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Are Genetic and Environmental Influences on Job Satisfaction Stable Over Time? A Three-Wave Longitudinal Twin Study

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Job satisfaction research has unfolded as an exemplary manifestation of the "person versus environment" debate in applied psychology. With the increasing recognition of the importance of time, it is informative to examine a question critical to the dispositional view of job satisfaction: Are genetic influences on job satisfaction stable across different time points? Drawing upon dispositional and situational perspectives on job satisfaction and recent research in developmental behavioral genetics, we examined whether the relative potency of genetic (i.e., the person) and environmental influences on job satisfaction changed over time in a 3-wave longitudinal twin study. Biometric behavioral genetics analyses showed that genetic influences accounted for 31.2% of the variance in job satisfaction measured at approximately Age 21, which was markedly greater than the 18.7% and 19.8% of variance explained by genetic factors at Age 25 and Age 30. Such genetic influences were mediated via positive affectivity and negative affectivity, but not via general mental ability. After partialing out genetic influences, environmental influences on job satisfaction were related to interpersonal conflict at work and occupational status, and these influences were relatively stable across the 3 time points. These results offer important implications for organizations and employees to better understand and implement practices to enhance job satisfaction.

Keywords: job satisfaction, heritability, interpersonal conflict, negative affectivity and positive affectivity, occupational status

Research on the antecedents of job satisfaction has unfolded as an exemplary manifestation of the "person versus environment" debate, which has long received intense interest in applied psychology (e.g., Arvey, Bouchard, Segal, & Abraham, 1989; House, Shane, & Herold, 1996; Judge, Ilies, & Zhang, 2012; Salancik & Pfeffer, 1978; Staw & Ross, 1985). The debate perhaps dates back to Lewin's (1935) famous formula that behavior is a joint product of the person and the environment (i.e., $B = f[P, E]$). Importantly, Lewin's theme has been split into two contrasting views on the antecedents of job satisfaction. The situational perspective, as embraced by work design research, has stressed the importance of work environments (e.g., Hackman & Oldham, 1975; Morgeson, Garza, & Campion, 2012; Parker, 2014). In contrast, the dispositional perspective has focused on the role of the person in shaping job satisfaction (e.g., Ilies, Arvey, & Bouchard, 2006; Judge & Hulin, 1993; Staw & Cohen-Charash, 2005). The latter line of research has focused on the effects of general mental ability (e.g., Judge, Higgins, Thoresen, & Barrick, 1999), personality (e.g., Staw, Bell, & Clausen, 1986), and genetic factors (e.g., Arvey et al., 1989). Because of their ability to disentangle influences related

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to the nature from influences related to the nurture (Plomin, Owen, & McGuffin, 1994), twin studies have been increasingly embraced by researchers to inform the "person versus environment" debate on job satisfaction (e.g., Arvey et al., 1989; Ilies & Judge, 2003; Judge, Ilies, et al., 2012).

A critical underlying assumption of the dispositional perspective is that influences from individual characteristics on job satisfaction are *stable* over time (e.g., George, 1992; Staw et al., 1986). The assumption has been particularly evident in research inferring dispositional influences through the demonstration of the stability of job satisfaction (Staw & Ross, 1985) and genetic influences on job satisfaction (Arvey et al., 1989). In fact, this assumption is not unique to job satisfaction research. In a review of the job performance literature, Sturman (2007) found that most research on job performance had examined "the correlates of various sorts of job performance ratings, with the often implicit assumption that the results would generalize to the same population of subjects at any other point in time" (p. 50). Nevertheless, this crucial assumption, to our knowledge, has yet to be rigorously tested for job satisfaction.

Investigating whether influences from the person (e.g., through genetic influences) on job satisfaction are constant over time has important theoretical and practical implications. Theoretically, explicitly incorporating a temporal perspective into the dispositional approach to job satisfaction "can change the ontological description and meaning" of dispositional influences (George & Jones, 2000, p. 675) and therefore contributes to better theory building in job satisfaction research (Mitchell & James, 2001). Practically, findings of significant dispositional influences on job satisfaction have often been incorrectly interpreted as indicating, as Staw and Cohen-Charash (2005) lamented, that "there was little organizations could do to improve the lot of workers" (p. 66). In this regard, examining whether and how genetic influences on job satisfaction may change over time can, at least partly, mitigate such misinterpretations, and thus contribute to forming a healthy public image of applied psychology.

The purpose of the current study is threefold. First, using a three-wave longitudinal twin design, we investigate whether genetic influences—reflecting influences from the person—on job satisfaction are constant over time in early adulthood. In doing so, this study contributes to the job satisfaction literature by enriching the dispositional approach to job satisfaction from a temporal perspective. We note that there is an important advantage of utilizing genetic influences to reflect effects of the "whole" person (vs. the environment). A large number of individual difference variables may affect job satisfaction (Arvey & Bouchard, 1994; Ilies & Judge, 2003). It is thus impractical to examine their effects all at once in a single study to capture person-related effects collectively. The longitudinal twin design, however, enables us to examine the aggregate contribution of these individual difference variables as reflected in the (potentially time-varying) estimates of overall genetic influences (Johnson, Turkheimer, Gottesman, & Bouchard, 2009), because virtually all individual characteristics are genetically influenced (Bouchard, 2004; Turkheimer, 2000).

Second, we discern the roles of general mental ability, positive affectivity (PA), and negative affectivity (NA) in mediating genetic influences on job satisfaction over time. These three individual characteristics have been most widely suggested or examined in previous job satisfaction research (e.g., Cropanzano, James, & Konovsky, 1993; Ilies & Judge, 2003; Staw et al., 1986; Watson & Slack, 1993) as well as in research on how genetic factors affect work-related outcomes through individual characteristics (Arvey & Bouchard, 1994; Ilies et al., 2006). The current study thus sheds light on the pathways through which genetic influences affect job satisfaction over time and the *relative explanatory power* of the three individual characteristics in the mediating processes. As such, this study serves as a critical first step to advance our understanding of the biological foundations of job satisfaction (Becker, Cropanzano, & Sanfey, 2011; Ilies et al., 2006; Judge, Piccolo, & Kosalka, 2009; Senior, Lee, & Butler, 2011).

Third, drawing upon the literature on the situational approach to job satisfaction, we investigate whether influences from two critical work environmental factors—occupational status and interpersonal conflict at work—contribute to job satisfaction over time while *partialing out* the aggregated, genetically involved influences that are attributable to the person (Johnson et al., 2009). Such an investigation not only complements the inquiries into genetic influences on job satisfaction over time but also addresses one important limitation of classical behavioral genetics research: a failure to examine specific genetic and/or environmental factors. The two work environment variables have been suggested and extensively examined in the literatures on omnibus and discrete work contexts (Johns, 2006) as well as on environmental influences on job satisfaction (e.g., Ilies, Johnson, Judge, & Keeney, 2011; Judge & Kammeyer-Mueller, 2012; Locke, 1976; Spector & Jex, 1998). It is vitally important to control for effects of the person (i.e., through genetic influences) when examining environmental influences on job satisfaction, because many presumed "environmental variables" are confounded by influences from the person through self and/or organizational selection (Arvey, Zhang, Avolio, & Krueger, 2007; Judge, Ilies, et al., 2012; Kendler & Baker, 2007). In fact, most research on situational influences of job satisfaction has not been able to partial out effects from the person, resulting in potential overestimates of situational effects (Judge, Ilies, et al., 2012). Therefore, by controlling for genetic influences, this study represents a more stringent test of the situational perspective on job satisfaction over time. Figure 1 depicts the conceptual model of this study adapted from Ilies and Judge (2003).

Theoretical Development and Hypotheses

Potential Change of Genetic Influences on Job Satisfaction Over Time

Genetic influences are a consequence of inherited variations in the DNA sequence, which are "responsible for all inherited physical, physiological, and psychological differences between individuals" (Plomin & Simpson, 2013, p. 1263). Statistically, the magnitude of genetic influences is estimated as heritability, representing "the percentage of the total phenotypic variance accounted for by genetic variance" (Arvey & Bouchard, 1994, p. 60). Environmental factors denote "all non-heritable factors," and can be further decomposed into shared environments and unique environments (Plomin et al., 1994, p. 1735). Classical twin studies have been conducted to examine the relative potency of overall genetic and environmental influences of "any sort" (Plomin, DeFries, Knopic, & Neiderhiser, 2013, p. 73). This "holistic" ap-

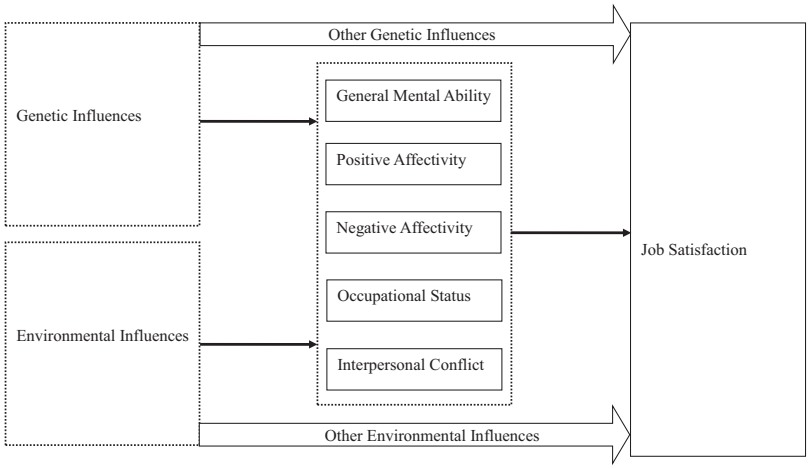

Figure 1. A conceptual model of genetic and environmental influences on job satisfaction through mediators.

proach represents a major strength, but it is also limited for not being able to pinpoint specific genetic or environmental factors. To partially address this limitation, we incorporate specific genetic factors related to general mental ability, PA, and NA, as well as work environments related to occupational status and interpersonal conflict at work. These investigations provide a more nuanced picture of job satisfaction's antecedents.

Previous dispositional research has implicitly or explicitly portrayed genetic influences on job satisfaction as relatively stable. Researchers have used two reasons to explain rank-order stability in job satisfaction: (a) the genetic variants influencing individual differences seldom change over time, and (b) the magnitude of genetic influences on job satisfaction are relatively stable (Arvey & Bouchard, 1994; Bouchard, Arvey, Keller, & Segal, 1992; Dormann & Zapf, 2001; George, 1992; Staw & Ross, 1985). Put differently, if influences from genetic factors or genetically affected dispositional variables change substantially over time, then we would not have observed between-person rank-order stability in job satisfaction longitudinally. Multiple single-time-point, cross-sectional twin studies, which suggest that the magnitude of genetic influence does not vary with age, seem to indirectly support stable genetic influences on job satisfaction. In their seminal article, Arvey et al. (1989) reported that approximately 30% of the variance in general job satisfaction was attributable to genetic differences. A follow-up study using a larger sample confirmed this finding (Arvey, McCall, Bouchard, Taubman, & Cavanaugh, 1994). This notion and related research findings have also become the foundation for subsequent meta-analyses examining mediating mechanisms in the relationship between genetic factors and job satisfaction (Ilies & Judge, 2003). Bouchard et al. (1992) even predicted that "twin studies of job satisfaction using adult samples in the age range 25 to 50 years will yield a heritability of about 0.30" (p. 92). However, to date, there have been no longitudinal examinations of whether genetic influences on job satisfaction are constant over time, especially during early adulthood when changes in one's work environment are prevalent (Rindfuss, 1991).

With regard to the direction of the potential change (i.e., increase or decrease) of genetic influence on job satisfaction over time, the person–environment fit literature and the situational perspective on job satisfaction offer two contrasting predictions. On the one hand, person–environment fit research posits that individual characteristics (e.g., abilities and personality traits) become increasingly important in shaping job satisfaction, because as individuals age, they select themselves into life experiences that are more compatible with their characteristics (Edwards, 2008; Kristof-Brown & Guay, 2010). As such, job satisfaction over time would be more reflective of the person, indicating increasing genetic influences on job satisfaction over time.

Multiple research streams support this argument. First, the gravitational hypothesis and related research suggest that through multiple processes (e.g., occupational and organization selection, and job crafting), individuals gradually gravitate into work environments compatible with their abilities (McCormick, Jeanneret, & Mecham, 1972; Wilk, Desmarais, & Sackett, 1995) and personality traits (Judge et al., 1999). By extension, via such selection processes, characteristics of the person become increasingly influential over the life span. Second, the ecology model of individuality (e.g., Mumford & Stokes, 1992; Mumford, Stokes, Owens, & Stokes, 1990; Stokes, Mumford, & Owens, 1989) indicates that the importance of individual characteristics in shaping work experiences may increase with age. Third, personality psychologists have also theorized and found that personality traits that lead people to compatible experiences are also likely to be further strengthened by such experiences (i.e., the corresponsive principle; Caspi, Roberts, & Shiner, 2005; Roberts, Caspi, & Moffitt, 2003). Therefore, the enhanced correspondence over time between individual characteristics and life experiences would lead to an increased degree of influence from the person. Similarly, behavioral genetic research suggests that as people age, they have increasing control over selecting or creating experiences that foster the development of their genetically influenced dispositions. Because such self-selected or self-created experiences partially reflect genetic dispositions, the enhanced control over environments can amplify genetic influences over time (Bouchard, 1997; McGue, Bouchard, Iacono, & Lykken, 1993; Plomin & Spinath, 2004; Scarr & McCartney, 1983).

On the other hand, the situational perspective on job satisfaction suggests decreasing genetic influences on job satisfaction over time. As they age, individuals are gradually exposed to more and more work experiences that are exogenously introduced by organizations (Rindfuss, 1991). Given that individuals' work experiences are not solely influenced by their individual characteristics, over time, the work experiences may be increasingly reflective of environmental influences. Indeed, considering the importance of organizational contexts, Staw (2004) stated, "It is possible that genetic effects become so diluted by strong work situations that they ultimately have little influence on job satisfaction" (p. 169). We therefore expect that such a diluting effect may be more pronounced in early adulthood because of the dramatic changes in one's work-related experiences (e.g., from being a newcomer to an experienced employee, switching employers, getting promoted and taking more responsibilities at work, starting to balance work and family demands; Rindfuss, 1991). Prior research suggests at least two broad forms of environmental influences on job satisfaction that can dilute the person's influences. The first form is related to the nature of work, including task, social, and physical aspects of work (e.g., Hackman & Oldham, 1975; Morgeson et al., 2012; Parker, 2014). Second, the Cornell model of job satisfaction suggests that economic situations and labor markets also affect job satisfaction by changing individuals' frames of reference (Judge, Hulin, & Dalal, 2012). Similar arguments have also been provided in behavioral genetics research: As individuals accumulate more experiences when they develop into adulthood, genetic influences on individual characteristics can become less important throughout the adult life span (Bleidorn, Kandler, & Caspi, 2014; Eaves, Long, & Heath, 1986; Plomin & Spinath, 2004).

Despite the lack of direct evidence, indirect evidence supports both predictions. Regarding the increasing importance of genetic influences over time, research has shown that genetic influences on general mental ability augment with age, from explaining approximately 60% of the variance at Age 20 to 80% at Age 30 (Bergen, Gardner, & Kendler, 2007; Bouchard, 2013; Johnson, 2010; Wilson, 1978). In contrast, genetic influences on personality traits have been found to decrease over time (Kandler, 2012; McCartney, Harris, & Bernieri, 1990). For example, the amount of variance in neuroticism explained by genetic factors diminished from approximately 40% in early adulthood to 20% in late adulthood (Kandler, 2012), though there is also evidence supporting the stability of genetic influences on personality traits (Hopwood et al., 2011). Given that the theoretical and empirical support for both predictions seems equally strong, we offer the following competing hypotheses:

Hypothesis 1a: Genetic influences on job satisfaction increase over time.

Hypothesis 1b: Genetic influences on job satisfaction decrease over time.

Individual Difference Variables as Mediators of Genetic Influences

In order to delineate the pathways through which genetics shape job satisfaction, we focus on three individual difference variables suggested by previous research: general mental ability, PA, and NA. These variables were identified by two means. First, Ilies and Judge (2003) specifically urged researchers to study the mediating role of general mental ability in probing genetic influences on job satisfaction. Second, PA and NA have long been examined as central dispositional sources of job satisfaction in previous research (e.g., Cropanzano et al., 1993; Staw et al., 1986; Watson & Slack, 1993). Moreover, general mental ability, PA, and NA have been found to be significantly influenced by genetic factors (Bouchard, 2004; Turkheimer, 2000). As such, they may mediate genetic influences on job satisfaction. Yet no previous research has examined whether they influence job satisfaction across different time points, let alone their mediating role in transmitting genetic influences on job satisfaction over time.

General mental ability. *General mental ability*, or general intelligence, refers to individuals' general cognitive abilities to learn, reason, and solve problems (Spearman, 1904). It has been regarded as one of the most useful constructs in psychology in terms of predictive validity for various achievement measures (Gottfredson & Deary, 2004). Individuals with high levels of general mental ability tend to learn quickly and easily obtain job knowledge (Ones, Dilchert, & Viswesvaran, 2012; Schmidt & Hunter, 2004). As a result, they are likely to outperform individuals with low general mental ability (Li, Arvey, & Song, 2011). Indeed, research has consistently shown that general mental ability facilitates job training effectiveness, overall job performance, and occupational achievement (Judge et al., 1999; Ones, Dilchert, Viswesvaran, & Salgado, 2010; Salgado, Anderson, Moscoso, Bertua, & De Fruyt, 2003; Schmidt & Hunter, 2004). Thus, as reported in previous research (e.g., Judge et al., 1999), general mental ability is likely to be positively correlated with job satisfaction.

General mental ability has also been reported to be significantly influenced by genetic factors (Plomin & Spinath, 2004). In fact, given its importance in shaping job satisfaction, Ilies and Judge (2003) have called for examinations of the role of "intelligence in explaining the genetic source of job satisfaction" (p. 755). Taken together, we hypothesize the following:

Hypothesis 2: General mental ability mediates genetic influences on job satisfaction at multiple time points.

PA and NA. PA and NA have received the most research attention in previous research on dispositional sources of job satisfaction (e.g., Cropanzano et al., 1993; Staw et al., 1986; Watson & Slack, 1993). PA and NA, as independent constructs, are defined as the general tendencies to experience positive and negative affective states across time and situations, respectively (Watson & Clark, 1984, 1992; Watson, Clark, & Tellegen, 1988). Judge and Larsen (2001) asserted that "PA and NA dimensions may be the most proximal dispositional influences on job satisfaction" (p. 82). Accordingly, in this study, we build on previous research and probe whether, and to what extent, PA and NA mediate genetic influences on job satisfaction at different time points.

Brief, Butcher, and Roberson (1995) argued that PA and NA are likely to influence job satisfaction through both *actions* and *perceptions*. With respect to actions, high-PA individuals are confident, active, and energetic, and are likely to experience positive emotions. Through their actions, they may select or create positive

situations at work, which in turn boosts their job satisfaction. High-NA individuals, in contrast, tend to dwell on their shortcomings and personal failures, and thus experience negative emotions. As such, they may foster negative circumstances at work, which in turn decrease their job satisfaction. Regarding perceptions as the second mechanism, high-PA individuals are sensitive to positive environmental cues and thus likely to perceive themselves and the world in a positive light, whereas high-NA individuals tend to view themselves and their environment through a negative lens. Two meta-analyses have supported the positive and negative relations of PA and NA with job satisfaction, respectively (Connolly & Viswesvaran, 2000; Thoresen, Kaplan, Barsky, Warren, & de Chermont, 2003).

Behavioral genetics research has found sizable genetic influences on PA and NA (Tellegen et al., 1988). Furthermore, Ilies and Judge (2003) reported that compared with the Big Five personality traits, PA and NA were stronger mediators of genetic influences on job satisfaction. Yet research has not examined whether the magnitudes of such mediating effects through PA and NA change across the life span. Taken in concert, we propose the following:

> *Hypotheses 3 and 4:* PA (H3) and NA (H4) mediate genetic influences on job satisfaction at multiple time points.

We do not propose any directional hypotheses regarding the potential changes (e.g., increase, decrease, or lack thereof) of the mediating effects of the three individual characteristics in transmitting genetic influences on job satisfaction over time. One major reason is that the existing literature does not provide sufficient theoretical and empirical grounds for such hypotheses. For example, in perhaps the most recent review of developmental genetics research, Turkheimer, Pettersson, and Horn (2014) found that researchers have just started to examine how genetic influences on individual difference variables change over time; no study has been found to examine possible magnitude of changes in the mediating effects of variables in channeling genetic influences on outcome variables. Because of its exploratory nature, we propose the following research question:

> *Research Question 1:* Do the magnitudes of the mediating effects via general mental ability, PA, and NA in the relationships between genetic factors and job satisfaction change over time?

Influences of Work Environment Variables Over Time

As noted before, previous research investigating environmental influences on job satisfaction has been limited in two regards (for notable exceptions, see Arvey et al., 2007; Judge, Ilies, et al., 2012). First, research in both behavioral genetics and applied psychology has shown that many work variables presumed to be environmental are affected by individual characteristics. This is because people are not randomly assigned to work environments; instead, they select themselves, and/or are selected into, compatible work environments to garner some level of person–environment fit (Holland, 1996; McCormick et al., 1972; Schneider, 1987; Vinson, Connelly, & Ones, 2007). Kendler and Baker (2007) have found that putative environmental variables such as life stressors, family environment, social support, and peer relationships are all subject to significant genetic influences. Applied psychology researchers have also found that leadership experiences (Arvey et al., 2007) and work stress (Judge, Ilies, et al., 2012) are influenced by genetic factors. Therefore, a more accurate examination of environmental influences on job satisfaction necessitates partialing out influences from the person, specifically those reflected in people's genetic endowments (Johnson et al., 2009; Judge, Ilies, et al., 2012).

Second, prior research on work characteristics has tended to take a static approach and has mostly employed cross-sectional designs (Morgeson et al., 2012; Parker, 2014), although a few studies have shown that effects of certain work characteristics on job satisfaction dissipated over time (Boswell, Boudreau, & Tichy, 2005; Campion & McClelland, 1993; Champoux, 1978; Griffin, 1991). Longitudinal research is critically needed in order to extend this line of research and gain a dynamic understanding of these effects over time (George & Jones, 2000; Mitchell & James, 2001). Drawing from previous research on job satisfaction, subjective well-being, and related literatures (e.g., Bowling & Beehr, 2006; Judge & Klinger, 2008; Lyubomirsky & Layous, 2013; Sheldon & Lyubomirsky, 2012), we examine whether the relationships between work characteristics and job satisfaction change across three waves of measurement.

We focus on two work environment variables: objectively measured occupational status and perceived interpersonal conflict at work. Selection of the two variables was based on Johns' (2006) research on context, "situational opportunities or constraints" that affect organizational variables and their relationships (p. 386). Johns put forth two critical levels of measuring context: omnibus (i.e., broad/general) and specific. *Occupational status* reflects the amount of authority and social recognition granted to individuals by their occupations (Wegener, 1992), and represents a broad contextual variable. It has been viewed to be a composite construct related to work tasks (and was thus used as an omnibus contextual variable) representing the complexity level, extrinsic rewards (e.g., income and reputation), education requirements, and decision-making authority afforded by one's occupation (Blaikie, 1977). All these component characteristics have been theorized and studied as important predictors of job satisfaction (Judge & Kammeyer-Mueller, 2012; Locke, 1976; Staw & Ross, 1985). *Interpersonal conflict at work* refers to various overt or covert negative encounters with people at work, typically coworkers and supervisors, and represents a specific contextual variable (Keenan & Newton, 1985). As one critical source of stressors stemming from the social aspect of one's job, the effect of interpersonal conflict has been increasingly highlighted in research on employee well-being (e.g., job satisfaction; Bowling & Beehr, 2006; Ilies et al., 2011; Spector & Jex, 1998).

Occupational status. Occupational status tends to be positively related to job satisfaction cross-sectionally, although there are scant theoretical grounds or empirical evidence indicating the stability of its link with job satisfaction over time when both are measured repeatedly. As mentioned, occupational status is an omnibus work environment variable covering various characteristics that may have significant effects on job satisfaction. For example, decision-making authorities and explicit rewards inherent to occupational status are important predictors of job satisfaction (Locke, 1976). Thus, occupational status tends to be positively related to job satisfaction. Indeed, Super (1939) reported such a substantive relationship, which was replicated in later research

(e.g., Ducharme & Martin, 2000; Gerhart, 1987; Staw & Ross, 1985).

Although typically deemed as an environmental factor related to ones' occupation and work, occupational status may be partially affected by influences from the person. For example, through occupational (Holland, 1996) and organizational (Schneider, 1987) selection, individuals may select themselves and/or be selected into occupations and jobs compatible with their individual characteristics. Thus, it seems necessary to partial out such person-related effects (i.e., genetic influences) when examining the effects of occupational status, as a purely environmental factor, on job satisfaction. Nevertheless, as a distal work variable, occupational status is less likely to be affected by genetic factors than personality traits are (Arvey, Li, & Wang, 2016; Plomin et al., 2013). As such, we expect that after controlling for genetic influences, environmental influences can still explain why occupational status is related to job satisfaction.

Interpersonal conflict at work. Interpersonal conflict at work tends to be negatively related to job satisfaction. Interpersonal conflict derived from social relationships at work has received continued research attention (Spector & Jex, 1998). It has long been recognized as one of the most significant work stressors (Keenan & Newton, 1985) and has been incorporated as part of job demands in Karasek's (1979) job demand-control model. It may be manifested in a number of ways, including minor and major disagreements, rumor spreading, and even physical assault. Such negative encounters likely drain individuals' resources and induce emotional reactions of frustration, annoyance, and even anger toward coworkers and supervisors, leading to low levels of job satisfaction (Hobfoll, 1989; Keenan & Newton, 1985; Spector & Jex, 1998).

Empirical evidence for a negative relationship between interpersonal conflict at work and overall job satisfaction has been provided by a meta-analysis (Bowling & Beehr, 2006). This quantitative review summarized cross-sectional relationships regarding antecedents and outcomes of an overarching variable composed of conceptually equivalent constructs of interpersonal conflict. These authors reported a meta-analytic correlation of −.39 between this variable and job satisfaction, which is similar in magnitude to the unreliability corrected correlations of job satisfaction with other important job characteristics (Humphrey, Nahrgang, & Morgeson, 2007).

Admittedly, negative encounters at work may be partially due to influence from the person, because such encounters may be triggered by or perceived based on individual characteristics (Judge, Ilies, et al., 2012; Kendler & Baker, 2007). In addition, similar to other distal work outcome variables (Arvey et al., 2007; Judge, Ilies, et al., 2012), interpersonal conflict at work may also to a large extent be affected by environmental factors related to the work context. We therefore expect that environmental influences may still account for the relationship between interpersonal conflict and job satisfaction after partialing out genetic influences.

In sum, although previous research has suggested *cross-sectional* relationships of occupational status and interpersonal conflict at work with job satisfaction, there seems to be little theoretical or empirical grounds for predicting whether the relationships between those variables may change across time, and if so, what direction such changes would take. Taken in concert, we propose the following two hypotheses and two exploratory research questions:

> *Hypotheses 5 and 6:* With possible genetic influences partialed out, environmental influences from occupational status (H5) and interpersonal conflict at work (H6) still affect job satisfaction over time.
>
> *Research Questions 2 and 3:* With possible genetic influences partialed out, do environmental influences on job satisfaction that stem from occupational status (RQ2) and interpersonal conflict at work (RQ3) change over time?

Method

Participants and Procedures

The data used in this study were collected as part of the Minnesota Twin and Family Study (MTFS; Iacono & McGue, 2002), a state population-based longitudinal investigation of reared-together, same-sex twin pairs. This project examines genetic and environmental influences on development from adolescence through adulthood. The work-related variables contained in the MTFS (i.e., job satisfaction, occupational status, and interpersonal conflict at work) have not been published in previous research. In the process of applying for access to the data, the MTFS project directors thoroughly reviewed the purpose of the current study and ensured that it did not overlap with other studies using the MTFS data.

The MTFS consists of two nonoverlapping cohorts of twins followed longitudinally. The younger cohort was initially assessed at Age 11. The older cohort was initially assessed at Age 17. The current study is based on both cohorts; participation rates at the follow-ups ranged from 87% to 92% (McGue, Irons, & Iacono, 2014). Their educational attainment and career development were assessed at approximately 21, 25, and 30 years of age. More information on the MTFS can be found in previous publications (e.g., Iacono, Carlson, Taylor, Elkins, & McGue, 1999; Iacono & McGue, 2002). Only those participants who worked during the three waves of data collection and provided full information on job satisfaction were included in analyses to ensure accuracy in the behavioral genetic modeling of job satisfaction at multiple points in time. Our final sample included 712 same-sex twin pairs (i.e., 1,424 individuals).

Of these participants, 61% were male (463 identical and 249 fraternal twin pairs) and over 98% were Caucasian. Their average year of education was 16.28 (SD = .81) at the first wave of job information collection, which was above the national average of educational attainment in the United States (Newburger & Curry, 2000). At the first wave, 12% held administrative or minor professional jobs; 27% held clerical, sales, or technician jobs; 14% had skilled manual jobs; 35% had semiskilled jobs; and 11% were unskilled employees.

Measures

Job satisfaction. Using one item to assess overall job satisfaction is a common practice in applied psychology. Such a measure has been shown to have appreciable reliability and validity (Wanous, Reichers, & Hudy, 1997). Job satisfaction in this study

was measured at the three waves by one item—"I enjoy my job"—on a 4-point scale (1 = *very true*, 4 = *not true at all*) to reflect overall job satisfaction. Similar questions (e.g., "I find real enjoyment in my work" and "My job is enjoyable") have been used in well-validated job satisfaction scales (e.g., Overall Job Satisfaction Scale [Brayfield & Rothe, 1951]; Job Satisfaction Survey [Spector, 1985]). A similar one-item measure has also been used in previous research (e.g., Judge & Hurst, 2008). Participants' responses were recoded, with higher scores indicating higher levels of job satisfaction.

General mental ability. Participants' general mental abilities were evaluated through assessments administered in person, at approximately Age 17 using the Wechsler Adult Intelligence Scale Revised (Wechsler, 1974). The verbal and quantitative scores were prorated and summed to give an overall indicator of general mental ability on an IQ scale (i.e., mean of 100 and *SD* of 15 in the normative sample). The overall IQ scores were used as the indicator for general mental ability in all analyses.

PA and NA. PA (α = .92) and NA (α = .92) were assessed using the 198-item form of the Multidimensional Personality Questionnaire (MPQ; Tellegen, 1982; Tellegen & Waller, 2008), a widely used, broad-band personality questionnaire. They (also called positive and negative emotionality) are two higher order factors of the MPQ. PA is primarily based on the social potency, well-being, social closeness, and achievement facets of the MPQ. NA is primarily based on the dimensions of aggression, alienation, and stress reaction. Although participants' personality data were obtained at the age of approximately 25 years, previous research has suggested that individuals' between-person rankings of personality traits in a sample are relatively stable and rarely display dramatic changes in a short period of time (Caspi et al., 2005; McCrae et al., 2000; Roberts & DelVecchio, 2000). Thus, the PA and NA scores are useful predictors of job satisfaction from Age 21 to Age 30.

Occupational status. Following previous research (Judge et al., 1999; Lykken & Tellegen, 1996; Zhang, Ilies, & Arvey, 2009), occupational status was assessed using the widely adopted and well-validated Hollingshead Index of Social Position (Hollingshead, 1975; also see D. C. Miller, 1991). During each of the three waves of data collection, participants provided descriptions of their job titles and major job responsibilities at their current jobs. This information was coded by trained MTFS researchers according to the Hollingshead index on a 7-point scale (1 = *business executives and major professionals with doctoral degrees*; 2 = *lesser professionals [e.g., upper-level managers, accountants, and editors]*; 3 = *administrative, minor professionals*; 4 = *clerical, sales, and technicians*; 5 = *skilled manual*; 6 = *semiskilled*; 7 = *unskilled employees*). Jobs were coded only if the person was working full time, so that the occupational status variable was missing for students, homemakers, and those working part time. We reversed these scores so that higher scores reflect higher status. Previous research shows that the Hollingshead index of occupational status correlates at r = .74 with the Duncan Socioeconomic Index, another widely used system of evaluating occupational status (Haug & Sussman, 1971).

Interpersonal conflict at work. Consistent with previous research showing that coworkers and supervisors are two major sources of work interpersonal conflict (e.g., Frone, 2000; Spector & Jex, 1998), interpersonal conflict at work in this study was measured three times. Two items were administered in each wave to measure the degree of conflict with coworkers and supervisors, respectively ("I have problems getting along with my co-workers" and "I have problems getting along with my supervisors"). Response options ranged from 1 (*very true*) to 4 (*not true at all*). We reversed the scores so that higher scores represent higher conflict. The correlation between the two items was .60, .63, and .49 at each of the three waves of data collection, respectively.

Control variables. In all the analyses, we controlled for gender because it may affect estimates of genetic and environmental influences (Johnson & Krueger, 2006; McGue & Bouchard, 1984; Zhang, Zyphur, et al., 2009; Zyphur, Li, Zhang, Arvey, & Barsky, 2015) as well as levels of job satisfaction (Judge & Kammeyer-Mueller, 2012). Age was not used as a control variable because the three waves of work information collection were conducted at approximately the same ages for all the participants. It is not appropriate to include years of education as a control variable because educational attainment has been theorized as a mechanism through which general mental ability exerts its influence on career outcomes (Schmidt & Hunter, 2004); thus, controlling for education would have partialed out the substantive effects of general mental ability (Spector & Brannick, 2011).

Analytical Strategy

Univariate biometric analyses. We performed three sets of biometric analyses: univariate, bivariate, and trivariate, all based on multigroup (i.e., monozygotic [MZ] and dizygotic [DZ] twin groups) structural equation modeling (Neale & Cardon, 1992; Plomin et al., 2013). Univariate biometric analyses were used to examine the stability and change of genetic influences on job satisfaction across the three measurement times (Hypotheses 1a and 1b). In univariate biometric analyses, an observed variable, P, is modeled to be influenced by three latent factors—A (additive genetic factors), C (shared environmental factors that cause similarity among family members), and E (unique environmental influences that make individuals different such as unique family and occupational experiences and potential measurement error):

$$P = u + a * \mathrm{A} + c * \mathrm{C} + e * \mathrm{E} \quad (1)$$

where P represents an observed variable; A, C, and E are standardized latent genetic and environmental variables (with means and variances specified at 0 and 1, respectively); *a*, *c,* and *e* are their corresponding coefficients to be estimated; and *u* denotes the intercept or mean phenotypic score.

Because the A, C, and E components are assumed to be uncorrelated, variance in P can be decomposed into three variance components, a^2, c^2, and e^2, which are associated with genetic, shared environmental, and unique environmental factors, respectively. Genetic influences on P can be estimated as $a^2/(a^2 + c^2 + e^2)$. Although it seems that such biometric analyses are similar to simple regression analyses in terms of variance decomposition, using multigroup structural equation modeling has three advantages. First, it readily offers estimates of confidence intervals (CIs), which can be used to assess the stability and change of genetic influences on job satisfaction over time. Second, it allows researchers to parametrize the corresponding cross-twin correlations (e.g., Twin 1 and Twin 2 of the same twin pair) of latent genetic and environmental factors to differ-

ent values for the MZ and DZ twin groups. As such, simultaneous estimation of all the parameters for the two groups is feasible. As shown in Figure 2, for the MZ (DZ) twin group, the correlation between two genetic factors, A_1 and A_2, was set to 1.0 (0.5) because co-twins, on average, share 100% (50%) of their genetic makeup. The correlation between two shared environmental factors, C_1 and C_2, was set to 1.0, by definition, for both twin groups. The correlation between two unshared environmental factors, E_1 and E_2, was set to zero for both groups. Third, this approach allows "different types of models to be explicitly tested and compared" (Plomin et al., 2013, p. 384) to determine the most parsimonious model "with the smallest number of parameters that generates expectations that match the observed data as closely as possible" (p. 383). To determine the best-fitting model, we compared the fit indices of alternative models (ACE, AE, CE, and E models) and tested the significance of the influences of A, C, and E (Kline, 2005). To assess model fit, we used fit indices including the chi-square difference test, the Comparative Fit Index, the Tucker-Lewis Index, the Root Mean Square Error of Approximation, and Akaike's information criterion, following previous research (e.g., Johnson & Krueger, 2006; Judge, Ilies, et al., 2012; Li, Arvey, Zhang, & Song, 2012).

Bivariate biometric analyses. Bivariate biometric analyses were carried out to test (a) whether general mental ability, PA, and/or NA mediated genetic influences on job satisfaction at the three points in time (Hypotheses 2, 3, and 4), as well as the magnitudes of such mediating effects (Research Question 1); and (b) the stability and change of environmental influences related to occupational status and interpersonal conflict at work on job satisfaction over time with genetic influences controlled for (Hypotheses 5 and 6 as well as Research Questions 2 and 3). The standard approach in behavioral genetics research, the Cholesky decomposition model (Neale & Cardon, 1992), was adopted. Specifically, bivariate biometric analyses decompose observed relationships into genetic and environmental components. Figure 3 illustrates an example with a predictor and job satisfaction (the effects of shared environmental factors, C1, were not modeled because their influences were negligible or null, a consistent finding in behavioral genetics research; Bouchard, 2009; McCartney et al., 1990; McGue et al., 1993).

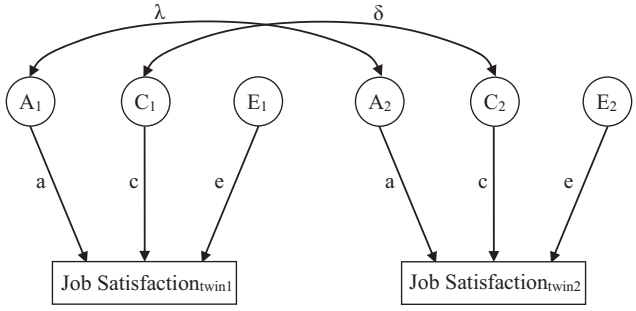

Figure 2. Univariate biometric analyses for job satisfaction. A = additive genetic factors; C = shared environmental factors; E = unique environmental factors and/or measurement error; λ = 1 for monozygotic twins and .5 for dizygotic twins; δ = 1 for both types of twins.

It is notable that total variance in job satisfaction is the same in univariate and bivariate biometric models. Furthermore, the parameters used in calculating the heritability of job satisfaction is also the same in both types of models (Neale & Cardon, 1992; Plomin et al., 2013). The variance component a^2 in a univariate model (see Figure 2) is further decomposed into two variance components a_{21}^2 and a_{22}^2 (see Figure 3), where a_{21} is genetic influence related to the predictor and a_{22} represents the "residual genetic influence" that is not related to the predictor. Thus, algebraically, $a^2 = a_{21}^2 + a_{22}^2$.

We adopted two approaches to examine the mediation effects via the individual difference variables. Our first approach is the dominant method employed in behavioral genetics studies. According to Jockin, McGue, and Lykken (1996), in order to examine "through which proximate causal variables do genes pass on their influence" (p. 288) to an outcome variable, three criteria should be met. First, a potential mediator, as well as the outcome variable, "must to some extent be genetically influenced." Second, the potential mediator must be related to the outcome variable. Third, the same genetic factors must influence both the mediator and the outcome in the Cholesky decomposition. The three criteria have been adopted in testing mediation in previous research using twin designs (Arvey, Rotundo, Johnson, Zhang, & McGue, 2006; Jockin et al., 1996; Judge, Ilies, et al., 2012; Saudino, Pedersen, Lichtenstein, McClearn, & Plomin, 1997; Shane, Nicolaou, Cherkas, & Spector, 2010; Zhang, Zyphur, et al., 2009). The Cholesky decomposition is particularly useful for meeting the third criterion, because it can examine whether the same genetic factors affect both a mediator and job satisfaction (i.e., through the CI associated with a_{21} in Figure 3).

This approach adopts the same theoretical rationale in inferring mediation as the conventional approaches used in applied psychology. Mathieu and Taylor (2006) suggested three important preconditions to infer mediation: experimental designs, temporal precedence, and theoretical guidance. Behavioral genetics research approximates the three preconditions because (a) twin study designs are naturally occurring quasi-experiments (Plomin et al., 1994); (b) genetic factors form before individual difference variables, and individual difference variables come into being before job satisfaction (Arvey & Bouchard, 1994; Plomin et al., 2013); and (c) previous research has suggested and found that one of the pathways through which genetic factors affect outcome variables is through individual difference variables such as general mental ability and personality traits (e.g., Arvey & Bouchard, 1994; Ilies & Judge, 2003; Plomin et al., 2013).

Under this first approach, we followed the variance decomposition tradition in behavioral genetics to use *explained variance* values to quantify mediation effects. For example, we estimated the percentage of the total variance in job satisfaction that was explained by PA's genetic factors ($= a_{21}^2/[a_{21}^2 + a_{22}^2 + e_{21}^2 + e_{22}^2]$), and this value represents the mediating effect of PA in the genetics/job-satisfaction relationship. This explained variance index has been suggested as an alternative effect size measure for testing of mediation effects (Preacher & Kelley, 2011). Similarly, the percentage of the total variance in job satisfaction accounted for by environmental factors related to an environmental predictor is $e_{21}^2/(a_{21}^2 + a_{22}^2 + e_{21}^2 + e_{22}^2)$, which was used to test Research Questions 2 and 3.

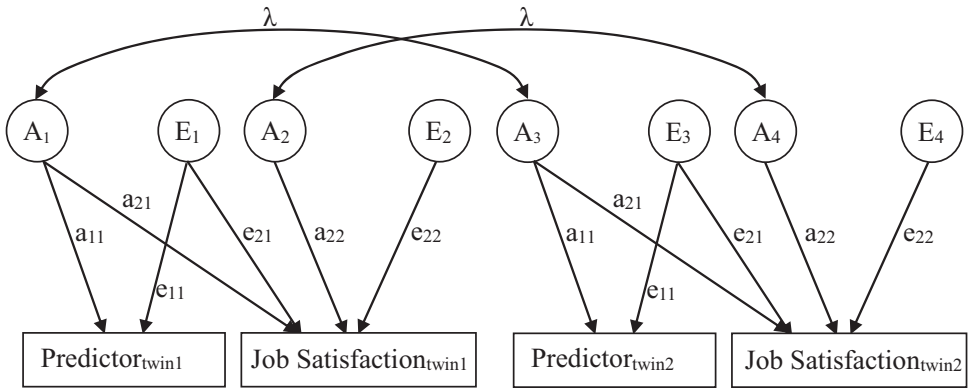

Figure 3. Bivariate biometric analyses for job satisfaction with a predictor using the Cholesky decomposition. A = additive genetic factors; E = unique environmental factors and/or measurement error; effects of shared environmental factors (C) were not modeled because the effects were not significant, which is also a consistent finding in previous research; λ = 1 for monozygotic twins and .5 for dizygotic twins.

Admittedly, this first approach of mediation testing in the behavioral genetics literature is different from the product-of-coefficients approach or the difference-in-coefficients approach used in the psychology literature (MacKinnon, 2008; MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Preacher & Kelley, 2011). The product-of-coefficients approach uses $a_m \times b_m$ to quantify the mediation effect, where a_m is the path from the predictor to the mediator, and b_m is the path from the mediator to the outcome while controlling for the predictor (with path c'_m). The difference-in-coefficients approach uses $c_m - c'_m$, where c_m is the total effect of the predictor on the outcome and c'_m is the predictor's residual effect after controlling for the mediator. Prior research has shown that $a_m \times b_m$ and $c_m - c'_m$ are algebraically equivalent (MacKinnon, Warsi, & Dwyer, 1995), and thus both have been used for mediation testing (Muller, Yzerbyt, & Judd, 2008).

As such, our second approach for mediation testing used the $c_m - c'_m$ method that is more accessible to applied psychology researchers. Because the total amount of variance in job satisfaction explained by genetic factors is the same in univariate as in bivariate models, the total effect of genetic influences (i.e., "c_m") on job satisfaction is captured by the path a in a univariate model (see Figure 2), which is equivalent to the square root of $(a_{21}^2 + a_{22}^2)$, where a_{21} and a_{22} are path coefficients in a bivariate model (see Figure 3). After an individual difference variable is introduced to the model, the a_{22} path represents the residual genetic effect "c'_m." Therefore, translating the $c_m - c'_m$ formula into a bivariate biometric model, our second approach used $[sqrt(a_{21}^2 + a_{22}^2) - a_{22}]$ to quantify a mediation effect.

Trivariate biometric analyses. Lastly, trivariate biometric analyses were conducted to corroborate the results of univariate analyses, examining the change of genetic influences on job satisfaction by simultaneously including all the three job satisfaction measures in one model (see Figure 4). Such analyses provided a more rigorous test of the possible change of genetic influences on job satisfaction over time (Hypotheses 1a and 1b). We used 1,000 resamples and reported the bias-corrected bootstrapped 95% confidence intervals (CIs). Because many estimated coefficients based on the ACE models have a lower bound of zero, the boostrapped CIs may not center around the point estimates.

Results

Table 1 displays the means, standard deviations, and correlations among the study variables. It shows that the three individual characteristics variables were substantively correlated with job satisfaction at all the three measurement occasions, though job satisfaction stability coefficient were low in magnitude. In addition, interpersonal conflict measured at each time was substantively related to concurrent job satisfaction. Occupational status appeared to show a similar pattern. These findings provide empirical grounds for further biometric analyses. Table 2 presents the within-twin pair correlations (e.g., the correlation between Twin 1's job satisfaction at Time 1 and Twin 2's job satisfaction at Time 1) of study variables for identical and fraternal twins. An inspection of Table 2 indicates greater similarities for identical twins (values in the upper diagonal) than for fraternal twins (values in the lower diagonal) on all study variables. These results suggest likely genetic effects on these variables (Loehlin, 1992; Plomin et al., 2013).

Tests of Hypotheses and Research Questions

Hypotheses 1a and 1b concerned possible changes of genetic influences on job satisfaction over time. In univariate biometric analyses, fitting the data with genetic factors (A), shared environmental factors (C), and unique environmental factors (E) for job satisfaction at Time 1 indicated that effects of the shared environmental factors were negligible (Model 1, Table 3). Such a finding is consistently reported in the behavioral genetic literature (Bouchard, 2009; McCartney et al., 1990; McGue et al., 1993; Plomin et al., 2013). Thus, following previous research (e.g., Arvey et al., 2007; Judge, Ilies, et al., 2012; Shane et al., 2010), effects of C were fixed to zero in the subsequent analyses. Model 2, with only genetic factors and unique environmental factors, fit the data best among all the alternative models. In this model, genetic factors accounted for 31.2% of the variance in job satisfaction at Time 1 (95% CI [28.8%, 37.1%]). Models with genetic and unique environmental factors (AE models) were also adopted as the best-fitting models for other study variables.

Similar results were observed for the job satisfaction variables measured at Time 2 and Time 3. The best-fitting models were the

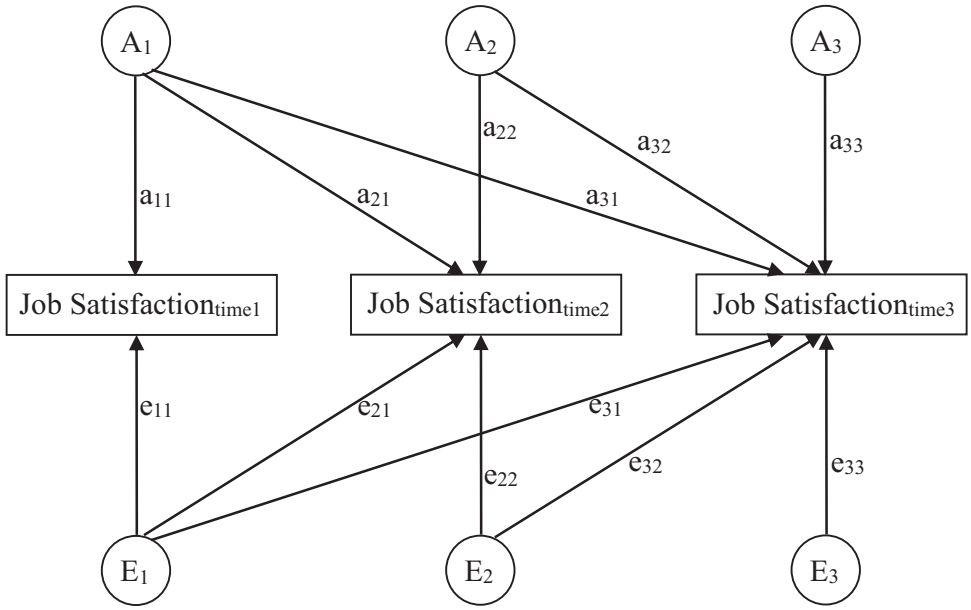

Figure 4. Trivariate biometric analyses for job satisfaction across time using the Cholesky decomposition. This is a partial diagram showing additive genetic factors (A_1, A_2, and A_3) and unique environmental factors (E_1, E_2, and E_3) for one twin for the sake of clarity. A = additive genetic factors; E = unique environmental factors and/or measurement error; effects of shared environmental factors (C) were not modeled because the effects were not significant, which is also consistent with previous research.

models with only genetic and unique environmental factors (AE models: Model 6 and Model 10; Table 3). Genetic factors accounted for 18.7% (95% CI [11.4%, 25.6%]) and 19.8% (95% CI [10.3%, 28.1%]) of the variance in job satisfaction at Time 2 and Time 3, respectively. Because the 95% CI for genetic influences at Time 1 did not overlap with the two CIs at Time 2 and Time 3, we concluded that genetic influences on job satisfaction significantly decreased from Time 1 to Time 2 and Time 3. There seemed to be no significant difference in genetic influences between Time 2 and Time 3.

The findings of decreased genetic influences on job satisfaction were also corroborated in trivariate analyses (see Table 4). Allowing genetic influences to be freely estimated in Model 1 yielded good model fit. However, fixing genetic influences at Time 1 equal to those influences at Time 2 (Model 2) or at Time 3 (Model 3), or specifying equal genetic influences across the three times (Model 5) produced poorer model fit. Fixing genetic influences at Time 2 equal to those at Time 3 did not substantially change model fit (Model 4). This result suggested that genetic influences on job satisfaction did not change substantially from Time 2 to Time 3. Thus, Hypothesis 1b, that genetic influences become weaker at later time points (i.e., at Ages 25 and 30), was supported.

Hypotheses 2, 3, and 4 focused on the role of general mental ability (H2), PA (H3), and NA (H4) in mediating genetic influences on job satisfaction at different time points. With the behavioral genetics approach for mediation testing, univariate analyses

Table 1
Descriptive Statistics and Zero-Order Correlations for Study Variables at the Individual Level

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. General mental ability	101.25	14.24	—										
2. Positive affectivity	124.70	12.87	.05	—									
3. Negative affectivity	81.77	13.42	−.04	−.13	—								
4. Occupational status, Time 1	5.11	1.31	.07	.08	−.08	—							
5. Occupational status, Time 2	6.11	1.59	.18	.09	−.12	.28	—						
6. Occupational status, Time 3	6.56	1.56	.24	.11	−.13	.23	.50	—					
7. Interpersonal conflict, Time 1	2.54	.83	.05	−.14	.20	−.05	−.13	−.09	—				
8. Interpersonal conflict, Time 2	2.53	.85	.10	−.18	.25	.00	−.05	−.10	.29	—			
9. Interpersonal conflict, Time 3	2.39	.76	.10	−.10	.17	.02	−.05	−.05	.26	.30	—		
10. Job satisfaction, Time 1	3.26	.70	−.05	.25	−.10	.12	.07	.04	−.24	−.14	−.09	—	
11. Job satisfaction, Time 2	3.30	.69	−.10	.32	−.15	.03	.07	.01	−.17	−.33	−.11	.25	—
12. Job satisfaction, Time 3	3.40	.62	−.07	.20	−.17	.05	.03	.07	−.07	−.17	−.26	.17	.31

Note. N = 743–1,424 individuals. Correlations with absolute values of .06 or higher are significant at $p < .05$; correlations with absolute values of .09 or higher are significant at $p < .01$. Time 1 = Age 21; Time 2 = Age 25; Time 3 = Age 30.

Table 2
Within-Twin-Pair Correlations for the Study Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. General mental ability, Twin 1	—	.07	−.09	.18	.11	.22	.05	.09	.10	−.06	−.08	−.13	**.80**	−.01	−.07	.14	.21	.26	.04	.14	.09	.04	−.05	−.09
2. Positive affectivity, Twin 1	.05	—	−.11	.09	.07	.12	−.19	−.14	−.02	.30	.32	.20	.01	**.47**	−.02	.03	.12	.04	.01	.00	−.01	.15	.20	.24
3. Negative affectivity, Twin 1	.02	−.18	—	−.14	−.10	−.08	.15	.19	.04	−.15	−.15	−.19	−.12	−.12	**.46**	−.12	−.20	−.12	.18	.07	.07	−.10	−.14	−.14
4. Occupational status, Time 1, Twin 1	.12	.18	−.07	—	.31	.20	−.05	.01	.05	.16	.07	.10	.10	.01	−.07	**.36**	.19	.13	−.13	.05	−.01	.00	−.03	−.03
5. Occupational status, Time 2, Twin 1	.33	.12	−.05	.34	—	.46	−.10	−.03	−.06	.05	.03	.05	.07	−.05	−.05	.26	**.43**	.32	−.09	−.07	−.03	.00	.02	−.15
6. Occupational status, Time 3, Twin 1	.28	.09	−.25	.28	.43	—	−.07	−.10	−.02	.08	.03	.00	.17	.05	−.12	.20	.43	**.48**	−.02	−.05	−.06	.03	.04	.01
7. Interpersonal conflict, Time 1, Twin 1	.10	−.13	.25	−.05	−.06	−.07	—	.29	.20	−.23	−.17	−.08	.02	−.06	.17	.05	−.09	−.02	**.20**	.15	.23	−.08	−.17	−.15
8. Interpersonal conflict, Time 2, Twin 1	.09	−.24	.34	−.01	.09	−.04	.32	—	.18	−.15	−.33	−.16	.08	.00	.05	.16	.00	.01	.21	**.13**	.20	−.06	−.10	−.12
9. Interpersonal conflict, Time 3, Twin	.12	−.22	.37	.03	.03	−.14	.26	.36	—	.00	−.07	−.23	.14	.02	.04	−.05	−.07	−.04	.17	.13	**.21**	−.14	−.12	−.07
10. Job satisfaction, Time 1, Twin 1	−.09	.23	−.18	.09	.07	.12	−.29	−.18	−.10	—	.25	.18	−.04	.15	−.10	.04	.05	.01	−.08	−.03	−.12	**.28**	.20	.19
11. Job satisfaction, Time 2, Twin 1	−.19	.27	−.10	.04	.09	−.04	−.23	−.38	−.19	.28	—	.35	−.08	.15	−.07	.03	.12	.06	−.12	−.04	−.10	.24	**.25**	.17
12. Job satisfaction, Time 3, Twin 1	−.01	.11	−.14	.08	−.04	.18	−.13	−.29	−.38	.28	.25	—	−.10	.16	−.08	−.01	.09	−.03	−.12	−.08	−.07	.20	.30	**.18**
13. General mental ability, Twin 2	**.41**	−.08	.14	−.11	.05	.17	.19	.04	.15	.03	−.06	−.01	—	.01	−.10	.07	.22	.28	.00	.15	.09	.04	−.07	−.07
14. Positive affectivity, Twin 2	.01	**.21**	−.04	−.16	.14	.12	.05	−.22	−.17	.07	.06	.09	.08	—	−.11	.10	.10	.09	−.06	−.16	−.12	.21	.35	.27
15. Negative affectivity, Twin 2	.09	.02	**.21**	−.08	−.03	−.06	.08	.16	.11	−.04	.02	−.09	.14	−.15	—	−.07	−.22	−.15	.25	.25	.16	−.05	−.19	−.14
16. Occupational status, Time 1, Twin 2	.02	−.02	−.13	**.25**	.12	.03	−.01	.09	−.06	−.01	−.10	.07	−.04	−.09	.00	—	.25	.23	−.05	.00	.04	.15	.02	−.03
17. Occupational status, Time 2, Twin 2	.10	−.03	−.14	−.02	**.14**	.00	.04	−.07	.00	.13	.02	−.07	.05	.13	−.04	.21	—	.55	−.22	−.12	−.12	.10	.14	.05
18. Occupational status, Time 3, Twin 2	.13	−.05	−.14	.06	.21	**.08**	.05	.08	−.05	.10	−.07	−.05	.16	.16	−.08	.26	.55	—	−.05	−.08	−.07	−.01	.08	.05
19. Interpersonal conflict, Time 1, Twin 2	.12	.04	.12	−.04	−.03	−.09	**.15**	−.02	.20	−.08	.03	.06	.09	−.18	.14	−.06	−.10	−.22	—	.28	.33	−.24	−.17	−.05
20. Interpersonal conflict, Time 2, Twin 2	.13	−.08	−.05	−.20	−.06	−.08	.08	**.11**	.12	−.01	.00	.05	.06	−.26	.28	−.04	−.10	−.19	.30	—	.41	−.11	−.29	−.12
21. Interpersonal conflict, Time 3, Twin 2	.13	.20	−.12	.05	.16	.07	.06	−.04	**.07**	−.04	.10	−.04	.09	−.08	.25	−.08	.01	.01	.27	.24	—	−.15	−.10	−.26
22. Job satisfaction, Time 1, Twin 2	−.01	.05	−.10	.01	.03	.04	−.03	−.12	−.18	**.17**	−.03	.07	−.13	.27	.00	.02	.07	−.03	−.21	−.19	−.10	—	.23	.15
23. Job satisfaction, Time 2, Twin 2	−.08	.08	−.10	−.07	−.01	.01	−.02	−.17	−.17	−.01	**.03**	.05	−.15	.35	−.17	−.08	.00	−.08	−.09	−.33	−.12	.21	—	.32
24. Job satisfaction, Time 3, Twin 2	.02	−.03	−.06	−.03	.05	.04	.01	−.08	−.19	.02	.07	**.08**	−.03	.20	−.21	.09	.01	.13	−.01	−.15	−.16	.09	.30	—

Note. $N = 463$ monozygotic (MZ) and 249 dizygotic (DZ) twin pairs; Twin 1 and Twin 2 refer to two co-twins of the same twin pair. Values in the upper diagonal are within-pair correlations for MZ twins, and values in the lower diagonal are within-pair correlations for DZ twins. Correlations with absolute values of .10 or higher are significant at $p < .05$; correlations with absolute values of .17 or higher are significant at $p < .01$. Bolded values indicate within-twin pair correlations for the same study variables.

Table 3
Results of Univariate Biometric Analyses for the Three Job Satisfaction Variables

Growth models for	Model fit indices					
	χ^2 (*df*)	$\Delta\chi^2$ (Δdf)	CFI	TLI	AIC	RMSEA
Job satisfaction, Time 1						
Model 1: A,C,E	2.26 (6)	—	1.00	1.01	6253.19	.001
Model 2: A,E[a]	2.36 (7)	.10 (1)	1.00	1.01	6251.29	.001
Model 3: C,E	7.01 (7)	4.75* (1)	1.00	1.00	6255.94	.002
Model 4: E	68.81*** (8)	66.55** (2)	.06	.76	6315.73	.112
Job satisfaction, Time 2						
Model 5: A,C,E	8.18 (6)	—	.91	.97	6183.16	.024
Model 6: A,E[a]	8.18 (7)	.00 (1)	.95	.99	6181.16	.017
Model 7: C,E	14.83* (7)	6.65** (1)	.69	.91	6187.82	.043
Model 8: E	32.14*** (8)	23.96*** (2)	.04	.76	6203.13	.071
Job satisfaction, Time 3						
Model 9: A,C,E	4.04 (6)	—	1.00	1.01	4415.58	.001
Model 10: A,E[a]	4.04 (7)	.00 (1)	1.00	1.01	4413.58	.001
Model 11: C,E	8.42 (7)	4.38* (1)	.93	.98	4417.96	.022
Model 12: E	25.03*** (8)	20.99*** (2)	.17	.79	4432.57	.071

Note. Sample sizes were 463 and 249 twin pairs for monozygotic and dizygotic twins, respectively. A, C, and E denote additive genetic factors, shared environmental factors, and unique environmental factors, respectively. *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation.
[a] Indicates the best-fitting model.
* $p < .05$. ** $p < .01$. *** $p < .001$.

showed that all the three individual difference variables were under significant genetic influences. In addition, all of them were significantly related to job satisfaction (except for the correlation between general mental ability and job satisfaction at Time 1; see Table 1). Thus, to meet the last precondition for testing mediation in behavioral genetics research (Jockin et al., 1996), we needed to examine whether the same genetic factors affected one of the three variables and job satisfaction simultaneously. Bivariate biometric analyses (see Table 5) revealed that genetic factors associated with general mental ability did not appreciably affect job satisfaction (in Models 1, 2, and 3 of Table 5, the 95% CIs for a_{21}, [−.05, .05], [−.05, .06], and [−.08, .03], all included zero). Such findings did not support H2. However, in support of H3 and H4, genetic factors related to PA (in Models 4, 5, and 6, the 95% CIs for a_{21} were [.16, .30], [.14, .28], and [.16, .31]) and NA (in Models 7, 8, and 9, the 95% CIs for a_{21} were [−.17, −.04], [−.22, −.09], and [−.24, −.09]) had moderate influences on job satisfaction at the three time points. The above findings were further confirmed by

Table 4
Results of Trivariate Biometric Analyses for Job Satisfaction Over Time

Trivariate biometric models for job satisfaction over time	Model fit indices						Path coefficients estimates											
	χ^2 (*df*)	$\Delta\chi^2$ (Δdf)	CFI	TLI	AIC	RMSEA	a_{11}	a_{21}	a_{31}	a_{22}	a_{32}	a_{33}	e_{11}	e_{21}	e_{31}	e_{22}	e_{32}	e_{33}
No constraints of equal influences, Model 1	33.45 (39)	—	1.00	1.00	16563.81	.001	.57	.33	.35	.30	.28	.00	.83	.07	.03	.90	.13	.88
Equal genetic influences at Time 1 and Time 2, Model 2	39.52 (40)	6.07* (1)	1.00	1.00	16567.88	.001	.51	.37	.38	.35	.23	.00	.86	.07	.03	.87	.12	.88
Equal genetic influences at Time 1 and Time 3, Model 3	38.68 (40)	5.32* (1)	1.00	1.00	16567.04	.001	.51	.34	.39	.28	.33	.00	.86	.08	.03	.90	.11	.86
Equal genetic influences at Time 2 and Time 3, Model 4 [a]	33.46 (40)	.01 (1)	1.00	1.00	16561.82	.001	.57	.33	.35	.30	.28	.00	.83	.07	.03	.90	.13	.88
Equal genetic influences at Time 1, Time 2, and Time 3, Model 5	41.09 (41)	7.64* (2)	1.00	1.00	16567.45	.002	.49	.37	.41	.32	.26	.04	.87	.07	.03	.88	.10	.87

Note. Sample sizes were 463 and 249 twin pairs for monozygotic and dizygotic twins, respectively. AE models were used in Cholesky decomposition. Parameters a_{11}, a_{21}, a_{31}, e_{11}, e_{21}, and e_{31} denote paths presented in Figure 3. Path coefficient estimates below .06 are not significant at the .05 level; estimates within the range between .07 and .10 are significant at the .05 level; and estimates larger than .10 are significant at the .001 level. Time 1 = Age 21; Time 2 = Age 25; Time 3 = Age 30. *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation.
[a] Indicates the best-fitting model.
* $p < .05$.

Table 5
Results of Bivariate Biometric Analyses for Individual Characteristics and Job Satisfaction Over Time

Bivariate biometric models	Model fit indices					Path coefficients estimates						Variance explained by genetic factors associated with individual characteristics (%)	
	χ^2 (*df*)	CFI	TLI	AIC	RMSEA	a_{11}	a_{21}	a_{22}	e_{11}	e_{21}	e_{22}	Estimate	95% CI
GMA with													
Job satisfaction T1, Model 1	12.48 (20)	1.00	1.01	12229.84	.001	.80	.01	.56	.61	.02	.83	.1	[0, .2]
Job satisfaction T2, Model 2	18.87 (20)	1.00	1.00	12157.64	.001	.80	.01	.43	.61	.06	.90	.1	[0, .2]
Job satisfaction T3, Model 3	15.14 (20)	1.00	1.01	10392.14	.001	.80	.02	.44	.61	.01	.90	.1	[0, .4]
Positive affectivity with													
Job satisfaction T1, Model 4	12.20 (20)	1.00	1.01	12372.46	.001	.68	.23	.51	.74	.11	.83	5.2	[2.6, 8.5]
Job satisfaction T2, Model 5	22.47 (20)	.99	1.01	12193.60	.014	.68	.21	.37	.74	.23	.88	4.5	[2.1, 7.9]
Job satisfaction T3, Model 6	19.09 (20)	1.00	1.00	10564.71	.001	.68	.24	.37	.74	.07	.89	5.5	[2.4, 9.7]
Negative affectivity with													
Job satisfaction T1, Model 7	19.38 (20)	1.00	1.00	12426.28	.001	.69	−.10	.55	.73	−.01	.83	1.0	[.1, 2.7]
Job satisfaction T2, Model 8	18.72 (20)	1.00	1.00	12296.42	.001	.69	−.15	.41	.73	−.12	.89	2.3	[.7, 4.9]
Job satisfaction T3, Model 9	16.52 (20)	1.00	1.00	10570.00	.001	.69	−.16	.41	.73	−.05	.90	2.6	[.8, 5.6]

Note. Sample sizes were 463 and 249 twin pairs for monozygotic and dizygotic twins, respectively. AE models were used in Cholesky decomposition. Parameters a_{11}, a_{21}, a_{22}, e_{11}, e_{21}, and e_{22} denote paths presented in Figure 2. Path coefficient estimates below .10 are not significant at the .05 level; estimates within the range between .11 and .26 are significant at the .05 level; and estimates larger than .27 are significant at the .001 level. T1 = Time 1 (Age 21); T2 = Time 2 (Age 25); T3 = Time 3 (Age 30). *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation; CI = confidence interval; GMA = general mental ability.

the proportion of the total variance in job satisfaction accounted for by those genetic factors related to the three individual characteristics (see the right portion of Table 5). The amount of variance accounted for by general mental ability seemed to be negligible, but the variance accounted for by PA and NA was sizable.

Using the difference-in-coefficients approach for mediation testing, we found similar results. Specifically, the difference-in-coefficients estimates of indirect effect were .001 (95% CI [0, .002]), .001 (95% CI [0, .002]), and .001 (95% CI [0, .007]) for general mental ability at the three time points, respectively. Given that all the three CIs included zero, it appears that general mental ability mediated little, if any, of the genetic influences on job satisfaction. PA and NA seemed to play a more important role in mediating genetic influences. For PA, the difference-in-coefficients estimates were .036 (95% CI [.019, .058]), .050 (95% CI [.025, .078]), and .057 (95% CI [.026, .100]), respectively, at the three time points. The estimates were .008 (95% CI [.001, .020]), .026 (95% CI [.009, .052]), and .029 (95% CI [.009, .058]) for NA.

To address Research Question 1, we compared the magnitudes of the mediating effects of the three individual difference variables in the relationship between genetic factors and job satisfaction over time. This was done with both the behavioral genetics approach and the difference-in-coefficients approach. With the behavioral genetics approach, as shown in the right portion of Table 5, general mental ability did not mediate much of the genetic influence on job satisfaction. Genetic factors associated with PA explained appreciable amount of total variance in job satisfaction at the three time points. The magnitudes of the mediating effects of PA did not seem to change substantially across time. NA's mediating role in transmitting genetic influence on job satisfaction did not change substantially either. Using the difference-in-coefficients approach generated similar results. The mediating role of the three individual difference variables did not change substantially over time.

Overall, trait affectivity, especially PA, played a more important role in mediating genetic influences on job satisfaction than general mental ability. These results, based on bivariate analyses, were confirmed in additional analyses incorporating four variables simultaneously in one model (three job satisfaction variables plus each of the three individual characteristic variables).

We were also interested in examining environmental influences related to occupational status (H5 and Research Question 2) and interpersonal conflict (H6 and Research Question 3) on job satisfaction over time, after controlling for genetic influences on all variables in the model. Univariate biometric analyses revealed that genetic factors accounted for 27.7% (95% CI [20.3%, 34.0%]), 40.8% (95% CI [35.2%, 46.8%]), and 46.5% (95% CI [38.8%, 53.3%]) of the variance in occupational status at the three measurement times, respectively. Genetic factors also explained 22.9% (95% CI [15.4%, 30.2%]), 14.7% (95% CI [7.6%, 22.5%]), and 18.1% (95% CI [10.0%, 27.1%]) of the variance in interpersonal conflict at work for the three measurement occasions. Such findings provided empirical evidence that measured, putative environmental variables are subject to genetic influences. As a result, such genetic influences needed to be partialed out when we examine environmental (vs. person-related) influences on job satisfaction.

Bivariate biometric analyses (see Table 6) showed that with genetic influences controlled for, environmental influences related to occupational status influenced job satisfaction over time: Environmental factors stemming from occupational status at the three measurement times also significantly affected job satisfaction at the corresponding time points (95% CIs for e_{21} in Models 1, 2, and 3 were [.06, .17], [.01, .12], and [.05, .19]). Those environmental factors accounted for approximately 1% of the total variance in job satisfaction across the three time points (the right portion of Table 6). Such findings provided support to H5 and H6. Occupational-status-related environmental influences on job satisfaction did not appear to have changed. Similarly, with genetic influences controlled for, environmental factors related to interpersonal conflict

Table 6
Results of Bivariate Biometric Analyses for Work Environmental Variables and Job Satisfaction Over Time

Bivariate biometric models	Model fit indices					Path coefficients estimates						Variance explained by work environmental factors with genetic influences controlled for (%)	
	χ^2 (*df*)	CFI	TLI	AIC	RMSEA	a_{11}	a_{21}	a_{22}	e_{11}	e_{21}	e_{22}	Estimate	95% CI
Occupational status at corresponding time point with													
Job satisfaction T1, Model 1	10.01 (20)	1.00	1.00	11878.90	.001	.53	.03	.56	.85	.11	.82	1.2	[.3, 2.6]
Job satisfaction T2, Model 2	15.19 (20)	1.00	1.00	12080.83	.001	.64	.05	.43	.77	.07	.90	.4	[.1, 1.4]
Job satisfaction T3, Model 3	21.05 (20)	.99	1.00	8536.42	.011	.68	.02	.44	.74	.12	.89	1.5	[.2, 3.5]
Interpersonal conflict at work at corresponding time point with													
Job satisfaction T1, Model 4	11.89 (20)	1.00	1.02	12383.04	.001	.48	−.21	.52	.88	−.16	.81	2.6	[1.2, 4.6]
Job satisfaction T2, Model 5	18.92 (20)	1.00	1.00	12070.47	.001	.39	−.30	.33	.92	−.22	.87	4.9	[3.0, 8.0]
Job satisfaction T3, Model 6	38.15** (20)	.87	.92	8525.54	.046	.43	−.18	.40	.91	−.20	.87	4.2	[2.1, 6.9]

Note. Sample sizes were 463 and 249 twin pairs for monozygotic and dizygotic twins, respectively. AE models were used in Cholesky decomposition. Parameters a_{11}, a_{21}, a_{22}, e_{11}, e_{21}, and e_{22} denote paths presented in Figure 2. Path coefficient estimates below .06 are not significant at the .05 level; estimates within the range between .17 and .13 are significant at the .05 level; and estimates larger than .14 are significant at the .001 level. T1 = Time 1 (Age 21); T2 = Time 2 (Age 25); T3 = Time 3 (Age 30). *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; AIC = Akaike's information criterion; RMSEA = root mean square error of approximation; CI = confidence interval.
** $p < .01$.

at work significantly affected job satisfaction assessed at corresponding time points (95% CIs for e_{21} in Models 4, 5, and 6 were [−.22, −.11], [−.28, −.17], and [−.26, −.14]). Those factors explained an appreciable amount of variance (from 2.6% to 4.9%) in job satisfaction over time, though the differences did not appear significant. Similar results were obtained in additional analyses with four variables included simultaneously in one model (i.e., the three job satisfaction variables plus each of the two work environmental variables). Taken together, the analyses indicated that environmental influences on job satisfaction related to the two work environmental variables did not seem to change over time.

Discussion

Due to its pivotal role in predicting work behaviors, job satisfaction has been one of the most widely studied constructs in applied psychology (Brief & Weiss, 2002; Dalal, 2013; Judge & Kammeyer-Mueller, 2012; Locke, 1976; Spector, 1996). Researchers have devoted a great deal of attention to examining the antecedents of job satisfaction, primarily from two contrasting perspectives—the dispositional and situational approaches. Mirroring this line of inquiry, behavioral genetics research has contributed greatly to the nature-versus-nurture debate, which is a variation of the person-versus-environment debate. As a result, twin studies have been increasingly adopted in applied psychology research to study how the person plays an indispensable role in shaping work experiences as reflected by their genetic influences, and more interestingly, the causal effects of environmental influences after genetic influences are partialed out (e.g., Arvey et al., 1989; Ilies et al., 2006; Judge, Ilies, et al., 2012; Shane et al., 2010).

With the emerging trend of developmental behavioral genetic research (e.g., Briley & Tucker-Drob, 2013; Plomin & Deary, 2015; Turkheimer et al., 2014), applied psychology research has lagged behind by not incorporating the role of time in examining genetic influences on job satisfaction. In their recent review, Bleidorn et al. (2014) pointed out that one important question that developmental behavioral genetic research should tackle is, "Do the relative contributions of genetic and environmental influences on individual differences . . . change across the adult life span?" (p. 248). Responding to this call, the present research used a three-wave longitudinal twin design to examine how genetic influences on job satisfaction change over time and the role of individual differences and work environment variables in those processes. Our findings have important theoretical and practical implications for job satisfaction research.

Theoretical Implications

Change of genetic influences on job satisfaction over time. An important assumption in previous dispositional research on job satisfaction was that the influences of individual characteristics on job satisfaction are stable over time (Bouchard et al., 1992; Dormann & Zapf, 2001; George, 1992; Staw & Ross, 1985). Such an assumption of static influences of individual characteristics has also been shared in other areas, such as job performance (Sturman, 2007). This is probably one important reason why researchers examined or called for more research on dynamic job performance (e.g., Dalal, Bhave, & Fiset, 2014; Lievens, Ones, & Dilchert, 2009; Sturman, Cheramie, & Cashen, 2005; Thoresen, Bradley, Bliese, & Thoresen, 2004; Zyphur, Chaturvedi, & Arvey, 2008). Such a focus on change over time has also been emerging in other areas of applied psychology research, such as justice (e.g., Hausknecht, Sturman, & Roberson, 2011), extrinsic career success (e.g., Judge, Klinger, & Simon, 2010), and job satisfaction (e.g., Chen, Ployhart, Thomas, Anderson, & Bliese, 2011; Liu, Mitchell, Lee, Holtom, & Hinkin, 2012). Similarly, in this study, we directly examined the assumption of stable genetic influences on job satisfaction. We found that when participants were approximately 21

years old, genetic influences explained 31.2% of the variance in job satisfaction. However, genetic influences on job satisfaction measured at Ages 25 and 30 were markedly smaller than those at Age 21. The results did not support the prediction by Bouchard et al. (1992) that genetic factors typically accounted for 30% of the variance in job satisfaction across life span, nor the statement by Dormann and Zapf (2001) that dispositional influences on job satisfaction are stable over time. Furthermore, the findings did not appear to provide support to the prediction from the gravitational hypothesis (McCormick et al., 1972) or from the corresponsive principle of personality development (Roberts et al., 2003), both of which suggested increased genetic influences on job satisfaction over time. However, the results were consistent with Staw's (2004) assertion that over time, genetic influences may be "diluted by strong work situations" (p. 169). Work characteristics (e.g., Hackman & Oldham, 1975; Morgeson et al., 2012; Parker, 2014), macroeconomic situations and labor market conditions (Judge, Hulin, et al., 2012), and individual differences in perceptions of objective environments may be possible explanations for such environmental influences during early adulthood.

Although general mental ability has been suggested as an important mediator for genetic influences on job satisfaction (Arvey & Bouchard, 1994; Ilies & Judge, 2003), previous research has not examined this issue explicitly. Our findings suggest that general mental ability measured at Age 17 played a very small role in mediating genetic influences on job satisfaction at Ages 21, 25, and 30. On the contrary, genetic factors associated with PA and NA measured at Age 25 seemed to be more important in transmitting the overall genetic influences on job satisfaction. The differential mediation roles of general mental ability, PA, and NA might be related to the fact that they were assessed at distinct measurement time points. However, genetic influences mediated by the three individual characteristics did not change substantially over time while the overall genetic influences on job satisfaction decreased with age. The results suggest that other individual differences may play a mediating role in accounting for the decrease in genetic influences on job satisfaction (Judge, Locke, & Durham, 1997; McCartney et al., 1990).

Environmental influences on job satisfaction over time. The current study is characterized by an important feature, that is, the effects of environmental factors were examined with genetic influences controlled for. In investigating environmental influences on work attitudes, it is crucial to control for influences due to selection (e.g., self selection and organization selection). This is because individuals select, and/or are selected into, work environments based on their individual characteristics (Holland, 1996; McCormick et al., 1972; Schneider, 1987; Wrzesniewski & Dutton, 2001). In behavioral genetics, Plomin and colleagues called the influences of selection on measured environmental factors "the nature of nurture" (Plomin & Asbury, 2005, p. 89). It challenges the assumption of environmental causation, which researchers have typically tried to demonstrate by finding significant relationships between measured environmental factors and outcomes of interest (Judge, Ilies, et al., 2012). Also challenging the environmental assumption are findings in many fields, including industrial and organizational psychology, in which researchers have reported significant genetic influences on what appear to be environmental factors, such as leadership experiences (Arvey et al., 2007), work stress (Judge, Ilies, et al., 2012), organizational climate (Hershberger, Lichtenstein, & Knox, 1994), and work characteristics (Li, Zhang, Song, & Arvey, in press). Put differently, research indicates that differences in measured work environments are associated with differences in individuals' genetic makeup. Indeed, at all three measurement times, occupational status and interpersonal conflict at work were influenced significantly by genetic factors. At the same time, genetically informative research designs afford a more refined examination of environmental causation. Because influences from the person are separated from environmental influences in behavioral genetics approaches, we can more clearly understand the influence of environmental factors by controlling for influences from the person (Johnson et al., 2009). In this vein, as Plomin et al. (1994) contended, "Genetics research provides the best available evidence for the importance of nonheritable [environmental] factors" (p. 1735).

After controlling for genetic influences, "pure" environmental influences related to interpersonal conflict accounted for a significant amount of the variance in job satisfaction over time. Further, the amount of explained variance did not significantly differ over time. Environmental influences related to occupational status also explained significant variance in job satisfaction, though to a lesser extent. The difference may be related to the fact that occupational status is deemed as an omnibus work characteristic that cuts across positions one holds, whereas interpersonal conflict at work is more job, organization, and even work-group specific (Johns, 2006). Relevant specific and concrete work features may be more pertinent to job satisfaction than broad and general features. The magnitude of variance explained by occupational status also did not differ significantly across time. Put differently, environmental influences from occupational status and interpersonal conflict at work on job satisfaction seemed stable over the time points examined in this study.

These stable influences from occupational status and interpersonal conflict at work are seemingly inconsistent with previous research, which has shown that the effects of job redesign on job satisfaction dissipated over time (Campion & McClelland, 1993; Champoux, 1978; Griffin, 1991). One critical reason for the disparity may be that in this study, we measured the two work environmental variables and job satisfaction repeatedly and at the same time points, whereas previous research used work characteristics measured at only one time point to predict job satisfaction over time. Indeed, inspection of zero-order correlations in Table 1 suggested that the two work environment factors had the highest correlations with job satisfaction measured at the same time, and their correlations with job satisfaction measured at later time points were smaller. This pattern of correlations seems consistent with previous work design research on long-term effects of job characteristics.

Similar to previous research on adult personality traits, intelligence (Bouchard & Loehlin, 2001; Loehlin, 2007), and work-related outcomes (Arvey et al., 2007; Judge, Ilies, et al., 2012; Shane et al., 2010; Zhang, Zyphur, et al., 2009), we found negligible influences of shared environmental factors in this study. However, this does not necessarily mean that family environments are not important.[1] As pointed out by Hoffman (1991), children of the same family may experience and interpret the same objective environment differently, resulting in an idiosyncratic, "subjective

[1] We thank our Action Editor, Michael Sturman, for pointing this out.

family experience" (p. 187). As such, family environments are critical to individuals' development, which may be captured by unique environmental (i.e., E) factors.

It is also noteworthy that we found negative relationships of general mental ability with job satisfaction. Previous research has shown both positive (e.g., Judge et al., 1999) and negative (e.g., Lounsbury, Gibson, Steel, Sundstrom, & Loveland, 2004) correlations between the two variables. Researchers also proposed that this relationship may even be nonlinear (Ganzach, Gotlibobski, Greenberg, & Pazy, 2013). Future research should tackle this question in greater depth.

Practical Implications

Findings from behavioral genetics research are often misinterpreted, and we caution against any simplistic interpretation of our findings. Results of the current research may have implications for both organizations and employees. First, the change of genetic influences on job satisfaction over time provided an explicit demonstration that we should not simply interpret genetics-related findings as indicating that because a variable is highly genetically influenced, it is not malleable (Gerhart, 2005). Our results suggest that genetic factors explained less individual differences in job satisfaction at Age 25 and Age 30 compared with Age 21. Put differently, the person seems to play a less important role in shaping job satisfaction as employees age. This finding also suggests that during early adulthood, employees' job satisfaction levels may be more shaped by environmental factors such as organizational practices, and that these external factors may become increasingly important over time. In other words, employees appeared to become gradually more adaptive during this period of time. Organizations may therefore have more room to influence employees' job satisfaction as employees progress through early adulthood.

Do the diminishing influences of genetic factors on job satisfaction mean that organizations can disregard individual differences over time? The literature on person–environment fit (Edwards, 2008; Kristof-Brown & Guay, 2010) suggests not. The current results do not suggest so either. Instead, our findings show that genetic influences on job satisfaction remained significant over time. Researchers have called for more individualized or personalized management practices that capitalize on person–environment correlations (Judge, Ilies, et al., 2012; Lawler, 1974; Rousseau, 2005). Along this line, our findings suggest that organizations need to consistently consider employees' individual characteristics when they strive to enhance employee job satisfaction over time during early adulthood. Our findings also suggest that PA was more important in mediating genetic influences on job satisfaction over time than general mental ability during early adulthood. In other words, PA played a more important role in reflecting the influences of the person. Thus, it seems that when organizations consider adopting individualized practices, they should pay more attention to the importance of personality (e.g., PA) in customizing their practices, rather than to general mental ability.

The finding that interpersonal conflict consistently explained an important amount of the variance in job satisfaction suggests that organizations and employees should endeavor to eliminate negative interactions and improve positive relationships in organizations as a means of improving employees' job satisfaction. Given that effects of work design practices oftentimes do not endure across time (Griffin, 1981), our finding has particular implications for organizations to enhance employee job satisfaction from a longer period of time. That is, maintaining lower levels of interpersonal conflict appears to be a useful approach for fostering enduring, high levels of job satisfaction across time. Among individual-differences variables, PA seems most important in shaping job satisfaction over time. Previous research drawing this conclusion often suggested utilizing personnel selection methods to hire individuals with elevated trait levels of PA. This seems to be a reasonable recommendation for organizations. On the other hand, recent personality research has shown that levels of personality traits may change over time (Judge, Simon, Hurst, & Kelley, 2014; Li, Fay, Frese, Harms, & Gao, 2014; Roberts et al., 2003; Wu & Griffin, 2012). In this vein, if organizations implement interventions to tune employees' personality traits, organizations might better attract and retain their talented members, which in turn may contribute to long term organizational effectiveness.

Study Strengths, Limitations, and Future Research

The most important strength of our study was that we used a three-wave longitudinal twin study design with data collected from multiple sources (e.g., self-report, proctored assessment, interview, and expert coding). Capitalizing on a longitudinal, natural quasi-experiment of two types of twins (Plomin et al., 1994) enabled us to address critical research questions about genetic and environmental influences on job satisfaction over time, which have not been addressed previously.

Still, this study was limited in several ways. First, using the longitudinal twin database allowed us to examine only a limited number of important predictors of job satisfaction. Although we studied important individual difference variables (e.g., general mental ability, PA, and NA) as well as omnibus and specific work contextual variables, as suggested by previous research, future research should examine other individual characteristics (e.g., core self-evaluations [Judge et al., 1997] and the Big Five factors and facets) as well as additional work characteristics (e.g., job autonomy; Humphrey et al., 2007). Second, we only studied overall job satisfaction in this study. Future research could examine other job satisfaction variables (e.g., intrinsic job satisfaction, satisfaction with pay). Third, in this study, PA and NA were measured before the first job satisfaction variable was assessed, and we examined them as antecedents of job satisfaction. Although personality traits, especially their rank-order stability, are unlikely to change dramatically over time (Caspi et al., 2005; McCrae et al., 2000; Roberts & DelVecchio, 2000), we cannot rule out the possibility of reciprocal relationships between individual characteristics and job satisfaction (Li et al., 2014; Scollon & Diener, 2006; Wu & Griffin, 2012). Fourth, as with any other research methodology, although the twin methodology has its strengths in estimating the relative potency of genetic and environmental influences on observed variables, and has been embraced by many disciplines (e.g., Briley & Tucker-Drob, 2013; Cesarini, Johannesson, Magnusson, & Wallace, 2012; Fowler & Schreiber, 2008; Freese, 2008; Ilies et al., 2006; P. Miller, Mulvey, & Martin, 1995), it also has limitations. For example, the equal environments assumption in

twin studies assumes that the similarity caused by environmental factors (including both family and societal influences) is generally the same for both identical and fraternal twins. Empirical research has shown that this is a reasonable assumption for most observed variables (Bouchard & Propping, 1993; also see Plomin et al., 2013). In addition, prenatal and neonatal differences may somewhat affect estimates of genetic influences, because identical twins share the same chorion and thus may experience different environmental differences than fraternal twins before they are born. However, such differences would lead to the genetic influences identified in twin studies to be underestimates (Plomin et al., 2013). Estimates of unique environmental influences (E factors) often include measurement error. In addition, it is possible that nonsignificant, shared environmental effects observed in this study were caused by range restriction (i.e., there was not sufficient variance in the family environments of participants).[2] Acknowledging those limitations, Zyphur, Zhang, Barsky, and Li (2013) nevertheless concluded that "if researchers are interested in understanding a broad sense of genetic influences on observed variables, traditional twin models are adequate" (p. 572). A fifth limitation of the current study is that the participants were only in their 20s and early 30s, and the findings may be specific to the economic situations that the participants encountered (Hulin, Roznowski, & Hachiya, 1985; Judge, Hulin, et al., 2012). Future research should examine whether the same findings hold for employees in other life stages and in other economic situations. Sixth, although we outlined two mechanisms through which PA and NA may affect job satisfaction, we were unable to distinguish them empirically. Seventh, the measure of occupational status in this study (Hollingshead, 1975; also see D. C. Miller, 1991), although widely adopted in applied psychology and management research (Judge et al., 1999; Lykken & Tellegen, 1996; Zhang, Ilies, et al., 2009), is based on relatively broad categories of occupations, and thus does not provide fine distinctions in socioeconomic status. Eighth, as pointed by one of our anonymous reviewers, we were unable to study potential changes of the genetic influences on the three individual difference variables at the three time points when job satisfaction was measured. This prevented us from examining whether the changes in genetic influences on job satisfaction over time were related to possible changes in the genetic and environmental influences on the three individual difference variables at the same time points. This is an important direction for future research. Lastly, we did not study specific genes related to job satisfaction over time, as done in previous research (Chi, Li, Wang, & Song, in press; Li et al., 2015; Song, Li, & Arvey, 2011). Future research can tackle this issue using a molecular genetics approach.

Conclusions

Investigating how time affects the relationships studied in applied psychology is a critical step toward building better theories (George & Jones, 2000; Mitchell & James, 2001). Given that time is considered as a "surrogate for environmental stimuli" (Johns, 2006, p. 392), examining the changes of genetic and environmental influences on job satisfaction at different points in time represents an initial step toward investigating a form of gene–environment interaction on job satisfaction. By examining both genetic and environmental antecedents of job satisfaction from a temporal perspective, we hope that this study can stimulate future longitudinal research on more nuanced interplays between nature and nurture in shaping job satisfaction and employee well-being.

[2] We thank one of our anonymous reviewers for pointing this out.

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