both work- and non-work-related activities and environments. How then, do vocational interests change over time during adolescence and young adulthood? We first consider changes across different interest traits,

independent of age. In other words, we explore whether people become more or less interested in different activities and environments over time.

Throughout adolescence and young adulthood, people are exposed to a variety of new experiences through school, work, and leisure activities. Because interests develop in relation to exposure and reinforcement (Hidi & Renninger, 2006; Holland, 1997), one possibility is that all interest traits will increase over time. This pattern of change would be consistent with research showing that mean-levels of self-esteem and sense of mastery increase throughout most of adolescence and young adulthood (Erol & Orth, 2011). Research on personality and cognitive development has also found that changes are generally positive (Roberts et al., 2006; Tucker-Drob, 2009). However, the Big Five traits show different patterns of change in response to social role transitions (Lodi-Smith & Roberts, 2007), and specific domains of cognitive ability show somewhat different lifespan trajectories. Thus, changes in vocational interests may vary across RIASEC categories, each of which captures different activities and environments (Holland, 1997). With *research question one*, we examine the overall direction of changes in vocational interests across RIASEC categories and the People, Things, Data, and Ideas orientations.

Research Question 2: Age Periods

Patterns of change may also vary across developmental stages. Research on personality trait development has revealed different patterns of change during early adolescence (~ages 11-14), late adolescence (~ages 14-18), and young adulthood (~ages 18-30). For example, the maturity principle primarily describes changes during young adulthood (Roberts et al., 2006; Roberts & Mroczek, 2008). Personality development follows a different path during early adolescence: *disruption*. Opposing the general trend of increasing social maturity, the disruption hypothesis (Soto & Tackett, 2015) describes short-term dips in agreeableness, conscientiousness,

and emotional stability during the transition from childhood to adolescence (Denissen, Van Aken, Penke, & Wood, 2013; Soto, John, Gosling, & Potter, 2011; Van den Akker, Dekovic, Asscher, & Prinzie, 2014). Researchers have also reported declines in self-esteem, situational interests, and competency beliefs during this age period (Bong, Lee, & Woo, 2015; Frenzel, Pekrun, Dicke, & Goetz, 2012; Renninger & Hidi, 2016; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). Although these motivational variables differ from trait-like vocational interests, theoretical descriptions of interest development would likely predict concurrent decreases in interest traits. For example, according to the SCCT (Lent et al., 1994), interests are unlikely to develop when students lose confidence in their abilities, or view themselves as incompetent (see also, Bandura, 1982).

In contrast, cognitive abilities generally do not show a pattern of decreasing during early adolescence. Gains in cognitive development among children and adolescents are persistent, with only slight stalls during summer months (e.g., Downey, von Hippel, & Broh, 2004). This divergence of research findings suggests that cognitive and academic development is progressive and cumulative, whereas personality development progresses in the context of ever shifting social circumstances (Briley & Tucker-Drob, 2017).

It is not known whether the maturity principle and disruption hypothesis apply to vocational interests. If the disruption hypothesis does apply, we would expect mean-level interest scores to decrease during early adolescence. After this period, the direction of change seems less clear. If vocational interests follow a similar pattern of change as personality traits, normative increases would be expected in most RIASEC categories during late adolescence and young adulthood. If, on the other hand, vocational interests develop more similarly to cognitive abilities, we would expect a relatively linear and constant trajectory of interest growth—without a

disruption during early adolescence. With *research question two*, we investigate the impact of developmental age periods on mean-level changes in vocational interests.

Research Question 3: Gender Differences

Patterns of change may also differ for men and women. Gender plays a key role in the interest development process, as outlined by Gottfredson (1981, 2005) in her theory on the development of occupational aspirations. Gottfredson proposes four stages of development. The first two stages (spanning ages 3-5 and 6-8, respectively) describe orientations towards size and power, and sex roles. Research has generally supported an early awareness of sex roles. For example, studies have shown that children are aware of gender-based occupational stereotypes by the age of five (O'Bryant & Corder-Bolz, 1978; Watson & McMahon, 2005), and both boys and girls tend to express greater interest in occupations associated with their own gender (Liben, Bigler, & Krogh, 2001; Signorella, Bigler, & Liben, 1993; Tracey, 2001). During Gottfredson's third stage (ages 9-13), adolescents are oriented towards social expectations and values. Gender differences in vocational interests would likely increase during this stage, as students become highly sensitive to peer approval. Finally, the fourth stage (age 14 and over) describes the development of an orientation to the internal, unique self (Gottfredson, 1981). With a shift away from peer group approval, gender differences may decline after age 14.

By far, the largest gender differences in vocational interests are found in Realistic and Social interests. Men have stronger Realistic interests; women have stronger Social interests (Su et al., 2009). These differences are relatively consistent across age and birth cohorts (Hansen, 1988). However, there is some evidence to the contrary (Morris, 2016; Su et al., 2009). For example, in Su et al.'s meta-analysis, smaller differences in Social interests were found in older samples. This finding suggests that gender differences may gradually decrease with age,

consistent with Gottfredson's (1981) fourth stage and Guttman's (1987) cross-over hypothesis. The cross-over hypothesis argues that men and women's personality traits "cross-over" somewhat during adulthood due to normative social role transitions (Guttman, 1987). According to this perspective, men become more emotionally nurturing during adulthood as family-life replaces the career as a primary focus, while women become more dominant and masterful as children age and require less attention (Guttman, 1987; Roberts & Helson, 1997).

Do gender differences in vocational interests increase or decrease with age? According to Gottfredson's (1981) theory and the cross-over hypothesis (Guttman, 1987), gender differences in Realistic and Social interests should gradually decrease throughout young adulthood. However, if gender-based occupational stereotypes have a persistent influence across the lifespan, gender differences may increase with age. With *research question three*, we investigate gender differences in the longitudinal development of vocational interests. The current meta-analysis is well suited to study gender differences because the vast majority of studies reported mean-level changes separately for female and male samples.

Other Potential Moderators

In addition to the three major research questions, we examined other potential moderators of interest change: retest interval, interest scale classifications, and cohort. Retest interval is particularly important from a theoretical standpoint. If interests change more over longer periods of time, this would be strong evidence that changes accumulate over time, rather than returning to a set point. Research on personality trait development shows that time has a positive influence on mean-level personality trait change (Roberts et al., 2006). We also expected that interests would exhibit greater change over longer periods of time.

The interest inventories included in this meta-analysis used different kinds of scales (all of which specifically measured interests, not broader "interest types"). Although we sorted all scales into the RIASEC framework, we tested the original scale classifications of each interest inventory as a potential moderator. This enabled us to assess whether patterns of change varied across different interest classification systems. Low et al.'s (2005) rank-order meta-analysis did not find any significant differences based on the interest inventory scale classification. We therefore did not expect differences based on scale classification.

Generational cohorts were tested as a moderator to assess whether patterns of interest change varied as a result of the normative experiences of individuals born in different time periods. In the cognitive domain, cohort differences have been identified revealing increasing performance on intelligence tests over time in the general population (i.e., "the Flynn effect", Flynn, 1987). A similar effect has recently been reported in personality traits (Jokela, Pekkarinen, Sarvimäki, Terviö, & Uusitalo, 2017). One explanation for these trends is that modern society has become successfully more information rich and complex (Pietschnig & Voracek, 2015). It is possible that these societal changes may influence interest development, such that younger cohorts may experience greater changes in their interest levels. However, Low et al. (2005) did not find any meaningful relationships between cohort and the rank-order stability of interests, and we expected to find similar results.

Method

The current study aggregates longitudinal data from primary studies to provide a summary of how vocational interests change from early adolescence (~age 12) through middle adulthood (~age 42). We first assess whether overall interest intensity changes over time, and in what direction. In doing so, we also investigate patterns of change across different kinds of

interests, independent of age. These meta-analytic regression models assess changes across Holland's RIASEC categories, and People, Things, Data, and Ideas interest orientations. Second, we examine age trends based on the timing of major educational transitions in the United States. These analyses test whether the size and direction of mean-level changes vary during different developmental periods. Third, based on previous meta-analytic research on gender differences in interests (Su et al., 2009), we test whether gender differences in Realistic and Social interests increase or decrease with age. Lastly, we examine potential moderating effects of cohort, retest interval, and interest classification systems.

Literature review. We used multiple strategies to locate both published and unpublished research, focusing specifically on studies that looked at mean-level changes in interests (see Figure 1 for PRISMA flow statement). During the Fall of 2014, we searched abstracts from PsycINFO, Proquest Dissertations and Theses, and ERIC databases using the following combination of words: (*interest* OR *interest trait*) AND (*vocational* OR *occupational* OR *career*) AND (*stability* OR *consistency* OR *continuity* OR *mean-level change* OR *longitudinal*). Next, we reviewed the reference list from a previous dissertation on mean-level changes in vocational interests (Low, 2009) and scanned the test manuals of popular interest inventories. This process produced 1,970 results, which were all scanned for relevance to the topic. Once we had a preliminary list of longitudinal studies, we scanned their reference lists and asked subject matter experts if they were aware of any studies we may have missed.

Inclusion criteria. To be included in the meta-analysis, studies needed to meet four criteria. First, the paper must have reported the means and standard deviations of interest scores at two time-points, retest interval, sample size, age of sample, and the type of inventory used. Second, the sample for which data was reported must have been defined by a specific age at the

first time testing (with a common retest interval). This criterion was necessary because age was our primary basis for examining changes across the lifespan. Third, the retest interval must have been one year or greater. This criterion was included to minimize carry over effects between tests; however, no studies were excluded for this reason. Fourth, papers must have been published in English and the research must have been conducted with participants in the U.S. or Canada. These criteria were included because the timing of educational transitions (e.g., beginning high school or graduating college) varies across countries; studies conducted in other countries could confound patterns of normative interest change in the U.S. and Canada. Forty-nine studies met all criteria and were subsequently included in the meta-analysis (see Table 1). The 49 studies contained 98 total samples, consisting of 20,639 participants, yielding 529 estimates of change within RIASEC categories (the most recent publication year was 2011).

Study/Variable Characteristics

Age categories. We recorded each sample's age at the first and final time of testing. The majority of studies explicitly reported the mean or median age of their sample. However, some studies only provided age-based descriptive information (e.g., college freshman). When this was the case, we assigned an age to the sample based on the typical age of individuals from that population (e.g., college freshman were recorded as 18 years-old).

We initially set up four age categories that separated the early lifespan based on normative educational transitions in the U.S.: middle school (ages 11-14), high school (ages 14-18), college (ages 18-22), and emerging adulthood (ages 22-30). Samples were assigned to an age category based on the midpoint of their age at each time of testing. We took this approach to reduce the complexity of our models by jointly taking into account both age and time interval effects. We expected non-linear trends given the sharp educational and occupational transitions,

but we also tested the robustness of alternative specifications (see *Analytic Approach* section).

Several samples had long retest intervals that spanned considerably more time than the age category to which they were initially assigned. For example, a sample that was 18-years-old during initial testing and 36-years-old at final testing (with a midpoint age of 27 years) would be assigned to the 22-30 age category. In this case, only 8 of the 18 years between testing fall within the 22-30 age category. To better account for these samples, we created a separate age category representing late adolescence through middle adulthood (or approximately ages 18-42). We assigned samples to this age category if more than 50% of their retest interval (in years) fell outside of their initially assigned age category. Altogether, 15 samples were reassigned through this procedure. The 15 samples in the late adolescence through middle adulthood age category were fairly homogenous in age, with an average age of 18.4 years at initial testing (SD = 3.2 years) and 41.9 years at final testing (SD = 8.7 years). The mean retest interval for this age category, weighted by sample size, was 25.7 years (SD = 7.3 years).

Gender. We coded samples of women, men, and mixed-gender participants separately. We then computed separate effect size estimates for samples comprised of men or women (in addition to overall effect sizes).

Interest Scale Classifications. There were three primary scale classifications: Holland's (1997) RIASEC scales, occupational scales (e.g., Strong, 1943), and basic interest scales (Campbell, 1971). We sorted the various scales into the RIASEC framework using an established method from a previous meta-analysis (Su et al., 2009; p. 866, Table 1). This procedure utilizes construct validity evidence from previous research to categorize scales into the RIASEC framework (e.g., Cole & Hanson, 1971). For example, the Kuder Preference Record (Kuder, 1977) contains scales for 10 basic interest areas. These basic interests map into Holland's (1997)

RIASEC framework based on overlapping factor structures (e.g., Outdoor and Mechanical interests are assigned to the Realistic category; Scientific interests are assigned to the Investigative category, etc.).

Cohort. Generational cohorts were coded by subtracting the age of participants in a sample from the year in which the first testing occurred. For studies that did not include specific testing dates, we used publication dates minus two years (to account for data collection and preparation for publication; Grijalva et al., 2015). The generational cohorts of samples varied considerably, ranging from samples born in 1916 to 1996.

Retest Interval. All longitudinal studies included information about the amount of time between assessments, which were coded in years (ranging from 1 to 36 years).

Intercoder reliability

Two graduate students coded the study variables, including: sample descriptions (including education), mean-level interest scores, standard deviations of interest scores, age, gender, interest inventory, scale classification, cohort, and retest interval. Each graduate student coded and double-checked two-thirds of the studies, such that one-third of the studies were double-coded. The double-coded studies were checked for intercoder reliability. Intercoder reliability was high, ranging from 94% for cohort to 100% for retest interval, gender, and interest scale. Studies with mismatched codes were jointly reexamined and recoded after reaching a consensus.

Data Analysis

Effect size computation. We computed effect sizes using raw mean scores and standard deviations for 96% of the studies. For the other 4% of studies, we inferred effect sizes from t-values using the formulas from Morris and Deshon (2002, p. 118). Effect sizes were computed

for each sample by subtracting the mean interest scores at final testing from those at initial testing, and then dividing these differences by the standard deviations of raw scores at initial testing.

We chose this metric, known as the *single-group, pretest-posttest raw score effect size* (Morris & DeShon, 2002), instead of a change-score metric (which divides difference scores by the standard deviations of change scores) for two reasons. First, unlike the change-score metric, the raw score metric does not utilize test-retest correlations in the computation of standardized difference scores. Because test-retest correlations are a function of rank-order consistency, the change-score metric confounds rank-order consistency with mean-level change. As we were only interested in mean-level change, we chose the raw score metric.[2] Second, the raw-score metric standardizes each sample's difference scores using units from the original scale, allowing for direct comparisons to be made across independent samples (Morris & DeShon, 2002). This procedure matches that used by Roberts et al. (2006) to maximize similarity across analyses and aid in comparison.

We first aggregated effect sizes within RIASEC categories using an established method from a previous meta-analysis (Su et al., 2009). If a single sample yielded multiple effect sizes within one RIASEC category, we averaged the various effect sizes into a single estimate of change. There were also eleven samples with overlapping data from the SVIB occupational scales and SVIB basic interest scales. For these samples, we first aggregated effect sizes from the original scales into the RIASEC taxonomy so that we had two effect sizes for each RIASEC

[2] It is important to note that the raw score metric does use test-retest information in the calculation of the standard errors due to the repeated measures study design (see Morris & DeShon, 2002, p. 117). If all other variables are held equal, standardized difference scores from samples with higher retest stabilities will have smaller standard errors. This implies that mean-level changes from samples with higher rank-order consistencies provide more precise effect size estimates. We obtained retest information for 92% of the studies in the meta-analytic dataset. For the other 8%, we used stability estimates from corresponding age categories reported in Low et al. (2005; see Table 2, p. 723).

category. We then averaged the effect sizes from the occupational scales and basic interest scales to compute single estimates of change for each RIASEC category.

After computing effect sizes within RIASEC interest categories, we computed effect sizes for People, Things, Data, and Ideas orientations. These dimensions were initially proposed to be bipolar. However, recent studies by Tay, Su, & Rounds (2011) and Graziano, Habashi, and Woodcock (2011) have shown that these dimensions are better represented from a bivariate perspective. In other words, an interest in People does not necessarily imply a lack of interest in Things; and similarly, one can be interested in activities that involve both Data and Ideas simultaneously (Woodcock et al., 2013). Based on this research, we separated the bipolar dimensions, scoring each end of the dimension separately and relabeling them according to Graziano et al. (2011). We used modified formulas from the UNIACT-Revised Edition manual (American College Testing Program, 1995, p. 126), such that:

People = [2(S) + (A) + (E)] / 4

Things = [2(R) + (I) + (C)] / 4

Data = [(E) + (C)] / 2

Ideas = [(I) + (A)] / 2

Consistent with our lifespan development approach, we then aggregated effect sizes within age categories. The vast majority of studies (98%) only reported data for two time-points, but one study reported data for three time-points (Tracey, Robbins, & Hofsess, 2005). For the study with three time-points, we used the difference between mean interest scores at final and initial testing because this interval completely covered an existing age category. Lastly, we aggregated all effect sizes (denoted by *d*) into a single dataset, along with the other coded variables.

Analytic Approach. We applied Cheung's (2008) framework to fit random and mixed effects meta-regression models to the dataset using Mplus statistical software (Muthén & Muthén, 1998-2015). Random effects meta-analysis estimates an omnibus effect size as well as the amount of systematic between-study variance, and mixed effects meta-regression attempts to explain the between-study variance using moderators. We treated each coded study characteristic as a potential moderator of mean-level change. Because each study contributed multiple effect sizes (i.e., multiple RIASEC categories), we applied two corrections to obtain robust standard errors. First, all analyses were weighted by the inverse sampling variance and the inverse number of effect sizes drawn from each sample. Second, we corrected for nonindependence via clustered standard errors (McNeish, Stapleton, & Silverman, 2016). We clustered standard errors based on sample identifiers, as this was the most relevant level of information in the dataset. Put differently, we corrected for nonindependence of participants contributing multiple effect sizes to the analysis (e.g., by contributing one effect size for each RIASEC dimension). We did not include clusters at the study- or author-levels as the participants that the effect sizes were drawn from were entirely non-overlapping.

Our first goal was to assess whether mean-level interest scores change over time. To investigate this question, we fit meta-regression models examining changes across RIASEC categories, and People, Things, Data, and Ideas orientations. These three models tested the degree to which overall interest intensity changes over time (independent of age), and whether changes varied across different kinds of interests.

Our second research question examined whether the size and direction of changes varied across age categories. We were also interested in the possibility that interest scores undergo continuous patterns of change, such that educational transitions are less impactful. If interest

development is responsive to qualitative educational transitions, then our linear model would be unable to detect this trend, and our categorical model would be preferred. Thus, we fit separate meta-regression models treating age as both a categorical and continuous variable. In the continuous model, we tested the effects of age at the first time of testing while controlling for the effect of retest interval. In the categorical model, we did not control for retest interval because this variable was already included in the computation of age categories, as described earlier. We also wanted to explore patterns of RIASEC interest change within each age category. Thus, we set up an additional meta-regression model to test for interactions between the age categories and RIASEC categories.

Our third goal was to assess whether patterns of change differed for men and women, focusing specifically on the idea that gender differences may decline with age (Gottfredson, 1981; Guttman, 1987; Roberts & Helson, 1997). We limited our investigation to Realistic and Social interests to avoid model over-specification and because these two interest categories have the greatest mean-level gender differences (Su et al., 2009). As discussed earlier, the cross-over hypothesis concerns age-related changes in adulthood, after the disruption period of early adolescence (Soto & Tackett, 2015). Thus, we examined gender differences separately within age categories. We explored patterns of change in Realistic and Social interests within the samples that comprised early adolescence (ages 11-14); late adolescence, the college years, and emerging adulthood (ages 14-30); and late adolescence through middle adulthood (ages 18-42). The estimates of change within the 14-30 age category were computed by adding the cumulative effect sizes from the original three age categories that spanned this interval: ages 14-18, 18-22, and 22-30. In summary, the first age category focused on gender differences during the

disruption period, while the latter two were different ways of aggregating studies during young adulthood.

In addition to our primary research questions, we tested whether overall effect sizes varied across other study characteristics, including: retest interval, cohort, and interest inventory scale classifications. We tested these potential moderators using overall effect sizes (i.e., average *d*-values for each sample), rather than within each age and RIASEC category separately, to increase our power to detect significant effects. Furthermore, the probability of making a Type I error would have increased substantially due to the multitude of tests required to test each moderator within each age and RIASEC category separately.

For purposes of analysis, all categorical variables were coded using effects coding. Therefore, we present expected effect size estimates for each moderator category (e.g., the expected effect size for Realistic interests), as well as the meta-regression coefficient for the coded moderator (e.g., how much more or less do Realistic interests change than the omnibus midpoint). These two statistics convey different information. The expected effect size gives the overall magnitude of the effect, and tests for statistical significance in reference to zero. We report this information in terms of *d*-scores. The meta-regression coefficient gives the coded moderators' deviation from the other levels of the moderator, and tests for statistical significance in reference to the midpoint effect size. We report this information in terms of *b* coefficients. We centered continuous moderators, and due to a large positive skew, retest interval was log transformed to normality. We report estimates of between-study heterogeneity in effect sizes as τ.

Results

Study Characteristics

Table 1 displays the study authors, gender, number of participants, retest interval, age category, cohort, interest measure, scale classification, and sample description for each sample included in the meta-analysis. Table 2 shows descriptive information for the samples within each age category, weighted by sample size when appropriate. The age of samples ranged from 11.5 to 23.5 years at the first time of testing, and from 12.5 to 53 years at the final time of testing. The median retest interval was 3.5 years mean; the weighted mean was 6.9 years. The median cohort was born in 1949. Men comprised 54% of the sample participants; women comprised 39%; and the remaining 7% were mixed-gender.

About half of the samples (49%) assessed interests with a version of the Strong Interest Inventory, which has undergone three major revisions since 1927 (see Campbell, 1971; Donnay, et al., 2005). The Kuder Preference Record (KPR) was the next most commonly used interest inventory (some form of the KPR was given to 31% of the samples; Kuder, 1948, 1977), followed by the Vocational Preference Inventory (6%; Holland, 1965) and the ACT Interest Inventory (5%; American College Testing Program, 1995; 2009). The RIASEC interest traits were all studied at similar rates: Investigative was studied the most (93%), while Enterprising and Social were studied the least (87%).

Because of our focus on educational transitions, we also examined the educational characteristics of the sample participants in each age category. All sample participants in the 11-14 age category were middle school students (ranging from 5th to 7th graders). Forty-three percent of the participants in the 14-18 age category were high school students at the onset of the study, while the other 53% were 8th graders. In the 18-22 age category, 80% of the participants were college students at study onset (notably, 45% were college freshman), and 20% were high school students. Eighty-eight percent of the 22-30 age category and at least 59% of the 18-42 age

category had some type of college education (we could not determine educational attainment rates for the other participants in these two age categories). In summary, the 11-14, 14-18, and 18-22 years-old age categories were well representative of middle school students, high school students, and college students, respectively; and most sample participants in the 22-30 and 18-42 years-old age categories were college graduates. There was insufficient data on attrition rates, socio-economic status, and race/ethnicity to include these variables in analyses.

Research Question 1

Do Interests Change? When considering our full meta-analytic dataset, we found evidence of a small, positive change in mean-level vocational interest scores ($d = .03$, $p < .05$). This suggests that if a given individual were to take an interest inventory twice over a period of at least one year, their average interest would likely increase slightly. However, there was substantial evidence of between-study heterogeneity ($\tau = .146$, $p < .01$) implying that there are systematic sources of variance in the overall effect size estimate that may be explained by moderators.

How Do Changes Vary Across Interest Traits? Table 3 displays the meta-regression models predicting mean-level changes for different interest traits, and Figure 2 presents these results graphically. We fit separate models for RIASEC categories, People and Things, and Data and Ideas interest orientations. In Figure 2, the horizontal lines display the average effect size for each model; the dots and error bars represent deviations and 95% random effects confidence intervals. In the RIASEC model, the average effect size was .03 ($p < .05$) and there were significant differences across RIASEC categories. Whereas Artistic ($d = .09$, $p < .01$), Social ($d = .08$, $p < .05$), and Enterprising ($d = .09$, $p < .01$) interests increased, Conventional interests decreased ($d = -.08$, $p < .01$), and Realistic ($d = .04$, $p = .10$) and Investigative ($d = -.02$, $p = .35$)

interests remained constant. The regression coefficients for Artistic (b = .06, p < .01) and Enterprising (b = .06, p < .01) interests were significantly greater than average, while Investigative (b = -.05, p < .01) and Conventional (b = -.12, p < .01) effect sizes were significantly lower than average.

These RIASEC differences are reflected within the results of the People and Things orientations. The average effect size for this model was .04 (p < .01), and effect sizes significantly differed across People and Things interest orientations. Interests involving People increased over time (d = .08, p < .01), whereas interests involving Things showed no change (d = .00, p = .83). These effect sizes were significantly different from each other (p < .01).

Smaller differences were found within the Data and Ideas orientations. Interests involving Ideas (d = .03, p = .09) increased slightly but did not reach statistical significance, while interests involving Data remained constant (d = -.01, p = .77). These effect sizes were not significantly different from each other (p = .16). In all three models examining changes across interest categories, we found significant between-study heterogeneity: RIASEC (τ = .136, p < .01, accounting for 6.8% of the variance), People and Things (τ = .124, p < .01, accounting for 4.6% of the variance), and Data and Ideas (τ = .138, p < .01, accounting for 0% of the variance).[3]

In relation to our first research question, the results suggest that overall interest intensity increases slightly over time, yet there are key differences across interest traits. The most notable distinction was found for the People and Things interest orientation. Over time, interests involving People increase (i.e., Artistic, Social, and Enterprising), whereas interests involving Things either decrease (Conventional) or remain constant (Realistic and Investigative). However, these changes were estimated without considering age.

[3] Between-study heterogeneity in the baseline model differed slightly for People and Things (τ = .130, p < .01) and for Data and Ideas (τ = .138, p < .01) due to the differing aggregation techniques.

Research Question 2

How Do Changes Vary Across Age Categories? Treated continuously, age (b = .00) and time interval (b = .02) accounted for less than 1% of the between study heterogeneity. Therefore, we proceeded to treat age categorically to test for nonlinear effects across developmental stages. Table 4 presents the results of the meta-regression model predicting changes in overall interest intensity by age category. See Figure 2 for a graphical representation. As mentioned, the first four age categories were based on the timing of major educational transitions in the U.S.: the middle school years (ages 11-14), high school years (ages 14-18), college years (ages 18-22), and emerging adulthood (ages 22-30). The fifth age category includes studies with long retest intervals that spanned late adolescence through middle adulthood (~ages 18-42).

Consistent with the *disruption hypothesis*, we found that mean-level interest scores decreased during the middle school years (d = -.10, p < .01), and this effect size was significantly lower than the other age categories (b = -.11, p < .01). Put differently, our model implies that interest intensity decreases by approximately 1/10th of a standard deviation across the middle school years, and this effect size is .11 standard deviations below the overall midpoint, a statistically significant deviation. Interest scores increased during the high school years (d = .08, p < .01), significantly more than the other age categories (b = .06, p < .01). During the college years (d = .01, p = .82) and emerging adulthood (d = .02, p = .38), interest scores plateaued. Lastly, in the age category representing late adolescence through middle adulthood, there was a statistically significant increase in interest scores (d = .07, p < .01) that differed from the other age categories (b = .05, p < .05). With age categories as an explicit moderator, we still found

significant between-study heterogeneity ($\tau = .139$, $p < .01$, accounting for 4.8% of the heterogeneity).

Are Age and Interest Category Effects Interdependent? We tested for interactions between age and interest categories to explore changes within RIASEC traits during each developmental age period. In other words, we examined more specific patterns of change within the effect size estimates in Table 4. Table 5 displays the results of this meta-regression model, and Figure 3 presents the results graphically. The solid lines in Figure 3 display cumulative effect sizes across the age categories spanning 11-30 years; the dotted lines represent effect sizes for the 18-42 age category. The average effect size for this model was .02 (p = .11), and the estimate of between-study heterogeneity was .112 ($p < .01$). This result implies that about 23% of the systematic between-study heterogeneity could be explained by modeling the interdependence of age and interest category effects, which was substantially better than any other model. For ease of presentation, we only report expected effect size estimates for this model involving interactions. (Table S2 in the Supplemental materials contains the *b* coefficients for this model.) Note that not all interaction parameters were statistically significant, and we focus on the model implications most relevant to our research questions.

As mentioned, the period of adolescence was marked by two general patterns of change: mean-level interest scores decreased during early adolescence, then increased during late adolescence. This general pattern of change was evident for most RIASEC categories. For example, Conventional interests showed the greatest decline during early adolescence ($d = -.30$, $p < .01$), before shifting in the positive direction during late adolescence ($d = .06$, $p = .20$). Realistic and Social interests showed similar patterns of change, but there were substantial gender differences within these two domains that are further explored in Table 6. There was one

notable exception to the pattern: Enterprising interests showed a pattern of increasing during both early (d = .16, p < .18) and late adolescence (d = .18, p < .01).

Although average interest intensity remained constant during both the college years and emerging adulthood, there were notable differences across RIASEC traits. The interest categories involving People either increased or remained constant. For example, Artistic (d = .11, p < .01) and Social (d = .14, p < .01) interests increased significantly during the college years. Artistic interests also increased significantly (d = .16, p < .01) during emerging adulthood, as did Enterprising interests (d = .10, p < .01). In contrast, the interest orientation involving Things either decreased or remained constant. During the college years and emerging adulthood, the majority of the effect sizes for Realistic, Investigative, and Conventional interests were negative or did not reach statistical significance.

The results from the final age category, covering late adolescence through middle adulthood, generally support those found during the college years and emerging adulthood. Interests involving People, particularly Artistic (d = .13, p = .10) and Social interests (d = .14, p = .15), were more likely to increase than Interests involving Things. The only exception was Investigative interests, which increased significantly in this age category (d = .16, p < .01).

With regard to our second research question, the results suggest that interest intensity changes nonlinearly across the lifespan, with interdependent effects among age and interest categories. When both age and interest categories were included in a single model, the general pattern of increasing People-oriented interests was most evident in the three age periods that comprised young adulthood: the college years, emerging adulthood, and late adolescence through middle adulthood. Before adulthood, most interest categories followed a general trend of decreasing during early adolescence, then increasing during late adolescence.

Research Question 3

Are There Gender Differences in Patterns of Change? As a preliminary test, we examined whether overall interest intensity differed in samples composed entirely of men or women and found that it did not (b = -.01, p = .52), leaving substantial unexplained between-study heterogeneity (τ = .146, p < .01). The result is consistent with our expectations and previous results indicating interdependent moderator effects. To explore gender differences in this context, we focus on whether age trends in Realistic and Social interests, the two interest categories with the largest previously established gender differences, differ for women and men. A major strength of this analysis is that we were able to compare results across samples composed entirely of men or women, rather than the percent of each within samples.

Table 6 displays the meta-regression results, including the differences between effect sizes for women and men. Figure 4 presents these results graphically. This model allowed us to test gender differences during early adolescence and young adulthood. The average effect for this model was -.09, (p < .01) and the estimate of between-study heterogeneity was .119 (p < .01). Because this model only used a subset of the dataset, the between-study variation above is not directly comparable to the previous models. For ease of presentation, we only report expected effect size estimates and difference scores for this model.

During the middle school years, there were significant gender differences in mean-level changes for both Realistic and Social interests. Both boys' (d = -.09, p < .01) and girls' (d = -.24, p < .01) Realistic interests decreased, but girls showed a significantly steeper decline than boys' (Δd = -.15, p < .05). There was also a significant gender difference in Social interests (Δd = .52, p < .01), as girls' Social interests increased slightly (d = .12, p < .05), while boys' showed a steep

decline (d = -.40, p < .05). Both difference scores indicate that gender differences in vocational interests widen during the disruption period of early adolescence.

The estimates of change within the 14-30 and 18-42 age categories offer two ways of examining gender differences during young adulthood. As mentioned, the 14-30 age category consisted of cumulative effect sizes from the original three age categories spanning this interval: late adolescence (14-18), the college years (18-22), and emerging adulthood (22-30). The 18-42 age category contained only samples with long retest intervals that spanned late adolescence through middle adulthood. The results from both age categories suggest that gender differences gradually decline with age. In Realistic interests, women's interest scores increased significantly within both the 14-30 (d = .27, p < .01) and 18-42 age categories (d = .24, p < .01), while men showed little change (for 14-30, d = .02, p = .89; for 18-42, d = -.03, p = .70). Social interests follow a similar trend: men's Social interests increased significantly in the 14-30 age category (d = .23, p < .05) and increased slightly less in the 18-42 age category (d = .15, p = .20), while women's Social interests changed little (for 14-30, d = .04, p = .71; for 18-42, d = .07, p = .27). We also tested whether these effect sizes were significantly different for men and women. The only significant difference was Realistic interest scores in the 18-42 age category (Δd = .27, p < .01), such that women's Realistic interests increased more than men's. However, the other effect sizes tended to be moderate and potentially meaningful in magnitude (differences in trends of approximately $\Delta d = |.2|$).

With regard to the third research question, the results suggest that gender differences in vocational interests follow two distinct patterns of change. During the disruption period of early adolescence, gender differences in Realistic and Social interests widen. After this period, however, gender differences appear to decline gradually, consistent with theoretical predictions

(Gottfredson, 1981, 2005; Guttman, 1987). In the two age categories that spanned late adolescence to adulthood, women's Realistic interests increased, while men's remained constant. Parallel changes were found in Social interests, as men's Social interests showed a pattern of increasing, while women's did not. In summary, vocational interests associated with the opposite gender increased during young adulthood, while interests associated with the same gender remained constant. Nevertheless, the effect sizes in the 14-30 and 18-42 age categories were only significantly different for men and women in one of four comparisons, most likely due to low power for estimating this difference.

Other Potential Moderators

We also investigated the potential moderating impact of study characteristics not included in our three primary research questions. We used three meta-regression models to test whether mean-level changes varied by cohort, retest interval, and interest scale classification. We tested these potential moderators using overall effect sizes to increase our power to detect significant effects, and to limit the probability of making a Type 1 error due to testing each artifact separately within the age and interest categories.

In the scale classification model, there were almost no deviations across RIASEC scales, basic interest scales, and occupational scales. (Table S1 in the Supplemental Material available online displays the results.) Including scale classifications in the model accounted for 0% of the between-study heterogeneity, which was estimated at .146 ($p < .01$). Next, we tested the impact of birth cohort. Cohort had a small, positive relationship with mean-level interest change; the estimated effect of a ten-year cohort difference was .01 ($p = .20$). These results suggest that the vocational interests of younger cohorts increased slightly more than older cohorts, but the effect size was non-significant and trivial in magnitude compared to cohort differences in abilities (e.g.,

Flynn, 1987; Pietschnig & Voracek, 2015). Again, including cohort accounted for only 2.1% of the between-study heterogeneity.

As a final test, we assessed whether longer retest intervals were associated with greater change while simultaneously controlling for age differences. Research on mean-level changes in personality traits suggests that time has a positive relationship with change (Roberts et al., 2006), so we expected studies with longer retest intervals to show greater changes. Retest interval had a small, positive relationship with change ($d = .02$, $p < .05$), suggesting that interests change slightly more over longer intervals. However, the model accounted for less than 1% of the between-study heterogeneity. Thus, similar to scale classifications and cohort, the effect of retest interval was slight.

Publication Bias

To assess for the possibility of publication bias, we created funnel plots for each of the six RIASEC categories. Funnel plots display the relationship between effect size estimates and the precision of each estimate (i.e., the inverse sampling variance). If there is no sign of publication bias, effect sizes concentrate around a precise estimate with increasing sample size, forming a symmetric "funnel" shape. Asymmetry in the funnel plots can be a sign of publication bias or denote the existence of outliers. After examining the funnel plots, we identified two studies (containing three samples, $N = 16$, $N = 32$, and $N = 52$) as potential outliers. We reran all models omitting these outliers. No inferences differed and the effect sizes were essentially unchanged across all models. Funnel plots for each RIASEC category are presented in Figure S1 in the Supplemental Material available online.

Discussion

The current meta-analysis examined mean-level changes in vocational interests from adolescence to adulthood across 98 samples. Findings indicate that mean-level interest scores generally increase over time, but this effect varied for different interest traits during different periods of the lifespan (See Figure 2). Adolescence was defined by two broad patterns of change: interest intensity decreased during early adolescence (i.e., middle school, ages 11-14) before increasing during late adolescence (i.e., high school, ages 14-18). During adulthood, the most striking changes were found across the People and Things orientations (Graziano et al., 2011). Interests involving People tended to increase (Artistic, Social, and Enterprising), whereas interests involving Things either decreased (Conventional) or remained constant (Realistic and Investigative). Finally, gender differences were found suggesting that the interests of men and women become more similar with age beginning in late adolescence.

Most of the effect sizes within each age category were relatively small in magnitude. However, examining the effect sizes across age categories reveals larger changes across the developmental span. If we assume that the mean-level changes within each age category are independent, the effect sizes can be summed to provide an estimate of the total amount of change for each interest category from early adolescence to middle adulthood. As shown in Figure 3, the total accumulation of positive change ranged from about two-fifths to one-half of a standard deviation in Artistic and Enterprising interests, respectively. In contrast, mean-level Conventional interest scores decreased by about one half of a standard deviation. Such changes can be characterized as medium in magnitude (Cohen, 1992), and are especially noteworthy because they reflect change across entire populations.

One of the more intriguing questions raised by this meta-analysis is why do vocational interests change in this way? The current meta-analysis identified clear patterns of mean-level

change occurring within groups of people. Such changes are likely associated with broad triggers that impact most people at similar points in the lifespan. Triggers can be events or situations that cause a shift towards new objects of attention (Renninger & Hidi, 2016). For example, most people progress through biological changes, such as puberty, and social role transitions, such as educational credentialing, at a similar age. These normative experiences may influence changes in interests and other related individual differences. Research on personality development has found that shared experiences can trigger normative changes in traits (Wrzus & Roberts, 2016). Yet, surprisingly little research has examined why interests change, especially across groups of people. In the following discussion, we integrate research and theory on the development of interests, personality traits, cognitive abilities, and other relevant individual differences. Then, we outline areas for future research and discuss implications for the use of interests in applied settings.

Adolescence: Disruption Breeds Growth

During early adolescence, mean-level interest scores decreased in almost every interest category. These findings extend previous research showing negative changes in ability-related beliefs (Wigfield et al., 1991) and interest in school subjects during early adolescence (Bong et al., 2015; Frenzel et al., 2012; Renninger & Hidi, 2016). In addition, research on personality trait development has found declines in conscientiousness, agreeableness, and openness to experience during this period (Denissen, Van Aken, Penke, & Wood, 2013; Soto et al., 2011; Van den Akker et al., 2014). These declines temporarily disrupt the general trend of increasing personality maturity across the early lifespan.

Our findings suggest that the disruption hypothesis, which originally focused on personality trait development (Soto & Tackett, 2015), can now be extended to interests. But why

do these decreases in interest intensity occur? What causes the disruption of early adolescence? Clearly, the transition from childhood to adolescence is not easy. With the onset of puberty, pressure from social groups, and an increased emphasis on school grades, early adolescence is accompanied by many challenges (Eccles et al., 1993). The school environment changes considerably from elementary school to middle school in the United States. Content tends to become more hierarchical and complex, making it difficult for students to keep up if they miss a foundational concept. In addition, students start making connections between school subjects and careers at about this age (Renninger & Hidi, 2016). If students experience difficulties in school courses, they may lose confidence in their abilities and experience more negative affect when thinking about career paths. Because of the close relationship between interests and self-efficacy beliefs, this would likely lead to decreases in vocational interests (Lent et al., 1994; Bandura, 1982).

In addition to changing educational environments, social networks increase in size with the onset of adolescence (Wrzus, Hänel, Wagner, & Neyer, 2013). Social influences play a central role in the process of interest development (Bergin, 2016), and may be particularly persuasive during adolescence (Sherman, Payton, Hernandez, Greenfield, & Dapretto, 2016). Friends, parents, and teachers can influence interest development by exposing students to new ideas and subject areas. Social support can help situational interest persist over time and develop into a trait-like disposition (Hidi & Renninger, 2006). But without sufficient social support, new interests are unlikely to develop and existing interests may fade away. Social influences can also lead to declines in interests, such as through competition or disapproval from peers. As outlined in Gottfredson's (1981, 2005) theory of occupational aspirations, peer approval is particularly influential in the development of gendered interests. For example, one study found that

adolescents who spent more time with same-sex peers had more stereotypical gendered qualities (McHale, Kim, Dotterer, Crouter, & Booth, 2009). This may partially explain why gender differences in vocational interests widened substantially during early adolescence.

A variety of social-contextual and biological factors likely play a role in the interest development process during adolescence. However, it is not yet clear how these factors work together to produce the patterns of change identified in this meta-analysis. More research is needed to better understand the mechanisms underlying changes in students' interest intensity, as well as their motivational implications. One promising approach is Krapp's (2005) person-object theory of interest, which focuses on the role of three basic needs: competence, autonomy, and relatedness (Deci & Ryan, 2000). According to this perspective, experiences that help fulfill one or more basic need play a crucial role in the formation of interest and intrinsic motivation. In contrast, experiences that prevent the fulfillment of a basic need can lead to decreases in interest through negative emotional reactions and cognitions. The various challenges of early adolescence may make it more difficult for students to fulfill their basic needs of competence, autonomy, and relatedness. As a result, vocational interest intensity may decrease.

Yet the disruption of early adolescence is only temporary. In the current meta-analysis, interest intensity increased in almost every interest category during late adolescence, recovering from the declines of early adolescence. It may be that the deficits of early adolescence fuel the growth of late adolescence. This interpretation of change is consistent with the *deficits-breeds growth* perspective within lifespan psychology (Baltes, Staudinger, & Lindenberger, 1999). Whereas the traditional *growth* perspective focuses on how people strive to reach higher levels of functioning with age, the *deficits-breeds growth* perspective focuses on how people adapt to new challenges and regulate losses after inevitable declines. These two perspectives are not mutually

exclusive. Rather, they are two different ways of interpreting events that motivate change. For example, from the growth perspective, one student may become more interested in learning guitar because she wants to master the ability to play her favorite songs. In contrast, another student's interest in playing a musical instrument may be triggered by an unmet need to relate to friends in the marching band.

Research on personality trait development is generally consistent with the deficits-breeds growth perspective of adolescent change. Studies have shown that after decreasing during early adolescence, conscientiousness and openness begin to increase rapidly in late adolescence (Soto et al., 2011; Denisson et al., 2013). This leads to one of the major practical implications of the current meta-analysis. Counselors, teachers, parents, and anyone else who interacts with adolescents can benefit by recognizing the normative trends of this age period. Rather than viewing the disruption of early adolescence as inherently negative, these changes can be viewed as a period of preparation and reorganization. Students likely increase their adaptive capacities by overcoming the initial disruption of early adolescence, thereby creating the necessary conditions for growth. Similar gain-loss dynamics occur throughout the lifespan as people adapt to the inevitable challenges associated with aging (Baltes et al., 1999).

Young Adulthood: People, not Things

Interests followed a different pattern of change during young adulthood. Unlike adolescence, young adulthood was defined by a general pattern of increasing People-oriented interests. Interests involving People tended to increase in all three age periods that spanned young adulthood (i.e., ages 18-22, 22-30, and 18-42), while interests involving Things remained constant. In general, these findings may reflect a similar developmental process as outlined by the maturity principle (Roberts et al., 2006). Previous research has revealed overlap between

personality traits and interests that involve People (e.g., extraversion, Social, and Enterprising interests; Ackerman & Heggestad, 1997; Mount et al., 2005). Evidence also suggests a negative relationship between Conventional interests and openness to experience (Hogan & Blake, 1999). This is notable because Conventional interests decreased during young adulthood, which is consistent with increasing levels of openness identified in personality research (Roberts et al., 2006). Together, these findings suggest that throughout young adulthood, people become more socially mature in their personality—while also becoming more interested in activities that involve self-expression, helping, influencing, and leading people. These findings have practical implications for the interpretation of interest scores. Many students will experience gradual increases in Social, Artistic, and Enterprising interests during young adulthood. Counselors who work with high school and college students can benefit by anticipating these changes.

In the study of interest development, this novel finding opens several new lines of future research. Why do People-oriented interests increase during young adulthood? What are the consequences of these changes? Although interest researchers have yet to address these questions, existing research on changes in personality traits and cognitive abilities can help guide future research efforts. Interests, personality traits, and cognitive abilities are interrelated in processes of development and several scholars have argued that interests and abilities are part of personality (Lubinski, 2004; Darley & Harenah, 1955; Holland, 1959). The findings concerning People-oriented interests should therefore be viewed from an integrative perspective. It is likely that mean-level changes in interest traits co-occur with changes in personality traits, abilities, and other individual differences. These changes may be motivated by the same normative transitions that occur during young adulthood or general social pushes toward psychological maturity as defined by the predominant culture.

Throughout young adulthood, social maturity becomes increasingly valued in various interpersonal contexts, and particularly at work. Work environments tend to reward employees for behaviors associated with conscientiousness and social dominance, such as showing initiative, leading others, or completing projects on time. These work-related reward structures help facilitate personality trait change (Nye & Roberts, 2013). For example, a longitudinal study of 14,718 Germans found that conscientiousness increased for young adults after they started their first job, and decreased for older adults after they retired (Specht, Egloff, & Schmukle, 2011). This pattern of change is consistent with research showing that conscientiousness predicts job satisfaction, income, and occupational status (Judge, Higgins, Thoresen, Barrick 1999). If work environments reward employees for being more conscientious, it should be expected that conscientious increases with entry into the workforce.

Considerable research has now found associations between work-related experiences and personality trait maturity (Clausen & Gilens, 1990; Elder, 1969; Lüdtke, Roberts, Trautwein, & Nagy, 2011; Roberts, Caspi, & Moffitt, 2003). These experiences may also cause People-oriented interests and abilities to increase. Socialization processes are particularly influential in work settings (Chatman, 1991; Denissen, Ulferts, Lüdtke, Muck, & Gerstorf, 2014). Organizations socialize new employees by explaining company expectations and helping them adjust to their roles (Nye & Roberts, 2013). Some occupations require less interpersonal interaction than others, but social contingencies are evident in almost all work settings to some degree. Mature people are better liked and more respected by others, creating an incentive to develop personality maturity (Hogan & Roberts, 2004).

People-oriented interests may also increase because of normative patterns of change in the way humans allocate resources across the lifespan—involving both deficits and growth.

Although there are some exceptions, biological aging is generally associated with declines in both cognitive and physical functioning. For example, research has found that older adults generally require more training and support to maintain the same levels of cognitive performance as younger adults (Baltes & Kliegl 1992, Dixon & Bäckman 1995). To compensate for these ability deficits, humans' need for culture increases with age (Baltes et al., 1999). As the need for culture increases, people may become more interested in work tasks that involve social interaction, rather than working alone. Research on social network size across the lifespan generally supports this perspective. During adulthood, personal network size generally decreases, while coworker network size increases (Wrzus et al., 2013). This suggests that social connections at work may become more important with age, possibly motivating increases in People-oriented vocational interests.

Gender Differences Decline with Age

To examine gender differences in patterns of change, we compared developmental trends for men and women in Realistic and Social interests. These two interest categories hold the greatest mean-level gender differences, with men having stronger Realistic interests and women have stronger Social interests (Su et al., 2009). As shown in Figure 4, results indicate that these gender differences follow two distinct patterns of change. During the disruption period of early adolescence, the gap widened in both Realistic and Social interests. These changes appear to be the result of large decreases in boys' Social interests (d = -.40) and moderate decreases in girl's Realistic interests (d = -.24). However, beginning in late adolescence these trajectories shifted direction, providing limited support for the cross-over hypothesis (Guttman, 1987; Roberts & Helson, 1997). In two independent age categories representing late adolescence through middle adulthood, women and men showed mean-level increases in the interest categories typically

associated with the opposite gender (*d*'s ranged from .15 to .27). During young adulthood, women become more interested in Realistic activities that involve the outdoors, using hands to fix things, and the manipulation of tools and machines. On the other hand, men become more interested in Social activities such as teaching, training, and helping others. These results are generally consistent with large-scale cross-sectional research (Morris, 2016; Su et al., 2009) and support Gottfredson's (1981, 2005) idea that students become less concerned with peer group approval after early adolescence, as the focus of development shifts internally toward the unique self.

Though men and women showed different trajectories of change throughout young adulthood, the magnitude of these changes does not appear to be large enough to make up for the overall gender differences in Realistic and Social interests. Su et al.'s (2009) meta-analysis found that men have stronger Realistic interests with an effect size of .84 and women have stronger Social interests with an effect size of -.68. In the current meta-analysis, the difference scores in the two age-categories spanning young adulthood ranged from .26 to .27 in Realistic interests, and from -.08 to -.19 in Social interests. Even if the upper bound estimates were accurate, the effect sizes from this meta-analysis would still be less than half the size of the effect sizes from Su et al.'s meta-analysis. Furthermore, the difference scores we found during early adolescence were also notable in magnitude for Social interests favoring females (d = .52) and to a lesser extent for Realistic interests favoring males (d = -.15).

Integrating these gender-difference findings leads to two conclusions. First, early adolescence is a key period when gender differences in vocational interests develop and increase. The end of early adolescence appears to be the *lifetime peak* of gender differences in vocational interests. Interest assessments in middle school should be interpreted cautiously with this finding

in mind. Second, although gender differences begin to decrease in late adolescence, there are still likely to be moderate to large gender differences in Realistic and Social interests by middle adulthood. Throughout young adulthood, both women and men gain interest in activities typically associated with the opposite gender, but they do not lose interest in activities associated with their own gender. Short of crossing over, gender differences in vocational interests gradually subside with age. This is a novel finding in the study of how psychological gender differences develop and change throughout the lifespan (Hyde, 2005). However, future research is needed to understand why these changes occur, as well as their consequences for work, relationship, and life outcomes.

Future Directions and Limitations

The current meta-analysis is the most comprehensive examination of mean-level changes in vocational interests to date. A primary strength is that the longitudinal studies included in the meta-analysis covered a wide range of age periods throughout adolescence and young adulthood. Furthermore, the vast majority of studies reported mean-level changes separately for men and women. This allowed us to analyze and compare gender differences in trajectories of change across distinct developmental periods, a unique feature of this study. However, it is also important to point out limitations and future research directions stemming from our results.

Childhood and late adulthood are particularly important age periods for future longitudinal research to address. Our study was unable to provide estimates of change during childhood and after middle adulthood due to a lack of longitudinal research during these age periods. Our results revealed pivotal changes in vocational interests during adolescence, but little is known about the changes that precede adolescence. More research is also needed on changes during late adulthood and retirement. Research on other dispositional traits, such as personality

(Roberts et al., 2006), suggests that interests may continue to change throughout middle and later adulthood. This is particularly important in light of recent research outlining the difficulties faced by older adults searching for reemployment after a job loss (Wanberg, Kanfer, Hamann, & Zhang, 2016).

Another limitation is that most samples included in our meta-analytic dataset were composed of individuals with higher than average levels of education. Almost all the samples in the age categories spanning young adulthood were college educated. The patterns of change identified in this study should be viewed with educational contexts in mind. For example, because there are fewer college majors classified as Realistic compared to the other interest categories, college-educated adults may not receive enough exposure to Realistic activities to increase their interest. In addition, instructional content typically becomes more specialized as students progress through grade-levels, which may limit students' overall exposure to different interest areas. Future longitudinal research should sample from more diverse populations to better understand the factors impacting development for different groups of people. Insights can be gained by examining patterns of change across race, ethnicity, educational attainment, and socioeconomic status (e.g. Morris, 2016; De Bolle et al., 2015).

Individual differences in interest development are an important area for future studies to address. In the current meta-analysis, we were unable to study individual differences in patterns of change because of the group-level data reported by primary studies. Past research has found that personality and cognitive development vary as a function of individual differences, and these differences have important behavioral consequences (Mroczek & Spiro, 2003; Roberts, Helson, & Klohnen, 2002; Tucker-Drob, Briley, Starr, & Deary, 2014; Woods & Hampson, 2010). Relatedly, the current study was unable to identify specific time courses of interest change as

studies tended to sample participants many years apart. The identified trends may smooth over times of punctuated change, such as when people start new jobs and are forced to quickly adapt to the responsibilities. Such experiences may result in dramatic shifts over a period of weeks, rather than the gradual, yearly change documented in this study. In the domain of personality development, these sorts of rapid, short-term change have been documented (Roberts et al., 2017).

Future work could also study more specific patterns of change within each RIASEC category. Our meta-analytic approach required us to categorize interest scales into the broad RIASEC framework to integrate findings from past studies. This process inherently led to a loss of information as more specific interest categories (e.g., basic interests) were generalized to fit within RIASEC categories. Facets of the Big Five tend to show different development trajectories, sometimes subtle but others substantial (Soto et al., 2011).

Another critical area for future research concerns why vocational interests change with age. Integrative theories that consider the relationships between interests and other variables offer considerable potential to address this question (Ackerman, 1996; Corno, Cronbach et al., 2002; Gottfredson, 1981, 2005; Schmidt, 2014; Schmidt & Hunter, 1998; Snow et al., 1996; von Stumm & Ackerman, 2013; Wrzus & Roberts, 2016). For example, future longitudinal studies could examine how interests change in relation to other individual differences. Certain abilities and personality traits may influence interest development at later stages. Individuals that possess socially valued abilities may be selected into more challenging jobs in terms of cognitive demand or attention to detail. The social pressure of these occupational roles could reshape the development of interests. Or alternatively, interests may develop before personality traits and abilities, exerting a lasting impact on their development. Individuals who are interested in

cognitively demanding jobs, such as a career in STEM, may be encouraged to pursue more advanced coursework, which may influence the development of personality and cognitive ability. Studies that address these questions can provide a more complete understanding of the forces that shape human development across the lifespan.

In testing these questions, it is critically important to consider the shared variance between interests and other individual differences. Reasoning errors can occur by neglecting such relationships (e.g., Judge, Jackson, Shaw, Scott, & Rich, 2007; Lubinski, 2010; Meehl, 2006; Sanders, Lubinski, & Benbow, 1995). For example, although gender differences in interests have been identified as a key contributor to the gender disparity in STEM fields, there are other important determinants, such as spatial abilities and lifestyle preferences (Ceci, Ginther, Kahn, & Williams, 2014; Kell, Lubinski, Benbow, & Steiger, 2013; Lubinski, Benbow, & Kell, 2014). Educational initiatives and other efforts aimed at reducing the gender disparity in STEM fields (e.g., Ceci & Williams, 2011; Karabenick & Urdan, 2014) should jointly consider the role of interests, abilities, lifestyle preferences, and other relevant individual differences.

We have argued that our results have implications for career counseling and can help organizations improve work conditions to better support the needs of employees as they age. By tailoring job requirements to normative developmental trends, employers may be able to maximize productivity and minimize counterproductive workplace behavior resulting from misfit. Similarly, career counselors could inform job seekers about the potential for their interests to change with development, either to suggest career areas where interests might mold to responsibilities or to encourage a reassessment of occupational interests whenever looking for a new job (rather than assuming that interests are fixed). However, such advice carries an important caveat. Interests may function in a relative sense in many real-world contexts. A

person's interest in a job depends not only on their absolute interest scores, but also on the relative standing of their interest compared to others.

Conclusion

The current meta-analysis showed that vocational interests undergo normative changes from adolescence to adulthood. Early adolescence was marked by widening gender differences and overall decreases in mean-level interest scores. In contrast, late adolescence was defined by a general disposition towards liking things. Early adolescence appears to be the lifetime peak of gender differences in vocational interests, as the interests of men and women gradually become more similar throughout late adolescence and young adulthood. Results also show that People-oriented interests increase throughout young adulthood, which may reflect a similar maturation process identified by personality trait research. Overall, the patterns of change identified in this study add a new perspective to theories of lifespan development and have widespread implications for the practical usage of interests.

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Note. * Indicates study included in meta-analytic dataset.

TABLES

Table 1. *Longitudinal Studies Reporting Mean-level Change in Interests*

Study Authors	Gender	N	Interval	Age Category	Cohort	Measure	Scale Class	Sample Description
Allen (1990)	F	32	4	18-22	1972	SCII	RIASEC	College freshmen
Benjamin/Hutchins (1967)*	M	91	3.5	22-30	1946	SVIB BIS & SVIB Occ	Occ/Basic	Medical school freshman
Benjamin/Hutchins (1967)*	M	106	3.5	22-30	1946	SVIB BIS & SVIB Occ	Occ/Basic	Medical school freshman
Benjamin/Hutchins (1967)*	M	82	3.5	22-30	1946	SVIB BIS & SVIB Occ	Occ/Basic	Medical school freshman
Benjamin (1967)*	M	229	31	18-42	1949	SVIB BIS & SVIB Occ	Occ/Basic	College students
Byers (1977)	M	57	27	18-42	1954	SVIB Occ	Occ	Business school students
Byers (1977)	M	135	27	18-42	1954	SVIB Occ	Occ	Business school students
Campbell (1971)*	F	56	3.5	18-22	1940	SVIB BIS	Basic	College students
Campbell (1971)*	M	171	8	22-30	1935	SVIB BIS & SVIB Occ	Occ/Basic	College graduates
Campbell (1971)*	M	93	26	18-42	1953	SVIB BIS	Basic	College freshman
Cisney (1944)	F	72	3	14-18	1930	SVIB Occ	Occ	High school freshman
Cisney (1944)	F	77	3	14-18	1930	SVIB Occ	Occ	High school freshman
Cisney (1944)	M	61	2	14-18	1930	SVIB Occ	Occ	High school freshman
Cisney (1944)	M	76	2	14-18	1930	SVIB Occ	Occ	High school freshman
Cooley (1967)	F	1590	3	14-18	1953	TALENT	Basic	High school freshman
Cooley (1967)	M	1466	3	14-18	1953	TALENT	Basic	High school freshman
Corbin-Sicoli (1983)	M & F	23	4	18-22	1965	SCII	RIASEC	College freshmen
Corbin-Sicoli (1983)	M & F	29	4	18-22	1965	SCII	RIASEC	College freshmen
Elmore et al. (1985)	M & F	458	4	14-18	1971	UNIACT	RIASEC	8th graders
Emling & Green (1982)	F	43	3.5	22-30	1960	SCII	RIASEC	Dental school freshman
Emling & Green (1982)	M	43	3.5	22-30	1958	SCII	RIASEC	Dental school freshman
Gehman & Gehman (1968)	M & F	93	4	18-22	1948	KPR	Basic	College students
Hansen & Stocco (1980)	M & F	70	3	14-18	1965	SCII	RIASEC	High school freshmen
Hansen & Stocco (1980)	M & F	615	3.5	18-22	1965	SCII	RIASEC	College freshmen
Harrangue (1965)	F	108	4	18-22	1936	KPR	Basic	College students

Table 1 (cont.)

Study Authors	Gender	N	Interval	Age Category	Cohort	Measure	Scale Class	Sample Description
Hawkes (1978)	F	362	2	14-18	1962	OVIS	Basic	High school students
Hawkes (1978)	M	297	2	14-18	1962	OVIS	Basic	High school students
Herzberg & Bouton (1954)	F	68	4	18-22	1937	KPR	Basic	High school graduates
Herzberg & Bouton (1954)	M	62	4	18-22	1937	KPR	Basic	High school graduates
King (1957)*	F	38	3.5	18-22	1939	SVIB Occ	Occ	College freshmen
Kuder (1964)	F	328	4	11-14	1953	KGIS-E	Basic	6th & 7th graders
Kuder (1964)	M	311	4	11-14	1953	KGIS-E	Basic	6th & 7th graders
Lau & Abrahams (1971)	M	174	5	22-30	1951	NVII	Basic	Navy recruits
Long & Perry (1953)	M	32	3	18-22	1935	KPR	Basic	College freshmen
Lubinski, Benbow & Ryan (1995)	F	48	15	18-42	1982	SCII	RIASEC	Intellectually gifted 8th graders
Lubinski, Benbow & Ryan (1995)	M	114	15	18-42	1982	SCII	RIASEC	Intellectually gifted 8th graders
McCoy (1954)	F	177	2	14-18	1939	KPR	Basic	High school students
McCoy (1954)	F	56	3	14-18	1939	KPR	Basic	High school students
McCoy (1954)	F	33	2	14-18	1937	KPR	Basic	High school students
McCoy (1954)	M	142	2	14-18	1939	KPR	Basic	High school students
McCoy (1954)	M	57	3	14-18	1939	KPR	Basic	High school students
McCoy (1954)	M	29	2	14-18	1937	KPR	Basic	High school students
Meinster & Rose (2001)	F	16	4	14-18	1986	VPI	RIASEC	High school students
Meinster & Rose (2001)	F	8	4	14-18	1986	VPI	RIASEC	High school students
Meinster & Rose (2001)	F	32	4	14-18	1986	VPI	RIASEC	High school students
Meinster & Rose (2001)	F	19	4	14-18	1986	VPI	RIASEC	High school students
Mullis, Mullis & Gerwels (1998)	F	141	3	14-18	1983	SCII	RIASEC	High school students
Mullis, Mullis & Gerwels (1998)	M	130	3	14-18	1983	SCII	RIASEC	High school students
Nauta, Kahn, Angell & Cantarelli (2002)	M & F	104	1	18-22	1984	SII	RIASEC	College freshmen
Nichols (1962)	F	204	4	18-22	1945	VPI	RIASEC	Merit finalists
Nichols (1962)	M	432	4	18-22	1945	VPI	RIASEC	Merit finalists
Nolting (1967)*	F	327	9	18-42	1950	SVIB BIS	Basic	College freshmen

Table 1 (cont.)

Study Authors	Gender	N	Interval	Age Category	Cohort	Measure	Scale Class	Sample Description
Nolting (1967)*	M	100	3.5	18-22	1949	SVIB BIS	Basic	College freshmen
Nolting (1967)*	M	126	3.5	18-22	1949	SVIB BIS	Basic	College students
Nolting/King (1967)*	M	189	3.5	18-22	1949	SVIB BIS & SVIB Occ	Occ/Basic	College freshmen
Onischenko (1978)	M	59	4	18-22	1959	KOIS	Basic	College freshman
Onischenko (1978)	M	59	14	22-30	1950	KOIS	Basic	College freshman
Onischenko (1978)	M	129	14	22-30	1950	KOIS	Basic	College freshman
Onischenko (1978)	M	59	18	18-42	1950	KOIS	Basic	College freshman
Rhode (1966)*	M	37	11	22-30	1946	SVIB BIS	Basic	College students
Roberts (1969)	M	32	2	18-22	1949	SVIB Occ	Occ	College juniors
Roberts (1969)	M	52	2	18-22	1949	SVIB Occ	Occ	College juniors
Rosenberg (1953)	F	86	3	14-18	1938	KPR	Basic	High school students
Rosenberg (1953)	M	91	3	14-18	1938	KPR	Basic	High school students
Rottinghaus et al (2007)	F	40	30	18-42	1960	KPR	Basic	High school juniors & seniors
Rottinghaus et al (2007)	M	36	30	18-42	1960	KPR	Basic	High school juniors & seniors
Schletzer (1963)	M	172	8	18-22	1946	SVIB Occ	Occ	High school students
Silvey (1951)	F	250	1	18-22	1933	KPR	Basic	College freshman
Silvey (1951)	M	267	1	18-22	1933	KPR	Basic	College freshman
Stordahl (1953)	M	111	2.5	18-22	1935	SVIB Occ	Occ	High school seniors
Stordahl (1953)	M	70	2.5	18-22	1935	SVIB Occ	Occ	High school seniors
Strong (1931)*	M	1214	36	18-42	1914	SVIB BIS & SVIB Occ	Occ/Basic	Adolescents
Strong (1955)	M	663	18	18-42	1935	SVIB Occ	Occ	College students
Strong (1955)*	M	191	22	18-42	1932	SVIB BIS	Basic	Graduate students
Strong (1955)*	M	220	22	18-42	1934	SVIB BIS & SVIB Occ	Occ/Basic	College Seniors
Sun (2011)	F	60	1	18-22	1991	SII	RIASEC	College students
Sun (2011)	M	37	1	18-22	1991	SII	RIASEC	College students
Thomas (1965)*	F	81	10	22-30	1947	SVIB BIS	Basic	College freshmen

Table 1 (cont.)

Study Authors	Gender	N	Interval	Age Category	Cohort	Measure	Scale Class	Sample Description
Thompson (1967)	F	198	1	18-22	1948	KPR	Basic	College sophomores
Thompson (1967)	F	132	2	18-22	1947	KPR	Basic	College juniors
Thompson (1967)	F	68	3	22-30	1946	KPR	Basic	College seniors
Tracey (2002)	F	71	1	11-14	1990	ICA-R	RIASEC	5th graders
Tracey (2002)	F	113	1	11-14	1989	ICA-R	RIASEC	7th graders
Tracey (2002)	M	55	1	11-14	1990	ICA-R	RIASEC	5th graders
Tracey (2002)	M	108	1	11-14	1989	ICA-R	RIASEC	7th graders
Tracey Robbins & Hofsess (2005)	M	810	2	14-18	1990	UNIACT	RIASEC	8th graders
Tracey, Robbins & Hofsess (2005)	F	837	2	14-18	1990	UNIACT	RIASEC	8th graders
Trimble (1965)*	F	56	10	22-30	1947	SVIB BIS	Basic	College freshmen
Trimble (1965)*	M	152	10	22-30	1947	SVIB BIS & SVIB Occ	Occ/Basic	High school seniors
Trimble/Campbell (1965)*	F	91	26	18-42	1947	SVIB BIS & SVIB Occ	Occ/Basic	College freshmen
Trimble/Nolting (1967)*	M	123	10	22-30	1947	SVIB BIS & SVIB Occ	Occ/Basic	College freshman
Van Dusen (1940)	M	76	3	18-22	1922	SVIB Occ	Occ	College freshmen
Wright & Scarborogh (1958)	F	205	2	18-22	1940	KPR	Basic	College freshmen
Wright & Scarborogh (1958)	F	105	4	18-22	1940	KPR	Basic	College freshmen
Wright & Scarborogh (1958)	M	174	2	18-22	1940	KPR	Basic	College freshmen
Wright & Scarborogh (1958)	M	125	4	18-22	1940	KPR	Basic	College freshmen
Yang (2010)	F	1810	2	14-18	1996	UNIACT	RIASEC	8th graders
Yang (2010)	M	1282	2	14-18	1996	UNIACT	RIASEC	8th graders

Note. *Indicates that study data was found in Campbell (1971). KGIS Kuder General Interest Survey; KOIS Kuder Occupational Interest Survey; KPR Kuder Preference Record; NVII Naval Vocational Interest Inventory; OVIS Ohio Vocational Interest Survey; SCII Strong Campbell Interest Inventory; SII Strong Interest Inventory; SVIB BIS Strong Vocational Interest Blank: Basic Interest Scales; SVIB OCC Strong Vocational Interest Blank: Occupational Scales; TALENT Project Talent Interest Inventory; UNIACT Unisex edition of ACT Interest Inventory; VPI Vocational Preference Inventory. Basic = Basic Interest Scale Classification; Occ = Occupational Interest Scale Classification; Occ/Basic = Averaged data from Basic and Occupational Interest Scale Classifications; RIASEC = Holland's RIASEC Scale Classification.

Table 2. *Sample Characteristics Across Age Categories*

			Interval		Cohort		Gender	
Age Category	*K*	*N*	Median	[a]Mean	Median	[a]Mean	[a]Male	[a]Female
11-14	6	986	1.0	2.9	1990	1959	48%	52%
14-18	28	10,285	3.0	2.5	1957	1973	43%	52%
18-22	34	4,436	3.5	2.9	1945	1950	47%	35%
22-30	15	1,415	8.0	7.7	1947	1948	82%	18%
18-42	15	3,517	26.0	25.7	1953	1935	86%	14%
All Samples	98	20,639	3.5	6.9	1949	1959	54%	39%

Note. [a]Indicates estimate weighted by sample size. Gender percentages do not always add up to 100% because of mixed-gender samples.

Table 3. *Mean-Level Changes by Interest Category (Aggregating across Age Categories)*

			Effect Size		Deviation	
Interest Category	*K*	*N*	*d*	95% CI	*b*	95% CI
Average *RIASEC d*			.03	[.00, .06]		
Realistic	90	19,163	.04	[-.01, .09]	.01	[-.04, .06]
Investigative	92	20,180	-.02	[-.07, .02]	-.05	[-.09, -.02]
Artistic	88	16,877	.09	[.05, .14]	.06	[.02, .10]
Social	85	16,027	.08	[.02, .13]	.04	[-.01, .09]
Enterprising	86	16,690	.09	[.05, .14]	.06	[.03, .09]
Conventional	89	17,051	-.08	[-.14, .03]	-.12	[-.16, -.08]
τ			.14	[.10, .17]		
Average *People and Things d*			.04	[.01, .07]		
People	91	17,148	.08	[.05, .12]	.04	[.02, .06]
Things	96	20,542	.00	[-.04, .03]	-.04	[-.06, -.02]
τ			.12	[.09, .16]		
Average *Data and Ideas d*			.01	[-.02, .06]		
Data	91	17,148	-.01	[-.05, .04]	-.02	[-.04, .01]
Ideas	96	20,542	.03	[.00, .06]	.02	[-.01, .04]
τ			.14	[.07, .15]		

Note. d = the expected effect size in reference to zero. *b* = each interest categories' deviation from the midpoint effect size. τ = between-study heterogeneity of the effect size estimate. 95% CI = 95% random effects confidence intervals. Separate meta-analytic regression models were estimated for RIASEC interests, People and Things, and Data and Ideas.

Table 4. *Mean-Level Changes by Age Category (Aggregating across Interest Categories)*

			Effect Size		Deviation	
Age Category	*K*	*N*	*d*	95% CI	*b*	95% CI
Average *d*			.01	[-.01, .03]		
11-14	6	986	-.10	[-.13, -.06]	-.11	[-.14, -.07]
14-18	28	10,285	.08	[.03, .12]	.06	[.02, .10]
18-22	34	4,436	.01	[-.05, .07]	-.01	[-.06, .04]
22-30	15	1,415	.02	[-.02, .06]	.00	[-.03, .04]
18-42	15	3,517	.07	[.02, .11]	.05	[.01, .09]
τ			.14	[.11, .17]		

Note. *d* = the expected effect size in reference to zero. *b* = each age categories' deviation from the midpoint effect size. τ = between-study heterogeneity of the effect size estimate. 95% CI = 95% random effects confidence intervals.

Table 5. *Mean-Level Changes in RIASEC Interests by Age Category*

Age Category	Interest Category	*K*	*N*	*d*	95% CI
11-14 (Middle School / Early Adolescence)	Realistic	6	986	-.17	[-.27, -.06]
	Investigative	6	986	-.10	[-.25, .05]
	Artistic	6	986	-.02	[-.12, .07]
	Social	6	986	-.12	[-.40, .16]
	Enterprising	6	986	.16	[-.07, .39]
	Conventional	6	986	-.30	[-.50, -.09]
14-18 (High School/ Late Adolescence)	Realistic	27	9,827	.13	[.07, .20]
	Investigative	24	9,999	.00	[-.05, .04]
	Artistic	26	7,193	.07	[-.01, .14]
	Social	22	6,907	.07	[-.03, .16]
	Enterprising	22	6,907	.18	[.12, .24]
	Conventional	26	7,193	.06	[-.03, .15]
18-22 (College Years)	Realistic	30	4,187	.03	[-.05, .12]
	Investigative	31	4,263	-.11	[-.19, -.02]
	Artistic	30	4,187	.11	[.04, .17]
	Social	31	4,112	.14	[.06, .22]
	Enterprising	30	4,036	.04	[-.04, .11]
	Conventional	30	3,814	-.17	[-.26, -.08]
22-30 (Emerging Adulthood)	Realistic	13	1,227	-.03	[-.12, .06]
	Investigative	15	1,415	.00	[-.14, .14]
	Artistic	12	1,053	.16	[.05, .27]
	Social	13	1,227	-.01	[-.12, .10]
	Enterprising	13	1,227	.10	[.03, .16]
	Conventional	13	1,227	-.08	[-.21, .05]
18-42 (Late Adolescence to Middle Adulthood)	Realistic	14	3,458	-.04	[-.22, .15]
	Investigative	15	3,517	.16	[.09, .23]
	Artistic	14	3,458	.13	[-.02, .28]
	Social	13	2,795	.14	[-.05, .32]
	Enterprising	14	3,458	.05	[-.04, .14]
	Conventional	14	3,458	-.09	[-.16, -.01]
	τ			.112	[.08, .15]

Note. *d* = the expected effect size in reference to zero. τ = between-study heterogeneity of the effect size estimate. 95% CI = 95% random effects confidence intervals. Beta coefficients for this model are presented in Table S2.

Table 6. *Gender Differences in Mean-Level Changes in Realistic & Social Interests*

		Women		Men		Difference	
Interest Category	Age Category	*d*	95% CI	*d*	95% CI	*d*	95% CI
Realistic	11-14	-.24	[-.40, -.08]	-.09	[-.15, -.03]	-.15	[-.28, -.02]
	14-30[a]	.27	[.13, .42]	.02	[-.20, .23]	.26	[.00, .51]
	18-42	.24	[.22, .26]	-.03	[-.21, .14]	.27	[.10, .45]
Social	11-14	.12	[.02, .23]	-.40	[-.72, -.08]	.52	[.18, .86]
	14-30[a]	.04	[-.17, .25]	.23	[.03, .43]	-.19	[-.48, .10]
	18-42	.07	[-.05, .19]	.15	[-.08, .38]	-.08	[-.34, .18]

Note. [a]14-30 represents the cumulative effect size from the three age categories spanning this interval (14-18, 18-22, 22-30). Sample characteristics by age category are presented in Table 2. *d* = the expected effect size in reference to zero. 95% CI = 95% random effects confidence intervals. Difference scores computed by subtracting men effect sizes from women. The between-study heterogeneity in the effect size estimate, τ, was .119, 95% CI = [.07, 17] for this model.

FIGURES

Figure 1. PRISMA flow used to identify longitudinal studies reporting mean-level changes in vocational interests

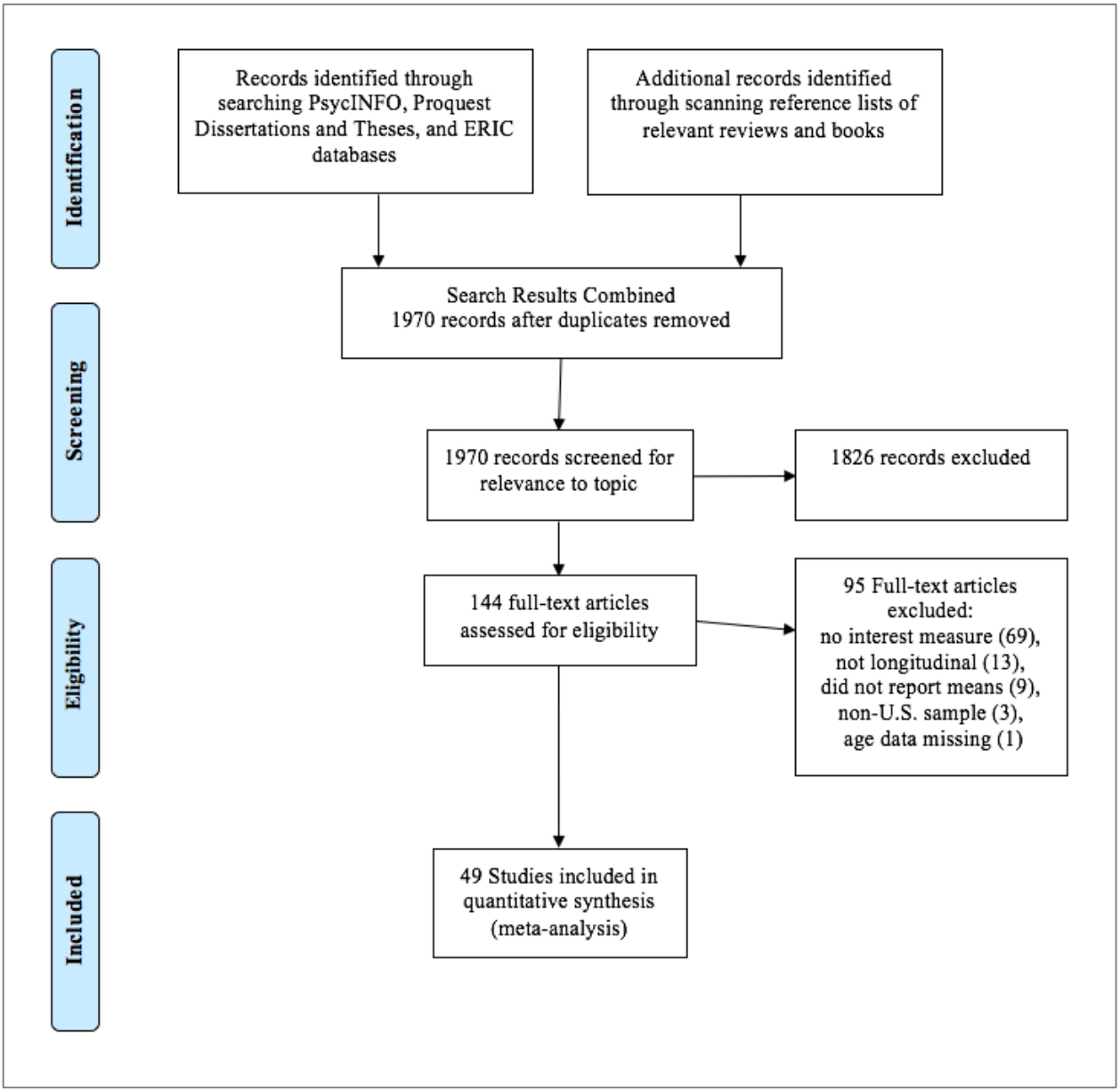
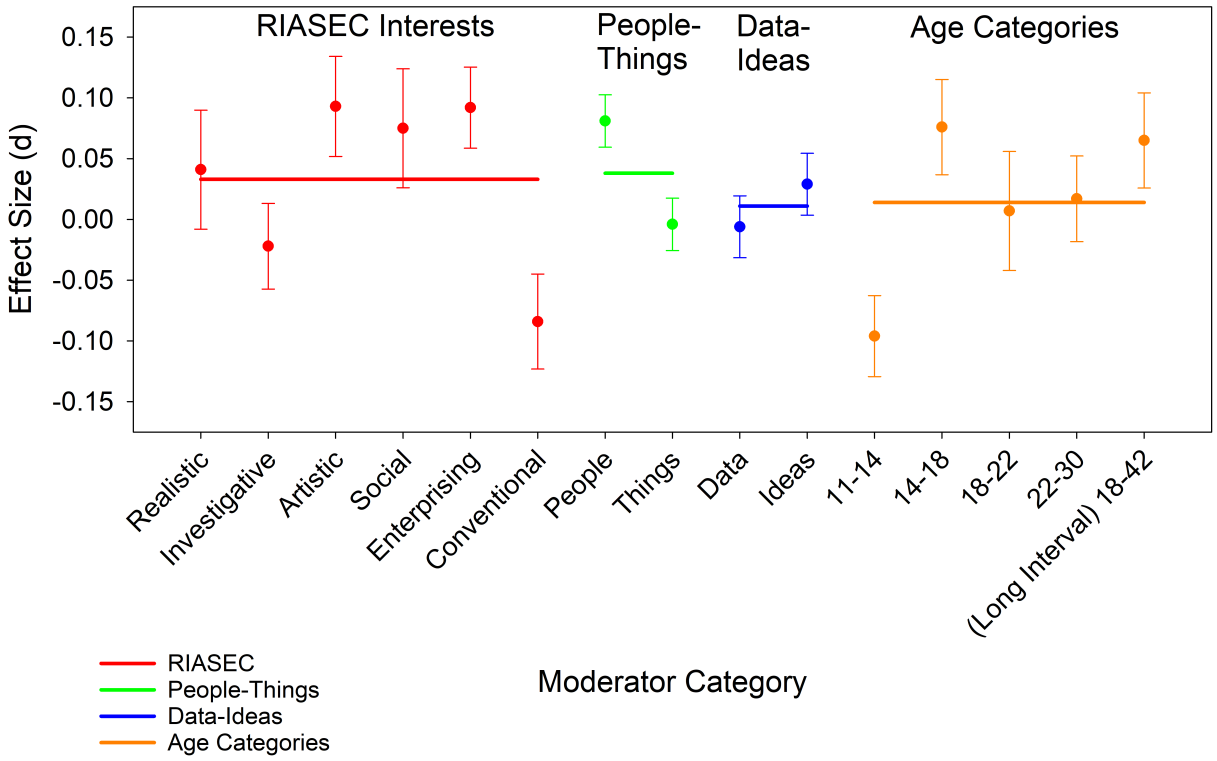
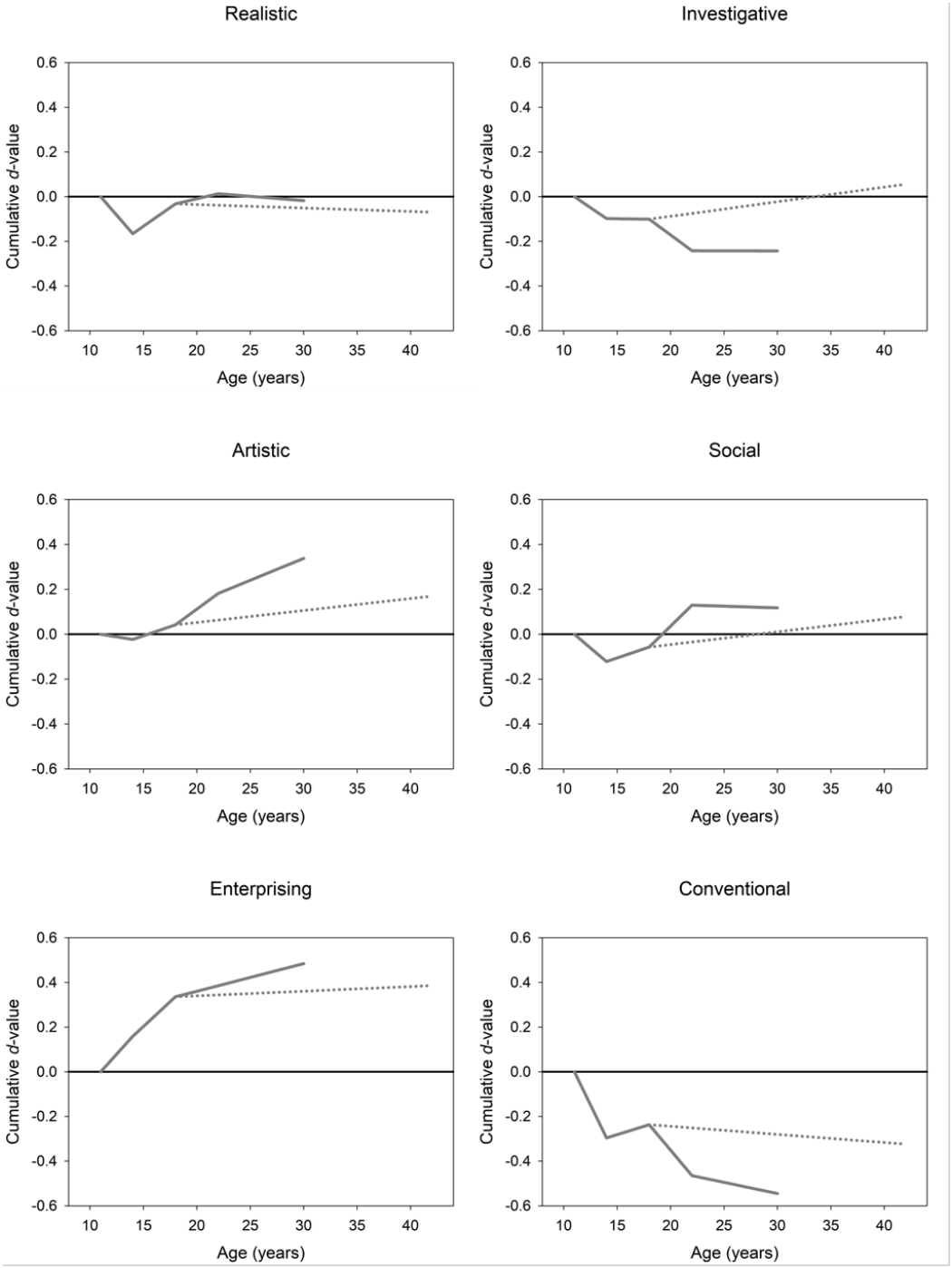


Figure 2. Overall changes in vocational interests across age categories and interest traits



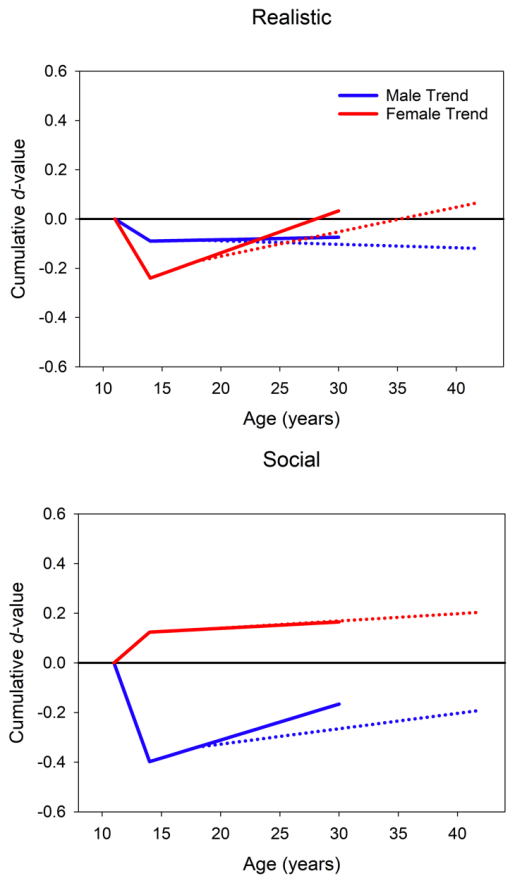
Note. Horizontal lines represent the midpoint effect size for each meta-analytic regression model. Dots indicate each moderators' deviations from the midpoint effect size, with error bars denoting 95% random effects confidence intervals.

Figure 3. Cumulative changes in RIASEC interests from adolescence to adulthood



Note. Solid lines represent cumulative effect sizes (d-values) from ages 11-14, 14-18, 18-22, and 22-30. Dotted lines represent effect sizes for the 18-42 age category.

Figure 4. Gender differences in Realistic and Social interests from adolescence to adulthood



Note. Solid lines represent cumulative effect sizes (d-values) from ages 11-14 and 14-30. Dotted lines represent effect sizes for the 18-42 age category.