Published in final edited form as:

J Pers Soc Psychol. 2011 March ; 100(3): 545–556. doi:10.1037/a0022409.

Genetic and environmental influences on personality trait stability and growth during the transition to adulthood: A three wave longitudinal study

Christopher J. Hopwood,
Michigan State University

M. Brent Donnellan,
Michigan State University

Daniel M. Blonigen,
VA Palo Alto Health Care System and Stanford University School of Medicine

Robert F. Krueger,
University of Minnesota

Matt McGue,
University of Minnesota

William G. Iacono, and
University of Minnesota

S. Alexandra Burt
Michigan State University

Abstract

During the transition to adulthood individuals typically settle into adult roles in love and work. This transition also involves significant changes in personality traits that are generally in the direction of greater maturity and increased stability. Competing hypotheses have been offered to account for these personality changes: the intrinsic maturation hypothesis suggests that change trajectories are endogenous, whereas the life-course hypothesis suggests that these changes occur because of transactions with the social environment. This study investigated the patterns and origins of personality trait changes from ages 17 to 29 using 3 waves of Multidimensional Personality Questionnaire data provided by twins. Results suggest that a) trait changes were more profound in the first relative to the second half of the transition to adulthood; b) traits tend to become more stable during the second half of this transition, with all the traits yielding retest correlations between .74 and .78; c) negative affectivity declined over time and constraint increased over time; minimal change was observed on agentic or communal aspects of positive affectivity; and d) both genetic and non-shared environmental factors accounted for personality changes. Overall, these genetically-informed results support a life-course perspective on personality development during the transition to adulthood.

The transition to adulthood between the ages of 18 and 30 involves significant psychological development with regard to intimacy, identity, work, and parenthood (see Arnett, 2000, 2007). These changes are also accompanied by both stability and change in personality traits (e.g., Blonigen, Carlson, Hicks, Krueger, & Iacono, 2008; Donnellan, Conger, & Burzette, 2007; Roberts, Caspi, & Moffitt, 2001; Robins, Fraley, Roberts, & Trzesniewski, 2001). However, debates exist regarding whether exogenous or endogenous factors are more responsible for personality development during this period of the lifespan (McCrae & Costa,

2006; Roberts, Walton, & Viechtbauer, 2006a). Accordingly, the goal of this study was to evaluate genetic and environmental influences on personality stability and change during the transition to adulthood using three waves of personality trait data. Specifically, we examined the etiological influences on stability and change in the higher order personality traits of the *Multidimensional Personality Questionnaire* (MPQ; Tellegen & Waller, 2008) using a sample of twins assessed in late adolescence (approximately age 17), emerging adulthood (approximately age 24), and young adulthood (approximately age 29).

Characterizing the Transition to Adulthood

Sociologists (Furstenberg, Kennedy, McLoyd, Rumbaut, & Settersten, 2004; Shanahan, 2000), demographers (Rindfuss 1991), and psychologists (Arnett, 2000; 2007) have identified several themes that characterize the transition to adulthood. First, this transition takes time as individuals negotiate aspects of identity development and gradually assume adult roles and responsibilities (Arnett, 2004). In light of this fact, Arnett (2000) has proposed that the period of development from the late teens through the end of the 20s is a time of “emerging adulthood”. Indeed, he described the period of the early 20s as the “volitional years of life” (p. 469) because individuals seem to spend considerable resources exploring issues of identity and intimacy. Second, on average, more demographic transitions occur during the years between 18 and 30 than any other in the life course (Rindfuss, 1991). Thus, by the age of around 30, most individuals have assumed at least one of the major roles of adulthood and therefore the 30s seem to mark the beginning of adulthood proper. Third, there appears to be a considerable amount of variability among individuals in terms of the sequencing of the life transitions between adolescence and adulthood (Rindfuss, 1991).

The salient developmental challenges and diversity of experiences people encounter in this phase of the life course suggest that the transition to adulthood represents an important period for research on personality development. Existing research suggests that many of the psychological changes that occur during this period tend to be in the direction of increased psychological maturity (Caspi, Roberts, & Shiner, 2005). Indicators of psychological well-being such as self-esteem appear to increase (Donnellan, Trzesniewski, & Robins, 2006; Galambos, Barker, & Krahn, 2006) whereas attributes such as depression, anger, and externalizing problems appear to decline (Arnett, 2000; 2007 Galambos et al. 2006). Consistent with these trends, personality trait change is generally positive: traits become more stable in general (Roberts & Del Vecchio, 2000) and individuals tend to decline in negative affectivity and show increases in behavioral constraint during the transition to adulthood (Blonigen et al., 2008; Donnellan et al. 2007; Roberts et al., 2001). Moreover, young adulthood appears to be the time in the life span when the majority of normative personality changes occur (Roberts, Walton, & Viechtbauer, 2006b). In light of these trends, Caspi et al. (2005) noted that “the causes of normative personality change are likely to be identified by narrowing research attention to the study of young adulthood” (p. 468).

Following this recommendation, we evaluated etiological influences on personality trait stability and change during the transition from adolescence to adulthood. Specifically, we assessed four broad personality traits assessed by the MPQ. Although arguments regarding the exact number of traits that best describe the broadest level of personality persist, diverse personality attributes can be organized around a relatively small set of higher order traits (Markon, Krueger, & Watson, 2005). It has been shown that candidate higher order trait models can be integrated such that they are not so much direct competitors as alternative ways of organizing personality dimensions within an integrated hierarchy (Church & Burke, 1994; Markon et al., 2005). The four factors that appear in more or less all structural models of personality involve negative emotionality or neuroticism (NEM), agentic positive

emotionality or extraversion (PEM-A), communal positive emotionality or agreeableness (PEM-C), and constraint (CON) (Caspi et al., 2005; Clark & Watson, 2008).

NEM involves a susceptibility to negative emotions as opposed to a tendency to be emotionally placid and adaptable. This domain appears to map onto neurobiological systems governing withdrawal behavior in the context of environmental threats (Watson et al., 1999) and represents a risk factor for psychopathology and interpersonal difficulties across the lifespan (Krueger, Caspi, & Moffitt, 2000; Watson, Hubbard, & Wiese, 2000). PEM generally involves the propensity for positive emotions such as happiness as well as behavioral surgency and vigor. This trait domain is associated with enhanced reward sensitivity (Lucas et al., 2000) and extraverted, prosocial behavior (Ashton et al., 2002). PEM has also been linked to neurobiological systems governing approach motivation (Depue & Collins, 1999). Agentic manifestations of this trait (i.e., PEM-A) involve social potency as well as ambition in achievement-related domains, whereas communal manifestations (i.e., PEM-C) involve closeness to others, affiliation, and well-being (Humbad, Donnellan, Iacono, & Burt, in press; Tellegen & Waller, 2010; Wiggins, 1991). CON involves the capacity to control or modulate one's behavioral reactions to internal states or external stimuli, to attend carefully and plan responsibly, and to be oriented toward long term goals. Reduced CON is a risk factor for substance use and externalizing problems (Krueger et al., 2000) as well as general health risks across the life span (Bogg & Roberts, 2004). This dimension of personality has been linked to neurobiological markers of attentional focus and other frontal lobe functions (Nigg, 2000).

Characterizing Personality Stability and Change during the Transition to Adulthood

In addition to questions regarding which traits to assess, researchers studying personality development must also consider multiple kinds of personality stability and change (Caspi et al., 2005; Donnellan & Robins, 2009; Roberts, Wood, & Caspi, 2008). Each of these types of stability involves a different analytic method and interpretive meaning. The two most commonly studied types are *absolute* or mean-level stability and *differential* or rank-order stability.

Absolute (mean-level) stability refers to changes in group averages over time on a given trait. Absolute stability can be indexed directly with repeated-measures ANOVA models or growth curve frameworks (e.g., Vaidya et al., 2008). During the transition to adulthood, age differences in absolute levels of personality traits seem to be well described by the *maturity principle* of personality development (Caspi et al. 2005) or the generalization that traits linked with self-control (i.e., CON) seem to increase whereas traits linked with negative affectivity (NEM) seem to decrease during the transition to adulthood (Donnellan & Robins, 2009). That is, as individuals mature they become more able to control their impulses and less prone to negative emotions. These kinds of personality changes are concordant with the fulfillment of adult roles and converge well with existing developmental research concerning trends in well-being (Galambos et al., 2006).

Beyond these mean-level trends there may also be significant variability between individuals in their degree of change (i.e., individual-level change). Importantly, growth curve frameworks allow for the characterization of absolute stability and change in a way that also draws attention to intra-individual differences in change (Vaidya et al., 2008). For example in a linear growth model, the fixed effect for the slope describes normative changes in terms of the average increase or decrease for the sample as a whole whereas the random effect indicates the amount of variability around that average trend. Statistically significant variability around the slope, or alternatively a statistically insignificant random effect for the

slope, indicates the presence of meaningful individual differences in change (see Mroczek, Spiro, & Griffin, 2006). Such variability points to the fact that some individuals increase in absolute trait levels whereas others decrease in absolute trait levels.

Differential (rank-order) stability refers to the degree of consistency in rank-ordering of individuals over time on a given trait. This type of stability is most often indexed by retest correlations. Notably, such retest coefficients tend to increase across development before eventually reaching a plateau in middle to later life (ages 50–70) (Roberts & DelVecchio, 2000). In other words, stability coefficients tend to be lower for adolescent samples than adult samples, a pattern that has been referred to as the *cumulative continuity principle* of personality development (Caspi et al., 2005). Moreover, personality maturity is temporally linked with increases in differential stability such that individuals who are lower in negative affectivity and higher in constraint in adolescence tend to show more differential stability during the transition to adulthood (Roberts et al., 2001), and individuals with borderline personality disorder show less differential stability over time (Hopwood et al., 2009).

Despite notable consistencies in the general patterns of absolute and differential stability among personality traits during the transition to adulthood, there are also controversies (see Costa & McCrae, 2006; McCrae & Costa, 2008). The most active area of disagreement involves the explanation of personality maturation (i.e., change). One perspective argues that biologically-based *intrinsic* processes underlie changes in personality in young adulthood (e.g., Costa & McCrae, 2006; McCrae & Costa, 2003, 2008), whereas another perspective argues that personality maturation is at least partially tied to participation in the social roles of adulthood (e.g., Roberts et al., 2006b; Roberts, Wood, & Smith, 2005). Consistent with this *life-course* perspective, some evidence links adult personality changes with contextual conditions such as work and romantic relationships (Neyer & Lehnart, 2007; Roberts, Caspi, & Moffitt, 2003; Robins, Caspi, & Moffitt, 2002; Roberts & Wood, 2006; although see McCrae & Costa, 2008, p. 168). A genetically-informed approach is well suited to informing this broad debate because the intrinsic maturation perspective would seem to predict that most trait changes during the transition to adulthood are driven predominantly by genetic factors, whereas the life-course perspective would seem to predict that personality changes during this period are also tied to environmental factors (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009).

Genetically informed cross-sectional studies have made important contributions to personality psychology by demonstrating that higher order traits are substantially and similarly heritable but also influenced by non-shared environmental factors (those environmental factors that make siblings within the same family different, e.g., Loehlin, 2001). However, longitudinal behavior genetic designs are needed to assess the genetic and environmental underpinnings of personality stability and change. In one such study, McGue et al. (1993) found that genetic factors were largely responsible for differential stability whereas change was primarily influenced by the non-shared environmental factors among twins assessed twice around the ages 20 and 30. Blonigen and colleagues (2008) used the first two waves of data analyzed in the current report to evaluate genetic and environmental contributions to personality development between the ages 17 and 24. Bleidorn et al. (2009) used genetically informed growth modeling as applied to a mixed-age sample of German twins assessed at multiple waves. Both of these studies reported results consistent with the maturity hypothesis and found that genetic *and* environmental factors accounted for personality changes.

These studies also provide consistency of results across ages, samples, and methods in support of the maturity hypothesis. However, this emerging behavioral genetic literature on personality development is limited in several ways. Most notably, although it is widely

recognized that multiple wave studies provide the opportunity to employ more sophisticated methodological approaches (e.g., Biesanz et al., 2003) most genetically informed longitudinal personality research has used only two measurement waves. In fact, most phenotypic studies of personality development during the transition to adulthood have relied on 2-wave studies (but see Vaidya et al., 2008 for an exception). Nonetheless, the application of growth curve modeling techniques to datasets with three or more assessments addresses important questions about personality development (Mroczek & Spiro, 2003). For example, such approaches can be used to test the adequacy of linear models of absolute growth and identify individual differences in absolute change. Twin studies that use this analytic approach are particularly important as they can be used to decompose the origins of individual differences in change into genetic and environmental components.

In light of these advantages, the work of Bleidorn and colleagues (2009) represents a seminal contribution as the first multi-wave behavior genetic study of personality trait stability. Nonetheless, this study assessed a relatively small sample of individuals who varied widely in age at first assessment. Thus, this work was limited in its ability to specifically characterize personality stability and change during the transition to adulthood. By comparison, the Minnesota Twin Family Study (MTFS) data, which sampled twins during this period, are well-suited to address such issues and can potentially resolve contrasting views regarding on the origins of personality stability and change.. Specifically, given varying links of NEM, PEM-A, PEM-C, and CON to biological and environmental processes and their varying phenotypic patterns of personality development in previous research (e.g., Blonigen et al., 2008; Donnellan et al., 2007; Roberts et al., 2001; Vaidya et al., 2007), the degree to which the intrinsic or life-course perspective is supported may also vary by trait.

The Present Study

The present study was designed to address these gaps in current knowledge about the influences on personality change during the transition to adulthood. The specific goal of this project was to extend research on personality development during the transition to adulthood using three waves of data from a community sample of twins who were assessed in adolescence (mean age 17), emerging adulthood (24) and young adulthood (29) with the MPQ (Tellegen & Waller, 2008). This study offers an important extension of the previous report on personality stability and change from this sample (Blonigen et al., 2008) in its examination of an additional wave of data that was not yet available at the time of the Blonigen et al. report. This additional wave allows tests regarding the linearity of personality change during the transition to adulthood, such as whether more changes occur during the peak of emerging adulthood (e.g., 17 to 24) as opposed to the period between 24 and 29 when participants are more likely to have settled into adulthood. Moreover, this additional wave allows the application of analytic techniques used by Bleidorn et al. (2009) to understand genetic and environmental contributions to personality changes. Unlike Bleidorn et al. (2009), however, our data allow us to focus on the critical period of the lifespan when individuals are transitioning to adulthood. Accordingly, the results can more specifically adjudicate among intrinsic and lifespan perspectives on the underlying impetus for personality maturation during the transition to adulthood.

Method

Participants

Participants were same-sex male and female monozygotic (MZ) and dizygotic (DZ) twins from the Minnesota Twin Family Study (MTFS), which is a population-based sample of reared-together twins (Iacono & McGue, 2002). Zygosity was determined by parent and

MTFS staff reports on physical resemblance and an algorithm which uses ponderal and cephalic indices and fingerprint ridge counts to assess similarity. When these estimates did not agree a serological analysis was performed to confirm twin status. This study used MPQ data from a cohort born between 1972 and 1979 who were identified in Minnesota public birth records and recruited to participate at approximately 17 years of age (range = 16–18 years). Exclusion criteria included living more than a 1-day drive from the data collection site or serious cognitive or physical disabilities which would preclude participation. Of those recruited, 83% agreed to participate and no significant differences were observed between participating and non-participating families or the Minnesota population more generally in terms of self-reported psychopathology or SES (Iacono et al., 1999; Holdcraft & Iacono, 2004). However, MZ twins are over-represented relative to DZ twins in terms of population incidence (Hur, McGue, & Iacono, 1995), and there was a slightly higher rate of agreement to participate among MZ families. At baseline there were 626 complete pairs of twins (Women $n_{MZ} = 223$, $n_{DZ} = 114$; Men $n_{MZ} = 188$, $n_{DZ} = 101$). Twins were reassessed at the average ages of 24 and 29.

Measure

Participants completed a 198-item version of the Multidimensional Personality Questionnaire (MPQ) and analyses focused on the four higher order MPQ traits, NEM (baseline $\alpha = .92$), PEM-A ($\alpha = .89$), PEM-C ($\alpha = .91$), CON ($\alpha = .88$). At baseline, complete MPQ data were available for 1111 participants ($N_{women} = 614$; $N_{men} = 497$), at age 24 there were 943 ($N_{women} = 553$; $N_{men} = 390$), and at age 29 there were 956 ($N_{women} = 505$; $N_{men} = 451$). Attrition analyses suggested that the baseline trait scores between those who continued versus those who dropped out at each follow-up were less than .10 standard deviations different on each of the four traits examined, suggesting that individuals who provided data at follow-ups were generally representative of the baseline sample. As in Blonigen et al. (2008), MPQ trait data were standardized with a T-scale metric using wave 1 data.

Analyses

Phenotypic Analyses—Test-retest coefficients were used to indicate the degree of differential stability of personality traits over time. Growth curve analyses were used to estimate the degree of mean-level change in traits across the three waves, as well as individual variability in rates of change following procedures outlined in Kashy, Donnellan, Burt, and McGue (2008) for working with twin data. These models were fit using maximum likelihood estimation in AMOS 17.0. Slope paths were fixed to 0 for the baseline assessment, 1 for the third assessment, and were estimated from the data for the second assessment (i.e., the same coefficient was estimated for both twins). This allows the model to estimate the extent to which change occurred during the first or second intervals given that an empirical value close to .58 (7 years/12 years = .58) would indicate linear growth over this time (see Preacher, Wichman, MacCallum, & Briggs, 2008, p. 52–55). Intercept paths were fixed to 1 for each measurement occasion so that the intercept represents scores at the first assessment. Residuals were freely estimated at each wave (but fixed to the same value for each twin) and we specified a twin correlation between these residuals within measurement occasions. Twins were constrained to have equal intercept and slope parameters.

Biometric Analyses—Structural equation modeling of twin data is based on the difference in the proportion of genes shared between MZ twins, who share 100% of their genetic material, and DZ twins, who share an average of 50% of their segregating genetic material. MZ and DZ twin correlations are compared to estimate the relative contributions of additive genetic effects (a^2), shared environmental effects (c^2), and non-shared

environmental effects plus measurement error (e^2) to the variance within observed behaviors or characteristics (i.e., phenotypes). Crucial to this methodology is the Equal Environments Assumption (EEA), which assumes that MZ pairs are no more likely to share the environmental factors that are etiologically relevant to the phenotype under study than are DZ pairs (Kendler, Neale, Kessler, Heath, & Eaves, 1993). Any differences in the MZ and DZ correlations are thus assumed to be due to differences in the genetic similarity of the corresponding twins.

To evaluate the origins of differential stability, we fitted a Cholesky decomposition model. Within a triangular, or Cholesky decomposition, model (see Figure 1), the variance within and the covariance between personality traits across each assessment were decomposed into their genetic and environmental components. In this model, the genetic, shared, and non-shared environmental covariances can be standardized on their respective variances to produce genetic, shared environmental, and non-shared environmental correlations. These statistics reveal the extent to which a specific effect (e.g., the genetic effect) at one assessment is correlated with the same effect at another assessment. A genetic correlation of 1.0 would indicate that all genetic influences persist across assessments, whereas a correlation of zero would indicate no genetic overlap. This model thus enabled us to explicitly estimate the extent to which genetic and environmental influences contribute to the differential or rank-order stability of personality over time.

Biometric latent growth curve modeling was used to evaluate the origins of absolute stability and change (Neale & McArdle, 2000). The full biometric growth model is depicted in Figure 2. In this model, the variance in personality at any given assessment was decomposed into three portions, all of which were then further decomposed into their additive genetic, shared environmental, and non-shared environmental components. We first examined genetic and environmental contributions to the latent intercept (i.e., a_i , c_i , e_i), which captures individual differences at the first assessment. We next examined genetic and environmental contributions to variability in absolute-level changes in personality over time. The factor loadings identified in the phenotypic growth curve analyses (as described previously) comprised the slope's factor loadings at ages 17, 24, and 29 (i.e., 0, .75, and 1.0, respectively, for Constraint; 0, .84, and 1.0, respectively, for Negative Emotionality). We finally examined the genetic and environmental contributions to the variance remaining at each assessment after accounting for the effects of the intercept and slope factors (i.e., a_1 , c_1 , e_1 at time 1, a_2 , c_2 , e_2 at time 2, a_3 , c_3 , e_3 at time 3, respectively).

To address incidental missing data, we made use of Full-Information Maximum-Likelihood (FIML) estimation fit to raw data for both the Cholesky and the latent growth curve model, which produce less biased and more efficient and consistent estimates than techniques like pairwise or listwise deletion for missing data (Little & Rubin, 1987). Mx (Neale, 1997) was used to fit the models to the raw data. When fitting models to raw data, variances, covariances, and means of those data are freely estimated by minimizing minus twice the log-likelihood ($-2\ln L$). The $-2\ln L$ under this unrestricted baseline model is then compared with $-2\ln L$ under more restrictive biometric models. This comparison provides a likelihood-ratio chi-square test of goodness of fit for the model, which is then converted to the Akaike's information criterion (Akaike, 1987); $AIC = \chi^2 - 2df$, the traditional fit index of behavioral genetics research. The AIC measures model fit relative to parsimony. Better fitting models have more negative values.

Results

Phenotypic Results

Differential Stability and Change—Stability coefficients are reported in Table 1 for the three intervals under investigation (17 to 24, 24 to 29, and 17 to 29). These results were consistent with previous studies in suggesting substantial differential stability in personality traits in general, with 12-year correlations ranging from .49 to .57. More change occurred during the first wave of the study (range = .52–.62) relative to the second (.74–.78), consistent with the cumulative continuity principle of personality development. Overall, the magnitude of differential stability was similar across traits.

Absolute Stability and Change—Observed changes in the absolute levels of traits (Table 1) were generally consistent with the maturity principle of personality development. Figure 3 plots changes in all four traits over the course of the study, with trait values standardized at the baseline assessment. NEM declined substantially in the first interval and more modestly in the second. CON tended to increase with changes again being more dramatic in the first than second interval. Agentic and Communal Aspects of PEM increased slightly but the trajectories of these aspects of PEM were somewhat different: whereas Agentic PEM increased very modestly across both intervals, Communal PEM increased during the first interval and decreased very modestly during the second. The overall results, however, suggest that much more developmental change occurs for NEM and CON relative to PEM-linked traits.

Greater individual-level change also occurred on NEM and CON. Individual-level variability can be conceptualized as the number of individuals who reliably change on a given variable over time (Jacobsen & Truax, 1991). Using the short-term retest coefficients provided by Tellegen and Waller (2008; i.e., .89 for all traits), 50% of the sample reliably (i.e., > 2 standard errors) changed on NEM over the course of the study, 43% changed on CON, 34% changed on PEM-A, and 36% changed on PEM-C. However, these results also suggest that, while most of the changes on NEM and CON were in a similar direction (46 out of 50% of those who changed on NEM showed decreases; 38 out of 43% showed increases on CON), change in PEM was the result of both individuals who increased and those that decreased on PEM-A (18% increased and 16% decreased) and PEM-C (13% increased and 23% decreased). Thus, the direction of individual change was more uniform for NEM and CON.

Growth curve modeling allows more specific inferences regarding absolute change in these traits. Models for PEM-A or PEM-C were not interpreted because of negative variances (i.e., 'Heywood cases'). Given that absolute change was not impressive in a descriptive sense, no further efforts were made to modify these models to obtain an admissible solution, and the origins of change were not pursued for these personality domains. The CON and NEM models were saturated after correcting the fit statistics for twin data (see Kashy et al., 2008; Kenny & Olson, 2006) and thus no fit statistics are reported. Parameters from these models are given in Table 2, and text explaining what these and other key parameters signify can be found in the Table 2 note as well as the notes for the other tables. The paths from the slope factor to the second measurement occasion were substantially greater than .58, consistent with descriptive results in suggesting that most of the change in NEM and CON occurred between adolescence and emerging adulthood, and that the rate of change declined from emerging to young adulthood. Both slope and intercept means and variances were statistically significant, again pointing to the existence of meaningful inter-individual variability in trait levels and change trajectories for both of these traits. The correlations between slopes and intercepts were negative for both traits, and only significant for CON.

Biometric Results

Fit statistics for the biometric Cholesky (to test influences on differential stability and change) and latent growth curve (to test influences on absolute stability and change) models are presented in Table 3. We initially estimated variances, covariances, and means for the raw data to get a baseline index of fit for each trait. The Cholesky and latent growth curve biometric models were then compared to the baseline model to yield a χ^2 goodness of fit test, which is then converted to AIC. All models fit their respective data well.

Differential Stability and Change—Parameter estimates for the Cholesky models are presented in Table 4, separately for each trait. There was evidence of significant genetic contributions to all four traits (accounting for 33–56% of the variance), as well as significant non-shared environmental influences (accounting for 42–61% of the variance). There was no evidence of significant shared environmental influence across any trait. These proportions of variance were essentially invariant across age, with little to no differences observed across the three assessments. These results suggest that personality is as heritable in late adolescence as it is in young adulthood.

As indicated by the generally non-overlapping 95% confidence intervals for the genetic and non-shared environmental correlations (see Table 5), genetic influences appeared to be more stable over time than were non-shared environmental influences across all personality factors. More importantly, however, the non-shared environmental correlations generally appeared to increase with age. In particular, the non-shared environmental correlations from ages 17 to 24 were significantly smaller (as evidenced by non-overlapping confidence intervals) than were those from ages 24 to 29, suggesting increased stability in the environmental effects associated with personality stability following emerging adulthood. The same general pattern of increasing etiological stability with age was also present for genetic effects, however, these differences were less pronounced (perhaps reflecting the rather high levels of genetic stability in general). In any case, such findings serve both to highlight strong genetic contributions to the differential stability of personality from late-adolescence through young adulthood and suggest that these influences become particularly stable following emerging adulthood.

Absolute Stability and Change—Results from the biometric latent growth curve models are presented in Table 5. As seen there, the intercept factor for NEM was significantly influenced by both genetic and non-shared environmental forces. The shared environment contribution was not significantly different from zero. The slope factor for NEM, by contrast, was influenced primarily by non-shared environmental influences. Moreover, these influences appeared to differ from those contained in the slope, as evidenced by the rather small non-shared environmental correlation between the two factors that were non-significant. The contributions of genetic and shared environmental influences to the slope were small and were not statistically significant. Finally, the residuals were relatively small and were solely non-shared environmental in origin. As measurement error will also be contained within the non-shared environmental residuals, such findings may or may not imply that there are assessment-specific non-shared environmental influences that meaningfully contribute to changes in personality over time. This cautious interpretation is augmented by the rather large amount of phenotypic variance accounted for by the latent intercept and slope factors (67–83% of the variance in NEM). All in all, it appears that there are unique environmental experiences that differ across the twin siblings and which meaningfully influence absolute changes in NEM over time.

The pattern of stability and change in CON was somewhat different. The intercept factor was primarily genetic in origin (68%), although non-shared environmental influences also

contributed (32%). Moreover, the slope factor was both genetic and non-shared environmental in origin. Such findings suggest that genetic influences play an important role in explaining absolute changes in CON that are associated with age. As before, these interpretations are augmented by the prominent amount of phenotypic variance in CON that is collectively accounted for by the latent intercept and slope factors (75–88% of the variance at each age).

Discussion

This study extends research on personality development by exploring genetic and environmental contributions to differential and absolute stability and change in personality traits assessed at the beginning, middle, and end of the transition to adulthood. The results for the differential stability of phenotypic traits corroborate previous reports suggesting that differential stability tends to increase with age for most personality traits (Roberts & Del Vecchio, 2000). These trends represent an example of the cumulative continuity principle of personality development – differential (or rank-order) stability tends to increase with age. In particular, differential stability is lower in the period from 17 to 24 than in the period from 24 to 29. This suggests that some important developmental periods can be characterized, in part, by different rates of personality stability. Arnett (2000) originally suggested that the period of emerging adulthood extended from the late teens to the mid 20s and these stability coefficients are consistent with the idea that there is more personality instability during this period of the life span as compared with the interval between 24 and 29.

Findings with respect to absolute stability and change varied more across the traits but they generally supported the maturity principle of adult personality development (e.g., Caspi et al., 2005) (see Figure 3). NEM showed overall decreases with age, but the decreases tend to be strongest in the early part of the transition to adulthood, and then started to level off somewhat during the mid-20s. CON showed overall increases with age, but again change was more profound during the first interval than the second interval. Agentic and Communal PEM (PEM-A, PEM-C, respectively) tended to show less systematic change than NEM or CON. Greater relative changes in NEM and CON relative to PEM-A and PEM-C during the transition to adulthood may be due to the fact that these former traits have more straightforward and more empirically consistent links to adaptation. Although both PEM-related traits increased modestly overall, patterns of change were also somewhat different across PEM-A and PEM-C. Whereas increasing levels of PEM-A remained fairly constant during the transition to adulthood, PEM-C increased initially, but then decreased somewhat. This may reflect the fact that relational patterns often tend to resolve somewhat before the attainments of careers or other agency-related achievement. For example, in Erikson's (1950) classic model, the issue of intimacy versus isolation is posited to be typical of young adulthood, whereas generativity versus stagnation is more salient during adulthood.

Beyond characterizing personality development during this period at a phenotypic level, this study provides insights into the genetic and environmental origins of stability and change, and is therefore particularly relevant to deciding between competing intrinsic maturation versus lifespan perspectives for the origins of adult personality development (see also Bleidorn et al. 2009). The intrinsic maturation perspective (McCrae & Costa, 2003, 2008) suggests that both stability and change are driven primarily by genetic influences. In contrast, the lifespan perspective (e.g., Roberts et al., 2006a; Roberts, Wood, & Smith, 2005) posits that personality changes occur partly as a consequence of interactions with and efforts to adapt to the social environment.

Although there was evidence for genetic contributions to stability and change in personality, these results provide support for the lifespan perspective given that non-shared

environmental factors accounted for personality changes over time (see also Bleidorn et al., 2009). For both NEM and CON, genetic factors tended to influence trait levels overall, as well as the stability of those levels, but the non-shared environment was an important influence on changes in trait levels over time. This effect appeared to be somewhat stronger for NEM than for CON. CON involves the person's ability to modulate their emotional responses to internal and environmental stimuli, and is linked to the forebrain (DeYoung & Gray, 2009), a structure that continues to develop into the transition to adulthood (Giedd et al., 1999; Gogtay et al., 2004). Thus, the finding that genetic effects are stronger predictors of change in CON may reflect the fact that there are genetic influences on developments in the forebrain that continue past adolescence. Unlike CON, NEM is linked to more primitive structures in the brain which are fairly-well developed by adulthood. Negative emotionality may be more responsive, during this age, to environmental conditions than to genetically-influenced developmental processes. There are also hints in the literature that changes in NEM are linked to environmental factors such as experiences in romantic relationships (e.g., Robins et al., 2002).

With regard to differential stability, genetic influences were important for explaining the differential stability of those levels over time; however, experiences that were unique to each individual twin (i.e., non-shared environment) also influenced differential patterns of change and these influences tended to increase during the second wave. This pattern suggests that environment factors that are unique to each twin act to promote greater stability in personality traits during the transition to adulthood. Moreover, the increasing level of connection between non-shared environmental influences from the second to the third wave suggests that individuals might be more consistently selecting into "stability-promoting" environments starting at around age 24. . It may be the case that the selection into adult roles and relationships enhances personality stability (Roberts & Wood, 2006; Robins et al., 2002). Accordingly, the domains of love and work are likely a fruitful area of exploration for environmental influences on personality stabilization.

In addition to providing valuable data relevant for ongoing debates about the underlying causes of adult personality development, the current findings also shed light on the nature of emerging adulthood. Arnett (2000; 2004) described the transition to adulthood in Western society as involving both a processes of exploration and identity consolidation. It is also a period marked by relative freedom from clearly defined roles and responsibilities. Individuals at this age are relatively free from external constraints such as the limitations on behavior imposed by parents during adolescence and the constraints imposed by formal adult roles that occur in adulthood (e.g., family and career demands). However, towards the mid 20s, individuals typically begin a process of selecting into environments that place constraints on development and may press for certain kinds of thoughts, feelings, and behaviors – they often enter into committed romantic relationships and form their own families, establish permanent residences, and settle into careers. These choices may further reinforce and accentuate personality traits that were linked with those choices in the first place, as posited by the corresponsive principle of adult personality development (Caspi et al., 2005).

All in all, the current study suggests that genetic factors are important for understanding both personality stability and change. Nonetheless, environmental factors matter as well which tends to support the broader transactional perspectives on adult personality development. The transactional or life course perspective on personality development suggests that both intrinsic and extrinsic factors play a part in shaping individual dispositions. Indeed, previous genetically-informed studies also point to environmental influences on personality development in adulthood (Bleidorn et al., 2009; Johnson, McGue, & Krueger, 2005). Collectively, these findings are seemingly incompatible with a pure

intrinsic maturation explanation. Nonetheless, future genetically-informed research is needed to definitively resolve this debate.

Despite several methodological strengths such as the use of twins and age-targeted sampling, a number of study limitations are also notable. First, controversies exist regarding the structure of personality traits; given that we observed some varying patterns across the traits, future research should test personality development using different trait models. Fortunately, recent work indicates that most omnibus trait models can be integrated within a hierarchical structure (Markon et al., 2005; Watson et al., 2008) suggesting that different trait models are not so much competitors but simply alternative ways of organizing personality attributes at different levels of abstraction.

Second, this study relied on a single self-report measure of personality. Beyond typical concerns associated with using any method in isolation or with self-report in particular, some evidence suggests that non-shared environmental effects may be over-estimated when using self-report measures only (Riemann et al., 1997). Thus, future research should employ multiple methods for the assessment of personality traits. Finally, although our sampling effectively targeted an important developmental period, future research that spans wider age ranges, and with assessments that occur more frequently, is needed to more clearly depict patterns of and influences on personality change across the life span. Related to this point, findings of greater variability in the first wave of this study may relate to both developmental processes described here as well as the somewhat longer assessment interval (7 versus 5 years). As such, future research is needed to confirm that this finding indeed reflects greater trait changes in the first stages of the transition to adulthood.

Overall, this study highlights the utility of an integrative and age-targeted approach for understanding genetic and environmental contributions to personality development during the transition to adulthood. Consistent with previous research, this study showed that traits tend to show quite similar patterns of differential stability but varying patterns of absolute stability. The general trend was in the direction of increased personality maturity and it appears that the period from 17 to 24 was more “active” than the period from 24 to 29. Biometric analyses provided greater insight into the etiology of stability and change and facilitated a straightforward test of different theoretical perspectives on personality changes during development. In conclusion, increased maturity coupled with a transactional perspective appears to best characterize personality development during the transition to adulthood.

Acknowledgments

This research was supported by NIH grants R01 DA05147 (Iacono) and R01 AA09367 (McGue).

References

- Akaike H. Factor analysis and AIC. *Psychometrika*. 1987; 52:317–332.
- Arnett JJ. Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*. 2000; 55:469–480. [PubMed: 10842426]
- Arnett JJ. Emerging adulthood: What is it, and what is it good for? *Child Development Perspectives*. 2007; 1:68–73.
- Biesanz JC, West SG, Kwok OM. Personality over time: Methodological approaches to the study of short-term and long-term development and change. *Journal of Personality*. 2003; 71:905–942. [PubMed: 14633053]
- Bleidorn W, Kandler C, Riemann R, Angleitner A, Spinath FM. Patterns and sources of adult personality development: Growth curve analyses of the NEO-PI-R scales in a longitudinal twin study. *Journal of Personality and Social Psychology*. 2009; 97:142–155. [PubMed: 19586245]

- Blonigen DM, Carlson MD, Hicks BM, Krueger RF, Iacono WG. Stability and change in personality traits from late adolescence to early adulthood: A longitudinal twin study. *Journal of Personality*. 2008; 76:229–266. [PubMed: 18331280]
- Bogg T, Roberts BW. Conscientiousness and health-related behaviors: A meta-analysis of the leading behavioral contributors to mortality. *Psychological Bulletin*. 2004; 130:887–919. [PubMed: 15535742]
- Caspi A, Roberts BW, Shiner RL. Personality development: Stability and change. *Annual Review of Psychology*. 2005; 56:453–484.
- Clark, LA.; Watson, D. Temperament: An organizing paradigm for trait psychology. In: John, OP.; Robins, RW.; Pervin, LA., editors. *Handbook of personality: Theory and Research*. 3rd ed.. New York: Guilford Press; 2008. p. 265-286.
- Costa, PT., Jr; McCrae, RR. Personality continuity and the changes of adult life. In: Storandt, M.; VandenBos, GR., editors. *The adult years: Continuity and change*. Washington, DC: American Psychological Association; 1989. p. 47-77.
- Costa PT Jr, McCrae RR. Age changes in personality and their origins: Comment on Roberts, Walton, and Viechtbauer (2006). *Psychological Bulletin*. 2006; 132:26–28. [PubMed: 16435955]
- DeYoung, CG.; Gray, JR. Personality neuroscience: Explaining individual differences in affect, behavior, and cognition. In: Corr, PJ.; Matthews, G., editors. *The Cambridge handbook of personality*. Cambridge University Press; 2009. p. 323-346.
- Donnellan MB, Conger RD, Burzette RG. Personality development from late adolescence to young adulthood: Differential stability, normative maturity, and evidence for the maturity-stability hypothesis. *Journal of Personality*. 2007; 75:237–263. [PubMed: 17359238]
- Donnellan, MB.; Robins, RW. The development of personality across the life span. In: Corr, PJ.; Matthews, G., editors. *Cambridge Handbook of Personality*. New York: Cambridge University Press; 2009. p. 191-204.
- Donnellan, MB.; Trzesniewski, KH.; Robins, RW. Personality and self-esteem development in adolescence. In: Mroczek, DK.; Little, T., editors. *Handbook of personality development*. Hillsdale, NJ: Erlbaum; 2006. p. 285-309.
- Erikson, E. *Childhood and Society*. New York: Norton; 1950.
- Furstenberg FF, Kennedy S, McLoyd V, Rumbaut R, Settersten RA. Growing up is harder to do. *Contexts*. 2004; 3:33–41.
- Galambos NL, Barker ET, Krahn HJ. Depression, self-esteem, and anger in emerging adulthood: Seven-year trajectories. *Developmental Psychology*. 2006; 42:350–365. [PubMed: 16569173]
- Giedd JN, Blumenthal J, Jeffries NO, Castellanos FX, Liu H, Zijdenbos A, Paus T, Evans AC, Rapaport JL. Brain development during childhood and adolescence: a longitudinal MRI study. *Nature Neuroscience*. 1999; 2:861–863.
- Gogtay N, Geid JN, Lusk L, Hayashi KM, Greenstein D, Vaituzis AC, Nugent TF, Herman DH, Clasen LS, Toga AW, Rapaport JL, Thompson PM. Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences*. 2004; 101:8174–8179.
- Holdcraft LC, Iacono WG. Cross-generational effects on gender differences in psychoactive drug abuse and dependence. *Drug and Alcohol Dependence*. 2004; 74:147–158. [PubMed: 15099658]
- Hopwood CJ, Newman DA, Donnellan MB, Markowitz JC, Grilo CM, Sanislow CA, McGlashan TH, Skodol AE, Shea MT, Gunderson JG, Zanarini MC, Morey LC. The stability of personality traits in individuals with borderline personality disorder. *Journal of Abnormal Psychology*. 2009; 118:806–815. [PubMed: 19899850]
- Humbad M, Donnellan MB, Iacono WG, Burt SA. Externalizing psychopathology and marital quality in long-term marriages: Results from a large combined sample of married couples. *Journal of Abnormal Psychology*. 2010; 119:151–162. [PubMed: 20141252]
- Hur YM, McGue M, Iacono WG. Unequal rate of monozygotic and like-sex dizygotic twin birth: Evidence from the Minnesota Twin Family Study. *Behavior Genetics*. 1995; 25:337–340. [PubMed: 7575362]

- Iacono WG, Carlson SR, Taylor JT, Elkins IJ, McGue M. Behavioral disinhibition and the development of substance abuse disorders: Findings from the Minnesota Twin Family Study. *Development and Psychopathology*. 1999; 11:869–900. [PubMed: 10624730]
- Iacono WG, McGue M. Minnesota Twin Family Study. *Twin Research*. 2002; 5:482–487. [PubMed: 12537881]
- Jacobsen NS, Truax P. Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology*. 1991; 59:12–19. [PubMed: 2002127]
- Johnson W, McGue M, Krueger RF. Personality stability in late adulthood: A behavioral genetic analysis. *Journal of Personality*. 2005; 73:523–551. [PubMed: 15745440]
- Kashy DA, Donnellan MB, Burt SA, McGue M. Growth curve models for indistinguishable dyads using multilevel modeling and structural equation modeling: The case of adolescent twins' conflict with their mothers. *Developmental Psychology*. 2008; 44:316–329. [PubMed: 18331125]
- Kendler KS, Neale MC, Kessler RC, Heath AC, Eaves LJ. A test of the equal-environment assumption in twin studies of psychiatric illness. *Behavior Genetics*. 1993; 23:21–27. [PubMed: 8476388]
- Krueger RF, Caspi A, Moffitt TE. Epidemiological personology: The unifying role of personality in population-based research on problem behaviors. *Journal of Personality*. 2000; 68:967–998. [PubMed: 11130741]
- Loehlin JC. Behavior genetics and parenting theory. *American Psychologist*. 2001; 56:169–170. [PubMed: 11279808]
- Little, RJA.; Rubin, DB. Statistical analysis with missing data. NY: Wiley; 1987.
- Markon KE, Krueger RF, Watson D. Delineating the structure of normal and abnormal personality: An integrative hierarchical approach. *Journal of Personality and Social Psychology*. 2005; 88:139–157. [PubMed: 15631580]
- McCrae, RR.; Costa, PT, Jr. Toward a new generation of personality theories: Theoretical contexts for the five-factor model. In: Wiggins, JS., editor. *The five-factor model of personality*. New York: Guilford; 1996. p. 51–87.
- McCrae, RR.; Costa, PT, Jr. *Personality in adulthood: A five-factor theory perspective*. 2nd ed.. New York: Guilford; 2003.
- McCrae, RR.; Costa, PT, Jr. The Five-Factor theory of personality. In: John, OP.; Robins, RW.; Pervin, LA., editors. *Handbook of personality: Theory and Research*. 3rd ed.. New York: Guilford Press; 2008. p. 159–181.
- McGue M, Bacon S, Lykken DT. Personality stability and change in early adulthood: A behavioral genetic analysis. *Developmental Psychology*. 1993; 29:96–109.
- Mroczek, DK.; Spiro, A., III; Griffin, PW. Personality and aging. In: Birren, JE.; Schaie, KW., editors. *Handbook of the psychology of aging*. 6th ed.. New York: Academic Press; 2006. p. 363–377.
- Neale, MC. *Mx: Statistical modeling*. 4th Ed.. Richmond, VA: Medical College of Virginia; 1997.
- Neale MC, McArdle JJ. Structured latent growth curves for twin data. *Twin Research*. 2000; 3:1–13.
- Neyer FJ, Lehnart J. Relationships matter in personality development: Evidence from a 9-year longitudinal study across young adulthood. *Journal of Personality*. 2007; 75:535–568. [PubMed: 17489891]
- Preacher, KJ.; Wichman, AL.; MacCallum, RC.; Briggs, NE. *Latent growth curve modeling*. Thousand Oaks, CA: Sage; 2008.
- Rindfuss RR. The young adult years: Diversity, structural change, and fertility." *Demography*. 1991; 28:493–512. [PubMed: 1769399]
- Riemann R, Angleitner A, Strelau J. Genetic and environmental influences on personality: A study of twins reared together using the self- and peer-report NEO-FFI scales. *Journal of Personality*. 1997; 65:449–475.
- Roberts BW, Caspi A, Moffitt T. The kids are alright: Growth and stability in personality development from adolescence to adulthood. *Journal of Personality and Social Psychology*. 2001; 81:670–683. [PubMed: 11642353]

- Roberts BW, Caspi A, Moffitt T. Work Experiences and Personality Development in Young Adulthood. *Journal of Personality and Social Psychology*. 2003; 84:582–593. [PubMed: 12635918]
- Roberts BW, Del Vecchio WF. The rank-order consistency of personality trait from childhood to old age: A quantitative review of longitudinal studies. *Psychologica Bulletin*. 2000; 126:3–25.
- Roberts BW, Walton K, Viechtbauer W. Personality changes in adulthood: Reply to Costa & McCrae (2006). *Psychological Bulletin*. 2006a; 132:29–32. [PubMed: 16435956]
- Roberts BW, Walton KE, Viechtbauer W. Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin*. 2006b; 132:1–25. [PubMed: 16435954]
- Roberts, BW.; Wood, D. Personality development in the context of the neo-socioanalytic model of personality. In: Mroczek, DK.; Little, TD., editors. *Handbook of personality development*. Mahwah, NJ: Erlbaum; 2006. p. 11-39.
- Roberts BW, Wood D, Smith JL. Evaluating five factor theory and social investment perspectives on personality trait development. *Journal of Research in Personality*. 2005; 39:166–184.
- Robins RW, Caspi A, Moffitt TE. It's not just who you're with, it's who you are: Personality and relationship experiences across multiple relationships. *Journal of Personality*. 2002; 70:925–964. [PubMed: 12498360]
- Robins RW, Fraley RC, Roberts BW, Trzesniewski KH. A longitudinal study of personality in young adulthood. *Journal of Personality*. 2001; 69:617–640. [PubMed: 11497032]
- Shanahan MJ. Pathways to adulthood in changing societies: Variability and mechanisms in life course perspective. *Annual Review of Sociology*. 2000; 26:667–692.
- Tellegen, A.; Waller, NG. Exploring personality through test construction: Development of the multidimensional personality questionnaire. In: Boyle, GJ.; Matthews, G.; Saklofske, DH., editors. *Sage handbook of personality theory and testing: Personality measurement and assessment*. London: Sage; 2008.
- Vaidya JB, Gray EK, Haig J, Mroczek DK, Watson D. Differential stability and individual growth trajectories of Big Five and affective traits during young adulthood. *Journal of Personality*. 2008; 76:267–304. [PubMed: 18331279]
- Watson D, Clark LA, Chmielewski M. Structures of personality and their relevance to psychopathology: II. Further articulation of a comprehensive unified trait structure. *Journal of Personality*. 2008; 76:1545–1585. [PubMed: 19012658]

Figure 1. Path diagram of Cholesky decomposition model

Note. The variance in liability to personality at each assessment is parsed into that which is due to additive genetic effects (A1, A2, and A3), shared environmental effects, and non-shared environmental effects (E1, E2, and E3). Though used in the model, shared environmental effects (C) are not represented herein for ease of presentation. Similarly, this path diagram represents only one twin in a pair (results are identical for the co-twin). Paths, which are squared to estimate the proportion of variance accounted for, are represented by lowercase letters followed by two numerals (e.g., a11). Genetic and environmental correlations are indicated by a lowercase r, followed by information regarding the specific correlation in question (e.g., $r_{A1 \rightarrow 24}$ Indicates the genetic correlation between ages 17 and 24).

Figure 2. Path Diagram of Biometric Latent Growth Curve Model

Note. For ease of presentation, this path diagram represents only one twin in a pair (results are identical for the co-twin). Variances in the intercept and linear slope factors are parsed into that which is due to additive genetic effects (A), shared environmental effects (C), and non-shared environmental effects (E). Paths are represented by lowercase letters followed by sub-scripted letters corresponding to their respective factor (e.g., a_i , a_s). Genetic and environmental correlations between the factors are presented at the top of the diagram (i.e., r_A , r_C , r_E). The assessment-specific residual paths loads directly onto personality at each assessment, and are indicated by a lowercase letter followed by a single sub-scripted numeral (i.e., a_1). Factor loadings for the intercept are fixed prior to analysis (x is determined by the phenotypic growth curve modeling results; .75 for Constraint and .84 for Negative Emotionality).

Figure 3. Absolute Changes in Personality Traits during the Transition to Adulthood
Note. Trait scores were standardized at the first wave using a T-score metric.

Stability and Change in Negative Emotionality, Agentive and Communal Positive Emotionality, and Constraint during the Transition to Adulthood.

Table 1

Trait	Differential Correlations				Absolute					F
	17-24	24-29	17-29	17	Mean (S.D.)		Cohen's <i>d</i>			
					24	29	17-24	24-29	17-29	
NEM	.53	.74	.49	50.00 (10.00)	42.30 (10.23)	41.01 (10.05)	-.77	-.13	-.90	550.79*
PEM-A	.59	.77	.58	50.00 (10.00)	50.75 (9.58)	50.43 (9.77)	.09	.03	.12	16.91*
PEM-C	.52	.74	.52	50.00 (10.00)	48.97 (9.91)	48.31 (9.68)	-.11	-.07	-.17	11.96*
CON	.62	.78	.56	50.00 (10.00)	54.95 (9.67)	56.62 (9.59)	.52	.17	.69	322.02*

Note. NEM = Negative Emotionality; PEM-A = Agentive Positive Emotionality; PEM-C = Communal Positive Emotionality; CON = Constraint. Trait scores were standardized on a T-scale (mean = 50, S.D. = 10) based on wave 1 data to facilitate interpretation.

Univariate Growth Curve Parameters for Models Depicting Absolute Stability and Change in Negative Emotionality and Constraint during the Transition to Adulthood.

Table 2

Trait	Intercept		Slope		Time 2 Slope path coefficient	Slope – intercept correlation
	Mean	Variance	Mean	Variance		
Negative Emotionality	50.11 *	70.97 *	-9.18 *	51.43 *	.84 *	-.34 *
Constraint	49.94 *	75.13 *	6.78 *	47.88 *	.72 *	-.35 *

Note. Agentic and Communal Positive Emotionality growth models did not fit the data because of negative variances. Data were standardized in a T-score metric using wave 1 data. Intercept means reflect estimates of these standardized scores. Significant intercept variances indicate that these means varied across participants. Slope means show that these traits significantly changed over the three waves, and slope variances show that there was variability across participants in terms of these changes. The time 2 slope path coefficient was estimated; if change were linear a value of .58 (7 years/12 years) would be expected. These values were both > .58 suggesting that more change occurred in the first relative to the second wave of the study. Significant slope-intercept correlations suggest that wave 1 scores were predictive of the magnitude of change observed over time.

*
p < .05.

Table 3

Fit Statistics for Cholesky (to assess influences on differential stability and change) and Growth Curve (to assess influences on absolute stability and change) biometric models.

Personality Trait	Model	-2lnL	df	X ² (Δ df)	AIC
Negative Emotionality	Baseline	24273.26	3117	---	---
	Cholesky	24310.44	3150	37.18 (33)	-28.82
	Growth Curve	24310.48	3147	37.22 (30)	-22.78
Constraint	Baseline	24854.86	3117	---	---
	Cholesky	24881.21	3150	26.35 (33)	-39.65
	Growth Curve	24880.09	3147	25.23 (30)	-34.77
Positive Emotionality - Agentic	Baseline	24326.69	3146	---	---
	Cholesky	24372.97	3179	46.28 (33)	-19.72
	Growth Curve	---	--	---	---
Positive Emotionality - Communion	Baseline	24549.54	3145	---	---
	Cholesky	24590.67	3178	41.13 (33)	-24.87
	Growth Curve	---	--	---	---

Table 4

Standardized parameter estimates from the Biometric Cholesky Decomposition Model.

Trait	Component of variance	% Age 17	% Age 24	% Age 29	r _{17→24}	r _{17→29}	r _{24→29}
Negative Emotionality	A	.34*	.33*	.33*	.75* (.32, .1.0)	.86* (.47, .1.0)	.99* (.77, .1.0)
	C	.05	.09	.10	--	--	--
	E	.61*	.58*	.57*	.36* (.26, .44)	.32* (.23, .40)	.60* (.54, .66)
Constraint	A	.53*	.56*	.49*	.81* (.67, .98)	.72* (.58, .88)	.96* (.86, .1.0)
	C	.02	.01	.01	--	--	--
	E	.44*	.42*	.50*	.44* (.35, .51)	.38* (.28, .46)	.65* (.58, .70)
Positive Emotionality - Agentic	A	.50*	.50*	.53*	.79* (.67, .93)	.73* (.62, .88)	.96* (.91, .1.0)
	C	.00	.00	.00	--	--	--
	E	.50*	.50*	.47*	.39* (.30, .48)	.42* (.34, .50)	.58* (.51, .65)
Positive Emotionality - Communion	A	.38*	.46*	.42*	.66* (.29, .85)	.69* (.32, .91)	.95* (.82, .1.0)
	C	.04	.02	.06	--	--	--
	E	.58*	.51*	.52*	.37* (.27, .46)	.35* (.26, .43)	.56* (.48, .63)

Note. A, C, and E represent genetic, shared, and non-shared environmental influences, respectively. Univariate variance estimates are presented for each age in columns 3–5. r_{17→24}, r_{17→29}, and r_{24→29} index the genetic and environmental correlations across ages 17 and 24, 17 and 29, and 24 and 29, respectively. Shared environmental correlations are not presented since they were uniformly nonsignificant (consistent with the non-significant amounts of variance in personality accounted for by shared environmental influences at all ages) and their confidence intervals ranged from –1.0 to 1.0.

Table 5

Biometric Latent Growth Curve Model results.

	A	C	E	Total Variance	Factors %
<u>Negative Emotionality</u>					
Factors					
Intercept (e.g., a_i)	.455*	.013	.532*	121.56	--
Slope (e.g., a_s)	.122	.086	.792*	85.01	--
Genetic/environmental correlations (e.g., r_A)	-.11	--	-.46	-29.81	--
Residuals					
Age 17 (e.g., a_1)	.082	.000	.246*	--	67%
Age 24 (e.g., a_2)	.029	.000	.222*	--	75%
Age 29 (e.g., a_3)	.000	.017	.155*	--	83%
<u>Constraint</u>					
Factors					
Intercept (e.g., a_i)	.677*	.000	.323*	198.43	--
Slope (e.g., a_s)	.504*	.000	.496*	120.49	--
Genetic/environmental correlations (e.g., r_A)	-.40	--	-.32	-55.63	--
Residuals					
Age 17 (e.g., a_1)	.048	.000	.197*	--	75%
Age 24 (e.g., a_2)	.049	.027	.124*	--	80%
Age 29 (e.g., a_3)	.000	.000	.121*	--	88%

Note. A, C, and E represent proportions of genetic, shared, and non-shared environmental influences, respectively. The intercept factor is composed of the variance that is common or stable across time. The slope factor captures systematic change over time. Both factors were decomposed into their genetic and environmental components, and therefore each row sums to 100% of the variance within that factor. Genetic and environmental correlations between factors are also indicated (none were statistically significant). The residual estimates index the variance remaining at each assessment after accounting for that contributed by the factors. Accordingly, the variance contributed by the factors is necessary for the rows to sum to 100%.

*
 $p < .05$