Personality trait development in the context of daily experiences and close social relationships

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PERSONALITY TRAIT DEVELOPMENT

IN THE CONTEXT OF DAILY EXPERIENCES AND CLOSE SOCIAL RELATIONSHIPS

JEROEN BORGHUIS

Personality Trait Development in the Context of Daily Experiences and Close Social Relationships

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Chapter 1

General introduction

Portions of this chapter have been adapted from: Klimstra, T. A., Borghuis, J., & Bleidorn, W. (2018). Personality development in adolescence and young adulthood. In V. Zeigler-Hill & T. K. Shackelford (Eds.), The SAGE handbook of personality and individual differences: Origins of personality and individual differences (pp. 181-202). London, SAGE Publications Ltd.

Personality traits reflect relatively enduring patterns of thoughts, feelings, and behaviors in which individuals differ (Wrzus & Roberts, 2017). The phrase 'personality trait development' would have looked like a *contradictio in terminis* to many researchers until approximately 30 years ago, as it was believed that people do not change in personality traits. In contrast, it is now widely acknowledged that people undergo personality trait changes throughout life, with the most pronounced changes occurring during adolescence and early adulthood. However, our understanding of how and why personality trait changes occur is still limited. For example, personality researchers have not reached consensus yet about the question whether psychological experiences, such as daily emotional and interpersonal experiences, can influence personality traits (Baumert et al., 2017; McCrae & Sutin, 2018).

The goal of this dissertation is to contribute to our understanding of personality trait development. I focus on the Big Five personality traits (i.e., extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience) and people's development on these traits during adolescence, ranging from approximately age 10 to 20, and during middle adulthood, ranging from approximately age 40 to 70. I examine (i) how people on average develop on the Big Five personality traits, (ii) to what extent people differ from each other in their development, (iii) whether daily affective and interpersonal experiences influence personality traits, and (iv) whether personality traits influence people's daily affective and interpersonal experiences.

Gaining a deeper understanding of personality trait development is important because personality traits are strongly related to desirable personal and societal outcomes, such as how much social support we receive, how happy, healthy, and productive we are, and how long we live (Mroczek & Spiro, 2007; Ozer & Benet-Martínez, 2006; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). Furthermore, a better understanding of personality trait development may, ultimately, be used to detect early signs of undesirable or abnormal personality development. Finally a better understanding may be used to formulate recommendations for practitioners, policy makers, and lay people about how to facilitate desirable and how to prevent undesirable personality trait development (Roberts & Hill, 2017).

In the following, I introduce the Big Five personality traits, discuss previous research and theory on personality trait development in adolescence and adulthood, and I describe the aims and research questions of this dissertation. Lastly, I briefly describe the RADAR data, and explain why this data set was well-suited for investigating the research questions of this dissertation.

The Big Five Personality Traits

People share countless psychological features that make us similar. For example, almost all people have the ability to speak, to recognize faces, to smile, and to feel emotions like anxiety. However, as members of a social species, we care more about traits on which we differ from each other. For example, we may wonder whether a new colleague or political candidate is trustworthy or unreliable, helpful or selfish, shy or talkative, and calm or easily stressed. We have invented thousands of words to describe relatively stable differences between people. According to the lexical hypothesis, trait words refer to actual traits that have been salient and socially relevant, for else they would not have become encoded in our natural languages (Allport, 1937).

The thousands of trait words have been organized and conceptualized to enable effective communication among personality researchers and practitioners and to stimulate systematic accumulation of knowledge (De Raad, Mulder, Kloosterman, & Hofstee, 1988; John, Naumann, & Soto, 2008). The resulting Big Five model (John & Srivastava, 1999) is the most widely used model to organize and conceptualize the thousands of traits encoded in our language. The Big Five is a taxonomy that summarizes covariation among many specific traits along five broad and abstract trait dimensions (John et al., 2008). In the present dissertation, I investigated people's development on the Big Five traits.

The *extraversion* dimension reflects the tendency to be social, outgoing, warm, assertive, and energetic. *Agreeableness* reflects the tendency to be cooperative, kind, polite, and empathic. *Conscientiousness* refers to characteristics such as being organized, responsible, planful, and hardworking. The trait of *emotional stability* (the inverse of neuroticism) represents the propensity to experience negative emotions, with low levels reflecting negative emotionality and sensitivity to threats and dangers, and high levels reflecting emotional stability and even-temperedness. Finally, *openness to experience* reflects the tendency to be imaginative, creative, intellectual, and curious.

The Big Five structure of personality has been replicated across a range of cultures, using various measures and samples from different backgrounds and ages (John et al., 2008; McCrae & Terracciano, 2005; Schmitt et al., 2007). The Big Five seems to represent a balance between conceptual breadth, descriptive accuracy, and generalizability across samples and measures (Bleidorn & Hopwood, 2018). However, it may be noted that traits can also be dimensionally organized in broader or narrower ways (Eysenck, 1991). In addition, it may be noted that the Big Five taxonomy is hierarchical and can therefore be studied at lower levels. At lower levels, each trait is composed of sub-traits called facets, and each facet is composed of sub-sub-traits called nuances. For example, the trait of extraversion can be divided into the facets warmth, gregariousness, assertiveness, activity, positive emotions, and excitement seeking (McCrae & Terracciano, 2005); and the facet

of excitement seeking, for example, can be further divided into nuances such as liking roller coasters, liking to attend games, and liking showy styles (Mõttus, Kandler, Bleidorn, Riemann, & McCrae, 2017).

Previous Research on Rank-Order Stability and Mean-Level Change

In this dissertation, I study personality trait development at the between-person level and at the within-person level. The *between-person* analyses investigate rank-order stability and rank-order change, defined as stability and change of individuals' *relative standing* on a trait dimension within a population over time. The *within-person* analyses investigate changes of groups or individuals relative to their own previous trait *level* or relative to an individual's own typical (average) trait level. Change in the average trait level within a group is referred to as mean-level change. Mean-level change is conceptually independent from rank-order change, because individuals' relative standing on a trait dimension can be perfectly maintained in groups that change in their average trait level. Likewise, individuals' relative standing may be completely reordered in groups who perfectly maintain their average trait level (Roberts, Walton, & Viechtbauer, 2006). Because this dissertation examines the development of rank-order stability and mean levels of the Big Five during adolescence and middle adulthood, I review previous research on these topics below.

Rank-Order Stability

Rank-order stability is commonly estimated by means of a test-retest correlation or a stability coefficient in a path model or a structural equation model (i.e., a trait measured at time t is regressed on the same trait measured in the same sample at time t-1). At least two important conclusions emerged from previous research on the rank-order stability of personality traits. First, although rank-order stability decreases when time intervals between measurement occasions increase, personality traits show significant rank-order stability even over decades (Fraley & Roberts, 2005). This implies that between-person differences on personality traits are partly influenced by constant (i.e., time-invariant, lasting) factors. As a result, individuals who rank at the top of the extraversion distribution during adolescence are unlikely to rank at the bottom of the extraversion distribution as adults.

Second, previous research has shown that the rank-order stability of personality traits increases from childhood to middle adulthood. This finding has been referred to as the cumulative continuity principle of personality development (Roberts & Mroczek, 2008). Specifically, meta-analyses suggested that the 6-year rank-order stability of personality or temperament traits is moderately high in preschool years (test-retest $r \approx .50$), increases until middle adulthood (test-retest $r \approx .70$), and then levels off (Anusic & Schimmack, 2016; Bazana & Stelmack, 2004; Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000).

Mean-Level Change

Mean-level personality trait change is often examined by comparing mean trait levels of different age groups or by analyzing changes within a group over time, for example by means of latent growth curve modelling (Duncan, Duncan, Strycker, Li, & Alpert, 1999). The most robust conclusion that emerged from previous research with respect to mean-level personality development is that during early adulthood, average traits levels of agreeableness, emotional stability, and conscientiousness increase over time (Bleidorn et al., 2013; Roberts et al., 2006). These age-graded mean-level increases are referred to as the maturity principle of personality development (Roberts & Mroczek, 2008), because being agreeable, conscientious, and emotionally stable corresponds closely to definitions of maturity that emphasize functioning in society and social relationships, such as being liked, respected, and admired (Roberts & Mroczek, 2008; Roberts, Wood, & Caspi, 2008).

Previous research on mean-level personality change during adolescence suggested that mean levels of most Big Five traits decrease during early adolescence and increase during late adolescence (i.e., a U-shaped change) (Denissen, Van Aken, Penke, & Wood, 2013; Soto, John, Gosling, & Potter, 2011). As such, mean-level personality changes during early and middle adolescence appear to deviate from the maturity principle.

Relatively little research has focused on the period of middle adulthood. The sparseness of research focusing at this life stage might reflect findings suggesting that personality traits are rather stable in this period (Costa & McCrae, 1994). This stability has led researchers to propose that personality traits "reach mature form in adulthood; thereafter they are stable in cognitively intact individuals" (McCrae & Costa, 1999, p. 145). However, contrary to the proposition that personality traits are stable in middle adulthood, previous research found evidence for mean-level increases in agreeableness, conscientiousness, and emotional stability and decreases in openness and extraversion during this life stage (Roberts et al., 2006; Soto et al., 2011; Srivastava, John, Gosling, & Potter, 2003; Terracciano, McCrae, Brant, & Costa, 2005).

What Predicts Changes in Personality Traits?

Background: Insights from Behavioral Genetics

An important goal of this dissertation is to gain more insight into the psychological predictors of personality trait change. However, before I review previous research findings on psychological/environmental predictors of personality trait change, I first briefly discuss several important conclusions that have been drawn from behavioral genetic research, because this research has provided abstract but important insights with respect to the question to what extent experiences may influence personality traits.

The most important conclusion from a large body of behavioral genetic research is that personality traits appear to be influenced by both genetic and (non-shared) environmental factors (Bleidorn, Kandler, & Caspi, 2014; Bouchard & Loehlin, 2001; Briley & Tucker-Drob, 2014). The conclusion that genetic factors play a role has been inferred from the fact that monozygotic (identical) twins, who share 100% of the genetic variants in the population, are more similar in their personality and develop more similarly over time than dizygotic twins, who share 50% of their segregating genes. Similarly, full siblings, who also share 50% of the genetic variants, have been found to develop more similarly in their personality traits than half-siblings, who share 25% of the genetic variants (Harris, 2007). Family and adoption studies suggest that personality traits are .22 heritable (Vukasović & Bratko, 2015), twin designs suggest that they are .47 heritable (Vukasović & Bratko, 2015), and multi-method designs typically find heritabilities of .50 to .70 (Mõttus et al., 2017; Riemann, Angleitner, & Strelau, 1997). The finding that (additive) genetic effects do not account for all the variance of personality traits suggests that environmental factors may also contribute to individual differences in personality traits.

By design, behavioral genetic studies are able to separate genetic and non-genetic sources of variation, but they are not able to identify specific environmental factors or genetic variants that influence personality. Nevertheless, these studies can disentangle shared and non-shared environmental influences on traits. Research has suggested that environmental sources of variance that are shared among siblings/household members (e.g., being reared by one or two parents, growing up in a wealthy or poor household, having a happy or depressed mother) have a negligible effect on personality. This has been inferred from the observation that twins or siblings raised together are no more similar than twins or siblings separated at birth and raised apart. The negligible influence of shared experiences has also been inferred from the observation that adoptive siblings, who grew up together in the same household but do not share genetic variants, show no similarity in personality trait (Harris, 2007).

To conclude, behavioral genetic research has suggested that both genes and non-shared environmental factors contribute to personality trait development (Bleidorn et al., 2014; Bouchard & Loehlin, 2001; Briley & Tucker-Drob, 2014; Harris, 1995; Vukasović & Bratko, 2015). However, not all theorists accept the suggestion from behavioral genetic research that environmental experiences, such as interpersonal experiences or major life events, have an influence on personality traits. These theorists argue that the non-shared environmental variance component may reflect the effects of random measurement error and systematic error of method variance, rather than true influences from the environment (Costa, McCrae, & Löckenhoff, 2018). Hence, more targeted research is needed to demonstrate the effects of specific environmental factors on personality traits.

Endogenous versus Dynamic Theories of Personality Development

Two broad theoretical perspectives on personality development offer different answers to the question how psychological experiences are causally related to personality traits. *Endogenous* personality theories, such as five-factor theory (McCrae & Costa, 2008; McCrae & Sutin, 2018), posit that the causal relation between personality traits and psychological experiences is unidirectional: Personality traits influence people's daily experiences, but psychological experiences have no influence of personality traits (McCrae & Sutin, 2018). According to this perspective, personality trait development is only driven by processes of intrinsic maturation, which include genetic influences and other biological processes that affect the brain, such as a traumatic brain injury and drug use (McCrae & Sutin, 2018, p. 155). Thus, endogenous perspectives assert that the environment can affect personality traits in a direct way, by affecting the biological bases of traits, but not in an indirect way via psychological mechanisms such as our thoughts, feelings, and behaviors.

In contrast, *dynamic* theories of personality development propose that the causal relation between personality traits and psychological experiences is bidirectional: Traits and experiences influence each other continuously over time (Endler & Parker, 1992; Magnusson, 1990; Roberts et al., 2008). In other words, according to dynamic perspectives, personality traits not only predispose people to certain psychological experiences, but experiences, in turn, can also affect people's personality traits.

A key prediction of contemporary dynamic personality theories is that personality trait changes occur gradually through the accumulation of daily experiences and through people's responses to these experiences (Baumert et al., 2017; Geukes et al., 2017; Roberts & Jackson, 2008; Wrzus & Roberts, 2017). Dynamic models posit that states (i.e., momentary thoughts, feelings, and behaviors) can influence personality traits, provided that states are experienced repeatedly or with an intensity beyond one's usual range of experience (Wrzus & Roberts, 2017). According to these theories, states may produce changes in personality traits via biological mechanisms (e.g., changes in gene expressions and neuroanatomical structures), associative mechanisms (e.g., implicit learning, reinforcement learning, and habit formation), or reflective mechanisms (e.g., conscious memories about one's past states) (Baumert et al., 2017; Roberts, 2018; Wrzus & Roberts, 2017).

What kind of states are most relevant for personality trait development? Many personality researchers have suggested that interpersonal experiences with close others play an important role in the development of personality traits (Back et al., 2011; Fraley & Shaver, 2008; Harris, 1995; Mund, Finn, Hagemeyer, & Neyer, 2016; Neyer & Asendorpf, 2001; Reitz, Zimmermann, Hutteman, Specht, & Neyer, 2014; Sullivan, 1953; Wrzus & Neyer, 2016; Wrzus & Roberts, 2017). As a species that is highly dependent on cooperation, man has a strong need to belong to others (Baumeister & Leary, 1995) and we are highly sensitive to rejection (Leary et al., 1995). It has been argued that the main evolutionary

selection pressures that shaped our personality system have likely come from our social environment (Penke, Denissen, & Miller, 2007). Moreover, as matters of finding food, avoiding predators, and finding sheltering have become relatively minor concerns in most contemporary societies, social experiences might have become all the more relevant for human personality trait development (Penke, 2011).

To illustrate how interpersonal experiences may affect personality traits, consider two examples of how Anne may become more neurotic (i.e., less emotionally stable) because of her interpersonal experiences. First, Anne may become more neurotic because she repeatedly experienced relationship conflicts with her best friend. These conflicts repeatedly made her feel anxious and sad. Also, they made her worry that she will lose her friend and become lonelier. Her repeated worries and negative emotions gradually changed her self-perceptions regarding her level of neuroticism. Second, Anne may become more neurotic because her best friend is relatively neurotic. Her friend becomes easily and often stressed at school. Anne observes her stressful reactions and unconsciously mimics her. When Anne does become stressed and worried, her friend actively reinforces her negative feelings. As a result of their interactions, Anne and her friend show interrelated development of their level of neuroticism, which I refer to as dyadic codevelopment in this dissertation. Theoretically, dyadic codevelopment might (consciously or unconsciously) result from social learning processes (Biddle, Bank, & Marlin, 1980; Caspi & Roberts, 2001; Hartup, 1996; Moffitt, 1993), active reinforcement learning (Bandura, 1971; Harris, 1995; Hartup, 1996; Hawley, 2006; Moffitt, 1993; Roberts et al., 2008; Wrzus & Roberts, 2017), and conformity to shared norms for behavior and other personality expressions (Berndt, 1999; Dishion & Tipsord, 2011; Harris, 1995; Reitz et al., 2014).

Past evidence regarding whether concrete psychological experiences such as relationship conflicts can influence personality trait development has been mixed. Most research reports on longitudinal predictors of personality trait change mention evidence suggesting that psychological experiences are associated with personality trait changes (e.g., Bleidorn, 2012; Denissen, Luhmann, Chung, & Bleidorn, 2018; Denissen, Ulferts, Lüdtke, Muck, & Gerstorf, 2014; Mund & Neyer, 2014). However, the available evidence does not allow us yet to draw strong conclusions about whether psychological experiences influence personality traits and which kind of experiences matter most for which traits. One reason is that no strong causal inferences can be made from correlational studies (Baltes, Reese, & Nesselroade, 2014; Luhmann, Orth, Specht, Kandler, & Lucas, 2014). Another reason is that evidence for robust associations that replicate across different data sets and populations is still limited (Bleidorn, Hopwood, & Lucas, 2018).

To conclude, despite a wealth of research, evidence regarding the exact conditions and mechanisms of changes in the Big Five is still limited, beyond the abstract conclusion from behavioral genetic research that both genetic and non-shared environmental influences

seem to play a role (Bleidorn et al., 2018). Hence, we need more research that examines the dynamic personality-environment interplay using large samples and rigorous designs. As mentioned above, contemporary dynamic theories of personality development suggest that more evidence for concrete environmental effects on personality may be found if we focus on the potential effects of repeated, everyday interpersonal experiences with close others.

Aims and Research Questions of this Dissertation

In this dissertation, I examined the structure of Big Five personality trait development (Research Question 1, 2, and 3). In addition, to gain more insight into the conditions of personality trait changes, I investigated the longitudinal relations between personality traits and affective and interpersonal experiences (Research Question 4 and 5).

1. How does the 1-year rank-order stability of the Big Five change from adolescence through early adulthood?

Most studies analyzed the rank-order stability of personality traits across relatively long intervals, spanning at least several years (for an exception, see Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2009). These studies have demonstrated, for example, that the rank-order stability of personality traits tends to be larger in early adulthood than in middle adolescence. However, to gain a finer-grained picture of age-graded changes in the rank-order stability of personality traits, we need to examine the stability of personality traits during shorter intervals, such as one year. This increases insight into the existence of periods during which personality traits temporarily stabilize more or less strongly, or do not further stabilize at all, which would violate the cumulative continuity principle. Therefore, to address these questions, Chapter 2 explored how the rank-order stability of the Big Five changed from early adolescence (age 12) to early adulthood (age 22) across relatively brief, 1-year time intervals.

2. How do people change on average on the Big Five from adolescence through early adulthood and during middle adulthood?

Notwithstanding some exceptions, most studies on mean-level change in the Big Five employed cross-sectional designs or longitudinal designs with few or infrequent measurement occasions per individual. Such designs are useful to gain insights into how people may change, but they do not allow for well-founded conclusions about the precise shape of within-person mean-level changes (Kraemer, Yesavage, Taylor, & Kupfer, 2000; Luhmann et al., 2014). Gaining a more precise picture of mean-level personality change requires frequently repeated measurements of the same traits among the same individuals

over a long developmental period. Closely conforming to these requirements, I used up to seven yearly personality trait measurements per participant to examine mean-level changes in the Big Five from early adolescence through early adulthood (Chapter 2) and during middle adulthood (Chapter 3).

3. To what extent do individuals differ with respect to their development on the Big Five?
To examine individual differences in personality change, studies using latent growth curve modeling sometimes reported variance estimates of latent change factors (reflecting the degree of individual variation around mean-level trajectories) in conjunction with mean estimates of these factors (e.g., Branje, Van Lieshout, & Van Aken, 2004; Kawamoto & Endo, 2015; Klimstra et al., 2009; Van den Akker, Dekovic, Asscher, & Prinzie, 2014). However, variance estimates of polynomial change factors are difficult to comprehend without visualizations. To my knowledge, the extent to which individuals differ with respect to their long-term personality changes have not yet been visualized. Therefore, Chapter 2 and Chapter 3 not only examined mean-level changes, but also estimated and graphically visualized the magnitude of individual differences in personality trait change during adolescence (Chapter 2) and middle adulthood (Chapter 3). More insight into the extent to which individuals differ with respect to their long-term personality changes informs us about how accurately mean-level change estimates describe the development of individuals.

4. Do best friends and siblings codevelop on the Big Five during adolescence?
Theory and research suggest that close social relationships may play an important role in adolescent personality trait development (e.g., Reitz et al., 2014). Research found that friends influence each other's behaviors (e.g., aggressive behavior), affect (e.g., negative emotionality), and motives (e.g., motivation for educational achievement; e.g., Dishion & Tipsord, 2011; Hogue & Steinberg, 1995; Ojanen, Sijtsema, & Rambaran, 2013; Ryan, 2000). However, few studies have examined whether these influences generalize to dyadic codevelopment on broad personality traits. Therefore, in Chapter 2, I investigated whether personality traits of best friends and siblings were longitudinally interrelated during adolescence. To explore potential boundary or facilitating conditions of codevelopment, this chapter also explored the effects of several potential moderators of personality trait codevelopment (i.e., same-sex versus different-sex dyads, high versus low perceived relationship quality, and being the younger versus being the older one in the relationship).

5. How are Big Five personality traits longitudinally related to daily affective and interpersonal experiences during adolescence and middle adulthood?
Dynamic theories of personality development hypothesize that personality trait changes unfold gradually through the accumulation of daily experiences and through people's

reactions to daily experiences (Geukes, van Zalk, & Back, 2018; Wrzus & Roberts, 2017). As such, dynamic theories predict that the longitudinal relation between personality traits and daily experiences is bidirectional. This contrasts with endogenous perspectives, which hypothesize that personality traits influence people's daily experiences, but daily psychological experiences do not influence personality traits (McCrae & Sutin, 2018). These contrasting hypotheses can be tested by means of a measurement burst design. A measurement burst design allows researchers to link participants' momentary or daily reports of everyday experiences to long-term changes in personality traits and vice versa. In addition, a measurement burst design enables researchers to empirically estimate for each individual the relation between one state (e.g., relationship conflict) and another state (e.g., negative affect), and associate such state contingencies with changes in personality traits.

To my knowledge, so far only one (unpublished) study has used a measurement burst design to investigate the relation between daily experiences and personality trait changes (Wrzus, Luong, Wagner, & Riediger, 2017). They found that increases in negative affect and hassle reactivity were associated with increases in neuroticism during the same period. Chapters 3 and 4 aimed to conceptually replicate and extend this previous study by examining the longitudinal relation between Big Five traits and people's daily affective and interpersonal experiences using a measurement burst design. More specifically, Chapter 3 tested for between-person longitudinal effects between the Big Five traits and daily experiences of positive affect and relationship support during middle adulthood. Furthermore, Chapter 4 tested for within-person longitudinal effects between neuroticism (i.e., the inverse of emotional stability) and daily experiences of negative affect and relationship conflict during adolescence. In Chapter 4, I used the novel random-intercept cross-lagged panel model (RI-CLPM; Hamaker et al., 2015), which differentiated covariance at the level of constant between-person differences from dynamic processes that occurred within persons. Together, Chapters 3 and 4 aimed at increasing our understanding of the predictors and consequences of personality traits with respect to everyday affective and interpersonal experiences.

The RADAR Data

I examined all research questions of this dissertation using data from the RADAR (Research on Adolescent Development and Relationships) study (Van Lier et al., 2011). RADAR is an ongoing prospective cohort-sequential study of Dutch-speaking families in the Netherlands. Using existing data that were collected though large collaborations enables researchers to address more difficult research questions with greater accuracy and validity than researchers could achieve on their own. However, using existing data also comes with

limitations. Most importantly, the study design and population of existing data may not perfectly match the researcher's research questions. With respect to the current dissertation, this disadvantage was small. Overall, I found that the RADAR data set was well-suited for investigating the research questions of this dissertation, because:

- it contains a large sample (i.e., N = 2,230 adolescents and 483 mothers), which produces sufficient statistical power to detect patterns;
- it contains personality trait assessments that were spaced across relatively brief, 1-year intervals, which allowed me to analyze development at a detailed level;
- it covers individuals' development over a long period (i.e., up to seven years, from 2005 to 2012);
- it contains two adolescent cohorts that partly overlapped with respect to age (M age_{t1} younger cohort = 13.5 years; M age_{t1} older cohort = 16.5 years), which allowed me estimate mean-level changes across a long developmental period;
- it includes self-reports of target adolescents, their self-nominated best friend, their parents, and one sibling, which allowed me to test for dyadic codevelopment and analyze personality changes during adolescence and during middle adulthood; and
- it includes measurement bursts (i.e., repeated bursts of online daily diary assessments), which allowed me to associate participants' actual experiences in daily life with long-term changes in their personality traits.


2

Chapter 2

Big Five Personality Stability, Change, and Codevelopment across Adolescence and Early Adulthood

This chapter is published as:
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Abstract

Using data from two large and overlapping cohorts of Dutch adolescents, containing up to seven waves of longitudinal data each (N = 2,230), the present study examined Big Five personality trait stability, change, and codevelopment in friendship and sibling dyads from age 12 to 22. Four findings stand out. First, the one-year rank-order stability of personality traits was already substantial at age 12, increased strongly from early through middle adolescence, and remained rather stable during late adolescence and early adulthood. Second, we found linear mean-level increases in girls' conscientiousness, in both genders' agreeableness, and in boys' openness. We also found temporal dips (i.e., U-shaped mean-level change) in boys' conscientiousness and in girls' emotional stability and extraversion. We did not find a mean-level change in boys' emotional stability and extraversion, and we found an increase followed by a decrease in girls' openness. Third, adolescents showed substantial individual differences in the degree and direction of personality trait changes, especially with respect to conscientiousness, extraversion, and emotional stability. Fourth, we found no evidence for personality trait convergence, for correlated change, or for time-lagged partner effects in dyadic friendship and sibling relationships. This lack of evidence for dyadic codevelopment suggests that adolescent friends and siblings tend to change independently from each other and that their shared experiences do not have uniform influences on their personality traits.

Keywords: personality development, adolescence, rank-order stability, mean-level change, peer influence

Most research on personality trait development has focused on the period of early adulthood (for reviews, see Bleidorn, 2015; Denissen, Van Aken, & Roberts, 2013; Luhmann, Orth, Specht, Kandler, & Lucas, 2014). By contrast, relatively little attention has been devoted to personality trait development in adolescence, which is an otherwise intensively studied developmental period, marked by rapid and oftentimes long-lasting biological, psychological, and social changes (Blakemore, 2008; Casey, Jones, & Hare, 2008; Koepke & Denissen, 2012; Weisfeld, 1999). This is unfortunate, because a better understanding of the general shape and the underlying conditions of personality trait development in adolescence would not only advance personality development theory, but would also increase insight into the conditions of (un)desirable personality changes during adolescence.

To address this gap, the present research aimed at shedding more light on the patterns and conditions of personality trait development during adolescence by analyzing longitudinal personality data from two large and partly overlapping cohorts. We examined (1) stability and change in the rank-order stability and mean levels of Big Five personality traits from adolescence through early adulthood, (2) the extent to which adolescents differ from each other with respect to their personality trait change, and (3) whether individual differences in adolescents' personality trait change are related to the personality trait levels and trajectories of their friends and siblings.

Previous Research on Big Five Stability and Change in Adolescence

Previous studies on personality trait development have mainly focused on (1) rank-order stability (i.e., the maintenance of the relative standing of individuals on a trait dimension within a population over time), on (2) mean-level change (i.e., change in the average trait levels of a population over time), and on (3) individual differences in change (i.e., individual deviations from the population mean-level pattern of change). Next, we review previous findings on these topics in adolescence and point out limitations of this research that we aimed to address in the present study.

Rank-order stability. One important conclusion from previous research is that personality/temperament traits are moderately stable in preschool years and become increasingly stable until middle adulthood (Bazana & Stelmack, 2004; Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000). This robust finding has been referred to as the cumulative continuity principle of personality development (Roberts & Mroczek, 2008). However, because meta-analyses have aggregated rank-order stability findings across broad age categories (e.g., ages 12-18), relatively little is known about differences in rank-order stability across narrower age categories. One study that has attempted to address this gap found that the one-year rank-order stability of Big Five traits indeed increased across early, middle, and late adolescence (Klimstra et al., 2009). However, finer-grained studies across circumscribed age periods are needed to describe the exact shape of rank-order stability and change across the life span.

Mean-level change. Previous research on mean-level change in personality traits has mainly focused on the period of early adulthood and found that young adults increase on average in their absolute levels of agreeableness, emotional stability, conscientiousness, and social dominance (Roberts et al., 2006). These normative increases have been referred to as the maturity principle of personality development (Roberts & Mroczek, 2008). That is because being agreeable, conscientious, and emotionally stable corresponds quite closely to definitions of maturity that emphasize functioning in society and social relationships, such as being liked, respected, and admired (Hogan & Roberts, 2004; Roberts & Mroczek, 2008; Roberts et al., 2008).

In contrast with the maturity principle, the disruption hypothesis proposes that adolescents tend to experience temporal dips in personality maturity due to biological, social, and psychological transitions from childhood to adolescence (Soto & Tackett, 2015). Other reasons why adolescence may not fit the maturity principle are that adolescents often temporarily conform to deviant peer norms (Moffitt, 1993) and that they may experience difficulties in adjusting to increasingly mature expectations (Denissen, Van Aken, Penke, et al., 2013). Indeed, both a recent meta-analysis (Denissen, Van Aken, Penke, et al., 2013) and a large-scale cross-sectional study (Soto et al., 2011) found that in adolescence, mean levels of most Big Five traits tend to first decrease and then increase (i.e., U-shaped change). Specifically, these studies both found evidence for temporary mean-level decreases in conscientiousness, openness, extraversion, and emotional stability (among girls) in early adolescence, whereas they found mean-level increases in conscientiousness, emotional stability, and openness in late adolescence and early adulthood. In addition, though contrary to Denissen, Van Aken, Penke, et al. (2013), Soto et al. (2011) also found evidence for U-shaped change in agreeableness.

Perhaps surprisingly, normative personality trait change during the period of childhood seems to be more consistent with the propositions of the maturity principle than the periods of early and middle adolescence. This is evidenced by increasing self-regulation capacity and agreeableness and by decreasing negative emotionality in childhood (for a review see Shiner, 2015). However, previous studies typically employed cross-sectional designs or longitudinal designs with few or infrequent measurement occasions per individual, which hampers strong conclusions about the exact shape of mean-level change in adolescence (Kraemer et al., 2000; Luhmann et al., 2014).

Individual differences in change. Previous research has focused more on normative change than on individual deviations from normative change trajectories (i.e., individual differences in change). The few studies on adolescent personality trait development that have examined individual differences in change have rarely interpreted or tried to explain these individual differences (e.g., Kawamoto & Endo, 2015; Klimstra et al., 2009).

Notable exceptions are the studies by Branje, van Lieshout, and Gerris (2007) and by Van den Akker, Dekovic, Asscher, and Prinzie (2014). These studies provided estimates for the degree of individual differences in change for each trait and gender and attempted to associate this variability with individual differences in maternal parenting behaviors, pubertal timing, and life events. However, although many associations were tested, few proved to be significant. Furthermore, although these studies agreed that variance in the magnitude of individual change trajectories was small for conscientiousness, moderate for openness, and large for emotional stability, Branje et al. (2007), Klimstra et al. (2009), and Van den Akker et al. (2014) found inconsistent results for extraversion and agreeableness. Thus, to date, little is known about the degree and possible sources of individual differences in adolescents' personality trait change.

Personality Codevelopment in Friendship and Sibling Dyads

Theory and empirical studies suggest that peers play an important role in explaining individual differences in adolescents' personality trait change (e.g., Briley & Tucker-Drob, 2014; Harris, 1995; Reitz, Zimmermann, Hutteman, Specht, & Neyer, 2014; Sullivan, 1953). The dynamics between personality and social relationships have received ample attention in previous research (e.g., Back et al., 2011; Mund & Neyer, 2014). Among the most prominent theoretical models are transactional models, which emphasize the reciprocal nature of the links between personality traits and social relationships (Wrzus, Zimmermann, Mund, & Neyer, 2016). According to such models, personality transactions might occur among members of dyadic relationships, resulting in codevelopment on personality traits. We use the term *codevelopment* to refer to the tendency of dyad or group members to show interrelated development on a trait because of their social connectedness. This codevelopment results in (1) convergence if dyad members become more similar over time, (2) correlated change if the change trajectories of dyad members are correlated (i.e., are more or less similar than the change trajectories of unrelated individuals), and (3) time-lagged partner effects if one dyad member's change is associated with the other's previous trait level.

Dyadic personality trait codevelopment might result from various processes, which may operate unconsciously (Dishion & Tipsord, 2011). First, personality trait change might result from social learning processes. In case of model learning, personality trait change occurs through watching and imitating other people's personality expressions (Biddle et al., 1980; Caspi & Roberts, 2001; Hartup, 1996; Moffitt, 1993). In case of active reinforcement learning, individuals may change if they receive persistent positive or negative reactions from others (e.g., verbal feedback, or a smile or frown) on their personality expressions (Bandura, 1971; Harris, 1995; Hartup, 1996; Hawley, 2006; Moffitt, 1993; Roberts et al., 2008; Wrzus & Roberts, 2017). These social learning mechanisms might be asymmetrical

or unidirectional, as older and more popular dyad members have been found to be more influential than younger and less popular dyad members (Brody, Stoneman, MacKinnon, & MacKinnon, 1985; Dishion & Tipsord, 2011; Wallace, 2015; Zukow, 1989). Social learning processes may not result in correlated change, though they would result in increasing dyadic trait similarity over time. They may also result in positive time-lagged partner effects if social influence is associated with personality traits. For example, if influential dyad members tend to be extraverted, higher initial extraversion of one dyad member will become associated with more positive extraversion change in the other dyad member.

A second possible mechanism for codevelopment is conformity to shared norms for behavior and other personality expressions (Berndt, 1999; Dishion & Tipsord, 2011; Harris, 1995; Reitz et al., 2014). Shared norms might be established at the level of dyads or peer groups (Harris, 1995; Reitz et al., 2014) and might result from individuals' preference for similarity, which facilitates trust and predictability and reduces relationship conflict (Byrne, 1971). Evidence has suggested that socialization effects occur most strongly in same-sex and strongly connected dyads (Dishion & Tipsord, 2011; R. J. Rose, Kaprio, Williams, Viken, & Obremski, 1990; Rowe & Gulley, 1992; Slomkowski, Rende, Novak, Lloyd-Richardson, & Niaura, 2005; Trim, Leuthe, & Chassin, 2006; Wallace, 2015). This symmetrical convergence process would result in increasing similarity and positive partner effects. In addition, it would result in negatively correlated change if dyad members tend to converge toward their average trait level (i.e., higher-scoring dyad members decrease whereas lower-scoring dyad members increase). Alternatively, it might also result in positively correlated change if dyad members are initially very similar and tend to establish new norms (as occurs for example in deviancy training; Dishion & Tipsord, 2011).

Finally, in addition to personality transactions between individuals, similarity in personality trajectories (i.e., positively correlated change) might also emerge from shared environmental experiences, given that these have uniform influences on dyad members' personality traits (Caspi, Herbener, & Ozer, 1992). Examples of shared experiences among friends or siblings are exposure to the same parents or teachers, joining the same sports team, and witnessing similar levels of neighborhood violence.

Previous research provides some evidence to suggest that friends and siblings might codevelop on Big Five personality traits, particularly during adolescence. Previous research has found that adolescents are particularly susceptible to peer influences (e.g., Berndt, 1979; Gardner & Steinberg, 2005; Smith, Steinberg, Strang, & Chein, 2015). Furthermore, friends have been shown to influence each other's behaviors (e.g., aggressive behavior), affect (e.g., negative emotionality), and motives (e.g., motivation for educational achievement; e.g., Dishion & Tipsord, 2011; Hogue & Steinberg, 1995; Ojanen, Sijtsema, & Rambaran, 2013; Ryan, 2000). Moreover, although growing up together in a shared home environment has been found to be unrelated to personality trait levels in adulthood (Bouchard & Loehlin,

2001), it has often been suggested that older siblings act as important socializing agents (Brody et al., 1985; McHale, Updegraff, & Whiteman, 2012; Whiteman, Bernard, & Jensen, 2011; Zukow, 1989). Indeed, one study has found that changes in some personality traits are positively correlated among siblings (Branje et al., 2004), and genetically-informed studies have found evidence for sibling influence regarding delinquency, substance use, weight gain, and neuroticism (McCaffery et al., 2011; R. J. Rose et al., 1990; Slomkowski et al., 2005; Wallace, 2015). In conclusion, there is evidence for social influences among adolescent friends and siblings with respect to various behaviors and traits, which suggests that they may also influence each other's Big Five personality trait trajectories.

To summarize, compared to adulthood, relatively little is known about personality trait stability and change in adolescence, especially with regard to the sources of individual differences in change. Theory and empirical studies suggest that these individual differences may at least partly be accounted for by individual differences in their friends' and siblings' personality development. However, to date, there is only preliminary and indirect evidence to support this prediction.

The Present Study

The present study focused on the general shape and conditions of Big Five personality trait development in adolescence by using data from two large and partly overlapping cohorts of Dutch adolescents, which contain six to seven waves of longitudinal personality data each. Our first goal was to provide a detailed description of the one-year rank-order stability and mean levels of Big Five personality traits from early adolescence (age 12) through early adulthood (age 22). We predicted that the rank-order stability of all Big Five traits increases with age and that most traits exhibit U- or J-shaped mean-level change (i.e., mean-level stability or a decrease in early adolescence followed by a mean-level increase in late adolescence and early adulthood). Our second goal was to estimate the magnitude of individual differences in adolescents' personality trait change. Our third goal was to examine whether the personality trait trajectories of adolescent friends or siblings were interrelated. We predicted increasing personality trait similarity across relationship duration, positively correlated change, and positive time-lagged partner effects. Fourth, in order to explore potential boundary conditions of codevelopment, we examined the effects of several potential moderators. We predicted that codevelopment would be most pronounced in same-sex dyads and dyads with higher perceived relationship quality, and that older dyad members produced stronger partner effects than younger dyad members. We also explored whether the degree of codevelopment differed between male dyads and female dyads.

Method

Participants and Research Design

The participants in this study were drawn from the Research on Adolescent Development and Relationships (RADAR) study. RADAR is an ongoing prospective cohort-sequential study of Dutch-speaking families in the Netherlands, including target adolescents (aged 13-18), their parents, one sibling, and the target adolescents' self-nominated best friend. Between 2005 and 2012, data were collected in two cohorts. In the present study, we analyzed the self-reported personality data from the target adolescents, their friend, and their sibling from all waves available at the time of analyzing the data (i.e., seven and six annual measurement waves in the younger and older cohort, respectively). At the first measurement occasion, participants in the younger cohort were 13.5 years old (*SD* = 1.8); participants in the older cohort were 16.5 years old (*SD* = 1.8). The younger cohort contains personality data from 681 target adolescents (six adolescents did not provide personality data) and the older cohort contains personality data from 239 target adolescents (five adolescents did not provide personality data). Siblings (*n* = 649) and friends (*n* = 705) of these target adolescents participated in all but the last wave in the two cohorts. In total, personality data from 1,128 boys (50.6%) and 1,102 girls (49.4%) were used in our analyses (*N* = 2,230). We created age groups based on the participants' age in years. Table 2.1 provides an overview of the combined sample sizes per age category.

Table 2.1. Sample size and proportion of missing data per age category (used to model rank-order and mean-level stability and change)

	Age										
	12	13	14	15	16	17	18	19	20	21	22
Boys	338	587	651	700	791	775	502	435	351	123	120
Girls	287	506	567	624	761	739	540	489	405	130	165
Total	625	1093	1218	1324	1552	1514	1042	924	756	253	285
Missing data	.72	.51	.45	.41	.30	.32	.53	.59	.66	.89	.87

In the younger cohort, target adolescents who were at risk of developing delinquent behaviors were oversampled. In an initial survey one year earlier, teacher ratings of 3,237 children's externalizing behavior were collected. Children with a score at or above the borderline clinical range (i.e., externalizing T-scores ≥ 60) were oversampled in a subsequent selection such that 284 (41%) target adolescents from the younger cohort had a T-score ≥ 60, whereas 16% of the larger initial sample had a T-score ≥ 60. Compared to control families, families of 'at-risk' adolescents had a lower SES and more often reported that one of the parents had left the household. Furthermore, at-risk target adolescents had lower mother-reported relationship quality, more mental health problems, and more self- and parent-reported behavioral problems than control group adolescents, with effects around

medium size (Van Lier et al., 2011). Families were only enrolled after the mother, the father, the target adolescent, as well as a sibling (≥ 10 years of age) agreed to participate for five years. The majority (73.6%) of the participants listed Dutch as their main ethnic identity; the largest non-Dutch ethnic identity was Moroccan (20.4%). Participants and their parents had a higher socio-economic status than the general Dutch population (for more information about the sample and sampling procedure, see Keijsers et al., 2012; Van Lier et al., 2011).

At each measurement occasion, target adolescents could nominate at most one friend and one sibling to participate in the study. Of the 920 target adolescents in RADAR, 218 (23.7%) did not have a friend who participated in the study, 306 (33.3 %) had one friend, and 407 (44.2%) had more than one friend participating across the different waves. Furthermore, 282 (30.7%) target adolescents did not have a participating sibling, 625 (67.9%) had one participating sibling, and 24 (2.6%) had multiple participating siblings across the different waves. In case of multiple participating friends or siblings per target adolescent, we retained only the responses of the most frequently participating friend or sibling. We identified ten friends who were nominated by two target adolescents; only the duplicate case that participated the longest in the study was retained in the data. Thus, we analyzed personality development of at most one friend and one sibling per target adolescent. In total, we analyzed codevelopment in 662 friendship and 631 sibling dyads.

Dropout and missing data. In Wave 4, dropout rates among target adolescents were 6% in the older cohort and 16% in the younger cohort. Dropout rates increased to 12% in Wave 6 in the older cohort and to 40% in Wave 7 in the younger cohort (which was largely due to discontinued sampling of Dutch-Moroccan adolescents after Wave 5). Most siblings (86%) and almost half of the friends (45%) participated at least five years (Table 2). Dropouts (i.e., those respondents who participated in the first wave but not in the last wave of their cohort; n = 610) differed from continued participators (n = 1,355) in their Wave 1 Big Five levels only with respect to openness and conscientiousness. Compared to continued participators, dropouts scored slightly lower with respect to openness (t(937.29) = 3.18, p = .002, d = .18) and slightly higher with respect to conscientiousness (t(1008.60) = -2.32, p = .020, d = .13). Table 2.1 shows that the cohort-sequential design, variable friendship nominations, and dropout resulted in large percentages of missing data, ranging between 30% (age 16) and 89% (age 21) missing data across age categories. In the younger cohort, personality data were largely missing in older age groups (age > 20), whereas in the older cohort, personality data were largely missing in younger age groups (age < 16).

Procedures

Participants from the younger cohort were recruited from randomly selected elementary schools in the western and central regions of the Netherlands. Participants from the older

cohort were recruited from various high schools located in the central-region province of Utrecht. Before participating, participants received written information about the aims of the study and parents provided informed consent of all participating family members. Participants were annually interviewed at home by trained interviewers (Keijsers et al., 2012; Van Lier et al., 2011). Participating families received €100 (equivalent to US $104) for each home visit. The RADAR study has been approved by the Medical Ethical Testing Committee of the Utrecht University Medical Centre (protocol number 05-159/K; "RADAR: Research on Adolescent Development and Relationships").

Measures

Personality. Personality traits were measured using the shortened Dutch version of Goldberg's Big Five questionnaire (Vermulst & Gerris, 2005). This questionnaire contains 30 adjectives – six per personality dimension – such as "creative" (openness), "systematic" (conscientiousness), "talkative" (extraversion), "sympathetic" (agreeableness), and "worried" (emotional stability, reverse coded). The participants indicated on a Likert scale ranging from 1 (*completely untrue*) to 7 (*completely true*) to what extent the adjectives described their own personality. Previous studies have shown that this instrument has adequate reliability and validity when administered among adolescents (Klimstra et al., 2009). Reliability was estimated using coefficient alpha (Cronbach, 1951). Reliability tended to increase with age. The range of coefficient alphas across ages 12 to 22 was as follows: openness (.68 – .82); conscientiousness (.81 – .92); extraversion (.75 – .91); agreeableness (.78 – .86); and emotional stability (.78 – .86).

Relationship quality. Perceived relationship quality was measured using eight items from the Support scale of the Network of Relationship Inventory (Furman & Buhrmester, 1985). Target adolescents, friends, and siblings reported their perceived degree of support in their dyadic relationships with each other on a 5-point Likert scale (1 = *little or none*; 5 = *could not be more*). A sample item is "How much does your best friend/brother/sister really care about you?" Reliability was high across raters and age categories, with coefficient alphas ranging from .83 to .91. For each dyad, we computed the mean relationship quality score across dyad members and across waves. Averaging the scores across waves and between dyad members was justified by the sufficiently high stability of scores over time (one-year stability correlations ranged from r = .60 to r = .76), and the sufficiently large correlations between the aggregated scores of dyad members (r = .49 between friends and r = .50 between siblings). The double-aggregated mean relationship quality scores were approximately normally distributed in friendship dyads (n = 704, M = 3.36; SD = 0.49) and sibling dyads (n = 648, M = 3.19; SD = 0.49).

Statistical Analyses

We briefly describe the most important steps of our statistical analyses. We refer readers to the supplemental materials for more details, explanation, and example syntax for each type of model. Table S2.1 in the supplemental materials shows the *M*s and *SD*s of the manifest personality variables in each age category.

We used latent variables in order to correct for measurement error. Therefore, stability and change in the rank-order stability and mean levels of personality traits are not confounded with temporal change in measurement reliability. Moreover, the use of latent variables allowed us to test and correct for possible lack of measurement invariance across age categories, genders, and cohorts. Measurement invariance indicates that the same construct is being measured across different groups (McArdle, 2009). We created three parcels (i.e., combined items that are used as observed variables) from the six items per trait via the item-to-construct balance technique (Little, Cunningham, Shahar, & Widaman, 2002). The main analyses were conducted by means of the *lavaan* (0.5-20) package (Rosseel, 2012) in R (3.2.3). We used full information maximum likelihood estimation to handle missing data. Because our analyses were exploratory rather than confirmatory, we conducted two-tailed tests.

Rank-order stability. We estimated the one-year rank-order stability coefficients for each trait and gender group separately across ages 12-22 by means of multiple-group (boys and girls) latent simplex models (Spiel, 1998), henceforth referred to as latent stability models (Figure 2.1). In these structural equation models, between-person personality differences at one age year (e.g., age 16) were regressed on between-person personality differences measured in the previous age year (e.g., age 15). The regression coefficients estimated for each age year the stable variation in personality scores after accounting for measurement error.

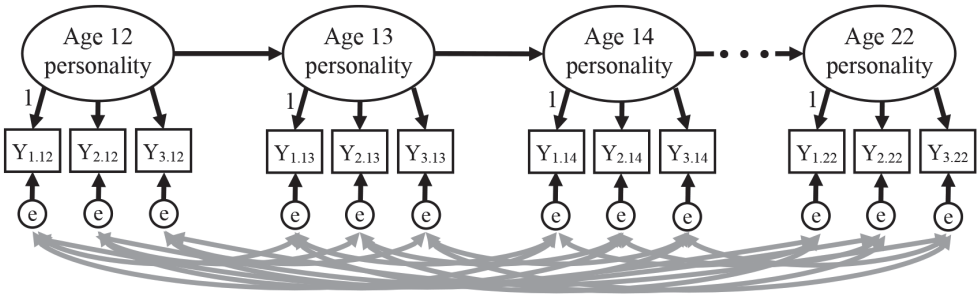

Figure 2.1. Latent stability model, used to estimate stability and change in the one-year rank-order stability in Big Five personality traits between age 12 and 22. Latent variables are shown in ovals; manifest parcels are shown in rectangles, with subscripts indicating the parcel number (i.e., 1, 2, or 3) and the age category (i.e., 12-22) of the manifest personality variable ('Y'). Bi-directional curved arrows indicate that residual terms ('e') of observed variables were allowed to covary. Numerical labels next to arrows represent fixed path coefficients.

Mean-level change and individual differences in change. Mean-level change and individual differences in change were estimated by means of latent growth curve models (LGCMs; Duncan, Duncan, Strycker, Li, & Alpert, 1999) for single personality variables across ages 12-22 (Figure 2.2). In the LGCMs, the mean estimates of the latent intercept and slopes represent the mean personality score at age 17 and the mean rate of linear and quadratic change per year, respectively. The variance estimates of the intercept and two slopes represent the variance of the individual growth trajectories around the mean growth trajectory, and indicate the degree of between-person variability in the individual intercept and slope parameters (i.e., inter-individual differences in personality levels and intra-individual change). We computed standard errors for the LGCM estimates that were corrected for the nested data structure (target adolescents, their friend and their sibling were nested within family household numbers) by means of the R package *lavaan.survey* (Oberski, 2014).

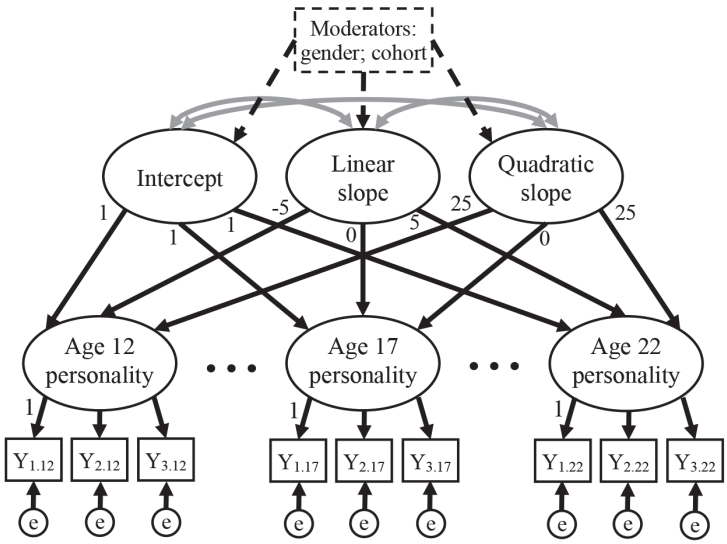

Figure 2.2. Latent growth curve model, used to estimate linear and quadratic mean-level change and individual differences in change in Big Five personality traits between ages 12 and 22. See Figure 2.1 for more explanation.

In order to avoid convergence problems regarding the LGCMs, residual terms of the personality factors were constrained not to covary, personality factor loadings and intercepts were constrained to be equal across time only at ages 15-19, and we did not use a multiple-group analysis for evaluating gender differences. Instead, gender and cohort were regressed on the intercept and two slopes in order to test for gender and cohort differences in growth trajectories. Modelling gender as a predictor of the intercept and slopes instead of a grouping variable had the advantage that all LGCMs converged, but it prohibited the option to

correct for lack of measurement invariance across gender groups. Because we found lack of measurement invariance across gender groups for conscientiousness and emotional stability (see 'Measurement Invariance'), gender differences in the growth trajectories of these traits should be interpreted with caution.

Codevelopment. We centered the personality assessments of each dyad at the first year of available reports by both dyad members. We modelled codevelopment from the first measurement occasion at which both dyad members participated ('observed relationship duration= 0') until (a) the cohort's last measurement occasion, or (b) the last measurement occasion before one or both dyad members dropped out of the study. In other words, we estimated codevelopment across observed relationship duration quantified in years, with zero duration indicating the dyad's first measurement occasion. Table 2.2 provides an overview of the number of dyads included in the data at each relationship duration year.

Table 2.2. Number of dyads (used to model codevelopment)

		Observed relationship duration (years)					
Dyad	Cohort	0	1	2	3	4	5
Friends	Younger	442	407	372	298	221	167
	Older	220	194	155	114	75	-
	Total	662	601	527	412	296	167
Siblings	Younger	424	391	385	376	354	334
	Older	207	201	194	195	191	-
	Total	631	592	579	571	545	334

We tested whether dyadic personality trait similarity changed across relationship duration in two ways. First, we tested whether the strength of the correlation between both dyad members' latent personality traits at zero duration differed between 'pre-existing' friendships that were already present at Wave 1 (n = 466 dyads) and 'newly formed' friendships that were first observed after Wave 1 (n = 196 dyads; 30%). For obvious reasons, this was not tested among siblings. Second, we examined among friends and siblings whether the strength of the associations between both dyad members' latent personality traits significantly changed over relationship duration years. We evaluated this by observing the pattern of correlation coefficients over time and by comparing two nested structural equation models in which the dyadic covariances were either freely estimated, or constrained to be equal across all six relationship duration years.

Furthermore, dyadic LGCMs were used to investigate correlated change and cross-lagged partner effects between target adolescents and their friend / sibling (Figure 2.3). In these models, we estimated separate linear growth trajectories across relationship duration for both dyad members, and allowed their intercepts and slopes to covary. Significant

slope-slope correlations indicated correlated change, whereas significant intercept-slope correlations indicated cross-lagged partner effects in which one dyad member's personality change was predicted by the other dyad member's relative standing on a personality trait at zero observed relationship duration. We also evaluated whether partner effects differed between older and younger dyad members. The average age difference between friends was 0.70 years (*SD* = 1.08) and the average age difference between siblings was 2.97 years (*SD* = 1.29). In all models, we tested codevelopment separately for friends and siblings and for each personality trait. The intercept and slope estimates were controlled for cohort.

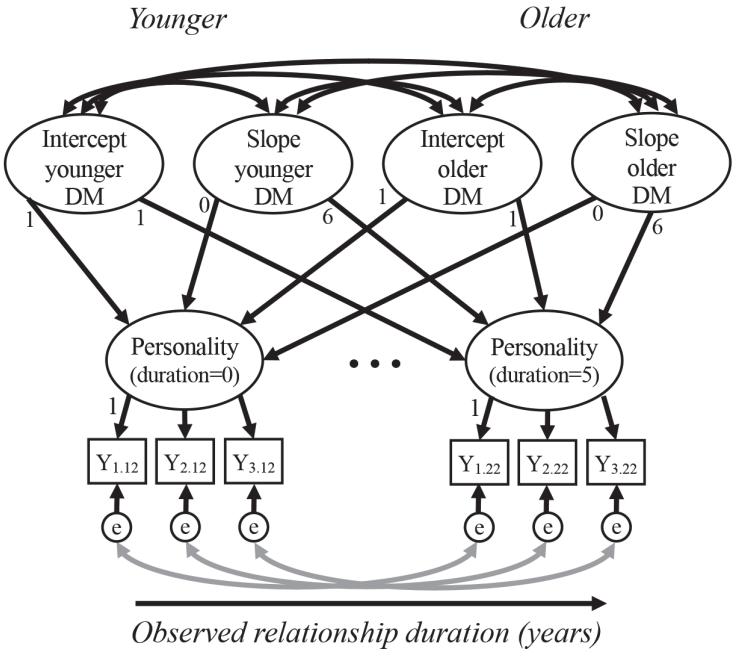

Figure 2.3. Dyadic latent growth curve model, used to estimate Big Five personality codevelopment between younger and older dyad members (DMs) in friendship and sibling relationships. The loadings and intercepts of the personality factors were constrained to be equal across dyad members and relationship duration years. See Figure 2.1 for more explanation.

Hertzog, Lindenberger, Ghisletta, and von Oertzen (2006) evaluated the statistical power to detect correlated change as a function of sample size, number of measurement occasions, and measurement error variance. Their results suggested that we had sufficient power (1 - β = .80) to detect a medium-sized correlation of r = .40.[1]

1 This rough approximation was obtained by inspecting Hertzog et al.'s (2006) statistical power estimation regarding a study with 500 dyads, 5 measurement occasions, and relatively high (.90) growth curve reliability. Choosing for 500 dyads and 5 measurement occasions seemed a fair compromise between (a) the fact that we were able to analyze data

Results

Measurement Invariance

We tested for each personality trait whether parcel loadings and intercepts were invariant across gender groups, age categories, and cohorts in order to evaluate whether the same personality constructs were being measured across different groups. Tables S2.2, S2.3, and S2.4 in the supplemental materials show the results of these analyses.

To summarize, for agreeableness, openness, and extraversion, the data were consistent with scalar invariance across gender groups, as indicated by non-significantly different factor loadings and intercepts between boys and girls. For conscientiousness and emotional stability, the data were partially consistent with scalar invariance across gender groups, as indicated by significant gender differences in some of the intercepts at some age categories. Similarly, the data were consistent with scalar invariance across age categories for openness, emotional stability, and conscientiousness, whereas the data were partially consistent with scalar invariance across age categories for extraversion and agreeableness. Finally, the data were fully consistent with scalar invariance across cohorts for all Big Five traits. Based on these results, we estimated some intercepts freely across gender groups and age categories to allow for a meaningful interpretation of gender and age differences in latent personality variables. These results justified collapsing of data across cohorts as well as interpreting age and gender differences between latent personality scores.

Rank-Order and Mean-Level Stability and Change in Personality Traits

The first goal of this study was to estimate stability and change in the rank-ordering and mean levels of Big Five personality traits from adolescence through early adulthood. Table S2.5 shows that model fit of the latent stability models (CFIs .95 – .98 and RMSEAs .02 – .03) and the LGCMs (CFIs: .82 – .94; RMSEAs: .06 –.03) was generally good, with the exception of the LGCM for openness (CFI = .82; RMSEA = .06).

Rank-order stability. Model comparison tests did not reveal evidence for cohort effects in rank-order stability at age lags 16-17 and 17-18 (where both cohorts overlapped the most). Figure 2.4 shows developmental stability and change in the one-year stability of the five personality traits. Except between age 16 and 17, the average one-year stability of personality traits increased substantially during early and middle adolescence, with standardized one-year rank-order stability coefficients increasing from .68 to .84 between ages 12 and 17. However, in late adolescence and early adulthood (ages 17-22), the stability

from a larger number of dyads (i.e., > 600 at the first measurement occasion) and a larger number of assessment waves (i.e., 6) and (b) the fact that our sample size decreased substantially due to attrition, especially among friends. We assumed that our growth curve reliability was relatively high because in contrast with Hertzog et al.'s (2006) simulations, we used multiple-indicator instead of single-indicator measurement models. Such models account for measurement unreliability, leaving only latent regression residuals to influence the growth curve reliability (Hertzog et al., 2006).

coefficients did not increase further. This pattern was similar in both gender groups. None of the Big Five traits deviated substantially from this aggregated pattern.

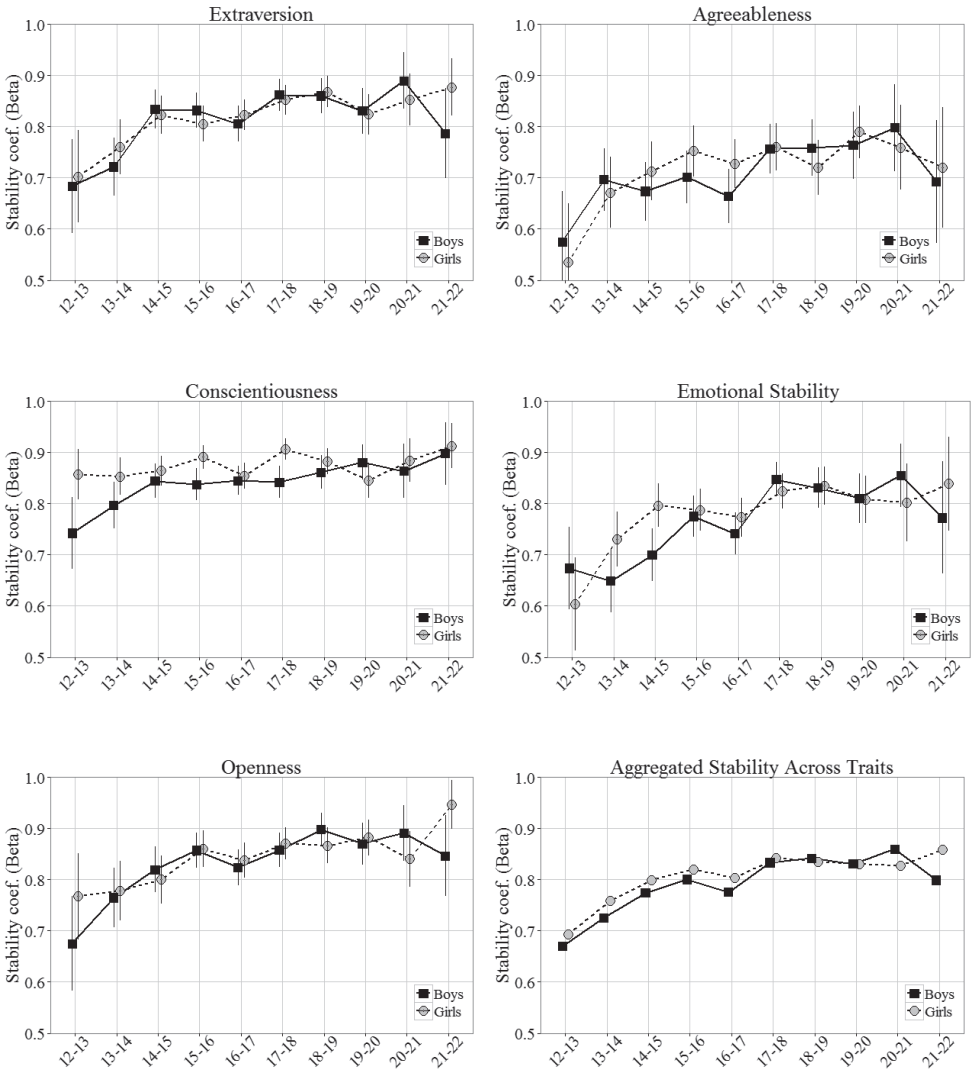

Figure 2.4. Graphical representation of the estimated one-year standardized rank-order stability coefficients (on *y*-axis) and 95% confidence intervals for boys and girls across age years (on *x*-axis).

Mean-level change. The results of the LGCMs estimating mean-level personality change are presented in Table 2.3 and Figure 2.5. Except for agreeableness (see below), there were no statistically significant effects of cohort on the intercept and slopes estimates. In

both genders, extraversion showed a small mean-level decrease in early adolescence followed by a small mean-level increase in late adolescence and early adulthood, although the quadratic slope was marginally significant among boys. Agreeableness increased similarly among both gender groups, but there was a cohort effect on the shape of the mean-level increase. The younger cohort showed a relatively small and linear increase, whereas the older cohort experienced a relatively strong but slightly decelerating increase. Conscientiousness increased substantially and linearly among girls throughout the study period, whereas boys first slightly decreased in early adolescence and then increased in late adolescence and early adulthood. Emotional stability showed no statistically significant linear or quadratic mean-level change among boys, whereas girls' emotional stability decreased during early and middle adolescence and thereafter increased during late adolescence and early adulthood. Openness increased linearly among boys, whereas girls' openness showed an inverse U-shaped mean-level change (i.e., an increase followed by a decrease).

Because the LGCMs did not converge after adding cubic change factors, the mean-level change results were restricted to linear and quadratic shapes. To inspect whether the data showed more complex change patterns, we also compared the LGCM results with the observed mean-levels in each age group (Table S2.1). Both analyses yielded similar results, with a few exceptions for the mean-levels of boys' openness, agreeableness, and extraversion.

Individual Differences in Change

The second goal of this study was to estimate the magnitude of individual variation in personality trait change in adolescence, which is represented by the variance estimates of the linear and quadratic change parameters of the LGCMs (Table 2.3). In the current model specification, in which we used gender as a moderator instead of a grouping variable in order to avoid convergence problems, we were unable to estimate gender differences in variance estimates. However, the results of an alternative multiple-group model showed that gender differences in intercept and slope variances were small.

The results show that individual differences in change were statistically significant for all traits, though the magnitude of these individual differences differed substantially across traits. Slope variance was highest for extraversion, emotional stability, and conscientiousness, somewhat lower for openness, and considerably and statistically significantly lower for agreeableness. To illustrate this difference, Figure 2.6 shows the individual trajectories of boys' conscientiousness, which exhibited high slope variance, and boys' agreeableness, which exhibited the lowest slope variance. These trajectories were based on 500 regression curves that were randomly drawn from a simulated multivariate normal distribution based on the LGCM parameter estimates.

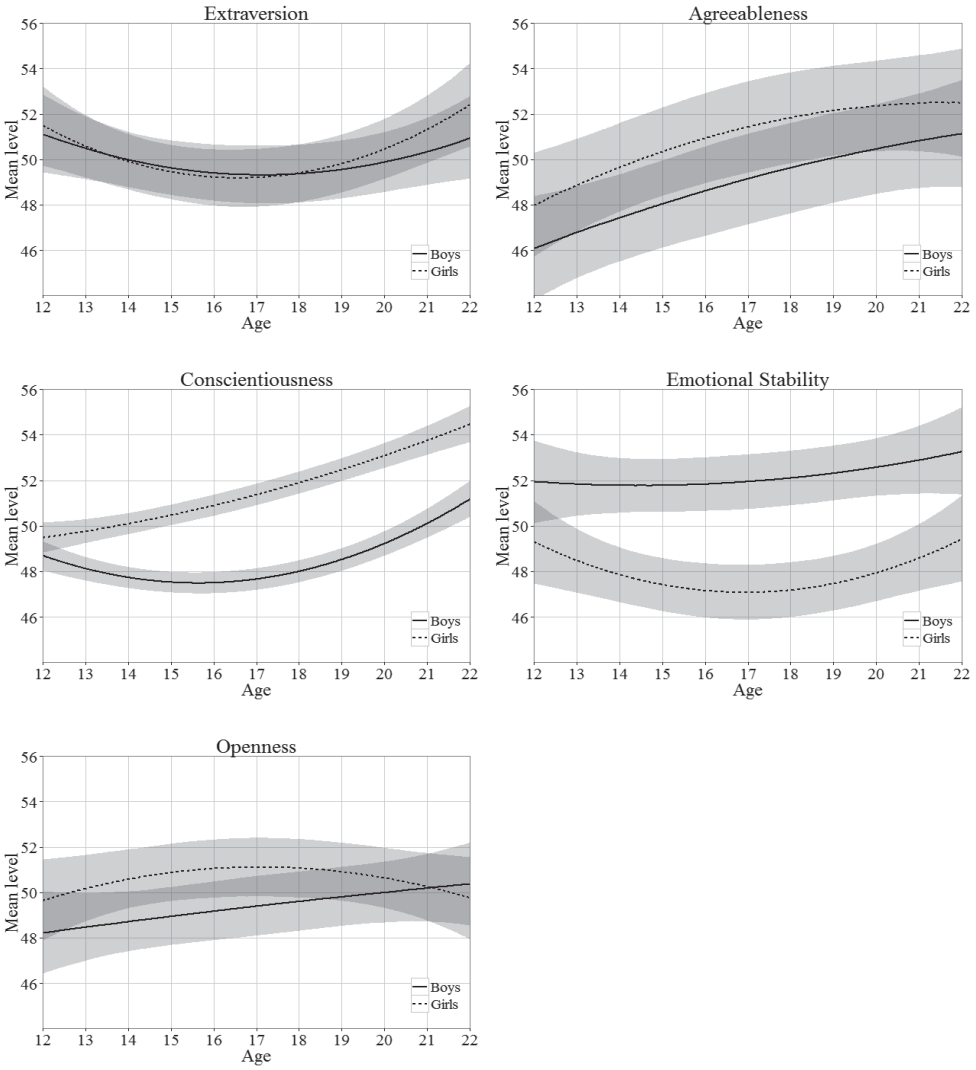

Figure 2.5. Mean-level change and 95% parametric bootstrap confidence intervals in Big Five personality traits across ages 12 to 22 for boys and girls, presented on a T-score metric (standard scores with $M = 50$ and $SD = 10$) to facilitate interpretation of effect sizes. Using Cohen's (1988) rules of thumb, a difference of 2 T-score points represents a small effect, a 5-point difference represents a medium effect, and an 8-point difference represents a large effect.

Table 2.3. Latent growth curve model coefficients (N = 2,230)

		Intercepts (age 17)				Linear slopes				Quadratic slopes			
		Mean		Variance		Mean		Variance		Mean		Variance (×10^{-4})	
Gender	Trait	Est	95% C.I.	Est	95% C.I.	Est	95% C.I.	Est	95% C.I.	Est	95% C.I.	Est	95% C.I.
Boys	E	6.36*	[6.17; 6.55]	1.29*	[1.20; 1.38]	-.002	[-.022; .018]	.017*	[.013; .022]	.009	[-.001; .018]	6.28*	[2.72; 9.85]
	A_y	5.14*	[4.96; 5.32]	0.24*	[0.21; 0.27]	.034*	[.022; .046]	.005*	[.004; .006]	-.001	[-.007; .005]	0.92	[-0.06; 1.91]
	A_o	5.21*	[5.03; 5.39]	0.24*	[0.21; 0.27]	.049*	[.037; .061]	.005*	[.004; .006]	-.006	[-.012; .000]	0.92	[-0.06; 1.91]
	C	3.84*	[3.77; 3.92]	1.22*	[1.14; 1.31]	.033*	[.020; .046]	.018*	[.015; .022]	.012*	[.008; .016]	5.38*	[2.77; 7.99]
	ES	5.71*	[5.53; 5.89]	1.06*	[0.99; 1.14]	.017	[-.003; .037]	.018*	[.013; .022]	.003	[-.007; .013]	6.22*	[2.82; 9.61]
	O	4.83*	[4.65; 5.00]	0.79*	[0.74; 0.84]	.024*	[.008; .040]	.011*	[.009; .014]	.000	[-.008; .008]	5.03*	[3.01; 7.06]
Girls	E	6.34*	[6.15; 6.53]	1.29*	[1.20; 1.38]	.012	[-.008; .031]	.017*	[.013; .022]	.014*	[.004; .023]	6.28*	[2.72; 9.85]
	A_y	5.32*	[5.14; 5.50]	0.24*	[0.21; 0.27]	.029*	[.017; .041]	.005*	[.004; .006]	-.003	[-.009; .003]	0.92	[-0.06; 1.91]
	A_o	5.38*	[5.20; 5.56]	0.24*	[0.21; 0.27]	.044*	[.033; .056]	.005*	[.004; .006]	-.008*	[-.014; -.002]	0.92	[-0.06; 1.91]
	C	4.33*	[4.25; 4.40]	1.22*	[1.14; 1.31]	.066*	[.052; .079]	.018*	[.015; .022]	.003	[-.001; .007]	5.38*	[2.77; 7.99]
	ES	5.09*	[4.91; 5.27]	1.06*	[0.99; 1.14]	.002	[-.018; .022]	.018*	[.013; .022]	.012*	[.002; .022]	6.22*	[2.82; 9.61]
	O	5.02*	[4.85; 5.19]	0.79*	[0.74; 0.84]	.001	[-.015; .017]	.011*	[.009; .014]	-.006	[-.014; .002]	5.03*	[3.01; 7.06]

Note. E = extraversion; A_y = agreeableness in the younger cohort; A_o = agreeableness in the older cohort; C = conscientiousness; ES = emotional stability; O = openness; 95% C.I. = 95% confidence intervals; * $p < .05$. Underlined coefficients indicate statistically significantly gender differences ($p < .05$). Cohort-specific estimates for agreeableness are shown because of a statistically significant cohort difference in mean intercept and slope estimates.

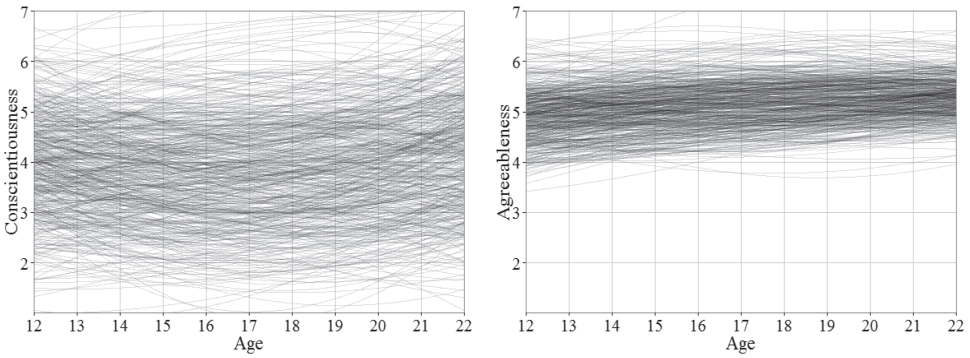

Figure 2.6. Graphical representation of the magnitude of individual differences in boys' personality trait change in conscientiousness and agreeableness. The regression curves represent development of individuals across age. Regression curves (N = 500) were drawn from a simulated multivariate normal distribution based on the parameter estimates presented in Table 2.3.

Dyadic Personality Trait Codevelopment

The third goal of this study was to test whether the personality trait changes of adolescent dyad members in friendship and sibling relationships were interrelated.

Trait similarity across relationship duration. We first investigated whether personality traits were correlated among dyad members and whether the strength of the correlations changed across relationship duration. Table 2.4 shows the estimated correlations between dyad members' latent personality traits at each relationship duration year. The personality traits of dyad members tended to be positively but weakly correlated among siblings and among friends. We found no evidence for similarity with respect to siblings' conscientiousness.

Table 2.4 also shows that for most traits, dyadic similarity tended to remain rather stable over time. Except for decreases in the similarity of friends' extraversion and siblings' openness, there appeared to be no systematic increases or decreases of similarity across relationship duration. We conducted model comparison tests for each trait and type of dyad in order to test whether the degree of similarity significantly varied across relationship duration years (df = 5). All ten model comparison tests revealed no significant differences in model fit, suggesting that dyadic personality trait similarly did not significantly vary over time.

In addition, the strength of the correlations between friends' personality traits was not significantly different between dyads that were already formed at Wave 1 and dyads that were first reported after Wave 1 and hence may represent relationships with a shorter history. The results were marginally significant with respect to emotional stability and openness,

Table 2.4. Personality trait correlations between adolescent dyad members across observed relationship duration years

	Personality trait										
	Extraversion		Agreeableness		Conscientiousness		Emotional stability		Openness		Mean
Duration	Friends	Siblings	Friends	Siblings	Friends	Siblings	Friends	Siblings	Friends	Siblings	
0	.14 (.04)*	.09 (.05)	.15 (.05)*	.08 (.05)	.18 (.04)*	.01 (.04)	.14 (.04)*	.18 (.05)*	.02 (.05)	.11 (.05)*	.11
1	.15 (.05)*	.07 (.05)	.17 (.05)*	.14 (.05)*	.23 (.04)*	.08 (.05)	.09 (.05)*	.04 (.05)	.11 (.05)*	.17 (.05)*	.13
2	.15 (.05)*	.13 (.05)*	.19 (.05)*	.06 (.05)	.17 (.04)*	.06 (.05)	.05 (.05)	.16 (.05)*	.08 (.05)	.14 (.05)*	.12
3	.07 (.05)	.04 (.05)	.13 (.06)*	.05 (.05)	.16 (.05)*	.00 (.04)	.10 (.05)	.07 (.05)	.08 (.05)	.09 (.05)	.08
4	.06 (.06)	.10 (.05)*	.13 (.06)	.12 (.05)*	.18 (.06)*	.05 (.05)	.09 (.06)	.08 (.05)	.03 (.06)	.09 (.05)	.09
5	-.01 (.08)	.05 (.06)	.23 (.08)*	.10 (.06)	.17 (.07)*	.09 (.05)	.17 (.08)*	.14 (.06)*	.18 (.08)*	.04 (.06)	.12
Mean	.09	.08	.17	.09	.20	.05	.10	.11	.08	.11	.11

Note. * $p < .05$. Standard errors in parentheses.

but the group differences were not in line with our convergence hypothesis: Similarity was higher among 'new friends' than among already existing friends. In summary, we found no evidence for increasing or decreasing dyadic personality trait similarity over time.

Correlated change and partner effects. Second, we fitted dyadic LGCMs in order to investigate whether the linear personality trait trajectories of dyad members were interrelated (i.e., correlated slopes) and whether higher relative trait levels at zero observed relationship duration of one dyad member predicted the direction of change in the other dyad member (i.e., intercept-slope correlations). Table S2.6 shows that all models fitted the data well (CFIs ≥ .95; RMSEAs ≤ .05). We used the Holm-Bonferroni correction to address multiple hypothesis testing, thus testing at α = .005 given ten tests (Table 2.5).

Table 2.5. Dyadic latent growth curve model intercept (I) and slope (S) correlations among younger and older adolescent dyad members.

		$r(I_{younger}, I_{older})$		$r(S_{younger}, S_{older})$		$r(I_{younger}, S_{older})$		$r(I_{older}, S_{younger})$	
Dyad	Trait	Est.	95% C.I.	Est.	95% C.I.	Est.	95% C.I.	Est.	95% C.I.
Friends	E	.19*	[.09; .29]	-.10	[-.33; .14]	.00	[-.16; .16]	-.06	[-.24; .13]
	A	.19*	[.08; .31]	.11	[-.16; .38]	-.21†	[-.42; -.00]	.03	[-.14; .21]
	C	.21*	[.12; .31]	.21	[-.01; .43]	-.05	[-.21; .11]	-.04	[-.20; .11]
	ES	.14†	[.04; .24]	-.06	[-.28; .16]	.04	[-.12; .20]	-.03	[-.19; .14]
	O	.06	[-.04; .17]	.16	[-.10; .43]	-.03	[-.21; .16]	.01	[-.17; .19]
Siblings	E	.13†	[.03; .23]	-.04	[-.25; .17]	-.10	[-.27; .07]	.06	[-.08; .19]
	A	.10	[-.02; .22]	.04	[-.19; .27]	.03	[-.15; .21]	.02	[-.14; .18]
	C	.05	[-.04; .15]	.06	[-.11; .23]	-.05	[-.18; .08]	.06	[-.06; .19]
	ES	.18*	[.07; .29]	.06	[-.14; .25]	-.04	[-.19; .11]	-.03	[-.18; .12]
	O	.20*	[.09; .30]	.10	[-.11; .31]	-.22†	[-.39; -.06]	.00	[-.14; .15]

Note. $r(I_{young}, I_{old})$ indicates the correlations between the younger and older dyad members' personality traits at the dyads' first measurement occasion; $r(S_{young}, S_{old})$ indicates the correlation between both dyad members' linear personality trait change; $r(I_{young}, S_{old})$ indicates the correlation between the younger dyad members' intercept and the older dyad members' slope; $r(I_{old}, S_{young})$ indicates the correlation between the older dyad members' intercept and the younger dyad members' slope; † $p < .05$; * $p < .005$ (Bonferroni-corrected α).

In line with the previous correlational analysis, we found evidence for a small degree of initial similarity (i.e., intercept-intercept correlations) between friends with respect to conscientiousness, extraversion, and agreeableness. Among siblings, we found evidence for a small degree of initial similarity regarding openness and emotional stability. Contrary to our predictions, we found no evidence for correlated change or partner effects. None of the slope-slope and intercept-slope associations were statistically significant after applying the Holm-Bonferroni correction. Moreover, all 30 effect sizes testing codevelopment were small in magnitude (rs < |.21|; $M|r|$ = .07). Thus, adolescents' personality trait change

was not significantly predicted by their friend's or sibling's personality trait change in the same period, nor by their friend's or sibling's relative standing on a personality trait at the intercept.[2]

Moderating effects of differences in age, relationship quality, and gender. Finally, we explored the moderating effects of (1) an age difference and (2) a gender difference within dyads, and (3) a perceived relationship quality difference and (4) a gender difference between dyads. First, in order to evaluate the potential moderating effect of an age difference within dyads, we tested whether the partner effect (i.e., intercept-slope association) of older dyad members on younger dyad members was different from the partner effect of younger dyad members on older dyad members. Constraining the two partner effects to be equal did not significantly affect the model fit for any of the five traits. This suggested that the partner effects of older dyad members were not significantly different from the partner effects of younger dyad members.

Second, in order to evaluate the moderating effect of a gender difference within dyads, we tested whether same-sex dyads differed from different-sex dyads with respect to the strength of the intercept-intercept, slope-slope, and two intercept-slope associations. We tested this only in sibling dyads because friends were usually (95%) of the same sex. For the Holm-Bonferroni corrected $\alpha = .010$, model comparison tests did not reveal evidence for a gender difference, suggesting that initial similarity and codevelopment were not significantly different between same-sex and different-sex sibling dyads.

Third, in order to evaluate the moderating effect of a relationship quality difference between dyads, we tested whether the intercept-intercept, slope-slope, and two intercept-slope associations were moderated by the dyads' aggregated level of perceived relationship quality. We used a median split to construct two groups with high vs. low relationship quality. We did not find significant differences between the two relationship quality groups, suggesting that the magnitude of initial similarity and codevelopment was not significantly different between high and low relationship quality dyads.

Fourth, in order to evaluate the moderating effect of a gender difference between dyads, we tested whether male dyads differed from female dyads with respect to the strength of the intercept-intercept, slope-slope, and two intercept-slope associations. We tested this in subsamples of same-sex friends ($n = 631$; 95% of the friendship dyads) and same-sex siblings ($n = 319$; 51% of the sibling dyads). Using the Holm-Bonferroni corrected $\alpha = .005$, we did not find evidence for a gender difference in initial similarity and codevelopment.

2 We also estimated a series of autoregressive cross-lagged panel models across six relationship duration years to provide an alternative test for codevelopment over annual assessment waves. Specifically, we compared nested models in which ten partner effect parameters and five correlated change parameters between dyad members were either fixed to zero or freely estimated (i.e., $df = 15$). We used the Holm-Bonferroni correction to correct for potential α inflation due to multiple testing (corrected $\alpha = .005$). Consistent with the results of our dyadic LGCM analyses, these models did not provide evidence for codevelopment among friends or siblings.

Discussion

Compared to early adulthood, little is known about the general shape and conditions of personality trait development in adolescence. Using data from two partly overlapping cohorts, the present study investigated (1) rank-order and mean-level stability and change in Big Five personality traits from adolescence through early adulthood, (2) individual differences in change, and (3) personality trait codevelopment in adolescent friendship and sibling dyads. To summarize, the results of the present research suggest that adolescents tend to become more stable in their ranking on personality trait dimensions and tend to grow linearly or curvilinearly (i.e., U-shaped) in the direction of greater psychological maturity (as defined by growing conscientiousness, agreeableness, and emotional stability). Furthermore, adolescents differed substantially with respect to their personality trait trajectories, but these individual differences in change were not related to the personality trajectories of their friends and siblings.

Rank-Order Stability and Change in Personality Traits

We found that the one-year rank-order stability of Big Five traits increased substantially in early and middle adolescence. Notably, these changes occurred even though the present rank-order stability estimates at age 12 were already larger than those that have been typically found among children, adolescents, and young adults (cf. Roberts & DelVecchio, 2000). By contrast, rank-order stability levels appeared not to increase further in late adolescence and early adulthood. These findings bear at least two important implications. First, the strongly increasing rank-order stability in early adolescence suggests that this is a particularly important formative period in adolescence because rank-order differences are still relatively fluid compared to later phases in adolescence, but are quickly becoming more stable during this period. It therefore seems valuable to study potential sources of stability and change in-depth in this age period. Second, our findings suggest that there may be periods in adolescence that deviate from the cumulative continuity principle of increasing rank-order stability.

Genetically informed longitudinal studies have found that the observed increases in personality trait stability can be traced back to increases in the stability of environmental influences on personality, rather than to increases in genetic stability (for a review and meta-analysis, see Bleidorn, Kandler, & Caspi, 2014; Briley & Tucker-Drob, 2014). Future research is needed to identify the most important environmental factors that exert increasingly stable influences on personality traits across early and middle adolescence. Promising candidate factors are increases in the stability of social relationships (Hardy, Bukowski, & Sippola, 2002), identity maturation (Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2010), and decreasing gene activity or brain development in areas related to

personality traits (Mills, Lalonde, Clasen, Giedd, & Blakemore, 2014). Such factors may contribute to increasingly consistent situational experiences during adolescence, which likely promotes personality consistency (Roberts et al., 2008).

Mean-level Stability and Change in Personality Traits

Our results regarding normative personality trait changes partly fit the maturity principle, which holds that young adults experience mean-level increases in agreeableness, conscientiousness, and emotional stability, and partly fit the disruption hypothesis, which posits that adolescents experience a temporal dip in these traits. In line with the maturity principle, we found that throughout adolescence and early adulthood, boys and girls showed increasing agreeableness and girls showed increasing conscientiousness. Consistent with the disruption hypothesis, we found temporal declines in boys' conscientiousness and girls' emotional stability. In general, our results are partly consistent with a meta-analysis (Denissen, Van Aken, Penke, et al., 2013) and two large-scale cross-sectional studies among North Americans (Soto, 2016; Soto et al., 2011), which found evidence for U-shaped mean-level changes in conscientiousness, openness, and emotional stability during adolescence. Our mean-level results are particularly consistent with a similar cohort-sequential study among Dutch adolescents (Klimstra et al., 2009), which suggests that results replicate well among studies that use similar methods and investigate similar populations.

The substantial mean-level increases in conscientiousness and agreeableness may be rooted in the continuous improvements in effortful control in childhood (Shiner, 2015) and may be driven by further increases in self-regulation capacity in adolescence (Casey et al., 2008) and early adulthood (Jensen-Campbell et al., 2002). More generally, Denissen, Van Aken, Penke, et al. (2013) have proposed that personality maturation among adolescents may be indirectly driven by increasing expectations concerning adolescents' behavior, thoughts, and feelings, and directly by incremental practice of self-regulatory mechanisms to meet these expectations. According to this account, the temporal dips in maturity may be partly explained by a temporary mismatch between external expectations and adolescents' actual behavior, affect, and cognition (Denissen, Van Aken, Penke, et al., 2013). One may indeed expect that parents and teachers stimulate conscientious behaviors (e.g., doing homework) and agreeable behaviors (e.g., being kind) more than, for example, extraverted behaviors (e.g., being talkative), for which we found no mean-level increase. Consistent with the idea that personality maturation is driven by incremental practice, one study found that investment in scholarly goals mediated conscientiousness increases among hi-schoolers that approached graduation (Bleidorn, 2012).

In addition, one could argue that personality trait maturation in late adolescence is driven by increasingly mature expectations among adolescents themselves. Early adolescents might be more concerned with getting along and getting ahead among peers than with

aiming to meet adult expectations (Harris, 1995; Hawley, 2006). For example, sloppy, careless, insensitive, or antisocial behaviors, which are indicative of low conscientiousness and agreeableness, may be more accepted among early adolescent peers than among late adolescent peers. Future research may investigate whether personality maturation in adolescence is mainly driven by increasingly mature expectations from adults, peers, or themselves, by social role transitions, or by other mechanisms, including biological processes such as growth in the prefrontal cortex that might underlie increases in self-regulatory capacity (Casey et al., 2008).

Individual Differences in Personality Trait Change

How well do mean-level changes describe the personality trait changes of individuals? We found that individual differences in change were relatively small in magnitude for agreeableness, but substantial for extraversion, conscientiousness, and emotional stability. This suggests that the average trajectory in agreeableness provides an accurate summary for the change in most individuals, whereas the average trajectories in extraversion, conscientiousness, and emotional stability provide less accurate descriptions for individuals' change in these traits.

The relatively homogeneous increase in agreeableness could be explained by the presence of a norm regarding agreeable behavior that (a) changes gradually from adolescence through early adulthood, (b) is shared among many adolescents (i.e., is not limited to a few social groups), and (c) is relatively easily to follow (Hennecke, Bleidorn, Denissen, & Wood, 2014; Wood & Wortman, 2012). By contrast, the large individual differences in change in conscientiousness, extraversion, and emotional stability suggests that adolescents do not adhere to general norms regarding these traits. Alternatively, they might differ in their capacity to keep up with these norms, or they tend to adhere to different, socially stratified norms.

Dyadic Personality Trait Similarity and Codevelopment

The idea that personality change may be clustered among dyad or peer group members was addressed in our analyses of codevelopment. Our results indicated that dyadic personality trait similarity among friends and among siblings did not systematically change over time and that adolescents' linear personality trait trajectories could not be predicted by their best friend's or sibling's initial trait level or linear trajectory in the same period. Thus, we found no evidence for our hypothesis that personality trajectories among best friends and among siblings are systematically interrelated. This finding is consistent with previous studies that found no personality trait codevelopment among college students (Anderson, Keltner, & John, 2003; Selfhout, Denissen, Branje, & Meeus, 2009) and among interacting dyads that were sampled in public spaces (Bahns, Crandall, Gillath, & Preacher, 2017).

However, we did find evidence for a small degree of dyadic personality trait similarity. We found evidence for similarity with respect to openness and emotional stability among siblings, and with respect to conscientiousness, extraversion, and agreeableness among friends. Among siblings, the observed similarity may have partly resulted from genetical resemblance (Bleidorn et al., 2014; Bouchard & Loehlin, 2001). Previous studies suggested that personality trait similarity among friends reflects selection effects (Selfhout et al., 2010; Selfhout, Branje, & Meeus, 2007; M. Van Zalk & Denissen, 2015) and that similarity is most important in the early stages of a relationship (Bahns et al., 2017). Alternatively, personality similarity may have been produced by unmeasured previous socialization effects or by a confounding factor. Overall, this pattern seems to imply that personality similarity may only be a criterion in the phase of friendship formation, and that friendship retention likely depends on other processes (e.g., mutual support and self-disclosure). Adolescent friends appeared to change independently from each other in their personality traits during this friendship retention phase, regardless of friendship quality and gender. It is important to note that this conclusion only applies to change in Big Five personality traits. It may very well be that other personality characteristics, such as self-esteem or motives, are more prone to dyadic social influence processes.

The lack of evidence for dyadic codevelopment leads us to conclude that shared experiences between friends or siblings (e.g., shared exposure to a peer group norm or parenting style) have either no significant effect on personality trait change in adolescence, or they exert idiosyncratic influences that are unique to each person in a dyad. This inference is inconsistent with Harris' (1995) group socialization theory of personality development, which proposed that peer group identification plays an important role in adolescents' personality development. To the extent that friends or siblings tend to belong to the same peer group, this identification process would have resulted in positively correlated change.

Strengths and Limitations

The design of the present study is unique because it encompasses the period of early to late adolescence (ages 12-22), contains up to seven longitudinal personality measurements per individual, and tracks year-to-year changes in personality traits. Other important strengths of this study are its large sample size (containing over 1,500 respondents in middle adolescence), the inclusion of adolescents' friends and siblings (allowing us to investigate codevelopment), and the use of advanced statistical techniques. However, we also notice some limitations.

First, the sample did not include the period of childhood and the earliest years of adolescence (i.e., ages 10 and 11). This omission prevented a replication of the often-found mean-level decreases in personality traits during early adolescence (Denissen, Van Aken, Penke, et al., 2013; Durbin et al., 2015; Soto, 2016; Soto et al., 2011). Future studies may include the transition from childhood to adolescence.

Second, we used a relatively short Big Five questionnaire that contained only six items per trait, which prohibited a finer-grained analysis of codevelopment at the level of lower-order facets. Based on previous research, one may predict that dyad members show codevelopment on facets related to deviant behaviors (Dishion & Tipsord, 2011), negative emotionality (Hogue & Steinberg, 1995; N. van Zalk, Van Zalk, Kerr, & Stattin, 2011), and motivational constructs (Ojanen et al., 2013; Ryan, 2000).

Third, we did not find evidence for partner effects or correlated change, though our findings indicate that dyad members tended to maintain their similarity over time. Caspi, Herbener, and Ozer (1992) argued that the mere maintenance of dyadic similarity over time requires codevelopment. Because of the imperfect rank-order stability of personality traits, initial dyadic similarity should slowly deteriorate over time in the absence of partner effects or correlated change. Our statistical power might have been insufficient to detect the small degree of codevelopment that might has maintained dyadic similarity over time.

Fourth, our dyadic growth curve model was restricted to estimate codevelopment in a linear fashion and across multiple years. However, codevelopment might occur in a more complex fashion or in a shorter time frame. In addition, opposing processes such as convergence within some dyads and divergence within others might have cancelled each other out in the aggregate, masking differential codevelopment that occurred among subgroups of dyads. Future research might use a different methodological or statistical approach, such as the modeling of codevelopment across shorter periods (e.g., months or weeks).

Finally, although we tested the role of several potential moderators of codevelopment (i.e., relative age, relationship quality, and gender constellations), our scope of moderating variables as well as the statistical tools we used to test them were limited. For example, we compared codevelopment parameters between two relationship quality groups based on a median split, thus ignoring potentially important temporal and dyad member-specific variance in relationship quality. Future research may investigate the moderating role of additional individual difference variables such as self-esteem (M. van Zalk and Van Zalk, 2015), popularity, and self-control (Dishion & Tipsord, 2011). In addition, future research might measure participants' subjective trait desirability and test whether individuals' degree of social influence is moderated by the extent to which they possess traits that are desired by the other member of their dyad.

Conclusions

Four conclusions stand out. First, the one-year rank-order stability of personality traits was already substantial at age 12, increased strongly from early through middle adolescence, and remained rather stable during late adolescence and early adulthood. Second, the linear mean-level increases in girls' conscientiousness and both genders' agreeableness

were consistent with the maturity principle, whereas the U-shaped mean-level changes in girls' emotional stability and boys' conscientiousness were consistent with the disruption hypothesis. Furthermore, we found U-shaped change in girls' extraversion, a linear increase in boys' openness, an increase followed by a decrease in girls' openness, and no evidence for mean-level change in boys' emotional stability and boys' extraversion. Third, for most Big Five traits, we found large individual differences in personality change trajectories, which implies that mean-level change estimates are not always accurate representations of individual development. Fourth, we did not find evidence for dyadic personality trait codevelopment in adolescent friendship and sibling dyads, suggesting that adolescents change independently from their best friend and sibling. The lack of association between dyad members' personality trajectories also suggests that shared experiences do not have uniform effects on personality trait change in adolescence. The major challenge for future research is to test alternative mechanisms for increasing rank-order stability and personality maturation in adolescence, including idiosyncratic mechanisms that drive individual differences in personality trait development.

Supplemental materials

Methods

Measurement invariance. We tested whether the parcels were similarly related to the latent personality factors (in terms of intercept and loading parameters) and thus had a similar meaning across gender, age, and cohort groups.

First, measurement invariance (MI) across gender was tested separately for each trait at ages 12 to 17 and ages 18 to 22 in a series of confirmatory factor analyses, using the 'measurementInvariance' function of the R package *semTools* (Pornprasertmanit, Miller, Schoemann, & Rosseel, 2015). Because of model convergence problems it was not possible to test for gender invariance across ages 12-22 in one test. In these models, we tested whether (1) constraining the loadings across gender resulted in significantly worse fit compared to the configural MI model in which loadings of the same parcels were freely estimated across genders (i.e., metric invariance); and whether (2) constraining also the intercepts of the parcels across gender resulted in significantly worse fit compared to the metric MI model with which only the leadings were constrained (i.e., scalar invariance). Following the recommendations by Cheung and Rensvold (2002), measurements were regarded as invariant when the decreases in the goodness-of-fit indices Comparative Fit Index (CFI) ≤ .010 or McDonald's Noncentrality Index (MFI) ≤ .020 in more constrained models.

R syntax for evaluating MI across gender (for emotional stability):

```
genderES12 <- '
ES12 =~ ES12.4.5 + ES12.1.6 + ES12.3.2
ES13 =~ ES13.4.5 + ES13.1.6 + ES13.3.2
ES14 =~ ES14.4.5 + ES14.1.6 + ES14.3.2
ES15 =~ ES15.4.5 + ES15.1.6 + ES15.3.2
ES16 =~ ES16.4.5 + ES16.1.6 + ES16.3.2
ES17 =~ ES17.4.5 + ES17.1.6 + ES17.3.2'
fit.genderES12 <- cfa(genderES12, group='gender', missing='fiml', data=dat)
migender12 <- measurementInvariance(genderES12, group="gender", missing='fiml', data=dat)
ES12.17 <- lapply(migender12, fitMeasures, c("cfi","mfi"))

genderES18 <- '
ES18 =~ ES18.4.5 + ES18.1.6 + ES18.3.2
ES19 =~ ES19.4.5 + ES19.1.6 + ES19.3.2
ES20 =~ ES20.4.5 + ES20.1.6 + ES20.3.2
ES21 =~ ES21.4.5 + ES21.1.6 + ES21.3.2
ES22 =~ ES22.4.5 + ES22.1.6 + ES22.3.2'
fit.genderES18 <- cfa(genderES18, group='gender', missing='fiml', data=dat)
migender18 <- measurementInvariance(genderES18, group="gender", missing='fiml', data=dat)
```

Second, longitudinal MI was evaluated by testing whether intercepts and loadings remained approximately equal across age categories within participants, using the 'longInvariance' function of the R package *semTools*. Respondents participated across an age range of at most seven years and therefore we could not directly test MI across the entire age range of

12 to 22. Instead, we first tested MI across the largest possible age range along which the longitudinal invariance model converged (i.e., ages 13 to 20) and then tested MI at the partly overlapping tails of the age range (i.e., across ages 12 to 13 and across ages 20 to 21). R syntax example for evaluating longitudinal invariance in openness:

```
invarO.middle<-'
O13 =~ O13.3.5 + O13.4.6 + O13.1.2
O14 =~ O14.3.5 + O14.4.6 + O14.1.2
O15 =~ O15.3.5 + O15.4.6 + O15.1.2
O16 =~ O16.3.5 + O16.4.6 + O16.1.2
O17 =~ O17.3.5 + O17.4.6 + O17.1.2
O18 =~ O18.3.5 + O18.4.6 + O18.1.2
O19 =~ O19.3.5 + O19.4.6 + O19.1.2
O20 =~ O20.3.5 + O20.4.6 + O20.1.2'
var13 <- c("O13.3.5", "O13.4.6", "O13.1.2")
var14 <- c("O14.3.5", "O14.4.6", "O14.1.2")
var15 <- c("O15.3.5", "O15.4.6", "O15.1.2")
var16 <- c("O16.3.5", "O16.4.6", "O16.1.2")
var17 <- c("O17.3.5", "O17.4.6", "O17.1.2")
var18 <- c("O18.3.5", "O18.4.6", "O18.1.2")
var19 <- c("O19.3.5", "O19.4.6", "O19.1.2")
var20 <- c("O20.3.5", "O20.4.6", "O20.1.2")
vars.middle <- list(var13,var14,var15,var16,var17,var18,var19,var20)
long.middle <- longInvariance(invarO.middle, auto="all", constrainAuto=T, varList=vars.middle, missing="fiml",
estimator="ML", strict=F, data=dat)

invarO.early <-'
O12 =~ O12.3.5 + O12.4.6 + O12.1.2
O13 =~ O13.3.5 + O13.4.6 + O13.1.2'
var12 <- c("O12.3.5", "O12.4.6", "O12.1.2")
var13 <- c("O13.3.5", "O13.4.6", "O13.1.2")
vars.early <- list(var12,var13)
long.early <- longInvariance(invarO.early, auto="all", constrainAuto=T, varList=vars.early, missing="fiml",
estimator="ML", strict=F, data=dat)

invarO.late <-'
O20 =~ O20.3.5 + O20.4.6 + O20.1.2
O21 =~ O21.3.5 + O21.4.6 + O21.1.2
O22 =~ O22.3.5 + O22.4.6 + O22.1.2'
fit <- cfa(invarO.late, data=dat, missing='fiml')
var20 <- c("O20.3.5", "O20.4.6", "O20.1.2")
var21 <- c("O21.3.5", "O21.4.6", "O21.1.2")
var22 <- c("O22.3.5", "O22.4.6", "O22.1.2")
vars.late <- list(var20,var21,var22)
long.late <- longInvariance(invarO.late, auto="all", constrainAuto=T, varList=vars.late, missing="fiml",
estimator="ML", strict=F, data=dat)
```

Finally, because we merged data from two cohorts, we evaluated MI also across cohorts. We tested cohort invariance at ages 16-18 because RADAR young and RADAR old respondents both provided many personality responses only at these ages (i.e., the cohorts largely overlapped at these ages). The analytical procedures for these tests were similar to the gender MI tests described above.

R syntax example for evaluating MI across cohorts at age 16-18 in openness:

```
cohortO <- '
O16 =~ O16.3.5 + O16.4.6 + O16.1.2
O17 =~ O17.3.5 + O17.4.6 + O17.1.2
O18 =~ O18.3.5 + O18.4.6 + O18.1.2'
fit.cohortO <- cfa(cohortO, group='cohort', missing='fiml', data=dat)
micohortO <- measurementInvariance(cohortO, group="cohort", missing='fiml', data=dat)
```

Parcel autocorrelations. In the latent stability models and the dyadic latent growth curve models, autocorrelations between measurement errors were imposed between the same parcels across all ages, except for cells that contained < 10 observations (e.g., the covariance between Parcel 1 at age 12 with Parcel 1 at age 22 was omitted). Moreover, the estimates of these autocorrelations were constrained to be equal within time duration lags. For example, the strength of the autocorrelation of a parcel between age 14 and 17 was equal to the autocorrelation of the same parcel between age 16 and 19 because the time lag is three years in both cases.

Latent stability model. R syntax example for latent stability model (openness):

```
stability_O <- '
O12 =~ c(a,a)*O12.3.5 + c(c,c)*O12.1.2 + c(d,d)*O12.4.6 #constrain loadings to be equal across time and gender
O13 =~ c(a,a)*O13.3.5 + c(c,c)*O13.1.2 + c(d,d)*O13.4.6 #the first loadings is automatically set to 1
O14 =~ c(a,a)*O14.3.5 + c(c,c)*O14.1.2 + c(d,d)*O14.4.6
O15 =~ c(a,a)*O15.3.5 + c(c,c)*O15.1.2 + c(d,d)*O15.4.6
O16 =~ c(a,a)*O16.3.5 + c(c,c)*O16.1.2 + c(d,d)*O16.4.6
O17 =~ c(a,a)*O17.3.5 + c(c,c)*O17.1.2 + c(d,d)*O17.4.6
O18 =~ c(a,a)*O18.3.5 + c(c,c)*O18.1.2 + c(d,d)*O18.4.6
O19 =~ c(a,a)*O19.3.5 + c(c,c)*O19.1.2 + c(d,d)*O19.4.6
O20 =~ c(a,a)*O20.3.5 + c(c,c)*O20.1.2 + c(d,d)*O20.4.6
O21 =~ c(a,a)*O21.3.5 + c(c,c)*O21.1.2 + c(d,d)*O21.4.6
O22 =~ c(a,a)*O22.3.5 + c(c,c)*O22.1.2 + c(d,d)*O22.4.6

#regression
O13 ~ c(st1a,st2a)*O12 #different parameters for boys and girls
O14 ~ c(st1b,st2b)*O13
O15 ~ c(st1c,st2c)*O14
O16 ~ c(st1d,st2d)*O15
O17 ~ c(st1e,st2e)*O16
O18 ~ c(st1f,st2f)*O17
O19 ~ c(st1g,st2g)*O18
O20 ~ c(st1h,st2h)*O19
O21 ~ c(st1i,st2i)*O20
O22 ~ c(st1j,st2j)*O21

#constrain intercepts to be equal across age and genders
O12.3.5~c(nu1,nu1)*1
O13.3.5~c(nu1,nu1)*1
O14.3.5~c(nu1,nu1)*1
```

```
O15.3.5~c(nu1,nu1)*1
O16.3.5~c(nu1,nu1)*1
O17.3.5~c(nu1,nu1)*1
O18.3.5~c(nu1,nu1)*1
O19.3.5~c(nu1,nu1)*1
O20.3.5~c(nu1,nu1)*1
O21.3.5~c(nu1,nu1)*1
O22.3.5~c(nu1,nu1)*1

O12.1.2~c(nu2,nu2)*1
O13.1.2~c(nu2,nu2)*1
O14.1.2~c(nu2,nu2)*1
O15.1.2~c(nu2,nu2)*1
O16.1.2~c(nu2,nu2)*1
O17.1.2~c(nu2,nu2)*1
O18.1.2~c(nu2,nu2)*1
O19.1.2~c(nu2,nu2)*1
O20.1.2~c(nu2,nu2)*1
O21.1.2~c(nu2,nu2)*1
O22.1.2~c(nu2,nu2)*1

O12.4.6~c(nu4,nu4)*1
O13.4.6~c(nu4,nu4)*1
O14.4.6~c(nu4,nu4)*1
O15.4.6~c(nu4,nu4)*1
O16.4.6~c(nu4,nu4)*1
O17.4.6~c(nu4,nu4)*1
O18.4.6~c(nu4,nu4)*1
O19.4.6~c(nu4,nu4)*1
O20.4.6~c(nu4,nu4)*1
O21.4.6~c(nu4,nu4)*1
O22.4.6~c(nu4,nu4)*1

#parcel covariances across time
O12.1.2 ~~ c(cov11,cov11)*O13.1.2 + c(cov12,cov12)*O14.1.2 + c(cov13,cov13)*O15.1.2 + c(cov14,cov14)*O16.1.2
+ c(cov15,cov15)*O17.1.2                    + c(cov17,cov17)*O19.1.2
O13.1.2 ~~ c(cov11,cov11)*O14.1.2 + c(cov12,cov12)*O15.1.2 + c(cov13,cov13)*O16.1.2 + c(cov14,cov14)*O17.1.2
+ c(cov15,cov15)*O18.1.2 + c(cov16,cov16)*O19.1.2 + c(cov17,cov17)*O20.1.2
O14.1.2 ~~ c(cov11,cov11)*O15.1.2 + c(cov12,cov12)*O16.1.2 + c(cov13,cov13)*O17.1.2 + c(cov14,cov14)*O18.1.2
+ c(cov15,cov15)*O19.1.2 + c(cov16,cov16)*O20.1.2
O15.1.2 ~~ c(cov11,cov11)*O16.1.2 + c(cov12,cov12)*O17.1.2 + c(cov13,cov13)*O18.1.2 + c(cov14,cov14)*O19.1.2
+ c(cov15,cov15)*O20.1.2
O16.1.2 ~~ c(cov11,cov11)*O17.1.2 + c(cov12,cov12)*O18.1.2 + c(cov13,cov13)*O19.1.2 + c(cov14,cov14)*O20.1.2
+ c(cov16,cov16)*O22.1.2
O17.1.2 ~~ c(cov11,cov11)*O18.1.2 + c(cov12,cov12)*O19.1.2 + c(cov13,cov13)*O20.1.2 + c(cov14,cov14)*O21.1.2
+ c(cov15,cov15)*O22.1.2
O18.1.2 ~~ c(cov11,cov11)*O19.1.2 + c(cov12,cov12)*O20.1.2 + c(cov13,cov13)*O21.1.2 + c(cov14,cov14)*O22.1.2
O19.1.2 ~~ c(cov11,cov11)*O20.1.2 + c(cov12,cov12)*O21.1.2 + c(cov13,cov13)*O22.1.2
O20.1.2 ~~ c(cov11,cov11)*O21.1.2 + c(cov12,cov12)*O22.1.2
O21.1.2 ~~ c(cov11,cov11)*O22.1.2
O12.3.5 ~~ c(cov31,cov31)*O13.3.5 + c(cov32,cov32)*O14.3.5 + c(cov33,cov33)*O15.3.5 + c(cov34,cov34)*O16.3.5
+ c(cov35,cov35)*O17.3.5                    + c(cov27,cov27)*O19.3.5
O13.3.5 ~~ c(cov31,cov31)*O14.3.5 + c(cov32,cov32)*O15.3.5 + c(cov33,cov33)*O16.3.5 + c(cov34,cov34)*O17.3.5
```

```
+ c(cov35,cov35)*O18.3.5 + c(cov36,cov36)*O19.3.5 + c(cov27,cov27)*O20.3.5
O14.3.5 ~~ c(cov31,cov31)*O15.3.5 + c(cov32,cov32)*O16.3.5 + c(cov33,cov33)*O17.3.5 + c(cov34,cov34)*O18.3.5
+ c(cov35,cov35)*O19.3.5 + c(cov36,cov36)*O20.3.5
O15.3.5 ~~ c(cov31,cov31)*O16.3.5 + c(cov32,cov32)*O17.3.5 + c(cov33,cov33)*O18.3.5 + c(cov34,cov34)*O19.3.5
+ c(cov35,cov35)*O20.3.5
O16.3.5 ~~ c(cov31,cov31)*O17.3.5 + c(cov32,cov32)*O18.3.5 + c(cov33,cov33)*O19.3.5 + c(cov34,cov34)*O20.3.5
+ c(cov36,cov36)*O22.3.5
O17.3.5 ~~ c(cov31,cov31)*O18.3.5 + c(cov32,cov32)*O19.3.5 + c(cov33,cov33)*O20.3.5 + c(cov34,cov34)*O21.3.5
+ c(cov35,cov35)*O22.3.5
O18.3.5 ~~ c(cov31,cov31)*O19.3.5 + c(cov32,cov32)*O20.3.5 + c(cov33,cov33)*O21.3.5 + c(cov34,cov34)*O22.3.5
O19.3.5 ~~ c(cov31,cov31)*O20.3.5 + c(cov32,cov32)*O21.3.5 + c(cov33,cov33)*O22.3.5
O20.3.5 ~~ c(cov31,cov31)*O21.3.5 + c(cov32,cov32)*O22.3.5
O21.3.5 ~~ c(cov31,cov31)*O22.3.5
O12.4.6 ~~ c(cov41,cov41)*O13.4.6 + c(cov42,cov42)*O14.4.6 + c(cov43,cov43)*O15.4.6 + c(cov44,cov44)*O16.4.6
+ c(cov45,cov45)*O17.4.6                    + c(cov37,cov37)*O19.4.6
O13.4.6 ~~ c(cov41,cov41)*O14.4.6 + c(cov42,cov42)*O15.4.6 + c(cov43,cov43)*O16.4.6 + c(cov44,cov44)*O17.4.6
+ c(cov45,cov45)*O18.4.6 + c(cov46,cov46)*O19.4.6 + c(cov37,cov37)*O20.4.6
O14.4.6 ~~ c(cov41,cov41)*O15.4.6 + c(cov42,cov42)*O16.4.6 + c(cov43,cov43)*O17.4.6 + c(cov44,cov44)*O18.4.6
+ c(cov45,cov45)*O19.4.6 + c(cov46,cov46)*O20.4.6
O15.4.6 ~~ c(cov41,cov41)*O16.4.6 + c(cov42,cov42)*O17.4.6 + c(cov43,cov43)*O18.4.6 + c(cov44,cov44)*O19.4.6
+ c(cov45,cov45)*O20.4.6
O16.4.6 ~~ c(cov41,cov41)*O17.4.6 + c(cov42,cov42)*O18.4.6 + c(cov43,cov43)*O19.4.6 + c(cov44,cov44)*O20.4.6
+ c(cov46,cov46)*O22.4.6
O17.4.6 ~~ c(cov41,cov41)*O18.4.6 + c(cov42,cov42)*O19.4.6 + c(cov43,cov43)*O20.4.6 + c(cov44,cov44)*O21.4.6
+ c(cov45,cov45)*O22.4.6
O18.4.6 ~~ c(cov41,cov41)*O19.4.6 + c(cov42,cov42)*O20.4.6 + c(cov43,cov43)*O21.4.6 + c(cov44,cov44)*O22.4.6
O19.4.6 ~~ c(cov41,cov41)*O20.4.6 + c(cov42,cov42)*O21.4.6 + c(cov43,cov43)*O22.4.6
O20.4.6 ~~ c(cov41,cov41)*O21.4.6 + c(cov42,cov42)*O22.4.6
O21.4.6 ~~ c(cov41,cov41)*O22.4.6'
fit.stability_O <- sem(stability_O, data=dat, missing='fiml', group="gender")
```

Latent Growth Curve Models. R syntax example for LGCM (openness):

```
model_O <- '
O12 =~ O12.3.5 + O12.1.2 + O12.4.6 #loadings (and intercepts) only constrained to be equal across time at ages
15-19
O13 =~ O13.3.5 + O13.1.2 + O13.4.6 #the first loadings is automatically set to 1
O14 =~ O14.3.5 + O14.1.2 + O14.4.6
O15 =~ O15.3.5 + c*O15.1.2 + d*O15.4.6
O16 =~ O16.3.5 + c*O16.1.2 + d*O16.4.6
O17 =~ O17.3.5 + c*O17.1.2 + d*O17.4.6
O18 =~ O18.3.5 + c*O18.1.2 + d*O18.4.6
O19 =~ O19.3.5 + c*O19.1.2 + d*O19.4.6
O20 =~ O20.3.5 + O20.1.2 + O20.4.6
O21 =~ O21.3.5 + O21.1.2 + O21.4.6
O22 =~ O22.3.5 + O22.1.2 + O22.4.6

i  =~ 1*O12 + 1*O13 + 1*O14 + 1*O15 + 1*O16 + 1*O17 + 1*O18 + 1*O19 + 1*O20 + 1*O21 + 1*O22 #intercept
s1 =~ -5*O12 + -4*O13 + -3*O14 + -2*O15 + -1*O16 + 0*O17 + 1*O18 + 2*O19 + 3*O20 +  4*O21 +  5*O22
#linear slope
s2 =~ 25*O12 + 16*O13 +  9*O14 +  4*O15 +  1*O16 + 0*O17 + 1*O18 + 4*O19 + 9*O20 + 16*O21 + 25*O22
#quadratic slope

i + s1 + s2 ~ gender #test gender differences in intercept and slopes
i + s1 + s2 ~ cohort #test cohort differences in intercept and slopes
```

```
O12 ~ 0*1 #fix the means of the latent variables to 0
O13 ~ 0*1
O14 ~ 0*1
O15 ~ 0*1
O16 ~ 0*1
O17 ~ 0*1
O18 ~ 0*1
O19 ~ 0*1
O20 ~ 0*1
O21 ~ 0*1
O22 ~ 0*1

O12.4.6~0*1 #fix the means of the first parcel also to 0
O13.4.6~0*1
O14.4.6~0*1
O15.4.6~0*1
O16.4.6~0*1
O17.4.6~0*1
O18.4.6~0*1
O19.4.6~0*1
O20.4.6~0*1
O21.4.6~0*1
O22.4.6~0*1

O12.1.2~1
O13.1.2~1
O14.1.2~1
O15.1.2~nu2*1
O16.1.2~nu2*1
O17.1.2~nu2*1
O18.1.2~nu2*1
O19.1.2~nu2*1
O20.1.2~1
O21.1.2~1
O22.1.2~1

O12.3.5~1
O13.3.5~1
O14.3.5~1
O15.3.5~nu4*1
O16.3.5~nu4*1
O17.3.5~nu4*1
O18.3.5~nu4*1
O19.3.5~nu4*1
O20.3.5~1
O21.3.5~1
O22.3.5~1' #no covariances between residuals
fit.O <- growth(model_O, missing="fiml", data=dat)
```

95% Confidence bands around mean-level change. The lines in the panels of Figure 2.6 represent the predicted mean-level changes and 95% confidence intervals based on the LGCM results. We calculated the 95% confidence bands by means of the following

steps. First, for each trait and gender we simulated a multivariate normal distribution (N = 10.000) of intercept and slope values in which the means, standard error, and co-variances of/among the intercept and two slope variables were set equal to the predicted values obtained from the LGCM results. Second, we predicted for 1,000 age values in the range between age 12 and 22 10,000 mean-level values based on our sample of possible intercepts and slopes. Third, we computed the 5%, 50%, and 95% quantiles of the distribution of the predicted mean-levels at each age value. Fourth, we drew three lines between these data points in the graphs, which represent the upper bound estimate, the predicted estimate, and the lower bound estimate of the mean-level change across age in the population.

Dyadic latent growth curve model. Example syntax dyadic latent growth curve model (openness):

```
corrO <- '
Ot1y =~ Ot1young.1 + c(c)*Ot1young.2 + c(d)*Ot1young.3 #younger friend
Ot2y =~ Ot2young.1 + c(c)*Ot2young.2 + c(d)*Ot2young.3
Ot3y =~ Ot3young.1 + c(c)*Ot3young.2 + c(d)*Ot3young.3
Ot4y =~ Ot4young.1 + c(c)*Ot4young.2 + c(d)*Ot4young.3
Ot5y =~ Ot5young.1 + c(c)*Ot5young.2 + c(d)*Ot5young.3
Ot6y =~ Ot6young.1 + c(c)*Ot6young.2 + c(d)*Ot6young.3
Ot1o =~ Ot1old.1 + c(c)*Ot1old.2 + c(d)*Ot1old.3 #older friend
Ot2o =~ Ot2old.1 + c(c)*Ot2old.2 + c(d)*Ot2old.3
Ot3o =~ Ot3old.1 + c(c)*Ot3old.2 + c(d)*Ot3old.3
Ot4o =~ Ot4old.1 + c(c)*Ot4old.2 + c(d)*Ot4old.3
Ot5o =~ Ot5old.1 + c(c)*Ot5old.2 + c(d)*Ot5old.3
Ot6o =~ Ot6old.1 + c(c)*Ot6old.2 + c(d)*Ot6old.3

#intercepts and slopes for both dyad members
iy =~ 1*Ot1y + 1*Ot2y + 1*Ot3y + 1*Ot4y + 1*Ot5y + 1*Ot6y
sy =~ 0*Ot1y + 1*Ot2y + 2*Ot3y + 3*Ot4y + 4*Ot5y + 5*Ot6y
io =~ 1*Ot1o + 1*Ot2o + 1*Ot3o + 1*Ot4o + 1*Ot5o + 1*Ot6o
so =~ 0*Ot1o + 1*Ot2o + 2*Ot3o + 3*Ot4o + 4*Ot5o + 5*Ot6o

iy + sy + io + so ~ cohort #control for cohort

Ot1y ~ 0*1
Ot2y ~ 0*1
Ot3y ~ 0*1
Ot4y ~ 0*1
Ot5y ~ 0*1
Ot6y ~ 0*1
Ot1o ~ 0*1
Ot2o ~ 0*1
Ot3o ~ 0*1
Ot4o ~ 0*1
Ot5o ~ 0*1
Ot6o ~ 0*1
```

```
Ot1young.3~0*1
Ot2young.3~0*1
Ot3young.3~0*1
Ot4young.3~0*1
Ot5young.3~0*1
Ot6young.3~0*1
Ot1old.3~0*1
Ot2old.3~0*1
Ot3old.3~0*1
Ot4old.3~0*1
Ot5old.3~0*1
Ot6old.3~0*1

Ot1young.2~c(nu2)*1
Ot2young.2~c(nu2)*1
Ot3young.2~c(nu2)*1
Ot4young.2~c(nu2)*1
Ot5young.2~c(nu2)*1
Ot6young.2~c(nu2)*1
Ot1old.2~c(nu2)*1
Ot2old.2~c(nu2)*1
Ot3old.2~c(nu2)*1
Ot4old.2~c(nu2)*1
Ot5old.2~c(nu2)*1
Ot6old.2~c(nu2)*1

Ot1young.1~c(nu3)*1
Ot2young.1~c(nu3)*1
Ot3young.1~c(nu3)*1
Ot4young.1~c(nu3)*1
Ot5young.1~c(nu3)*1
Ot6young.1~c(nu3)*1
Ot1old.1~c(nu3)*1
Ot2old.1~c(nu3)*1
Ot3old.1~c(nu3)*1
Ot4old.1~c(nu3)*1
Ot5old.1~c(nu3)*1
Ot6old.1~c(nu3)*1

#covariances
Ot1young.2 ~~ c(cov11)*Ot2young.2 + c(cov12)*Ot3young.2 + c(cov13)*Ot4young.2 + c(cov14)*Ot5young.2 +
c(cov15)*Ot6young.2
Ot2young.2 ~~ c(cov11)*Ot3young.2 + c(cov12)*Ot4young.2 + c(cov13)*Ot5young.2 + c(cov14)*Ot6young.2
Ot3young.2 ~~ c(cov11)*Ot4young.2 + c(cov12)*Ot5young.2 + c(cov13)*Ot6young.2
Ot4young.2 ~~ c(cov11)*Ot5young.2 + c(cov12)*Ot6young.2
Ot5young.2 ~~ c(cov11)*Ot6young.2

Ot1young.1 ~~ c(cov21)*Ot2young.1 + c(cov22)*Ot3young.1 + c(cov23)*Ot4young.1 + c(cov24)*Ot5young.1 +
c(cov25)*Ot6young.1
Ot2young.1 ~~ c(cov21)*Ot3young.1 + c(cov22)*Ot4young.1 + c(cov23)*Ot5young.1 + c(cov24)*Ot6young.1
Ot3young.1 ~~ c(cov21)*Ot4young.1 + c(cov22)*Ot5young.1 + c(cov23)*Ot6young.1
Ot4young.1 ~~ c(cov21)*Ot5young.1 + c(cov22)*Ot6young.1
Ot5young.1 ~~ c(cov21)*Ot6young.1
```

```
Ot1young.3 ~~ c(cov31)*Ot2young.3 + c(cov32)*Ot3young.3 + c(cov33)*Ot4young.3 + c(cov34)*Ot5young.3 +
c(cov35)*Ot6young.3
Ot2young.3 ~~ c(cov31)*Ot3young.3 + c(cov32)*Ot4young.3 + c(cov33)*Ot5young.3 + c(cov34)*Ot6young.3
Ot3young.3 ~~ c(cov31)*Ot4young.3 + c(cov32)*Ot5young.3 + c(cov33)*Ot6young.3
Ot4young.3 ~~ c(cov31)*Ot5young.3 + c(cov32)*Ot6young.3
Ot5young.3 ~~ c(cov31)*Ot6young.3

Ot1old.2 ~~ c(cov11)*Ot2old.2 + c(cov12)*Ot3old.2 + c(cov13)*Ot4old.2 + c(cov14)*Ot5old.2 + c(cov15)*Ot6old.2
Ot2old.2 ~~ c(cov11)*Ot3old.2 + c(cov12)*Ot4old.2 + c(cov13)*Ot5old.2 + c(cov14)*Ot6old.2
Ot3old.2 ~~ c(cov11)*Ot4old.2 + c(cov12)*Ot5old.2 + c(cov13)*Ot6old.2
Ot4old.2 ~~ c(cov11)*Ot5old.2 + c(cov12)*Ot6old.2
Ot5old.2 ~~ c(cov11)*Ot6old.2

Ot1old.1 ~~ c(cov21)*Ot2old.1 + c(cov22)*Ot3old.1 + c(cov23)*Ot4old.1 + c(cov24)*Ot5old.1 + c(cov25)*Ot6old.1
Ot2old.1 ~~ c(cov21)*Ot3old.1 + c(cov22)*Ot4old.1 + c(cov23)*Ot5old.1 + c(cov24)*Ot6old.1
Ot3old.1 ~~ c(cov21)*Ot4old.1 + c(cov22)*Ot5old.1 + c(cov23)*Ot6old.1
Ot4old.1 ~~ c(cov21)*Ot5old.1 + c(cov22)*Ot6old.1
Ot5old.1 ~~ c(cov21)*Ot6old.1

Ot1old.3 ~~ c(cov31)*Ot2old.3 + c(cov32)*Ot3old.3 + c(cov33)*Ot4old.3 + c(cov34)*Ot5old.3 + c(cov35)*Ot6old.3
Ot2old.3 ~~ c(cov31)*Ot3old.3 + c(cov32)*Ot4old.3 + c(cov33)*Ot5old.3 + c(cov34)*Ot6old.3
Ot3old.3 ~~ c(cov31)*Ot4old.3 + c(cov32)*Ot5old.3 + c(cov33)*Ot6old.3
Ot4old.3 ~~ c(cov31)*Ot5old.3 + c(cov32)*Ot6old.3
Ot5old.3 ~~ c(cov31)*Ot6old.3'

fit.corrO.BB <- growth(corrO, data=datwide.BB, missing='fiml')
```

Results

Table S2.1. Observed means and standard deviations of Big Five personality variables across age

		Personality trait									
		Openness		Conscientious-ness		Extraversion		Agreeableness		Emotional stability	
Gender	Age	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Boys	12	4.78	0.91	4.03	1.04	5.03	0.95	5.44	0.74	4.59	1.00
	13	4.70	1.00	4.01	1.10	5.02	1.01	5.36	0.82	4.71	1.06
	14	4.70	0.95	3.94	1.09	5.04	1.04	5.33	0.76	4.75	1.08
	15	4.75	0.92	3.90	1.18	5.00	1.08	5.38	0.75	4.73	1.07
	16	4.80	0.98	3.96	1.20	5.01	1.13	5.48	0.72	4.73	1.08
	17	4.89	0.96	4.02	1.22	5.00	1.09	5.56	0.69	4.77	1.08
	18	4.93	0.92	3.99	1.16	5.00	1.11	5.58	0.71	4.75	1.08
	19	4.98	0.91	4.01	1.19	5.04	1.15	5.68	0.67	4.83	1.07
	20	4.93	0.92	4.19	1.18	4.95	1.13	5.72	0.57	4.76	1.12
	21	4.96	0.98	4.28	1.13	4.96	1.14	5.71	0.68	4.84	1.11
	22	4.81	1.01	4.36	1.17	5.04	1.24	5.74	0.63	4.99	1.02
Girls	12	4.87	0.90	4.03	1.14	5.14	0.99	5.52	0.72	4.36	1.09
	13	4.84	0.99	4.16	1.19	5.05	1.07	5.56	0.72	4.26	1.16
	14	4.90	0.95	4.19	1.21	5.03	1.12	5.56	0.70	4.23	1.16
	15	5.00	0.92	4.30	1.24	5.03	1.16	5.63	0.66	4.19	1.13
	16	5.03	0.88	4.36	1.24	4.95	1.19	5.69	0.63	4.21	1.16
	17	4.97	0.95	4.46	1.22	4.95	1.19	5.74	0.63	4.19	1.17
	18	5.03	0.91	4.47	1.22	4.94	1.19	5.74	0.66	4.26	1.17
	19	4.98	0.91	4.58	1.21	4.96	1.15	5.76	0.60	4.25	1.12
	20	4.90	0.92	4.63	1.21	4.99	1.15	5.83	0.58	4.30	1.11
	21	4.96	0.95	4.79	1.18	5.00	1.13	5.86	0.60	4.51	0.98
	22	4.85	0.90	4.86	1.19	5.06	1.14	5.86	0.49	4.42	1.09

Table S2.2. Measurement invariance tests across gender

Personality trait	Age	Model	Equivalence test	Model comparison	CFI	ΔCFI	MFI	ΔMFI
O	12-17	2	Metric	1 vs. 2	0.830	-0.001	0.623	-0.001
		3	Scalar	2 vs. 3	0.823	-0.007	0.612	-0.012
	18-22	2	Metric	1 vs. 2	0.861	-0.001	0.729	-0.002
		3	Scalar	2 vs. 3	0.855	-0.006	0.719	-0.010
C	12-17	2	Metric	1 vs. 2	0.959	-0.001	0.843	-0.002
		3	Scalar	2 vs. 3	0.943	**-0.016**	0.789	**-0.054**
		3bis	Partial scalar[3]	2 vs. 3bis	0.956	-0.003	0.832	-0.011
	18-22	2	Metric	1 vs. 2	0.964	0.000	0.884	0.001
		3	Scalar	2 vs. 3	0.955	-0.009	0.857	**-0.027**
E	12-17	2	Metric	1 vs. 2	0.943	-0.001	0.823	-0.003
		3	Scalar	2 vs. 3	0.940	-0.003	0.814	-0.009
	18-22	2	Metric	1 vs. 2	0.957	0.000	0.877	0.001
		3	Scalar	2 vs. 3	0.955	-0.001	0.874	-0.004
A	12-17	2	Metric	1 vs. 2	0.929	-0.001	0.819	-0.001
		3	Scalar	2 vs. 3	0.926	-0.003	0.813	-0.006
	18-22	2	Metric	1 vs. 2	0.961	0.000	0.914	0.001
		3	Scalar	2 vs. 3	0.954	-0.007	0.899	-0.015
ES	12-17	2	Metric	1 vs. 2	0.927	-0.002	0.781	-0.005
		3	Scalar	2 vs. 3	0.918	-0.009	0.757	**-0.024**
	18-22	2	Metric	1 vs. 2	0.913	-0.003	0.801	-0.007
		3	Scalar	2 vs. 3	0.895	**-0.018**	0.765	**-0.036**
		3bis	Partial scalar[4]	2 vs. 3bis	0.907	-0.006	0.832	-0.011

Note. O = Openness; C = Conscientiousness; E = Extraversion; A = Agreeableness; ES = Emotional stability. Criterion violations are printed in **bold**. The fit statistics for all Model 1's 'Configural equivalence' (not shown) can be inferred from the fit statistics of Model 2 and the delta fit statistics of Model 1 vs. Model 2. For example, if the $CFI_{Model\ 2}$ = 0.897 and $\Delta CFI_{Model1vs.Model\ 2}$ = -0.002, then the CFI of Model 1 was (.897 + .002 =) .899.

3 Releasing gender equality constraint intercepts conscientiousness parcel '3.2' at age 14-17.
4 Releasing gender equality constraint intercepts emotional stability parcel '1.6' at age 18 and 20.

Table S2.3. Measurement invariance tests across age

Factor	Age	Model	Equivalence test	Model comparison	CFI	ΔCFI	MFI	ΔMFI
O	13-20	2	Metric	1 vs. 2	0.993	0.002	0.991	0.023
		3	Scalar	2 vs. 3	0.990	-0.004	0.986	-0.005
	12-13	2	Metric	1 vs. 2	1.000	0.001	1.000	0.001
		3	Scalar	2 vs. 3	1.000	0.000	1.000	0.000
	20-22	2	Metric	1 vs. 2	0.993	-0.002	0.991	-0.002
		3	Scalar	2 vs. 3	0.990	-0.004	0.986	-0.005
C	13-20	2	Metric	1 vs. 2	0.996	0.000	0.979	-0.002
		3	Scalar	2 vs. 3	0.995	-0.001	0.971	-0.008
	12-13	2	Metric	1 vs. 2	0.999	0.001	0.999	0.001
		3	Scalar	2 vs. 3	0.998	0.000	0.998	0.000
	20-22	2	Metric	1 vs. 2	0.998	0.000	0.995	0.001
		3	Scalar	2 vs. 3	0.998	0.000	0.996	0.000
E	13-20	2	Metric	1 vs. 2	0.995	-0.001	0.976	-0.003
		3	Scalar	2 vs. 3	0.993	-0.002	0.968	-0.008
	12-13	2	Metric	1 vs. 2	0.996	-0.003	0.997	-0.002
		3	Scalar	2 vs. 3	0.996	0.000	0.997	0.000
	20-22	2	Metric	1 vs. 2	0.978	**-0.013**	0.957	**-0.024**
		2bis	Partial metric[5]	1 vs. 2bis	0.990	-0.001	0.978	-0.002
		3	Scalar	2 vs. 3	0.967	**-0.011**	0.937	-0.020
A	13-18	2	Metric	1 vs. 2	0.933	-0.001	0.808	-0.001
		3	Scalar	2 vs. 3	0.917	**-0.016**	0.768	**-0.041**
		3bis	Partial scalar[6]	2 vs. 3bis	0.923	-0.010	0.783	**-0.025**
	12-13	2	Metric	1 vs. 2	0.997	0.001	0.998	0.000
		3	Scalar	2 vs. 3	0.995	-0.002	0.996	-0.002
	18-22	2	Metric	1 vs. 2	0.994	-0.001	0.986	-0.002
		3	Scalar	2 vs. 3	0.993	-0.001	0.984	-0.001
ES	13-20	2	Metric	1 vs. 2	0.998	0.000	0.988	-0.001
		3	Scalar	2 vs. 3	0.997	-0.001	0.985	-0.003
	12-13	2	Metric	1 vs. 2	0.995	-0.003	0.995	-0.003
		3	Scalar	2 vs. 3	0.994	-0.001	0.994	-0.001
	20-22	2	Metric	1 vs. 2	1.000	0.000	1.006	0.000
		3	Scalar	2 vs. 3	1.000	0.000	1.003	-0.003

*Not*e. O = Openness; C = Conscientiousness; E = Extraversion; A = Agreeableness; ES = Emotional stability. Criterion violations are printed in **bold**. The fit statistics for all Model 1's 'Configural equivalence' (not shown) can be inferred from the fit statistics of Model 2 and the delta fit statistics of Model 1 vs. Model 2. For example, if the CFIModel2 = 0.897 and ΔCFIModel1vs.Model2 = -0.002, then the CFI of Model 1 was (.897 + .002 =) .899.

5 Releasing equality constraint loading extraversion parcel '1.5' at age 22.

6 Releasing equality constraint intercepts agreeableness parcel '2.6' at age 13 and 14.

Table S2.4. Measurement invariance tests across cohorts (Radar young vs. Radar old) at ages 16-18

Factor	Age	Model	Equivalence test	Model comparison	CFI	ΔCFI	MFI	ΔMFI
O	16-18	2	Metric	1 vs. 2	0.869	0.001	0.778	0.001
		3	Scalar	2 vs. 3	0.867	-0.002	0.776	-0.002
C	16-18	2	Metric	1 vs. 2	0.967	0.000	0.908	-0.001
		3	Scalar	2 vs. 3	0.967	-0.001	0.905	-0.003
E	16-18	2	Metric	1 vs. 2	0.954	-0.001	0.890	-0.002
		3	Scalar	2 vs. 3	0.954	0.000	0.890	0.000
A	16-18	2	Metric	1 vs. 2	0.955	-0.001	0.916	-0.001
		3	Scalar	2 vs. 3	0.953	-0.003	0.911	-0.005
ES	16-18	2	Metric	1 vs. 2	0.938	0.001	0.860	0.001
		3	Scalar	2 vs. 3	0.935	-0.002	0.856	-0.005

Note. O = Openness; C = Conscientiousness; E = Extraversion; A = Agreeableness; ES = Emotional stability. Criterion violations are printed in **bold**. The fit statistics for all Model 1's 'Configural equivalence' (not shown) can be inferred from the fit statistics of Model 2 and the delta fit statistics of Model 1 vs. Model 2. For example, if the CFIModel 2 = 0.897 and ΔCFIModel 1 vs. Model 2 = -0.002, then the CFI of Model 1 was (.897 + .002 =) .899.

Table S2.5. Fit indices for the univariate latent lag models and latent growth curve models (N = 2,230)

	Latent stability model				LGCM (mean-level change)			
Factor	χ^2	*df*	CFI	RMSEA	χ^2	*df*	CFI	RMSEA
O	1745.28	1034	0.96	0.02	4210.75	543	0.82	0.06
C	1567.39	1032	0.98	0.02	2287.46	543	0.94	0.04
E	1648.98	1033	0.97	0.02	2160.28	543	0.93	0.04
A	1970.33	1033	0.95	0.03	2056.78	573	0.92	0.03
ES	1519.58	1030	0.98	0.02	2875.09	543	0.90	0.04

Note: All χ^2-statistics were statistically significant ($p < .001$).

Table S2.6. Fit indices for the dyadic growth curve models testing co-development in dyads

Dyad	Factor	χ^2	*df*	CFI	RMSEA
Friends	O	628.88	414	0.95	0.05
(*n* = 911)	C	572.31	414	0.97	0.04
	E	587.10	414	0.96	0.04
	A	629.53	414	0.94	0.05
	ES	535.30	414	0.97	0.04
Siblings	O	614.49	414	0.97	0.03
(*n* = 908)	C	537.14	414	0.99	0.03
	E	658.52	414	0.97	0.04
	A	746.44	414	0.95	0.04
	ES	553.88	414	0.98	0.03

Note. All χ^2-statistics were statistically significant ($p < .001$).


3

Chapter 3

Positive Daily Experiences are Associated with Personality Trait Changes in Middle-Aged Mothers

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Abstract

Theory and research have suggested that recurrent daily experiences can affect personality traits. The present study examined the longitudinal relation between individual differences in positive daily experiences and the Big Five personality traits. Data came from Dutch mothers (N = 483; M age = 44 years at T1) who completed up to 6 yearly personality questionnaires and 15 between-year assessment bursts, lasting 5 consecutive days each. Using multilevel structural equation modeling, we found that individual differences in daily experiences of positive affect and perceived relationship support/affection with partners and children were positively associated with subsequent rank-order changes in all Big Five personality traits. In contrast, we found little evidence that personality traits were associated with rank-order changes in daily experiences, which may be due to the very high rank-order stability of positive affect and relationship support. Furthermore, positive daily experiences demonstrated incremental validity in predicting rank-order changes in trait agreeableness, emotional stability, and openness, over and above daily negative affect and relationship conflict. The results suggest that positive affective and interpersonal daily experiences contribute to positive personality trait changes middle adulthood. We discuss these results in the context of contemporary theories of personality trait development.

Keywords: Adulthood; daily diary; positive affect; personality development; social relationships.

Contemporary dynamic personality theories posit that personality traits can change throughout life as a result of daily experiences (Baumert et al., 2017; Geukes et al., 2018; Roberts & Jackson, 2008; Wrzus & Roberts, 2017). In support of this proposition, recent research found that recurrent negative daily experiences were associated with rank-order decreases in emotional stability in adolescence (Borghuis, Bleidorn, et al., 2017) and adulthood (Wrzus et al., 2017). However, to the best our knowledge, no study to date has tested whether these effects generalize to positive experiences. In addition, there is a relative lack of research focused on personality trait development in middle adulthood (Allemand, Gomez, & Jackson, 2010). To investigate the associations between positive daily experiences and change in personality traits, we examined dynamic transactions between Big Five personality traits (extraversion, agreeableness, conscientiousness, emotional stability, and openness) and daily experiences of positive affect and relationship support/affection with partners and adolescent children in a sample of middle-aged Dutch mothers over a period of 5 years.

Personality Trait Development in Middle Adulthood

Compared to the burgeoning literature on personality development in adolescence and young adulthood, little research has focused on the period of middle adulthood. The relative sparseness of research on this life stage might reflect findings suggesting that personality traits are rather stable in this period (Costa & McCrae, 1994), which has led researchers to propose that personality traits "reach mature form in adulthood; thereafter they are stable in cognitively intact individuals" (McCrae & Costa, 1999, p. 145). However, more recent longitudinal research has found that personality traits continue to change throughout middle adulthood and even in old age (Bleidorn & Hopwood, 2018; Roberts et al., 2006).

Most longitudinal studies have examined personality trait development in terms of two types of stability and change, namely stability and change in the rank ordering of individuals on a trait and in the mean level of a trait. In recent years, this research has been complemented by studies on individual differences in change. Rank-order stability refers to the maintenance of individuals' relative standing on a trait dimension within a population over time. Past research has suggested that the rank-order stabilities of personality traits peak in middle adulthood. Nevertheless, even during middle adulthood, individuals continue to show small changes over time in their ranks on trait dimensions (Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000; Wortman, Lucas, & Donnellan, 2012).

Mean-level change refers to change in average trait levels of a population over time. Previous research on mean-level change in middle adulthood has found evidence for increases in agreeableness, conscientiousness, and emotional stability and decreases in openness and extraversion during this life stage (Helson, Jones, & Kwan, 2002; Lucas & Donnellan, 2011; Mroczek & Spiro, 2003; Roberts et al., 2006; Schwaba & Bleidorn, 2018;

Soto et al., 2011; Specht, Egloff, & Schmukle, 2011; Srivastava et al., 2003; Terracciano et al., 2005; Wortman et al., 2012).

Finally, longitudinal studies on individual differences in change have found that, during middle adulthood, individuals differ from each other in the shape of their personality trait trajectories, albeit to a smaller extent than during earlier stages in life (Mroczek & Spiro, 2003; Roberts et al., 2008; Schwaba & Bleidorn, 2018). To conclude, although personality traits are relatively stable in middle adulthood, personality trait changes occur during this period. These findings raise questions about the sources and mechanisms of personality change during this hitherto relatively understudied life stage.

Theoretical Perspectives on the Relation between Traits and Daily Experiences

Different theories of personality development have emphasized different pathways to connect personality traits and daily psychological experiences. *Endogenous* personality theories, such as five factor theory (McCrae & Costa, 2008; McCrae & Sutin, 2018), posit that that the causal relation between personality traits and psychological experiences is unidirectional. According to this perspective, personality traits are distal causes of daily experiences because traits set in motion various downstream processes (cognitive, behavioral, emotional, and motivational) that, together with environmental influences, produce individual differences in psychological experiences. For example, compared to individuals scoring low on trait agreeableness, highly agreeable individuals may be inclined to act kindly, generously, and cooperatively towards close others, and, as a result, may come to experience higher levels of positive affect and relationship support in their daily lives. According to endogenous personality theories, changes in personality traits are exclusively influenced by processes of intrinsic maturation, which includes genetic influences and any other biological process that affects the brain, such as a traumatic brain injury. As such, individual differences in psychological experiences, such as relationship support and positive affect, should have no influence on individual differences in trait development (McCrae & Sutin, 2018).

In contrast, *dynamic* theories of personality development propose that the causal relation between personality traits and daily psychological experiences is bidirectional: Traits and experiences are assumed to influence each other continuously over time (Endler & Parker, 1992; Magnusson, 1990; Roberts et al., 2008). That is, personality traits not only predispose people to certain psychological experiences, but experiences, in turn, can also impact people's personality traits through their influence on momentary or daily thoughts, feelings, and behaviors (i.e., states). As such, contemporary dynamic personality theories emphasize the accumulation of daily experiences and people's short-term responses to daily experiences as key mechanisms of personality trait change throughout life (Fajkowska, 2018; Geukes et al., 2017; Roberts, 2018; Roberts & Jackson, 2008; Wrzus & Roberts, 2017; for an integrative summary, see Baumert et al., 2017). For example, daily experiences

of positive affect and relationship support may repeatedly stimulate kind, generous, and cooperative behaviors. According to dynamic perspectives, individual differences in these behaviors/states may in turn lead to differential changes in agreeableness via biological mechanisms (e.g., changes in gene expressions and neuroanatomical structures), associative mechanisms (e.g., implicit learning, reinforcement learning, and habit formation), and/or reflective mechanisms (e.g., conscious memories about one's past states) (Baumert et al., 2017; Roberts, 2018; Wrzus & Roberts, 2017).

Past Research on Dynamic Transactions between Personality Traits and Daily Experiences

A large body of research has shown that Big Five traits are associated with individual differences in affective and interpersonal experiences. Specifically, high levels of emotional stability, agreeableness, conscientiousness, and particularly extraversion have been related to more frequent and higher levels of momentary, daily, and trait levels of positive affect (Ching et al., 2014; Costa & McCrae, 1980; Eid & Diener, 1999; Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Lucas & Baird, 2004; Lucas, Le, & Dyrenforth, 2008; McCrae & Costa, 1991) and higher levels of relationship quality and support (Asendorpf & van Aken, 2003; Branje et al., 2004; Lopes, Salovey, & Straus, 2003; Neyer & Lehnart, 2007; Noftle & Shaver, 2006). What processes account for these associations?

Consistent with both endogenous and dynamic perspectives, several lines of past research have suggested that these associations may, at least partly, be driven by downstream effects of personality traits on experiences. Personality traits have been found to prospectively predict important life outcomes and experiences (e.g., Denissen, Luhmann, Chung, & Bleidorn, 2018), including interpersonal experiences, such as relationship formation, support, closeness, and conflict (Asendorpf & van Aken, 2003; Asendorpf & Wilpers, 1998; Mund & Neyer, 2014; Neyer & Asendorpf, 2001; Selfhout et al., 2010; Zimmermann & Neyer, 2013). Findings that (changes in) personality traits are heritable (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009; Briley & Tucker-Drob, 2017; Vukasović & Bratko, 2015) and related to biological variables such as brain structures (DeYoung et al., 2010) and allostatic load (i.e., stress; Stephan, Sutin, Canada, & Terracciano, 2017) are also consistent with the idea that traits predispose individuals to certain experiences.

In contrast to the relatively broad evidence for the predictive power of traits, relatively little is known about the impact of everyday experiences on personality traits. Consistent with endogenous perspectives that psychological experiences are unrelated to changes in personality traits, some studies have found that changes in personality traits were not related to previous relationship experiences (Asendorpf & van Aken, 2003; Asendorpf & Wilpers, 1998; Branje et al., 2004) and not or weakly related to previous major life transitions such as parenthood and divorce (Denissen et al., 2018; Van Scheppingen et al., 2016).

However, there is also evidence consistent with the premise of dynamic theories that (daily) psychological experiences can affect personality traits. For example, some evidence has suggested that the experience of social role demands, particularly in the domains of work and the first romantic relationship, lead to personality trait changes (Bleidorn et al., 2018; Denissen et al., 2014). Moreover, some studies have found that personality traits do not only predict changes in relationship experiences, but that relationship experiences also predict subsequent changes in personality traits (for reviews, see Mund, Finn, Hagemeyer, & Neyer, 2016; Wrzus & Neyer, 2016; Wrzus, Zimmermann, Mund, & Neyer, 2016). For example, Mund and Neyer (2014) have found bidirectional longitudinal relations between the Big Five traits and relationship conflict, closeness, insecurity, and contact frequency. Finally, and more directly related to the present research, two recent measurement burst studies have found that daily experiences were associated with subsequent rank-order changes in personality traits (Borghuis, Bleidorn, et al., 2017). These studies incorporated bursts of momentary/daily assessments of participants' experiences into a multi-wave longitudinal design. Measurement burst designs are particularly well-suited for the investigation of dynamic transactions between traits and daily experiences because they link participants' momentary or daily reports of everyday experiences to long-term changes in personality traits. Given these studies' relevance to the present research, we next discuss their designs and results in more detail.

Wrzus and colleagues' (2017) 6-year longitudinal study contained three assessment bursts during which over 500 participants (aged 14 to 86 years old) provided daily reports of their negative affect and hassles (i.e., unpleasant experiences or thoughts). They found that increases in participants' average level of daily negative affect and the extent to which hassles resulted in negative affect (i.e., their short-term hassle reactivity) predicted rank-order decreases in trait emotional stability across two 3-year intervals. They did not find consistent longitudinal effects on any other of the Big Five traits, nor did they find evidence for effects of personality traits on changes in negative affect, hassle occurrence, or hassle reactivity.

Replicating these findings, Borghuis, Bleidorn et al. (2017) examined the longitudinal associations between the Big Five personality traits (measured yearly) and daily experiences of negative affect and relationship conflict (measured in three bursts of 5 daily assessments in-between the trait measurements) across 5 years in a sample of more than 1,000 Dutch adolescents. They have found ample evidence that daily experiences of negative affect and interpersonal problems were associated with subsequent rank-order decreases in trait emotional stability, extraversion, agreeableness, and conscientiousness. By contrast, they have found comparatively little evidence that personality traits were also associated with rank-order changes in daily experiences. Moreover, they found that mutually reinforcing, bidirectional longitudinal effects between emotional stability and daily negative affect

produced an indirect effect – of initial emotional stability on emotional stability one year later via intervening individual differences in daily negative affect – that partly accounted for the rank-order stability of emotional stability. This finding suggests that individual differences in emotional stability stabilized because adolescents scoring relatively low on emotional stability were more likely to experience negative affect, which further solidified previously existing individual differences in emotional stability. This mediation effect is consistent with the idea that positive feedback loops between states and traits stabilize individual differences (Dingemanse & Wolf, 2010; Kandler et al., 2010; Luttbeg & Sih, 2010; Roberts & Caspi, 2003; Sih & Bell, 2008).

To summarize, past evidence has been mixed and mostly indirect with regard to the question how daily psychological experiences are longitudinally related to personality traits. Two recent measurement burst studies have found longitudinal effects of negative daily experiences on rank-order changes in personality traits. These findings raise the question whether and how other daily experiences, such as positive affect and relationship support, are associated with rank-order stability and change in personality traits.

The Roles of Positive vs. Negative Daily Experiences in Personality Trait Development

Researchers have discussed two ways in which valence may moderate the links between daily experiences and change in personality traits. First, valence may moderate the direction of effects, with negative experiences (i.e., unpleasant emotional or situational experiences) generally leading to negative personality trait changes, and positive experiences generally leading to positive personality changes (e.g. Soto, 2015). Recurrent negative experiences may eventually lead to negative personality trait changes because they tend to trigger negative thoughts, feelings, and behaviors that may be related to, for example, low levels of extraversion (e.g., withdrawal), emotional stability (e.g., anxiousness), and agreeableness (e.g., anger, self-focus). In contrast, positive experiences tend to elicit positive thoughts, feelings, and behaviors that may be related to high levels of extraversion (e.g., affiliation), agreeableness (e.g., altruism), conscientiousness (e.g., mastery, persistence), emotional stability (e.g., even-temperedness), and openness (e.g., creativity, exploration) (Ching et al., 2014; Isen, 1999; Judge, Simon, Hurst, & Kelley, 2014; Soto, 2015; Wilson, Thompson, & Vazire, 2017). To the degree that states can influence traits (Wrzus & Roberts, 2017), recurrent positive (negative) daily experiences should eventually lead to positive (negative) personality trait changes, as indicated by increases (decreases) in extraversion, agreeableness, conscientiousness, emotional stability, and perhaps also openness to experience (cf. Soto, 2015).

Second, researchers have suggested that valence may moderate the size of effects, with negative experiences having a stronger impact on personality traits than positive experiences

(Wrzus & Roberts, 2017). This perspective is based on research showing that negative experiences tend to elicit stronger short-term physiological, affective, cognitive, and behavioral responses and lead to more cognitive reflection than positive experiences (for reviews, see Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Labianca & Brass, 2006; Taylor, 1991). For example, effects of relationship conflict on stress and rumination may be stronger than the effects of relationship support on altruism and affiliation (Isen, 1999), because negative interpersonal information is generally less ambiguous, less expected, and more consequential for survival and reproduction than positive information (Labianca & Brass, 2006). Consistent with this reasoning, past research has suggested that negative relationship experiences have a larger and more enduring impact on outcomes such as life satisfaction, mood, illness, stress (Labianca & Brass, 2006), and personality traits (Mund & Neyer, 2014) than positive relationship experiences.

To summarize, theory and research have suggested that positively valenced daily psychological experiences (e.g., positive affect, relationship support) may be associated with positive personality trait changes, such as rank-order increases in extraversion and emotional stability, but their impact may be smaller than the impact of negatively valenced daily psychological experiences (e.g., negative affect, relationship conflict). However, to the best of our knowledge, the differential effects of positive versus negative daily experiences on personality traits have not been tested in longitudinal measurement burst data.

The Present Study

We investigated the longitudinal associations between individual differences in personality traits and positive daily experiences in a sample of middle-aged women. Data came from 483 Dutch mothers who participated as part of a broader longitudinal study on the psychosocial development of adolescents.[7] Participating mothers completed 6 personality trait measurements (once each year) and 15 assessment bursts (3 bursts in-between each yearly trait measurement). During assessment bursts, they reported about the quality of their daily affective and interpersonal experiences. We focused on participants' daily perceived relationship support from their intimate partner as well as from their adolescent child, thereby exploring potential differences between these relationships. These relationships may be differentially related to personality because support may have a different meaning, origin, and occurrence frequency and may trigger different responses in intimate partner relationships compared to parent-child relationships (Branje et al., 2004). In intimate partner relationships, which are typically balanced, dyad members may tend to reciprocate support/affection (Trivers, 1971). Therefore, partner support may be particularly related to

7 Participants are the mothers of adolescents whose data were analyzed by Borghuis, Bleidorn et al. (2017). These authors examined dynamic transactions between negative daily experiences and the Big Five in adolescence. None of the data analyzed in the current study have been published elsewhere.

agreeableness. In parent-child relationships, which are not equal, support from a child may signal effective parenting practices. Therefore, child support may be particularly related to conscientiousness.

We tested three hypotheses. First, consistent with endogenous and dynamic personality theories, we hypothesized that higher levels of trait extraversion, agreeableness, conscientiousness, and emotional stability are associated with 1-year rank-order increases in daily positive affect and relationship support (Hypothesis 1). Second, consistent with dynamic perspectives but inconsistent with endogenous perspectives, we hypothesized that higher levels of daily positive affect and relationship support are associated with 1-year rank-order increases in extraversion, agreeableness, conscientiousness, and emotional stability (Hypothesis 2). Third, based on theory suggesting that a positive state-trait feedback loop stabilizes individual differences (e.g., Dingemanse & Wolf, 2010) and preliminary supporting evidence (Borghuis, Bleidorn, et al., 2017), we hypothesized that bidirectional longitudinal associations between personality traits and daily experiences partly account for the 1-year rank-order stabilities of extraversion, agreeableness, conscientiousness, and emotional stability (Hypothesis 3).

Given mixed evidence concerning the associations between openness and positive affect (Ching et al., 2014; Eid & Diener, 1999; Kuppens et al., 2007; Leger, Charles, Turiano, & Almeida, 2016) and between openness and relationship quality/support (Branje et al., 2004; Noftle & Shaver, 2006), we adopted an exploratory approach to examining these longitudinal associations. In a follow-up analysis, we also examined exploratory the dynamic transactions between positive daily experiences and personality traits controlled for the effects of daily negative affect and relationship conflict. The goals were to evaluate whether positive daily experiences demonstrated incremental validity in predicting personality change over and above negative experiences, and whether the effect magnitudes on personality change differed between positive and negative daily experiences. Finally, because the general shape of long-term personality trait development has been studied relatively little in middle adulthood, we also explored the mean-level development and individual differences in change in the Big Five traits across the entire study period. We uploaded our hypotheses and statistical analysis plan after we received the data but before we tested the hypotheses (https://osf.io/uj2dr/).

Method

Research Design and Procedures

Data came from the RADAR-Young (Research on Adolescent Development and Relationships – younger cohort) study (Van Lier et al., 2011), which is an ongoing prospective

cohort-sequential study of Dutch-speaking families in the Netherlands. The RADAR study includes data collected from 497 Dutch target adolescents (who were on average 13 years old at the first assessment wave) and their parents/caregivers, self-nominated best friends, and siblings. In this study, we used data from the target adolescents' *mothers* collected between 2005 and 2010. Target adolescents were recruited from randomly selected elementary schools in the western and central regions of the Netherlands. Participants received written information about the aim of the study and parents provided informed consent of all participating family members.

Big Five personality traits were measured during yearly home interviews, which took place in February or March. Daily affective and interpersonal experiences were measured during three bursts of online daily assessments, which took place in June, September, and December – that is, in-between the yearly trait measurements. Each between-year assessment burst spanned five consecutive days (from Monday to Friday), adding up to 15 daily assessments per year. Participants with missing data during the assessment bursts were invited to participate in catch-up assessment bursts two weeks later. Assessment weeks always covered the weekdays of a normal school week of the adolescent. At approximately 5:30 p.m., participants were invited through email to participate in an online daily dairy assessment. Participating families received €100 for each home visit, which lasted approximately 2.5 hours. Participants received an additional €10 for each weekly internet assessment that they completed. The RADAR study has been approved by the Medical Ethical Testing Committee of the Utrecht University Medical Centre (protocol number 05-159/K; "RADAR: Research on Adolescent Development and Relationships"). We made openly accessible online the part of the data (https://osf.io/x7pgq/) and measures (https://osf.io/q9jy3/) that the RADAR management team has granted us access to.

Participants and Missing Data

After excluding 13 participants who did not provide at least one yearly personality trait report and at least one daily report about positive affect or relationship support, the sample consisted of N = 483 mothers. Mean age was 44 years at the first measurement occasion (range: 33 – 64, SD = 4.36). Participants were predominantly native Dutch (94%) and part-time or full-time employed (75%). Most participants lived together with their partner (88%). By design, they had at least one child who was 13 years old at the first measurement occasion. Based on teacher ratings of children's externalizing behavior, the RADAR study oversampled adolescents who were at risk of developing delinquent behaviors. Despite this oversampling, participating RADAR families on average had a higher socio-economic status than the general Dutch population, because most were of middle to high socio-economic status (91%). (For more elaborate descriptions of the procedures and participants, see Keijsers et al., 2012; Neumann, van Lier, Frijns, Meeus, & Koot, 2011).

Sixty-seven mothers (14%) participated in the first trait measurement but not in the last trait measurement. Attrition analyses indicated that these dropouts were more agreeable at the first trait measurement than participants who participated in both the first and the last wave ($t(89.45) = 2.67$, $p = .009$, $d = 0.35$). They did not significantly differ with regard to the other Big Five traits, nor with regard to their average level of positive affect, negative affect, relationship support, and relationship conflict across the first three assessment bursts. The proportion of data that were missing ranged for the Big Five from 0.4% (first measurement) to 14.1% (sixth measurement), and for the assessment bursts from 11.6% (positive affect during the first three bursts) to 45.9% (relationship support from partner during the last three bursts). Almost all participants (98%) had missing data on at least one measure. We handled missing data using MLR estimation (i.e., maximum likelihood estimation with robust standard errors).

Measures

Personality traits. Big Five personality traits were measured using the shortened Dutch version of Goldberg's Big Five questionnaire (Vermulst & Gerris, 2005). Participants received the following instruction: "In the following list you see words about characteristics of people. Please answer to what extent each of these characteristics apply to you. Try to answer as honestly as possible, even if you dislike it that this characteristic applies to you." This instruction was followed by 30 adjectives – six per personality dimension – such as "talkative" (extraversion), "friendly" (agreeableness), "systematic" (conscientiousness), "worried" (emotional stability, reverse coded), and "creative" (openness). Response categories ranged from 1 (*completely untrue*) to 7 (*completely true*). The range of coefficient alphas (Cronbach, 1951) across the six trait measurements was: extraversion (.89 – .91); agreeableness (.85 – .90); conscientiousness (.90 – .91); emotional stability (.84 – .88); and openness (.87 – .88). We established longitudinal scalar measurement invariance (i.e., consistent item loadings and intercepts) for all Big Five traits across the six measurements (ΔCFIs $\leq .007$; ΔRMSEAs $\leq .003$).

Daily positive and negative affect. On each day during the assessment bursts, participants rated their affect level using the Happiness, Anger, Anxiety, and Sadness subscales of the Daily Mood Device (Hoeksma et al., 2000). Mothers were asked in the late afternoon to rate the intensity of their emotional experiences of that particular day ("Please answer below how you feel today") using 9-point Likert scales (e.g., from 1 = *not happy* to 9 = *happy*; from 1 = *not afraid* to 9 = *afraid*). We measured daily positive affect by averaging participants' scores on the adjectives "happy," "cheerful," and "lively". We measured daily negative affect by averaging scores on "angry," "cross," "short-tempered," "sad," "down," "dreary," "afraid," "anxious," and "worried". Nested coefficient alpha values (items nested in assessment days nested in participants; Nezlek, 2017) were substantial for positive affect

(.94) and negative affect (.88). An analysis of within- and between-person variance (using the *statsBy* function of the *psych* package in R; Revelle, 2017) indicated that, across all 75 daily assessments structured in long format, 42% of the total variance in positive affect was attributable to stable between-person differences in positive affect (i.e., the ICC1 coefficient was .42). The ICC1 coefficient for negative affect was .62. When aggregated across the three adjacent assessment bursts that were administered each year, participants differed reliably from each other in their average levels of positive and negative affect (i.e., ICC2 coefficients ranged between .91 and .97). We established longitudinal scalar measurement invariance for our yearly measure of positive affect across the study period, using the 15 daily reports per year as indicator variables of yearly aggregated levels of positive affect (ΔCFIs $\leq$ .003; ΔRMSEAs $\leq$ .001).

Daily relationship support and conflict. During assessment bursts, mothers also reported the extent to which they experienced relationship support/affection and conflicts with their child and intimate partner, using four items based on the Support and Negative Interaction scales of the Network of Relationship Inventory (Furman & Buhrmester, 1985). We measured relationship support/affection with the questions "How pleasant was your relationship with your child/partner today" and "Did your child/partner show that he/she cares about you today?". We measured relationship conflict with the questions "Did you and your child/partner get on each other's nerves today?" and "Did you and your child/partner quarrel today?". Response categories ranged from 1 = *not at all* to 7 = *very much*. Nested coefficient alpha values (items nested in assessment days nested in participants) were moderate to substantial for relationship support from child (.47), support from partner (.59), conflict with child (.79), and conflict with partner (.66). ICC1 coefficients, indicating the proportion of variance attributable to between-person differences, were .41 for relationship support from child, .48 for relationship support from partner, .37 for conflict with child, and .43 for conflict with partner. Yearly ICC2 coefficients, indicating the reliability of individual differences in average levels across three assessment bursts, ranged from .91 to .94 for relationship support, and ranged from .82 to .90 for relationship conflict. We established longitudinal scalar measurement invariance for our yearly measure of positive affect across the study period, using the 15 daily reports per year as indicator variables of yearly aggregated levels of relationship support from partner (ΔCFIs $\leq$ .001; ΔRMSEAs $\leq$ .001) and child (ΔCFIs $\leq$ .002; ΔRMSEAs $<$ .001).

Statistical Analyses

First, we estimated the longitudinal relations between individual differences in the Big Five and daily experiences using Mplus version 7 (Muthén & Muthén, 1998-2012), by means of the *MplusAutomation* package (Hallquist & Wiley, 2017) in R. Because we had

multilevel data, with up to 15 daily reports varying each year within and between persons[8], we used multilevel structural equation modelling (Preacher, Zyphur, & Zhang, 2010) to test our hypotheses. This approach allowed us to estimate the within- and between-person parameters simultaneously in one model, while taking into account missing data on both levels. We used manifest personality variables in the multilevel SEM analyses to limit model complexity and ensure model convergence.

We estimated 15 (3 daily experience dimensions × 5 trait dimensions) statistical models to test our hypotheses. Each model tested all three hypotheses (i.e., personality effects on daily experiences; daily experience effects on personality; and indirect effects between adjacent personality trait measurements via daily experiences) for a specific personality trait-daily experience combination. We tested all hypotheses at the between-persons level.

To test Hypotheses 1 and 2, Models 1a-3a (Figure 3.1) estimated bidirectional longitudinal effects between the individual differences in the Big Five and individual differences in daily levels of positive affect (Model 1a), daily levels of support from partner (Model 2a), and daily levels of support from child (Model 3a). These models contained random intercepts, which decomposed the total variance of daily positive affect/relationship support per year into between-person variance, reflecting individual differences in *average* levels across three measurement bursts, and within-person (residual) variance not accounted for by between-person differences. The 'between' part of the model is similar to the more familiar autoregressive cross-lagged panel model (CLPM). Specifically, the models estimated whether rank-order differences in Big Five traits were associated with later rank-order differences in daily positive affect/support, controlling for previous rank-order differences in daily positive affect/support one year earlier (and vice versa).

We tested Hypothesis 3 that the indirect effects (paths 'a'×'b') are statistically significant using the Delta (or Sobel) method (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). A statistically significant, positive indirect effect indicates that dynamic transactions explained part of the temporal consistency in participants' rank-order position on a personality traits dimension.

In Models 1b-3b (Figure 3.2), we tested Hypotheses 1-3 again while controlling for the effects of each positive experience's negative counterpart. That is, in Model 1b we controlled for negative affect; in Model 2b we controlled for daily conflict with partner; and in Model 3b we controlled for daily conflict with child. In each model, we allowed negative and positive experiences to covary within and between persons.

8 We structured the data in a mixed long-wide format, with at most 15 rows per participant. For example, the data column 'BF11MMext' contained for each mother up to 15 rows of time-invariant (between-person) data on the 1st extraversion measurement; the column 'posaffect5' contained for each participant up to 15 rows of time-varying (within-person) daily positive affect data collected during the last three assessment bursts (i.e., the 5th year).

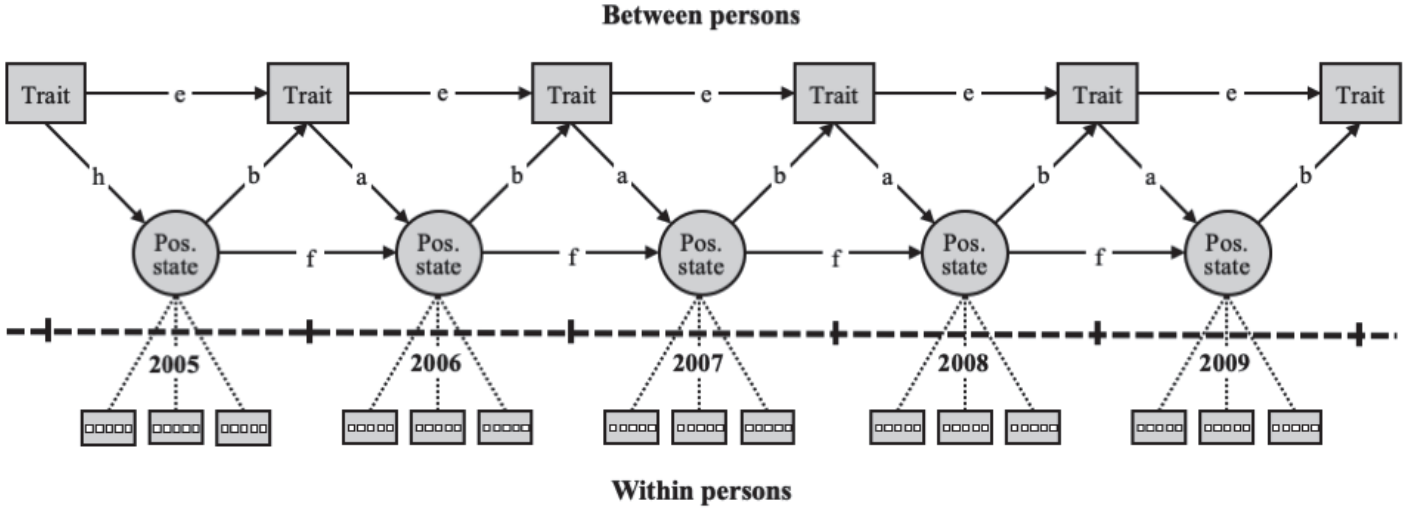

Figure 3.1. Multilevel SEM for estimating bidirectional longitudinal regression effects between yearly measured Big Five personality traits and daily measured positive experiences ('Pos. state'). Model 1a, 2a, and 3a estimated dynamic transactions with positive affect, relationship support from partners, and relationship support from children, respectively. Each year, we measured daily experiences using three assessment bursts that each lasted five consecutive days. Observed variables are shown in rectangles and latent variables are shown in circles. The latent variables in the 'between' part of the model reflect individual differences in average levels of daily positive affect/relationship support, estimated by means of a random intercept. We constrained path coefficients with identical letters to be equal. We omitted (residual) variances and the effects of control variable age to enhance clarity. Path 'h' estimated the initial association between personality traits and (unresidualized) between-person differences in daily experiences.

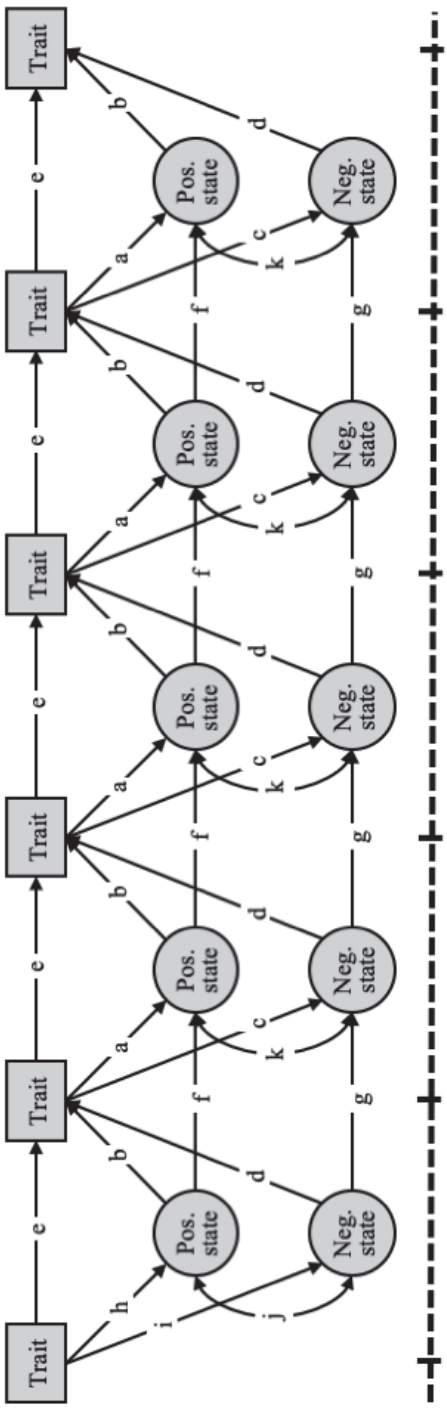

Figure 3.2. Simplified representation of our multilevel SEM for estimating bidirectional longitudinal regression effects between yearly measured Big Five personality traits and daily measured positive experiences controlled for the daily measured negative counterparts of these experiences. We omitted (residual) variances, the effects of control variable age, and the 'within persons' part of the model to enhance clarity. Models 1b included positive and negative affect, Model 2b included relationship support and conflict with partners, and Model 3b included relationship support and conflict with children. Bidirectional curved arrow indicate that positive and negative experiences were allowed to covary within and between persons. See Figure 3.1 for more explanation.

We accounted for mean-level changes across the study period in personality traits and daily experiences by allowing the regression intercepts to vary across time. We accounted for potentially confounding age effects on individual differences in personality traits and daily experiences by including age as a covariate in all models. We constrained all equivalent regression paths to be equal over time because χ^2-difference tests for nested models indicated that this did not significantly reduce model fit (*df* = 21; *p*-values > .05). The equality constraints reduced the complexity of our statistical models and ensured that we estimated each hypothesized cross-lagged association only once using data from all assessments. This made the results easier to interpret and increased statistical power.

We used MLR estimation in all models, which estimated model parameters using maximum likelihood and computed standard errors that were robust to non-normality of observations. We applied a Bonferroni-corrected significance level equal to $\alpha = .05/15 = .0033$ (two-sided) because we tested each direct and indirect effect 15 times, once in each of the 15 statistical models. We applied the same significance level of $\alpha = .0033$ in the exploratory analyses that controlled for negative daily experiences. A simplified a priori power analysis using simulation in R suggested that we had sufficient statistical power ($1 - \beta \geq .80$) to detect cross-lagged effects with β's $\geq .05$.[9] The Mplus syntaxes of our multilevel SEMs and the complete results can be found at https://osf.io/rvp9n/. The R script that we used to prepare the data, to conduct the LGCM analyses, and to run the Mplus models can be found at https://osf.io/cdev3/.

Second, we estimated mean-level and individual-level growth trajectories across the entire study period by means of univariate latent growth curve analyses (Duncan, Duncan, Strycker, Li, & Alpert, 1999) using the *lavaan* (0.5-23.1097) package (Rosseel, 2012) in R (R Core team, 2016; version 3.4.3). First, we estimated and plotted quadratic growth trajectories on latent Big Five variables (i.e., second-order latent growth curve models). We applied indictor-specific method factors for the Big Five traits, using the *M* – 1 approach (Geiser & Lockhart, 2012). For each trait, we selected the item with the highest factor loading as reference item. The *M* - 1 approach is more parsimonious and has better psychometric properties than allowing the residuals of the same items to covary over time (Geiser & Lockhart, 2012).

Third, we examined associations between the intercept factors and linear change factors of all study variables. For the Big Five, we re-estimated the second-order latent growth curve models after removing the quadratic slope factors. For the daily experience variables, we estimated linear growth trajectories using five observed variables that reflect participants'

9 We randomly generated 10.000 studies resembling the 'between' part of Models 1a-3a, with the following population parameters (see Figure 1 for path labels): $\beta_c = .80$; $\beta_f = .90$; $\beta_h = .30$; $\beta_a = .05$; $\beta_b = .05$; $N = 450$; $\alpha = .0033$. The results of these studies indicate that our power was .97 and .83 with respect to path 'a' and 'b', respectively. The R code of this simulation can be found at https://osf.io/cdev3/.

daily experiences averaged across the 15 daily observations per year. We correlated the intercept and linear change factors after saving them using the 'lavPredict' function of the *lavaan* package.

Results

Descriptive statistics of all study variables are reported in Table 3.1.

Table 3.1. Descriptive statistics

Variable	Year	*n*	*M*	*SE*	*SD*	Min.	Max.
Extraversion	1	481	5.06	0.05	1.13	1.83	7.00
	2	457	5.17	0.05	1.14	2.00	7.00
	3	451	5.16	0.05	1.12	1.00	7.00
	4	438	5.24	0.05	1.14	1.50	7.00
	5	420	5.27	0.05	1.12	2.00	7.00
	6	415	5.22	0.06	1.13	1.67	7.00
Agreeableness	1	481	5.81	0.03	0.60	3.17	7.00
	2	457	5.85	0.03	0.59	2.67	7.00
	3	451	5.89	0.03	0.57	3.67	7.00
	4	438	5.88	0.03	0.64	1.00	7.00
	5	420	5.93	0.03	0.62	3.50	7.00
	6	415	5.90	0.03	0.62	3.33	7.00
Conscientiousness	1	481	5.11	0.05	1.06	1.67	7.00
	2	457	5.14	0.05	1.05	1.33	7.00
	3	451	5.19	0.05	1.04	1.17	7.00
	4	438	5.22	0.05	1.05	1.83	7.00
	5	420	5.27	0.05	1.00	2.00	7.00
	6	415	5.24	0.05	1.02	2.17	7.00
Emotional stability	1	481	4.51	0.05	1.06	1.33	7.00
	2	457	4.68	0.05	1.08	1.17	7.00
	3	451	4.74	0.05	1.11	1.33	7.00
	4	438	4.79	0.05	1.12	1.67	7.00
	5	420	4.84	0.06	1.13	1.83	7.00
	6	415	4.82	0.06	1.14	1.67	7.00
Openness	1	481	4.72	0.05	1.10	1.83	7.00
	2	457	4.74	0.05	1.07	1.83	7.00
	3	451	4.72	0.05	1.12	1.17	7.00
	4	438	4.73	0.05	1.11	1.83	7.00
	5	420	4.73	0.05	1.12	1.33	7.00
	6	415	4.78	0.05	1.09	1.67	7.00

Table 3.1. Descriptive statistics *(continued)*

Variable	Year	*n*	*M*	*SE*	*SD*	Min.	Max.
Positive affect	1	481	20.65	0.17	3.66	9.00	27.00
	2	454	20.52	0.18	3.80	8.67	27.00
	3	434	20.33	0.19	3.95	7.13	27.00
	4	417	20.44	0.19	3.91	8.67	27.00
	5	391	20.25	0.21	4.14	5.82	27.00
Negative affect	1	481	6.01	0.13	2.77	3.00	19.33
	2	454	6.19	0.14	3.02	3.00	21.85
	3	434	6.21	0.15	3.08	3.00	18.48
	4	417	6.11	0.16	3.21	3.00	18.60
	5	391	6.30	0.18	3.51	3.00	19.40
Rel. support partner	1	481	10.84	0.07	1.48	5.00	14.00
	2	453	10.70	0.07	1.52	6.00	14.00
	3	434	10.51	0.08	1.58	4.93	14.00
	4	412	10.55	0.08	1.56	5.18	14.00
	5	391	10.47	0.08	1.66	4.64	14.00
Rel. support child	1	451	10.60	0.08	1.78	2.00	14.00
	2	425	10.64	0.08	1.72	2.87	14.00
	3	404	10.63	0.09	1.72	2.54	14.00
	4	381	10.70	0.09	1.70	3.29	14.00
	5	356	10.65	0.09	1.70	4.20	14.00
Rel. conflict partner	1	481	3.65	0.06	1.42	2.00	9.00
	2	453	3.72	0.07	1.43	2.00	8.67
	3	434	3.80	0.07	1.50	2.00	8.33
	4	412	3.61	0.08	1.53	2.00	10.00
	5	391	3.60	0.08	1.52	2.00	9.00
Rel. conflict child	1	451	3.32	0.06	1.36	2.00	11.00
	2	425	3.45	0.07	1.49	2.00	11.00
	3	404	3.43	0.07	1.49	2.00	10.00
	4	381	3.38	0.07	1.45	2.00	8.62
	5	356	3.35	0.07	1.40	2.00	8.11

Note: N = 483. The daily affect and relationship variables were averaged across three assessment bursts that were administered each year.

Cross-Lagged Analysis

Models 1a, 2a, and 3a, which we estimated separately for each Big Five trait, fit the data acceptably (CFIs = .88–.93; RMSEAs = .02; $SRMR_{within}$ = .02–.03; $SRMR_{between}$ = .07–.10; Table S3.1). Table 3.2 shows the rank-order stabilities (paths 'e' and 'f' in Figures 3.1 and 3.2), the initial associations between the Big Five traits and the daily experiences (paths 'h'), and their cross-lagged associations (paths 'a' and 'b'). Note that the effect sizes of the cross-lagged paths should be interpreted in the light the rank-order stabilities of the two variables

Table 3.2. Rank-order stabilities of positive daily experiences, initial associations between the Big Five traits and positive daily experiences, and cross-lagged regression effects

		Stability		Initial association Trait ~ Daily exp.				Trait → rank-order change Daily exp.				Daily exp. → rank-order change Trait			
Trait	Daily experience	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
Ext.	Positive affect	**.90**	.01	**.29**	.88	.15	<.001	.02	.08	.04	.038	**.06**	.02	.00	<.001
	Rel. support partner	**.91**	.01	**.21**	.29	.07	<.001	.00	.00	.02	.934	**.04**	.03	.01	<.001
	Rel. support child	**.90**	.01	.14	.17	.06	.006	.03	.04	.02	.025	**.04**	.03	.01	<.001
Agr.	Positive affect	**.90**	.01	**.23**	1.30	.28	<.001	.03	.20	.07	.007	**.14**	.02	.00	<.001
	Rel. support partner	**.91**	.01	**.21**	.55	.14	<.001	.01	.02	.03	.474	**.07**	.03	.01	<.001
	Rel. support child	**.90**	.01	**.28**	.65	.12	<.001	.02	.06	.03	.083	**.10**	.04	.01	<.001
Con.	Positive affect	**.90**	.01	**.23**	.73	.15	<.001	.01	.04	.04	.290	**.06**	.02	.00	<.001
	Rel. support partner	**.92**	.01	.14	.22	.08	.006	-.01	-.02	.02	.323	**.04**	.02	.01	<.001
	Rel. support child	**.90**	.01	**.19**	.24	.06	<.001	.00	.00	.02	.855	**.04**	.03	.01	<.001
Emo.	Positive affect	**.89**	.01	**.33**	1.05	.14	<.001	**.04**	.16	.05	.002	**.14**	.04	.00	<.001
	Rel. support partner	**.91**	.01	.10	.15	.07	.039	.02	.02	.02	.200	**.04**	.03	.01	.001
	Rel. support child	**.90**	.01	**.19**	.24	.06	<.001	.02	.03	.02	.060	**.06**	.05	.01	<.001
Ope.	Positive affect	**.90**	.01	.16	.50	.14	.001	.01	.04	.04	.341	**.04**	.01	.00	<.001
	Rel. support partner	**.91**	.01	**.18**	.27	.07	<.001	.00	.00	.02	.885	.02	.02	.01	.015
	Rel. support child	**.90**	.01	**.24**	.30	.06	<.001	.03	.04	.02	.035	**.04**	.03	.01	<.001

Note. Standardized and unstandardized regression coefficients from 15 (i.e., 5 trait dimensions × 3 daily experience dimensions) separate multilevel SEMs (Models 1a-3a). The rank-order stabilities of the personality traits (not tabulated) were β = .82 (*SE* = .01) for extraversion; β = .67 (*SE* = .02) for agreeableness; β = .82 (*SE* = .01) for conscientiousness; β = .78 (*SE* = .02) for emotional stability; and β = .86 (*SE* = .01) for openness. We controlled all associations for age. *N* = 483. Because we allowed (error) variances to freely vary over time, β's varied slightly across time lags; therefore, we report average β's.
Bold coefficients: $p < .0033$ (significance level after Bonferroni correction).

in the model and their concurrent association (paths 'h'; see also the intercept-intercept correlations of Table 3.5). Small cross-lagged effects (e.g., β < .10) are more meaningful if rank-order stabilities and concurrent associations are large than if they are small (Adachi & Willoughby, 2015).

Stability effects. We found high (β's ≥ .89) 1-year rank-order stabilities for the random intercepts of daily positive affect and relationship support. These stability coefficients exceeded the 1-year stabilities of the personality trait measures, which ranged from β = .67 (agreeableness) to β = .86 (openness). The high stabilities implied that most of the variance in our measures of personality traits and aggregated daily experiences was accounted for by participants' scores on the same measure one year earlier. Given the relatively small residual variance, we expected cross-lagged associations to be small.

Cross-lagged personality effects on positive daily experiences. We found little evidence for Hypothesis 1 that extraversion, agreeableness, conscientiousness, and emotional stability are associated with rank-order increases in positive affect and relationship support. Except for the positive effect of emotional stability and daily positive affect, none of the predicted associations were statistically significant after Bonferroni correction.

Cross-lagged positive daily experience effects on personality. Supporting Hypothesis 2, we found that daily experiences of positive affect and relationship support were associated with rank-order increases in extraversion, agreeableness, conscientiousness, and emotional stability. We further found that daily positive affect and relationship support from child were associated with rank-order increases in openness. The strongest cross-lagged associations were the effects of positive affect on emotional stability (β = .14) and agreeableness (β = .14).[10]

Indirect stability effects. We found no support for Hypothesis 3 that dynamic transactions between daily experiences and traits account for the 1-year rank-order stability of personality traits. Although emotional stability predicted rank-order change in positive affect as well as vice versa, the indirect effect from emotional stability to daily positive affect to subsequent emotional stability was not statistically significant after Bonferroni correction (*indirect effect* = .006, *SE* = .002, $p = .004 > \alpha = .0033$).

Exploratory analysis: Incremental predictive validity of positive and negative daily experiences. Models 1b, 2b, and 3b, in which we controlled for the negative counterpart of each positive daily experience variable, provided an excellent fit to the data (CFIs = .97–.98; RMSEAs = .01–.02; $SRMR_{within}$ = .03; $SRMR_{between}$ = .05–.08; Table S3.2). Table 3.3 shows that, when we included the measures of positive affect and negative affect in the same model,

10 We conducted a sensitivity analysis in which we excluded all data of every third assessment burst to investigate the possibility that the daily experience effects on rank-order change in personality traits were driven by the most recently measured daily experiences, which were assessed a few months before the next trait measurement. The results (Table S3) are very similar to the results of Table 2.

Table 3.3. Rank-order stabilities of positive and negative daily experiences, initial associations between the Big Five traits and daily experiences, and cross-lagged regression effects

		Stability		Initial association Trait ~ Daily exp.				Trait → rank-order change Daily exp.				Daily exp. → rank-order change Trait			
Trait	Daily experience	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
Ext.	Positive affect	**.91**	.01	**.29**	.88	.15	<.001	.02	.07	.04	.093	.03	.01	.00	.022
	Negative affect	**.91**	.01	**-.24**	-.54	.10	<.001	-.02	-.06	.03	.054	**-.04**	-.02	.00	.002
	Rel. support partner	**.92**	.01	**.21**	.29	.07	<.001	.00	.00	.02	.846	.02	.01	.01	.098
	Rel. conflict partner	**.91**	.01	**-.19**	-.20	.05	<.001	-.02	-.02	.01	.163	-.03	-.02	.01	.026
	Rel. support child	**.91**	.01	.14	.17	.06	.006	.02	.03	.02	.030	.02	.02	.01	.074
	Rel. conflict child	**.92**	.01	-.14	-.15	.05	.005	-.01	-.02	.01	.282	-.03	-.02	.01	.006
Agr.	Positive affect	**.91**	.01	**.23**	1.29	.28	<.001	.03	.17	.07	.020	**.12**	.02	.00	<.001
	Negative affect	**.91**	.01	-.09	-.38	.23	.109	-.02	-.09	.07	.184	-.02	.00	.00	.414
	Rel. support partner	**.92**	.01	**.20**	.55	.14	<.001	.01	.02	.03	.617	.04	.01	.01	.135
	Rel. conflict partner	**.91**	.01	-.16	-.32	.11	.005	-.02	-.05	.03	.108	-.06	-.03	.01	.009
	Rel. support child	**.91**	.01	**.28**	.65	.12	<.001	.02	.04	.03	.153	**.08**	.03	.01	<.001
	Rel. conflict child	**.91**	.01	-.10	-.21	.11	.058	-.03	-.07	.03	.027	-.05	-.02	.01	.008
Con.	Positive affect	**.91**	.01	**.22**	.72	.15	<.001	.01	.03	.04	.408	**.04**	.01	.00	.003
	Negative affect	**.91**	.01	**-.18**	-.45	.12	<.001	.00	-.02	.04	.668	-.03	-.01	.00	.055
	Rel. support partner	**.92**	.01	.14	.22	.08	.006	-.01	-.02	.02	.222	.02	.02	.01	.079
	Rel. conflict partner	**.91**	.01	**-.21**	-.24	.06	<.001	-.01	-.01	.02	.520	-.03	-.02	.01	.033
	Rel. support child	**.91**	.01	**.19**	.24	.06	<.001	.00	.00	.02	.984	.03	.02	.01	.032
	Rel. conflict child	**.91**	.01	**-.18**	-.22	.07	.001	-.02	-.03	.02	.066	-.03	-.02	.01	.005
Emo.	Positive affect	**.90**	.01	**.33**	1.06	.14	<.001	.03	.12	.05	.012	**.06**	.02	.00	<.001
	Negative affect	**.90**	.01	**-.42**	-1.01	.11	<.001	-.03	-.09	.04	.028	**-.14**	-.05	.01	<.001
	Rel. support partner	**.92**	.01	.10	.15	.07	.041	.01	.02	.02	.221	.01	.00	.01	.600
	Rel. conflict partner	**.91**	.01	**-.20**	-.22	.06	<.001	-.02	-.02	.02	.110	**-.06**	-.05	.01	<.001
	Rel. support child	**.91**	.01	**.19**	.24	.06	<.001	.02	.03	.02	.084	.02	.02	.01	.134
	Rel. conflict child	**.91**	.01	**-.27**	-.32	.06	<.001	-.02	-.03	.02	.063	**-.08**	-.07	.01	<.001

Table 3.3. Rank-order stabilities of positive and negative daily experiences, initial associations between the Big Five traits and daily experiences, and cross-lagged regression effects ***(continued)***

		Stability		Initial association Trait ~ Daily exp.				Trait → rank-order change Daily exp.				Daily exp. → rank-order change Trait			
Trait	Daily experience	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
Ope.	Positive affect	**.91**	.01	**.16**	.49	.15	.001	.01	.03	.04	.412	**.04**	.01	.00	.002
	Negative affect	**.91**	.01	.00	.01	.11	.956	.00	.01	.03	.829	.01	.00	.00	.385
	Rel. support partner	**.92**	.01	**.18**	.26	.07	<.001	.00	.00	.02	.755	.04	.02	.01	.005
	Rel. conflict partner	**.91**	.01	-.02	-.02	.06	.678	.00	.00	.01	.963	.02	.02	.01	.142
	Rel. support child	**.90**	.01	**.24**	.30	.06	<.001	.02	.03	.02	.057	**.05**	.04	.01	<.001
	Rel. conflict child	**.91**	.01	-.10	-.11	.05	.041	.00	.00	.02	.742	.01	.01	.01	.308

Note. Standardized and unstandardized regression coefficients from 15 separate multilevel SEMs (i.e., each of the five traits and each of the three pairs of experiences, such as 'relationship support from partner' and 'relationship conflict with partner', were combined in separate models; Models 1b-3b). We controlled all associations for age. $N = 483$. Because we allowed (error) variances to freely vary over time, β's varied slightly across time lags; therefore, we report average β's.
Bold coefficients: $p < .0033$ (significance level after Bonferroni correction).

residualized positive affect (i.e., positive affect controlled for overlap with negative affect)[11] predicted rank-order increases in agreeableness, conscientiousness, emotional stability, and openness, whereas residualized negative affect (i.e., negative affect controlled for overlap with positive affect) predicted rank-order decreases in extraversion and emotional stability. Furthermore, when we included the measures of relationship support and conflict with partner in the same model, relationship support did not make an independent contribution to the prediction of rank-order changes in personality traits, whereas residualized conflict with partner predicted rank-order decreases in emotional stability. Finally, when we included the measures of relationship support and conflict with child in the same model, residualized relationship support predicted increases in agreeableness and openness, whereas residualized conflict with child predicted decreases in emotional stability.

Thus, after accounting for shared variance between positive and negative affect and between relationship support and conflict, positive affect and relationship support re-emerged as significant predictors of rank-order change in personality traits in 6 of the 14 previously found associations, demonstrating incremental validity in the prediction of rank-order changes in agreeableness, emotional stability, and openness. Residualized negative affect and relationship conflict emerged as predictors of rank-order change in personality traits in 4 of the 15 estimated associations, predicting rank-order decreases in emotional stability and extraversion. The strongest cross-lagged effects were the effects of residualized positive affect on agreeableness (β = .12) and of residualized negative affect on emotional stability (β = -.13). None of the personality effects on rank-order changes in positive or negative daily experiences were statistically significant.

Latent Growth Curve Analysis

All growth models provided an acceptable fit to the data (CFIs = .92–.98; RMSEAs = .03–.06; Table S3.4). Table 3.4 shows the results of the growth curve analyses (visualized in Figure 3.3). The 'Mean' estimates of the latent intercepts represent participants' mean personality score at the third personality measurement. The 'Mean' estimates of the linear and quadratic slopes represent the mean rate of linear and quadratic personality trait change per year. The 'Variance' estimates represent the variance of the individual growth trajectories around the mean growth trajectory.

11 Relatively high residualized positive affect scores indicate that participants reported 'unexpectedly' high levels of positive affect; that is, they reported more positive affect than predicted based on their reported level of negative affect (and their age).

Table 3.4. Latent growth curve model coefficients (N = 483)

	Intercept						Linear change						Quadratic change					
	Mean			Variance			Mean (×100)[a]			Variance (×100)[a]			Mean (×100)[a]			Variance (×100)[a]		
Trait	Est	*SE*	*p*	Est	*SE*	*p*	Est	*SE*	*p*	Est	*SE*	*p*	Est	*SE*	*p*	Est	*SE*	*p*
E	5.01*	.06	<.001	1.34*	.10	<.001	5.49*	0.87	<.001	0.99*	.34	.004	-1.03*	.45	.021	0.09	.08	.265
A	5.74*	.03	<.001	0.34*	.03	<.001	3.54*	0.67	<.001	0.65*	.19	.001	-0.64*	.30	.035	-0.03	.04	.488
C	5.22*	.05	<.001	1.13*	.08	<.001	3.58*	0.80	<.001	0.91*	.30	.003	-0.41	.41	.315	0.07	.07	.303
ES	5.20*	.06	<.001	1.47*	.11	<.001	8.03*	1.12	<.001	2.88*	.51	<.001	-1.88*	.50	<.001	0.17	.10	.100
O	3.98*	.07	<.001	2.17*	.16	<.001	1.61	1.11	.146	1.96*	.52	<.001	0.35	.50	.485	0.07	.11	.506

Note. E = extraversion; A = agreeableness; C = conscientiousness; ES = emotional stability; O = openness. We set the intercept at the third personality trait measurement. *M* age at the first measurement was 44 years (*SD* = 4.36).

[a] Because the Mean and Variance estimates and *SE*'s of the linear and quadratic change parameters contained many leading zeros, we multiplied them by 100; *p*-values were not multiplied.

* $p < .05$.

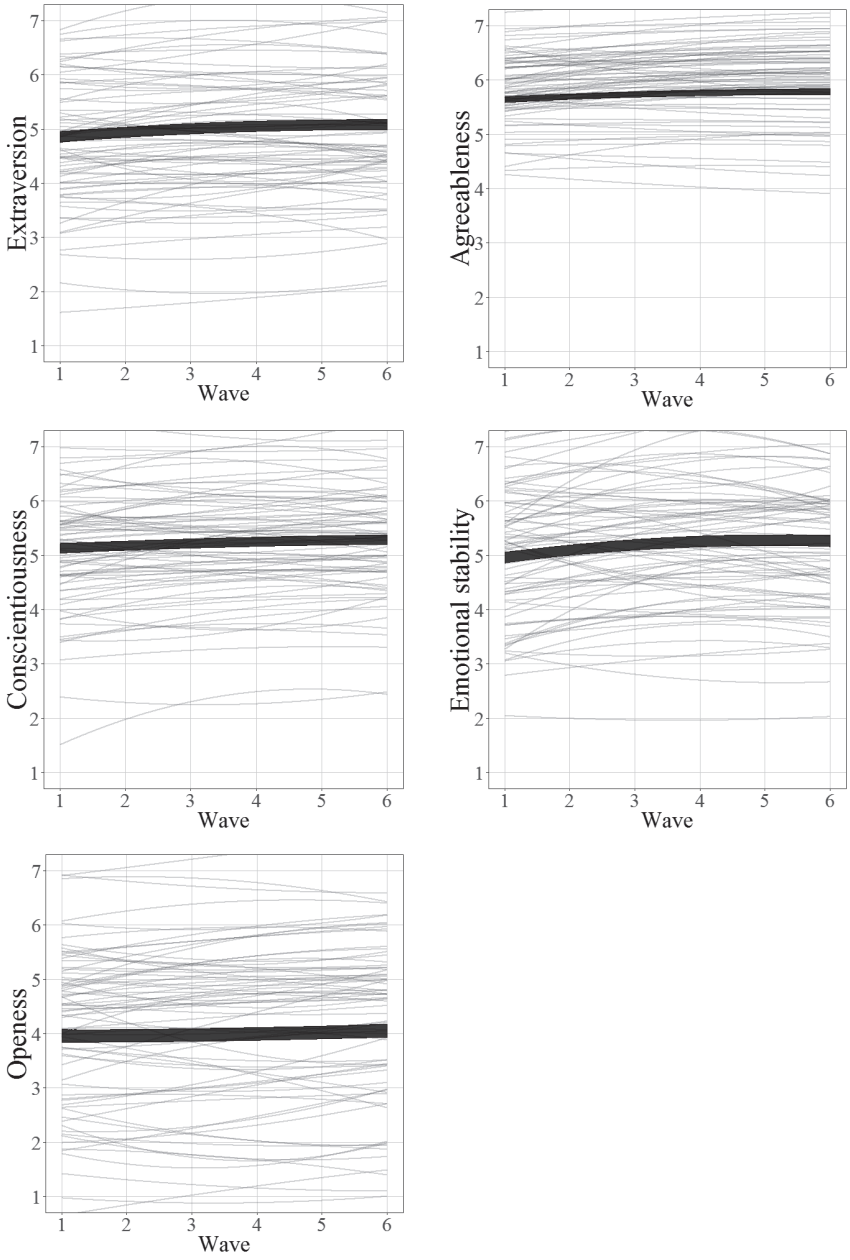

Figure 3.3. Mean-level and individual-level development in Big Five personality trait levels from the first to the sixth yearly personality trait measurement. The upper and lower bounds of the thick black lines represent the 95% parametric bootstrap confidence intervals of the mean-level slope. The individual growth trajectories (N = 75) were drawn from a simulated multivariate normal distribution of quadratic trajectories based on the LGCM parameter estimates (Table 3.2). At the first wave, participants were on average 44 years old (SD = 4.36) and had at least one 13-year old child.

We found evidence for a linear mean-level increase in conscientiousness, and curvilinear, deaccelerating increases in mean levels of extraversion, agreeableness, and emotional stability across the six yearly measurement occasions. We found no evidence for mean-level change in openness. Figure 3.3 shows that all mean-level changes were small. We also found evidence for significant individual differences in linear growth trajectories, particularly with respect to emotional stability.

Correlated Intercepts and Linear Growth Trajectories

Using univariate latent growth curve analysis, we estimated each participant's linear growth trajectories on all variables. All intercept and linear slope factors had significant variance (p-values ≤ .001), indicating that mothers differed from each other in their personality and average daily experiences in 2007, and in their linear rates of change in personality traits and daily experiences across the study period. Table 3.5 shows the correlations among the intercept factors (below the diagonal) and among the linear slope factors (above the diagonal).

We found evidence for small-to-medium-sized positive intercept-intercept correlations between extraversion, agreeableness, conscientiousness, and emotional stability and all three positive affect and relationship support variables. Furthermore, the linear slopes of the Big Five showed small, positive associations with the linear slopes of positive affect and relationship support from child, but not with relationship support from partner. Finally, we found evidence for strong intercept-intercept- and slope-slope correlations between positive affect and negative affect, and between relationship support and relationship conflict. Furthermore, the intercepts of positive affect and support were substantially negatively correlated with negative affect and relationship support. The strongest correlation was found between the intercepts of positive and negative affect (r = -.72).

Discussion

In this study, we examined the dynamic transactions between individual differences in Big Five personality traits and positive daily experiences in a sample of middle-aged mothers. Using 5-year measurement burst data and multilevel SEM, we found little evidence for associations between personality traits and rank-order changes in positive daily experiences. In contrast, daily experiences of positive affect and perceived relationship support/affection were positively associated with subsequent rank-order changes in all Big Five traits. Furthermore, we found that for some of these associations, positive daily experiences demonstrated incremental validity in predicting rank-order changes in personality traits over and above negative daily experiences. Taking the high rank-order stability of our trait

Table 3.5. Intercept correlations (lower triangle) and linear slope correlations (upper triangle) among study variables

		1. Ext.	2. Agr.	3. Con.	4. Emo.	5. Ope.	6. PA	7. NA	8. Su. p	9. Co. p	10. Su. c	11. Co. c
1	Extraversion	-	.13**	.05	.29***	.13**	.11*	-.14**	.05	.00	.10*	-.08
2	Agreeableness	.30***	-	.34***	.16***	.28***	.19***	-.24***	.06	-.15**	.11*	-.18***
3	Conscientious.	.02	.22***		.03	.27***	.09*	-.12**	.03	-.07	.06	-.06
4	Emotional stab.	.41***	.19***	.05	-	.10*	.19***	-.26***	.03	-.10*	.10*	-.11*
5	Openness	.11*	.24***	-.03	-.01		.17***	-.16***	.04	-.04	.11*	-.03
6	Pos. affect	.30***	.33***	.23***	.42***	.08	-	-.64***	.28***	-.22***	.31***	-.20***
7	Neg. affect	-.27***	-.21***	-.19***	-.51***	.06	-.72***		-.21***	.35***	-.25***	.29***
8	Supp. partner	.20***	.24***	.12**	.14**	.08	.52***	-.36***	-	-.55***	.36***	-.16***
9	Confl. partner	-.20***	-.18***	-.20***	-.23***	.06	-.51***	.64***	-.59***		-.14**	.36***
10	Supp. child	.15***	.28***	.15***	.21***	.16***	.57***	-.38***	.52***	-.35***		-.54***
11	Confl. child	-.14**	-.18***	-.20***	-.30***	-.03	-.49***	.60***	-.29***	.65***	-.57***	-

Note: * $p < .05$; ** $p < .01$; *** $p < .001$. Intercepts were set at the third trait measurement or the daily assessments of the third study duration year (2005). We also examined within-person associations. At the within-person level, daily positive affect was positively associated with daily relationship support ($r = .25$ for support from both partner and child) and daily support from partner was positively associated with daily support from child ($r = .24$). We found negative within-person associations between positive and negative affect ($r = -.62$), between relationship support and conflict with partner ($r = -.53$), and between relationship support and conflict with child ($r = -.56$).

measures into account (Adachi & Willoughby, 2015), the effect sizes of the daily experience effects on subsequent personality traits ranged from small to medium.

Daily Experiences Were Associated with Rank-order Changes in Personality Traits

Consistent with our hypotheses, we found that daily positive affect and perceived relationship support were associated with subsequent rank-order increases in extraversion, agreeableness, conscientiousness, emotional stability, and openness. We found similar effects of relationship support from partners and relationship support from children. These results are consistent with dynamic perspectives suggesting that personality is an open system that can be affected and changed by contextual and psychological influences, even in middle adulthood (Baumert et al., 2017; Geukes et al., 2018; Roberts, 2018; Roberts & Jackson, 2008; Wrzus & Roberts, 2017).

In contrast, these results are more difficult to reconcile with the notion that personality traits are immune to the effects of psychological experiences, as asserted by endogenous personality theories (McCrae & Costa, 2008; McCrae & Sutin, 2018). Our results also speak against the view that the difference between "happy and unhappy people" can be almost entirely traced back to individual differences in extraversion and emotional stability (Costa & McCrae, 1980). Rather, the present results are more consistent with the view that people's personality traits can be, at least partly, traced back to their idiosyncratic accumulation of happy and unhappy everyday experiences (Soto, 2015).

An open question concerns the mechanisms that underlie the observed longitudinal associations between positive experiences and change in personality traits. It has been argued that positive affective and interpersonal experiences may trigger increases in trait-relevant thoughts, feelings, and behaviors, which may over time accumulate and manifest in increased trait levels (Fleeson, 2007; Judge et al., 2014; Roberts & Jackson, 2008; Soto, 2015). In the present study, it may be that on days on which mothers experienced more positive affect and relationship support, they might have also acted more outgoing, friendly, persistently, even-tempered, and creatively than usual (Ching et al., 2014; Huang & Ryan, 2011; Isen, 1999; Wilson et al., 2017), corresponding to higher state levels of extraversion, agreeableness, conscientiousness, emotional stability, and openness, respectively. According to contemporary dynamic personality theories (Baumert et al., 2017; Geukes et al., 2018; Roberts & Jackson, 2008; Wrzus & Roberts, 2017), recurrent enactment of such Big Five-relevant states may gradually lead to changes in Big Five traits by means of biological mechanisms (e.g., changes in gene expressions and neuroanatomical structures), associative mechanisms (e.g., implicit learning, reinforcement learning, and habit formation), and reflective mechanisms (e.g., conscious memories about one's past states) (Baumert et al., 2017; Roberts, 2018; Wrzus & Roberts, 2017). Future research is needed to advance our

understanding of the mechanisms through which daily psychological experiences may lead to personality trait changes.

Incremental predictive validity of positive daily experiences. Aggregated positive experiences were negatively associated with aggregated negative experiences, indicating that mothers who experienced on average more happiness and relationship support tended to experience on average less anger, sadness, anxiety, and relationship conflict. We tested the incremental validity of negative and positive experiences in predicting rank-order change in personality traits and found evidence for both common and unique effects of positive and negative daily experiences. With regard to common effects, we found that some associations weakened and were no longer statistically significant after entering positive and negative experiences as simultaneous predictors of rank-order change in personality traits. That is, some associations seemed to be driven by joint effects of the absence of negative experiences and the presence of positive experiences.

However, positive and negative daily experiences also showed unique associations with rank-order changes in personality traits. For example, consistent with research showing that people act more cooperatively when experiencing positive affect (Isen, 1999), we found that, after controlling for negative affect, positive affect was still associated with rank-order increases in agreeableness. The unique effects of positive experiences on personality traits are inconsistent with perspectives that emphasize the dominance of negative experiences over positive experiences (Baumeister et al., 2001; Labianca & Brass, 2006; Taylor, 1991; Wrzus & Roberts, 2017). Taken together, our results suggest that the effects of daily experiences on personality traits are partly driven by aspects that are unique to pleasant and unpleasant daily experiences, and partly by aspects that are shared between having pleasant experiences and not having unpleasant experiences.

Personality Traits Were Not Associated with Rank-order Changes in Daily Experiences

The Big Five were positively associated with the daily experiences of positive affect and relationship support during the first assessment bursts. These associations are consistent with both endogenous and dynamic personality theories and with a large body of previous research. However, contrary to our predictions, we found little evidence suggesting that individual differences in personality traits developmentally preceded individual differences in daily experiences. Although this finding seems to conflict with the widely held view that personality traits are distal causes of daily psychological experiences (Allport, 1937; Deary, 2009; Fleeson & Jayawickreme, 2015; McCrae & Costa, 1991; McCrae & Sutin, 2018; Roberts, 2018; Wrzus & Roberts, 2017), we cannot rule out alternative explanations

that are consistent with this view. First, our results are consistent with the possibility that, during an earlier developmental phase, a fixed, stable component of personality produced stable individual differences in daily experiences, resulting in a stable correlation between traits and experiences during middle adulthood (Roberts, 2018). Second, the effects of personality traits might have been obscured by environmental constraints. Due to their role as a parent, our participants might have had relatively little flexibility in selecting new situations corresponding to their personality traits. For example, personality traits may play a more important role in the selection and initial development of newly formed relationships (Selfhout et al., 2010) than in the development of highly stable, well-established relationships.

Perhaps counter-intuitively, but consistent with previous research on adolescence (Borghuis, Bleidorn, et al., 2017), we found that the rank-order stabilities of the random intercepts of the daily experiences were larger than the rank-order stabilities of the personality trait variables. In fact, individual differences in daily positive affect and relationship support experiences were so stable that no significant rank-order changes may have occurred that could be predicted by personality traits. This finding raises conceptual questions related to the meaning of traits and aggregated states. For example, what accounts for the stable between-person differences in daily experiences/states after averaging across a large number of observations? One possible source of variance are personality traits. Whereas mothers' ratings on any particular day might have been largely influenced by external factors, such as their partner's mood, their *average* level across multiple weeks might have been influenced by a (combination of) underlying trait(s), such as dispositional positive affect or optimism. It is also possible that other factors exerted a persistent, stabilizing influence on individual differences in the daily diary ratings, such as stable environmental characteristics (e.g., job or neighborhood characteristics, partner/child characteristics) and response styles (e.g., acquiescence and desirability response biases).

Furthermore, the relatively lower rank-order stability of the Big Five raises the question to what extent ordinary one-shot personality trait questionnaires contain unintended state variance, which may be caused by temporary effects of unsystematic recent experiences (Roberts, 2018). For example, feeling nervous before giving a presentation may temporarily bias one's self-perceived trait-level of emotional stability downwards. As statistical aggregation cancels out random temporary influences on states (Epstein, 1979), it is possible that one-shot personality trait measures contain more state variance than aggregated daily experience measures. State variance in personality trait measures is undesirable and can be considered noise because unstable characteristics such as states do not have a long-term influence on future experiences and traits, nor can they be influenced by experiences and trait levels in the distant past (Asendorpf & van Aken, 2003; Neyer & Asendorpf, 2001).

Limitations and Future Directions

This study was not without limitations, which may be addressed in future studies. First, we cannot infer from our correlational design that the longitudinal associations between traits and daily experiences were causal. It is possible that the non-unspecific effects on the Big Five traits were driven by multiple third variables that exerted trait-specific effects, of by a non-specific third factor that influenced multiple traits (e.g., biological maturation, improved self-regulation ability; Hennecke, Bleidorn, Denissen, & Wood, 2014). Relatedly, the assessment bursts were timed in-between the personality measurements. Therefore, we cannot rule out that ongoing personality changes between trait measurements confounded participants' daily reports. Future research should administer the assessment bursts simultaneously with the personality measurements.

Second, our statistical models were designed to investigate developmental processes that occurred between persons; therefore, we cannot draw inferences about within-person processes. To gain a deeper understanding of the longitudinal relations between daily experiences and personality traits, future research may use within-person statistical models (Bainter & Howard, 2016; Berry & Willoughby, 2017; Hamaker et al., 2015) and experimentally manipulate daily experiences. For example, intervention studies could test whether random assignment of participants to either a control condition or a treatment condition aimed at increasing daily positive affect (e.g., by repeatedly sending unexpected small gifts and complements; Ogedegbe, 2012) and relationship support (e.g., by creating support groups; Stewart, Craig, MacPherson, & Alexander, 2001) is associated with differential changes in personality traits (Sih et al., 2015).

Third, self-report measures are prone to certain biases. As discussed above, it is possible that our aggregated daily experience measure contained substantial trait variance. To gain a finer-grained and more objectively measure of participants' momentary experiences in daily life, future research may also use smartphone sensing methods, experience sampling methods, and informant reports (Harari et al., 2016). Likewise, it is possible that our trait measure contained substantial state variance. Even though our results were robust to excluding data of every third assessment burst, which was administered most recently before each trait measurement (see footnote 10; Table S3.3), we cannot completely rule out the possibility that participants temporary appraised their personality traits differently as a result of past daily experiences, without having truly changed in their personality traits (Roberts, 2018). Future research may elapse more time between assessment bursts and subsequent personality trait measurements by administering assessment bursts simultaneously with the personality measurements. Moreover, future research may use alternative personality measures that are less prone to bias caused by recent experiences, such as behavioral data and informant reports (Eid & Diener, 2006), or by means of aggregating bursts of repeatedly measured personality states, analogous to how we measured daily positive affect and relationship

support (Geukes et al., 2018; Roberts, 2018). An advantage of the latter method is that it may reduce state variance to similar extents in both aggregated daily experience variables and trait variables, which allows for a fairer test of their dynamic transactions.

Fourth, we used a rather homogeneous sample of Dutch mothers of at least one adolescent child. It remains an open question whether our results generalize to other populations and other relationship experiences. For instance, it may be that the effects or relationship support are stronger for mothers than for fathers, as women have been found to be interpersonally more sensitive than men (Hall, 1978; Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005).

Conclusions

Four conclusions stand out. First, we found little evidence for Big Five personality trait effects on rank-order changes in daily experiences. Second, individual differences in average levels of daily positive affect and relationship support were highly stable; therefore, no significant rank-order changes may have occurred that could be predicted by personality traits. Third, consistent with contemporary dynamic personality theories but inconsistent with endogenous theories, we found that high levels of daily positive affect and relationship support/affection were related to rank-order increases in extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience. Third, for some of these associations, positive daily experiences demonstrated incremental validity in predicting rank-order changes in personality traits over and above their statistical overlap with negative daily experiences. Taken together, our results suggest that recurrent daily positive experiences contribute to personality trait changes among middle-aged women.

Supplemental Materials

Table S3.1. Fit statistics Models 1a-3a

Daily experience	Trait	#para.	χ^2	*df*	*p*	CFI	RMSEA	$SRMR_{within}$	$SRMR_{between}$
Pos. affect	Ext.	38	456.28	67	<.001	.90	.02	.03	.08
Pos. affect	Agr.	38	385.25	67	<.001	.88	.02	.03	.10
Pos. affect	Con.	38	429.93	67	<.001	.90	.02	.03	.09
Pos. affect	Emo.	38	359.95	67	<.001	.92	.02	.03	.08
Pos. affect	Ope.	38	479.97	67	<.001	.90	.02	.03	.08
Supp. child	Ext.	38	429.17	67	<.001	.90	.02	.02	.08
Supp. child	Agr.	38	374.71	67	<.001	.88	.02	.02	.10
Supp. child	Con.	38	421.20	67	<.001	.90	.02	.02	.08
Supp. child	Emo.	38	324.38	67	<.001	.93	.02	.02	.07
Supp. child	Ope.	38	449.22	67	<.001	.91	.02	.02	.08
Supp. partner	Ext.	38	391.11	67	<.001	.91	.02	.03	.08
Supp. partner	Agr.	38	322.05	67	<.001	.90	.02	.03	.10
Supp. partner	Con.	38	380.69	67	<.001	.91	.02	.03	.08
Supp. partner	Emo.	38	291.21	67	<.001	.93	.02	.03	.08
Supp. partner	Ope.	38	404.62	67	<.001	.91	.02	.03	.08

Note: #para. = number of free parameters.

Table S3.2. Fit statistics Models 1b-3b

Daily experience	Trait	#para.	χ^2	*df*	*p*	CFI	RMSEA	$SRMR_{within}$	$SRMR_{between}$
Pos. & neg. affect	Ext.	66	537.53	159	<.001	.98	.02	.03	.06
Pos. & neg. affect	Agr.	66	480.77	159	<.001	.98	.01	.03	.08
Pos. & neg. affect	Con.	66	503.10	159	<.001	.98	.01	.03	.06
Pos. & neg. affect	Emo.	66	424.48	159	<.001	.98	.01	.03	.06
Pos. & neg. affect	Ope.	66	554.47	159	<.001	.98	.02	.03	.06
Supp. & confl. child	Ext.	66	508.33	159	<.001	.98	.01	.03	.06
Supp. & confl. child	Agr.	66	483.58	159	<.001	.97	.01	.03	.08
Supp. & confl. child	Con.	66	516.57	159	<.001	.97	.01	.03	.06
Supp. & confl. child	Emo.	66	410.29	159	<.001	.98	.01	.03	.05
Supp. & confl. child	Ope.	66	545.18	159	<.001	.97	.02	.03	.06
Supp. & conf. partner	Ext.	66	511.84	159	<.001	.97	.01	.03	.06
Supp. & confl. partner	Agr.	66	458.25	159	<.001	.97	.01	.03	.08
Supp. & confl. partner	Con.	66	509.91	159	<.001	.97	.01	.03	.06
Supp. & confl. partner	Emo.	66	404.61	159	<.001	.98	.01	.03	.06
Supp. & confl. partner	Ope.	66	516.21	159	<.001	.97	.01	.03	.06

Note: #para. = number of free parameters.

Table S3.3. Sensitivity analysis: results of Models 1a-3a after excluding data from every third assessment burst

		Stability		Initial association Trait ~ Daily exp.				Trait → rank-order change Daily exp.				Daily exp. → rank-order change Trait			
Trait	Daily experience	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
Ext.	Positive affect	**.86**	.02	**.29**	.88	.15	<.001	.04	.13	.05	.004	**.06**	.02	.00	<.001
	Rel. support partner	**.90**	.01	**.21**	.30	.08	<.001	.01	.01	.02	.629	**.04**	.03	.01	<.001
	Rel. support child	**.87**	.02	.14	.18	.06	.006	.04	.05	.02	.009	**.04**	.03	.01	.001
Agr.	Positive affect	**.86**	.02	**.25**	1.41	.28	<.001	**.04**	.26	.09	.003	**.13**	.02	.00	<.001
	Rel. support partner	**.90**	.01	**.23**	.61	.14	<.001	.00	.01	.04	.785	**.07**	.03	.01	<.001
	Rel. support child	**.87**	.02	**.28**	.65	.12	<.001	.03	.07	.04	.037	**.10**	.04	.01	<.001
Con.	Positive affect	**.86**	.02	**.24**	.78	.15	<.001	.01	.05	.05	.324	**.06**	.02	.00	<.001
	Rel. support partner	**.90**	.01	**.15**	.24	.08	.002	-.01	-.02	.02	.310	**.04**	.02	.01	<.001
	Rel. support child	**.87**	.02	**.18**	.24	.06	<.001	.01	.01	.02	.561	**.04**	.03	.01	<.001
Emo.	Positive affect	**.84**	.02	**.33**	1.05	.14	<.001	**.07**	.26	.06	<.001	**.13**	.04	.00	<.001
	Rel. support partner	**.90**	.01	.10	.16	.07	.031	.02	.03	.02	.114	**.05**	.03	.01	<.001
	Rel. support child	**.87**	.02	**.17**	.23	.06	<.001	.03	.04	.02	.020	**.07**	.05	.01	<.001
Ope.	Positive affect	**.86**	.02	**.18**	.56	.15	<.001	.01	.05	.05	.302	**.03**	.01	.00	.001
	Rel. support partner	**.90**	.01	**.18**	.26	.08	.001	.00	.00	.02	.814	.02	.02	.01	.020
	Rel. support child	**.87**	.02	**.25**	.31	.06	<.001	.03	.04	.02	.024	**.04**	.03	.01	<.001

Note. **Bold** coefficients: $p < .0033$ (significance level after Bonferroni correction).

Table S3.4. Fit statistics models second-order latent growth curve models for the Big Five

	χ^2	*df*	*p*	CFI	RMSEA
Extraversion	948.44	621	<.001	.98	.03
Agreeableness	1583.01	621	<.001	.92	.06
Conscientiousness	978.32	621	<.001	.98	.03
Emotional stability	1080.82	621	<.001	.97	.04
Openness	1090.38	621	<.001	.97	.04


4

Chapter 4

Longitudinal Associations between Trait Neuroticism and Negative Daily Experiences in Adolescence

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Abstract

It is well established that trait neuroticism bears strong links with negative affect and interpersonal problems. The goal of this study was to examine the longitudinal associations between neuroticism and daily experiences of negative affect and interpersonal problems during the developmentally important period of adolescence. Dutch adolescents and their best friends (N = 1,046) completed up to six yearly personality trait questionnaires and up to 15 between-year assessment bursts between the ages 13 and 18. During each assessment burst, participants reported on five consecutive days about their experiences of negative affect and interpersonal conflict with their mother and their best friend. We estimated a series of multilevel random-intercept cross-lagged panel models to differentiate covariance at the level of constant between-person differences from dynamic processes that occurred within persons. At the level of constant between-person differences, higher neuroticism was associated with more negative daily experiences. At the within-person level, yearly changes in neuroticism were bidirectionally and positively associated with yearly changes in daily negative affect. The most parsimonious, best fitting models did not contain a random intercept for daily conflict with friend and adolescents' contingency between daily experiences of conflict with mother and negative affect. Rank-order differences in these variables were positively associated with subsequent within-person changes in neuroticism. We discuss these results with regard to endogenous versus dynamic theories of personality development and the value of using a differentiated statistical approach.

Keywords: Adolescence; experience sampling; negative affect; neuroticism; relationship conflict.

Neuroticism represents a continuum of individual differences, with low levels representing emotional stability and even-temperedness, and high levels representing negative emotionality (John et al., 2008). High levels of neuroticism have been related to undesirable life outcomes, including poor mental and physical health (Lahey, 2009; Ormel, Jeronimus, et al., 2013), negative affect (Ching et al., 2014; Costa & McCrae, 1980; Mroczek & Almeida, 2004), and interpersonal problems (Karney & Bradbury, 1995; Kelly & Conley, 1987; Lopes et al., 2003). In addition, neuroticism has been associated with substantial costs for both the individual and society (Cuijpers et al., 2010), so it is not surprising that many individuals desire to be less neurotic (Hudson & Fraley, 2016a). Longitudinal research has identified adolescence as a sensitive period during which individual differences in neuroticism become increasingly settled (Bleidorn & Hopwood, 2018; Borghuis, Denissen et al., 2017; Briley & Tucker-Drob, 2014; Roberts & DelVecchio, 2000). However, little is known about the factors and mechanisms underlying the development of neuroticism during this life stage. Given the relevance of neuroticism for both individual and society, an interesting question is what predicts changes in neuroticism?

Previous research suggested that, even though most youth experience few difficulties (Arnett, 1999), prevalence rates of mood disorders and interpersonal problems peak during adolescence (e.g., Hadiwijaya, Klimstra, Vermunt, Branje, & Meeus, 2017; Maciejewski, van Lier, Branje, Meeus, & Koot, 2017). This finding led some researchers to theorize that increases in adolescents' neuroticism can be traced back to increasing problems in daily life (Göllner et al., 2017; Soto, 2016). Therefore, neuroticism may not only have an influence on affective and interpersonal problems that typically occur during adolescence, but these problems may also influence adolescents' level of neuroticism.

The present study aimed to gain a better understanding of the longitudinal associations between neuroticism and daily experiences of negative affect and interpersonal problems during adolescence. We tested whether changes in neuroticism predict changes in negative daily experiences, whether changes in negative daily experiences predict changes in neuroticism, or both. To address these questions, we used multi-wave data collected as part of a 5-year measurement burst study (i.e., 6 yearly personality measurements combined with intermitted daily diary assessments administered between age 13 and 18). We used multilevel structural equation models to differentiate constant (i.e., time-invariant, enduring) between-person differences from changes that occurred within persons.

Theoretical Perspectives on the Associations between Neuroticism and Negative Daily Experiences

Two broad theoretical traditions have made contrasting predictions about the longitudinal relation between neuroticism and negative daily experiences. These traditions focused on personality development in adult populations, but their propositions can be generalized to

adolescents. *Endogenous* personality theories, such as five factor theory (McCrae & Costa, 2008; McCrae & Sutin, 2018), posit that personality traits have a unidirectional influence on people's daily psychological experiences. According to this perspective, personality traits set in motion downstream processes (emotional, behavioral, cognitive, and social) that, in interaction with external influences, produce specific experiences. As such, endogenous personality theories would predict that increases in neuroticism lead to subsequent increases in negative affect and relationship conflict. Over time, these unidirectional influences may accumulate and manifest as stable between-person associations. Furthermore, endogenous theories predict that daily experiences have no or only a negligible influence on broad personality traits such as neuroticism (McCrae & Sutin, 2018). As such, endogenous theories would predict that changes in daily experiences of negative affect and conflict are unrelated to subsequent changes in neuroticism.

Contrary to endogenous accounts, *dynamic* personality theories posit that people's personality traits and their daily experiences continuously influence each other over time (Endler & Parker, 1992; Magnusson, 1990; Roberts et al., 2008). A key tenet of dynamic personality theories is that personality trait changes unfold gradually through the accumulation of daily experiences and through people's responses to these experiences (Baumert et al., 2017; Geukes et al., 2017; Roberts & Jackson, 2008; Wrzus & Roberts, 2017). More specifically, dynamic theories posit that personality trait changes are driven by experiences that influence *state levels* (i.e., momentary thoughts, feelings, and behaviors) and/or *state contingencies* (i.e., how much different states depend on each other) that are relevant to a personality trait (see also Buss & Craik, 1983; Fleeson & Jolley, 2006). For example, adolescents may increase in neuroticism because they repeatedly experience daily relationships conflicts or anxious and nervous states. In addition, their neuroticism level may increase because they become increasingly upset during conflicts; that is, because their affective states increasingly depend on their conflict experiences. During development, these dynamic transactions may partly crystalize as stable between-person associations between neuroticism and state levels/contingencies.

To summarize, endogenous and dynamic personality theories agree that changes in neuroticism are likely associated with subsequent changes in negative daily experiences, and that constant between-person differences in neuroticism might be associated with constant between-person differences in negative daily experiences. However, whereas endogenous theories posit that daily experiences are unrelated to subsequent changes in neuroticism, dynamic theories predict that changes in daily experiences are positively associated with subsequent changes in neuroticism.

Previous Research on the Associations between Neuroticism and Negative Daily Experiences

Consistent with both endogenous and dynamic theories, previous research has suggested several processes through which neuroticism may influence people's daily experiences of negative affect and interpersonal problems. For example, compared to emotionally stable individuals, neurotic individuals pay more attention to negative and threatening stimuli and recollect them better (Ormel, Bastiaansen, et al., 2013), are more likely to interpret ambiguous social cues as signs of rejection (Finn, Mitte, & Neyer, 2013), have more hostile and stronger affective reactions to stress (Gunthert, Cohen, & Armeli, 1999; Leger et al., 2016; Mroczek & Almeida, 2004; Suls & Martin, 2005; Suls, Martin, & David, 1998), and experience negative affective reactions that are more likely to spill over to other situations (Suls & Martin, 2005). Note, however, that most of these results were drawn from cross-sectional studies, which are not suited to address questions concerning the directionality of effects.

Evidence regarding the question whether negative daily experiences can affect neuroticism during adolescence is mixed. Some studies suggested that experiences of daily hassles (Vollrath, 2000) and stressful life events, such as unemployment and divorce, are related to changes in neuroticism (Jeronimus, Ormel, Aleman, Penninx, & Riese, 2013; Jeronimus, Riese, Sanderman, & Ormel, 2014; Kandler, Bleidorn, Riemann, Angleitner, & Spinath, 2012; Riese et al., 2014). However, other studies found no evidence that such experiences are related to changes in neuroticism (Allemand, Hill, & Lehmann, 2015; Denissen, Luhmann, Chung, & Bleidorn, 2018; Specht, Egloff, & Schmukle, 2011; for a review, see Bleidorn, Hopwood, & Lucas, 2018). Similarly, studies yielded mixed and inconclusive results about the effect of interpersonal problems with peers (cf. Asendorpf & Wilpers, 1998; Mund & Neyer, 2014; for reviews, see Wrzus & Neyer, 2016; Wrzus, Zimmermann, Mund, & Neyer, 2016) and the experience of a depression (Ormel, Jeronimus, et al., 2013) on neuroticism.

Notably, these findings reflect indirect evidence with respect to the present research question. First, most studies were based on samples of adults rather than adolescents (for an exception, see Sturaro et al., 2008). Second, most studies used general, retrospective reports about the occurrence of stress, conflicts, or negative life events, administered simultaneously with personality questionnaires. Only few studies used daily diary or experience sampling measures to assess actual daily experiences in people's everyday lives (for an exception, see Wrzus, Luong, Wagner, & Riediger, 2017; see below). Third, although theories of human development usually refer to development that occurs at the within-person level (Baltes & Nesselroade, 1979), most studies examined longitudinal associations between neuroticism and experiences at the between-person level (for exceptions, see Allemand et al., 2015; Denissen et al., 2018; Mund & Neyer, 2014). The between-person level focuses

on whether individual differences in experience predict subsequent rank-order changes (i.e., changes of individuals' relative standing) on a personality trait and/or vice versa. This may be problematic, because simulation studies suggest that associations found at the between-person level are not always a good representation of the processes that operated at the within-person level (Berry & Willoughby, 2017; Hamaker et al., 2015).

A more direct and reliable test of the prediction of dynamic personality theories that changes in state levels and state contingencies influence personality traits requires a measurement burst design in which participants report repeatedly about their momentary or daily experiences over a longer period. Using a measurement burst design enables researchers to empirically estimate for each individual the relation between one state (e.g., relationship conflict) and another state (e.g., negative affect), and to associate state levels and state contingencies with changes in personality traits. In addition, gaining a better understanding of the relation between neuroticism and daily experiences requires statistical approaches that differentiate covariance at the level of constant between-person differences (Anusic & Schimmack, 2016; Fraley & Roberts, 2005; Roberts, 2018) from dynamic processes that occurred within persons.

To our knowledge, only one study used a measurement burst design and within-person modelling to examine the longitudinal relationships between personality traits, state levels, and state contingencies. Wrzus et al. (2017) examined the links between affective experiences and neuroticism using 6-year longitudinal data from more than 500 German participants (14 to 86 years old) who reported on both their trait neuroticism and their daily negative affect and hassles (i.e., unpleasant experiences or thoughts) across three assessment waves. This study found no evidence that within-person changes in neuroticism predicted subsequent within-person changes in participants' daily experiences of negative affect, their daily experiences of hassles, or their affective reactivity to daily hassles (i.e., the extent to which hassles increased their momentary negative affect), nor vice versa. However, Wrzus and colleagues did find evidence that within-person increases in negative affect and hassle reactivity were concurrently associated with rank-order change in neuroticism. Specifically, across two three-year assessment intervals, they consistently found that latent changes in negative affect and hassle reactivity between two assessments predicted rank-order differences in neuroticism at the later assessment, controlling for rank-order differences in neuroticism at the prior assessment. This study provides initial evidence for dynamic developmental processes between daily experiences and change in broad personality traits. However, more evidence is needed to test whether these results replicate and generalize to other developmental periods and experiences.

The Present Study

The purpose of this measurement burst study was to examine the longitudinal associations between neuroticism and daily experiences of negative affect (operationalized as feelings of anxiety, sadness, and anger) and interpersonal problems with parents and peers (operationalized as conflicts with mother and best friend) between age 13 and 18. We focused on adolescence, because this period seemed particularly suited to examine the longitudinal relationship between neuroticism and negative daily experiences. After all, adolescents tend to experience more turmoil (Arnett, 1999) and undergo more pronounced changes in their level of neuroticism than adults; (Borghuis, Denissen, et al., 2017; Roberts & DelVecchio, 2000; Soto & Tackett, 2015). Hence, transactional processes between neuroticism and negative daily experiences should be more salient during adolescence than during later life stages. At later ages, personality traits might have stabilized to such an extent that one would need very large samples to detect presumably small transactional effects (Adachi & Willoughby, 2015).

Furthermore, we focused on interpersonal problems with both parents and peers, because conflicts that characterize these relationships may have different implications for adolescents' neuroticism development. Conflicts with parents may occur more frequently (Van Doorn, Branje, Hox, & Meeus, 2009) and may arise from adolescents' need for separation-individuation from their parents (Koepke & Denissen, 2012). Conflicts with peers may arise from competition for access to important resources, such as social status (Ellis et al., 2012; Hawley, Little, & Card, 2007), and may pose a threat of social exclusion.

We used random-intercept cross-lagged panel modeling (Hamaker et al., 2015) to differentiate covariance at the level of constant between-person differences from dynamic processes that occurred within persons. We applied this technique to examine associations between neuroticism and adolescents' daily experiences of negative affect (Model 1), interpersonal problems with their mother (Model 2), and interpersonal problems with their best friend (Model 3). In addition, we examined the associations between neuroticism and adolescents' affective reactivity to interpersonal problems with their mother (Model 4) and their best friend (Model 5). We operationalized affective reactivity as the degree to which adolescents' level of daily negative affect was contingent on their level of daily relationship conflict (Denissen & Penke, 2008; Wrzus et al., 2017).

In our interpretation of the results, we will pay special attention to the cross-lagged effects of negative daily experiences on neuroticism. Positive within-person effects of negative daily experiences on neuroticism are consistent with dynamic perspectives, but inconsistent with endogenous perspectives. Positive cross-lagged effects of neuroticism on negative daily experiences and positive associations at the level of constant between-person differences are consistent with dynamic perspectives as well as with endogenous perspectives. Finally, because our participants underwent relatively rapid and profound biological, psychological,

and social changes during the study period (Blakemore, 2008; Casey et al., 2008; Koepke & Denissen, 2012; Weisfeld, 1999), we explored whether the magnitude of the longitudinal effects changed during adolescence.

Method

The RADAR study has been approved by the Medical Ethical Testing Committee of the Utrecht University Medical Centre (protocol number 05-159/K; "RADAR: Research on Adolescent Development and Relationships").

Research Design and Procedures

Data came from the RADAR-Young (Research on Adolescent Development and Relationships – younger cohort) study (Van Lier et al., 2011), which is an ongoing prospective cohort-sequential study of Dutch-speaking families in the Netherlands. The study includes a Dutch population sample of target adolescents (n = 497) and a Dutch-Moroccan sample of target adolescents (n = 165). In addition, the study includes data from best friends, parents/caregivers, and one sibling of the target adolescents with a native Dutch background. For the present study, we used self-reports from the target adolescents and their best friends between 2005 (the first yearly trait measurement) and 2010 (the sixth yearly trait measurement). External funding for the Dutch-Moroccan subsample ran out a year earlier, so only five waves were collected in this group. In each wave, target adolescents could nominate one best friend, which could be a different friend in each wave. For target adolescents from the Dutch population sample, the nominated friend was invited to participate in the study. We modelled each participating friend as a unique participant. Participants were recruited from randomly selected elementary schools in the western and central regions of The Netherlands. Participants received written information about the aim of the study and parents provided informed consent of all participating family members. During the study, target adolescents from the Dutch-Moroccan sample showed a higher dropout rate (37% in the first five waves compared to 15% in the Dutch population sample). We included the Dutch-Moroccan sample in the present study to increase the size and diversity of our sample.

RADAR participants participated in yearly home interviews and in online daily diary assessments. We measured participants' personality traits during the yearly interviews, which took place in February or March. We measured negative affect and interpersonal problems during three bursts of daily assessments that took place in-between the yearly trait measurements, in June, September, and December. Each between-year assessment burst lasted five consecutive days (from Monday to Friday), adding up to 15 daily

assessments per year, totaling a maximum of 75 daily assessments per participant across the study period. The assessment bursts always covered the weekdays of a normal school week. At approximately 5:30 p.m., participants were invited via email to participate in the daily assessment. Participating families received €100 for each home visit, which lasted approximately 2.5 hours. Adolescents received an additional €10 for each between-year assessment burst they completed.

Some previous studies have also used the RADAR data to study personality traits (Borghuis, Denissen, et al., 2017; Creemers et al., 2015; Evans et al., 2016; Hawk et al., 2013; Mercer, Keijsers, Crocetti, Branje, & Meeus, 2016; Salemink, van Lier, Meeus, Raaijmakers, & Wiers, 2015; Yu, Branje, Keijsers, Koot, & Meeus, 2013). However, none of these studies have examined associations between personality traits and daily affective or interpersonal experiences during adolescence.

Participants and Missing Data

Our final sample included N = 1,046 adolescents, who were 13.1 years old (SD = 0.65) at the first trait measurement. Of these participants, 49% were best friends, 54% were female, 8% reported having a Moroccan ethnic identity, and 5% reported having another non-Dutch ethnic identity. Among the 534 target adolescents, 22% did not have a friend who participated in RADAR and met our inclusion criterion, 62% had one friend, 14% had two friends, and 2% had three participating friends who met our study inclusion criterion. Initially, our data contained 1,733 records (i.e., 662 target adolescents and 1,071 friends). Due to early dropout or friendship dissolutions, some records (mostly friends) had missing data on our study variables across the entire study period. For example, 201 adolescents did not participate in any of the yearly neuroticism measurements, and 389 adolescents did not participate in any of the assessment bursts. To reduce the proportion of missing data and to increase the covariance coverage between temporally widely spaced assessments, we included only target adolescents and friends who completed at least one yearly trait measurement and at least 15 daily negative affect or conflict assessments.

Based on teacher ratings of children's externalizing behavior, the RADAR study oversampled adolescents who were at risk of developing delinquent behaviors (Keijsers et al., 2012; Neumann et al., 2011). In our final sample, 209 adolescents (39% of the target adolescents; 13% had a Moroccan background) were classified 'at risk'. Compared to adolescents who were not at risk, at risk target adolescents reported more negative affect (t(358.88) = 3.23, p = .001, d = 0.29) and more conflict with their mother (t(380.94) = 3.74, p < .001, d = 0.33) during the first three assessment bursts. Despite the oversampling of at risk-adolescents, on average our participants and their parents had a higher socio-economic status than the general Dutch population (Keijsers et al., 2012; Neumann et al., 2011; Van Lier et al., 2011).

There were 237 adolescents (74% friends) who participated in the first trait measurement wave but not in the last one. These dropouts did not significantly differ from continuing participants (i.e., adolescents who participated in both the first and the last trait measurement; n = 622[12]; 25% friends) with regard to their Big Five scores at the first trait measurement or their average level of conflict and negative affect across the first three assessment bursts. Table 4.1 provides an overview of the number of available reports for neuroticism, negative affect, and relationship conflict.

Measures

Neuroticism. Neuroticism was measured using the shortened Dutch version of Goldberg's Big Five questionnaire (Vermulst & Gerris, 2005), using six adjectives (e.g., "worried"). Participants indicated on a Likert scale ranging from 1 (*completely untrue*) to 7 (*completely true*) to what extent the adjectives described their personality. Previous research using data from this sample showed that this measure demonstrated longitudinal scalar measurement invariance (i.e., consistent item loadings and intercepts) across six yearly measurements, indicating that participants used and interpreted this scale in a similar way from age 13 to age 18 (Borghuis, Denissen, et al., 2017). In the present study, coefficient alpha (Cronbach, 1951) of the six neuroticism measurements ranged from .80 to .87. An analysis of within- and between-person variance (using the *statsBy* function of the *psych* package in R; Revelle, 2017) indicated that the ICC1 coefficient of the random intercept of neuroticism (see 'Statistical Analysis') was .59. Hence, 59% of the total variance of neuroticism across the six measurements was attributable to constant between-person differences in neuroticism, and the remaining 41% was due to yearly within-person fluctuations.

Daily negative affect. On each day of the assessment bursts, participants rated their level of negative affect using the Anger, Anxiety, and Sadness subscales of the Daily Mood Device (Hoeksma et al., 2000). Adolescents were asked in the late afternoon to rate the intensity of their emotional experiences on that particular day ("Today I feel …") using 9-point Likert scales (e.g., from 1=*not down* to 9=*down*; from 1=*not afraid* to 9=*afraid*). We measured adolescents' daily negative affect by averaging their scores on the following nine adjectives: "angry," "cross," "short-tempered," "sad," "down," "dreary," "afraid," "anxious," and "worried". Coefficient alpha per assessment day was high, ranging from .89 to .97 ($\overline{\alpha}$ = .95) across the 75 daily assessments. Previous research has established longitudinal scalar measurement invariance of this measure across days and annual assessment waves during adolescence (Maciejewski et al., 2017). ICC2 coefficients of the year-specific (Level 2) random intercepts of this measure (see 'Statistical Analysis') ranged from .93 to .96 across

12 One-hundred-and-eighty-seven adolescents did not participate in the first trait measurement. These adolescents were neither continuing participants, nor dropouts.

Table 4.1. Number of reports in each year and number of reports per participant across the entire study period

	# Reports per year							# Reports per participant			
Construct	IDs	2005	2006	2007	2008	2009	2010	Min.	Max.	Mean	*SD*
Neuroticism	1,046	859	869	856	849	793	655	1	6	4.67	1.61
Daily negative affect	1,046	11,096	11,513	10,673	10,676	9,294		15	80[a]	50.92	19.61
Daily conflict with mother	534	6,115	5,126	4,169	3,767	3,079		3	77[a]	41.68	19.51
Daily conflict with friend	1,046	5,797	4,938	4,213	3,347	2,141		0	73	19.54	15.94

Note. IDs = number of participants that provided reports on the construct; 2005 – 2010 = number of reports provided by participants in each year; Min. – *SD* = minimum, maximum, mean, and standard deviation of the amount of reports provided by the participants. (For example, the table shows that 859 of the 1,046 adolescents participated in the first yearly neuroticism measurement. Furthermore, the 534 adolescents who reported about daily conflicts with their mother provided at least 3 and at most 77 conflict with mother reports across the entire study period.)

[a] Max. > 75 due to participation in catch-up assessment bursts, which were meant for participants with missing data.

the five study years, indicating that participants differed reliably from each other in their yearly average level of negative affect. The ICC1 coefficient of the Level 3 random intercept of the five Level 2 random intercepts was .69, which indicates that 69% of the variance across the five yearly mean levels of negative affect was attributable to between-person differences and 31% was attributable to yearly within-person fluctuations.

Daily relationship conflict. During assessment bursts, participants reported the extent to which they had experienced relationship conflict with their mother and their best friend, using two items of the Negative Interaction Scale of the Network of Relationship Inventory (NRI; Furman & Buhrmester, 1985). Participants responded on a 7-point Likert scale (1 = *not at all*; 7 = *very much*) to the questions "Did you and your friend/mother get on each other's nerves today?" and "Did you and your friend/mother quarrel today?". For conflict with mother, coefficient alpha ranged from .79 to .92 ($\overline{\alpha}$ = .87) across the 75 daily assessments. For conflict with friend, alpha ranged from .59 to .89 ($\overline{\alpha}$ = .78) across the 75 daily assessments. Agreement between the target adolescents' and friends' self-reported level of daily conflict with each other was moderate (on average, r = .30 across the 75 daily assessments). Previous research established longitudinal metric invariance (i.e., consistent item loadings) across adolescence for this measure (Crocetti, Branje, Rubini, Koot, & Meeus, 2017). Note that the subsample of best friends did *not* report daily relationship conflicts with their mother; all other measures included in this study were collected among both target adolescents and best friends. ICC2 coefficients of the yearly Level 2 random intercepts ranged from .84 to .88 for conflict with mother and from .79 to .85 for conflict with friend. The ICC1 coefficients of the Level 3 random intercepts were .56 (conflict with mother) and .49 (conflict with friend).

Statistical Analysis

We analyzed the longitudinal associations between neuroticism and daily experiences using multilevel structural equation modelling (MSEM, Preacher, Zyphur, & Zhang, 2010) in Mplus version 7 (Muthén & Muthén, 1998-2012), by means of the *MplusAutomation* package (Hallquist & Wiley, 2017) in R (R Core team, 2016; version 3.4.4). The multilevel approach allowed us to account for the nested structure of the yearly measurement burst data, with up to 15 daily reports varying each year within and between persons.[13] To also account for the dependency between friends' observations, we used the "complex twolevel" (Models 1 and 3) and "complex twolevel random" (Model 5) functions offered in Mplus, in conjunction with a cluster variable identifying friendship dyads.

13 We structured the data in a mixed long-wide format, with at most 15 rows per participant. For example, the data column 'Neuroticism_year1' contained for each participant up to 15 rows of time-invariant (between-person) data on the first neuroticism measurement; the column 'Negative affect_year5' contained for each participant up to 15 rows of time-varying (within-person) daily negative affect data collected during the last three assessment bursts.

We used MLR estimation in all models, which estimated model parameters using maximum likelihood and computed standard errors that were robust to non-normality and non-independence of observations. By default, Mplus handles missing data based on variables that are included in the analysis model. To improve the handling of missing data, we also specified auxiliary variables. Auxiliary variables are variables that are not part of the analysis model but improve the estimation of missing data provided they were missing at random. The auxiliary variables that we included were gender, type of respondent (target adolescent vs. friend), subsample (Dutch population vs. Dutch-Moroccan), risk status for developing delinquent behavior, all yearly extraversion, agreeableness, conscientiousness, and openness variables, and those daily conflict with mother/conflict with friend/negative affect variables that were not part of a particular analysis model.

We freely estimated the yearly within-person residual variances of negative affect and conflict and the yearly means of all variables (to allow for potential mean-level changes). Because past research has found that personality traits become more stable during adolescence (Borghuis, Denissen, et al., 2017; Roberts & DelVecchio, 2000), we allowed the stability effects to change linearly over time. We imposed equality constraints on equivalent cross-lagged regression paths to ensure that we tested each cross-lagged path only once using all available data. This maximized statistical power and simplified the interpretation of the results. We also imposed equality constraints on equivalent residual variances to reduce model complexity and to ensure that we estimated only one standardized coefficient per cross-lagged effect, rather than a unique standardized coefficient for each time lag because of yearly fluctuations in variance. In a subsequent sensitivity analysis, we released all equality constraints on the variables' variances to evaluate whether our results were robust against these constraints. Finally, we also explored whether cross-lagged effects changed linearly over time. We used a Bonferroni-corrected significance level equal to α = .05/5 = .01 (two-sided), because we tested for dynamic transactions between neuroticism and five daily experience variables.

To study the longitudinal associations between neuroticism and the five negative daily experiences variables (i.e., negative affect, conflict with mother, conflict with friend, contingency between conflict mother and negative affect, and contingency between conflict friend and negative affect), we estimated five multilevel[14] random intercept cross-lagged panel models (RI-CLPM; Hamaker et al., 2015) (see Figures 4.1 and 4.2). The RI-CLPMs can account for constant (i.e., time-invariant, enduring) between-person differences in

14 Our models resembled the standard RI-CLPM, but were different in two ways. First, our models did not contain contemporaneous residual covariances, because we measured neuroticism and daily experiences not contemporaneously but sequentially (i.e., daily experiences were assessed in-between the trait measurements). Second, because our daily diary data had a multilevel structure, we included negative daily experiences not as observed variables, but as latent variables (i.e., as Level 2 random intercepts or random slopes; see below).

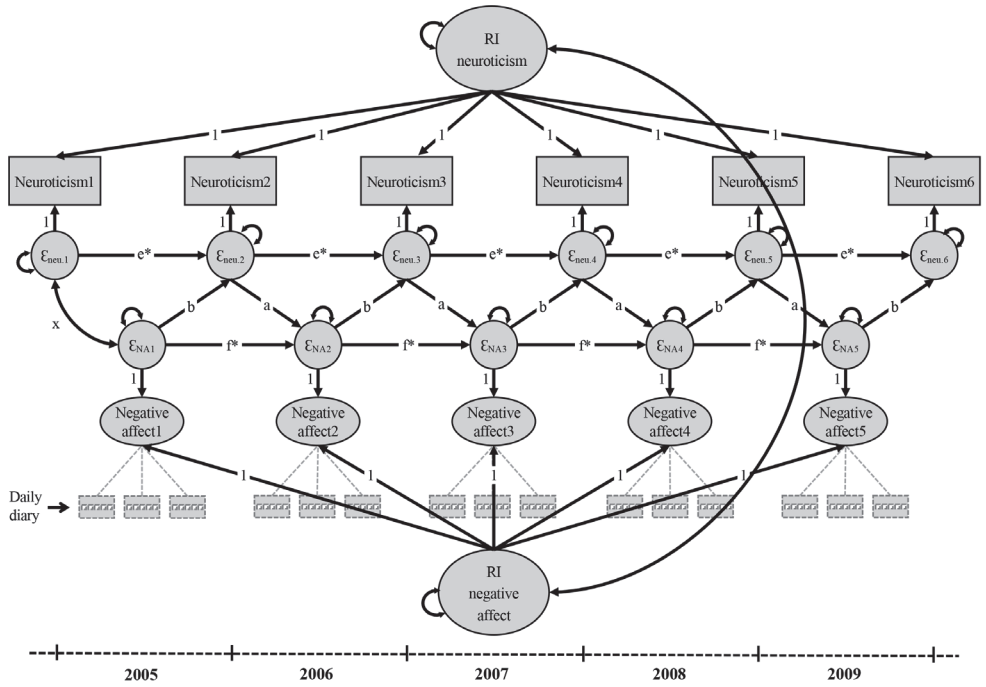

Figure 4.1. Multilevel RI-CLPM (Model 1) estimating longitudinal associations between yearly measured neuroticism and daily measured negative affect. As indicated by the dashed gray boxes, we measured daily experiences each year using three bursts of daily diary assessments that each lasted five consecutive days. Observed variables are shown in rectangles and latent variables are shown in circles. The latent 'Negative affect1-6' variables are year-specific Level 2 random intercepts, reflecting participants' average level of daily negative affect across 15 days. 'RI neuroticism' and 'RI negative affect' are Level 3 random intercepts, reflecting individual differences in constant levels of neuroticism and negative affect across the study period. We constrained path coefficients with identical letters to be equal. Paths 'e*' and 'f*' were allowed to change linearly over time.

daily experiences and in neuroticism (Anusic & Schimmack, 2016; Fraley & Roberts, 2005; Roberts, 2018) through the inclusion of (Level 3) random intercepts across the entire study period. As such, the RI-CLPMs were suited to differentiate constant between-person differences in our variables from year-specific within-persons changes therein. The Level 3 random intercepts reflected constant between-person differences (i.e., individual differences in mean levels of neuroticism and negative daily experiences across the entire study period). The yearly structured residuals (ε) reflected participants' year-specific deviations from their own constant level; that is, within-person residual variation not accounted for by constant between-person differences, which includes measurement error.

We modelled neuroticism as year-specific observed variables, and the daily experiences as year-specific (i.e., Level 2) latent random intercepts (Models 1-3) or random slopes (Model 4 and 5). Models 1 to 3 contained five Level 2 random intercepts that decomposed the variance

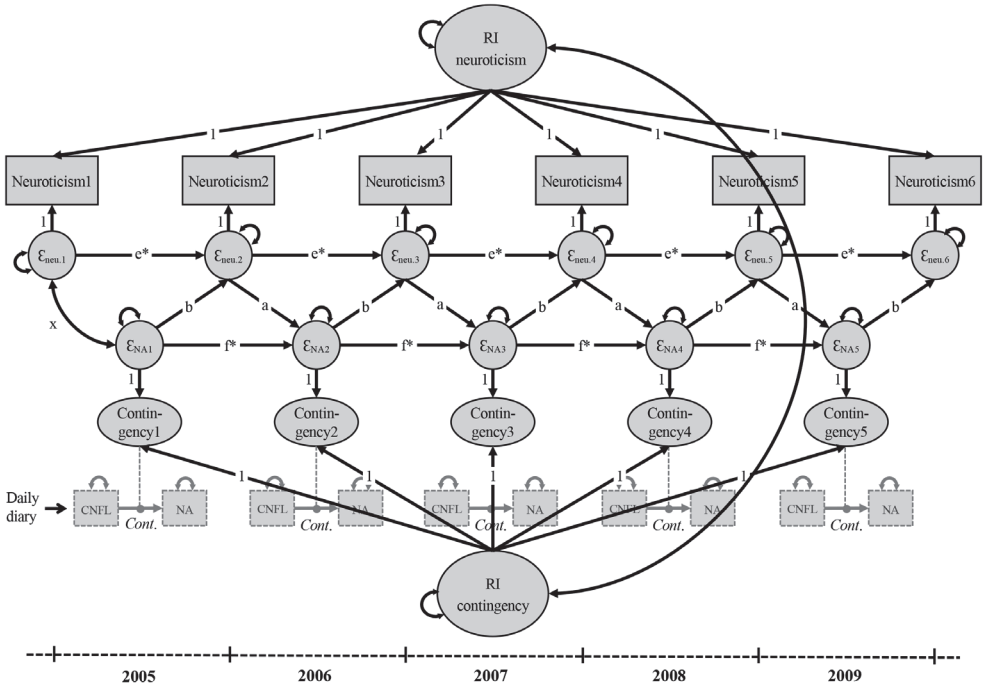

Figure 4.2. Multilevel RI-CLPM estimating longitudinal associations between yearly measured neuroticism and yearly estimated within-person contingencies between daily negative affect (na) and daily conflict (cnfl) with mother (Model 4) or with best friend (Model 5). The filled circles in the arrows from cnfl to na represent random slopes, which were estimated across three assessment bursts (shown in Figure 4.1). The random slopes/contingencies ('Contingency1-5') reflect in each year the extent to which participants' level of daily negative affect was contingent on their level of relationship conflict on the same day. We person-mean centered negative affect and conflict in each year. See Figure 4.1 for more explanation.

of daily negative affect (Model 1; Figure 4.1), conflict with mother (Model 2), and conflict with friend (Model 3) per year into constant between-person variance and within-person (residual) variance not accounted for by constant between-person differences. Hence, the Level 2 random intercepts reflected individual differences in participants' constant levels of daily negative affect/conflict across three consecutive assessment bursts per year. Models 4 and 5 (Figure 4.2) contained five Level 2 random slopes that reflected participants' year-specific within-person contingencies between daily relationship conflict and daily negative affect. In other words, in each year, the Level 2 random slopes reflected the extent to which daily conflicts with mother (Model 4) or friend (Model 5) were related to participants' level of negative affect on that same day. We used yearly person-mean centered negative affect and relationship conflict scores to estimate the Level 2 contingencies (Preacher et al., 2010). To ensure convergence of all models, we only included respondents who participated in at least one daily negative affect/conflict assessment in at least two different years.

To evaluate whether the differentiated RI-CLPM indeed fit our data better than the more parsimonious and widely used cross-lagged panel model (CLPM), we compared the fit of both models. The CLPMs were nested in the RI-CLPMs, but the CLPMs did not contain Level 3 random intercepts that accounted for constant between-person differences. We selected the best-fitting models using the comparative fit index (CFI; values ≥ 0.95 indicate good fit), the root mean square error of approximation (RMSEA; values ≤ 0.06 indicate good fit), the standardized root mean residual (SRMR; values ≤ 0.08 indicate good fit), and MLR χ^2-difference test for nested models based on loglikelihood (α = .05) (Hu & Bentler, 1999).[15]

Results

Table 4.2 shows the descriptive statistics of neuroticism and daily negative affect and relationship conflict in each year.

Preliminary Analyses

Adolescents reported more conflict with their mother (*M* = 3.91, *SE* = .02) than with their best friend (*M* = 3.36, *SE* = .01). Daily negative affect was positively correlated with daily relationship conflict, both at the between-person level (*r* = .64 for conflict with mother; *r* = .56 for conflict with friend) and at the within-person level (*r* = .28 for conflict with mother; *r* = .21 for conflict with friend). Daily conflict with mother was also positively correlated with daily conflict with friend at both the between-person level (*r* = .60) and at the within-person level (*r* = .19). A multilevel analysis on all 75 assessment days indicated that adolescents differed substantially with respect to how strongly their level of daily negative affect was associated with their level of daily conflict with mother (β = .17, *b* = 0.37, *SE* = .02, $SD_{(b)}$ = 0.32) and their level of daily conflict with friend (β = .12, *b* = 0.34, *SE* = .02, $SD_{(b)}$ = 0.37).

Model Selection

To evaluate whether the differentiated RI-CLPMs fit our data better than CLPMs, we compared the fit of both models (Table S4.1 in the supplemental materials). The CFI and SRMR measures and the MLR χ^2-difference tests (*df* = 3, *p*-values < .001 for all five tests) indicated that the RI-CLPMs fit the data better than the CLPMs.

15 We adopted a different statistical analysis strategy in an earlier version of this study. In a previous version, we conducted a two-step analysis in which we first computed mean level, variability, and contingency variables using multilevel analyses and subsequently included these as 'observed' variables in path models to test for cross-lagged associations with all Big Five personality traits. In these analyses, we found evidence for bidirectional effects. The first submitted version of this article can be found at https://osf.io/pm9th/.

Table 4.2. Descriptive statistics

Variable	Year	*n*	*M*	*SE*	*SD*	Min.	Max.
Neuroticism	1	859	3.54	0.04	1.08	1.00	7.00
	2	869	3.45	0.04	1.17	1.00	7.00
	3	856	3.50	0.04	1.20	1.00	6.83
	4	849	3.54	0.04	1.21	1.00	7.00
	5	793	3.52	0.04	1.20	1.00	7.00
	6	655	3.55	0.05	1.19	1.00	7.00
Negative affect	1	873	6.04	0.10	3.04	3.00	24.84
	2	904	6.62	0.12	3.53	3.00	22.21
	3	866	6.76	0.12	3.53	3.00	17.98
	4	831	6.79	0.13	3.81	3.00	21.45
	5	755	6.68	0.13	3.71	3.00	19.19
Conflict with mother	1	529	3.87	0.07	1.70	2.00	9.67
	2	506	4.22	0.09	1.96	2.00	14.00
	3	469	4.14	0.09	1.84	2.00	11.00
	4	428	3.91	0.09	1.86	2.00	12.00
	5	383	3.97	0.10	1.93	2.00	12.00
Conflict with friend	1	764	3.17	0.05	1.39	2.00	9.83
	2	729	3.49	0.06	1.74	2.00	11.50
	3	661	3.36	0.07	1.69	2.00	14.00
	4	560	3.26	0.07	1.57	2.00	9.33
	5	428	3.17	0.08	1.57	2.00	11.00

Note: The negative affect and conflict variables were averaged across three assessment bursts per year.

We found no significant random component for the Level 3 random intercept of conflict with friend (s^2 = 0.25, *SE* = 0.57, p = .661) and the Level 3 random intercept of the contingency between daily conflict with mother and negative affect (s^2 = 0.00, *SE* = 0.03, p = .970). This indicates that there were no constant between-person differences in these variables. Removing these random intercepts from the models by fixing their variances to 0 did not reduce model fit (χ^2 = 3.06, *df* = 2, p = 0.22; and χ^2 = -0.59, *df* = 2, p = 1, respectively). Hence, the most parsimonious models that fit the data best were models with Level 3 random intercepts for neuroticism (Models 1-5), negative affect (Model 1), conflict with mother (Model 2), and the contingency between conflict with friend and negative affect (Model 5), but without Level 3 random intercepts for conflict with friend (Model 3) and the contingency between conflict with mother and negative affect (Model 4).

Table 4.3 shows model summary statistics of the most parsimonious, best-fitting models that we selected. The parameter estimates of the initial CLPMs and RI-CLPMs can be found in Table S4.2. The Mplus output files of our selected models, which contain all model specifications and parameter estimates, can be found at https://osf.io/dsnvc.

Table 4.3. Model summary statistics

Model	Dyads	IDs	Obs.	Para.	χ^2	*df*	*p*	CFI	RMSEA	SRMR
Negative affect	550	1,020	57,690	30	131.22	62	<.001	0.98	0.01	0.04
Conflict with mother	-	530	25,159	30	114.84	62	<.001	0.98	0.01	0.04
Conflict with friend	492	878	24,298	28	116.08	64	<.001	0.98	0.01	0.05
Contingency (mother)	-	530	56,366	35	-	-	-	-	-	-
Contingency (friend)	492	878	71,059	37	-	-	-	-	-	-

Note. Dyads = number of friendship dyads; IDs = number of participants; Obs. = number of daily diary and yearly trait reports; Para. = number of freely estimated parameters; CFI, RMSEA, and SRMR are model fit measures. The subsample of best friends was not included in Model 2 and Model 4 because only target adolescents reported daily conflicts with their mother. Model fit statistics were not available for models with random slopes (i.e., Models 4 and 5).

Main Results

Associations between random intercepts. Table 4.4 shows a substantial positive correlation between the (Level 3) random intercepts of neuroticism and daily negative affect, indicating that overall mean levels of neuroticism were positively associated with overall mean levels of negative affect (i.e., a between-person association). Furthermore, the random intercept of neuroticism was moderately positively correlated with the random intercept of daily conflict with mother and with the random intercept of adolescents' contingency between conflict with friend and negative affect.

Table 4.4. Level 3 random intercept variances and their bivariate associations of Models 1-5

	RI daily experience			RI neuroticism			Associations between RIs			
Model	s^2	*SE*	*P*	s^2	*SE*	*p*	*r*	cov.	*SE*	*p*
Negative affect	**4.91**	0.87	<.001	**0.68**	0.05	<.001	**.50**	0.92	0.12	<.001
Conflict with mother	**1.36**	0.49	0.005	**0.73**	0.07	<.001	**.32**	0.32	0.09	<.001
Conflict with friend	-[a]	-[a]	-[a]	**0.65**	0.05	<.001	-[a]	-[a]	-[a]	-[a]
Contingency (mother)	-[a]	-[a]	-[a]	**0.72**	0.07	<.001	-[a]	-[a]	-[a]	-[a]
Contingency (friend)	**0.14**	0.02	<.001	**0.68**	0.05	<.001	**.25**	0.08	0.02	<.001

Note: RI = random intercept; s^2 = variance; *r* = correlation; cov = covariance.
[a] Not applicable because we removed the non-significant Level 3 random intercepts of 'conflict with friend' and 'contingency (mother)' from the model.
Bold coefficients: $p < .01$.

Stability effects. We found substantial stability effects for all measures (Table 4.5; see paths 'e*' and 'f*' in Figures 4.1 and 4.2). Because we accounted for constant between-person differences in neuroticism, negative affect (Model 1), conflict with mother (Model 2), and the contingency between conflict with friend and negative affect (Model 5), the stability effects of these variables can be interpreted as within-person carry-over effects, which represent the extent to which higher-than-typical values on one measurement occasion predicted higher-than-typical values on the next occasion. The within-person

Table 4.5. Stability effects, initial associations between neuroticism and negative daily experiences, and cross-lagged effects

	Stability[b]		Initial association Neu.~Daily exp.				Neu. → Daily exp.				Daily exp. → Neu.			
Model	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
Negative affect	**.78**	.08	.05	.08	.09	.399	**.06**	.18	.06	.004	**.07**	.03	.01	.001
Conflict with mother	**.58**	.28	.11	.10	.07	.192	.04	.05	.05	.364	.06	.05	.04	.238
Conflict with friend[a]	**.83**	.04	**.17**	.17	.05	.001	.02	.02	.04	.529	**.11**	.07	.02	<.001
Contingency (mother)[a]	**.56**	.06	-.14	-.04	.02	.094	.02	.01	.02	.553	**.08**	.21	.08	.004
Contingency (friend)	**.75**	.09	-.14	-.01	.02	.652	-.02	.00	.02	.739	.00	.04	.04	.404

Note. The standardized and unstandardized regression coefficients are estimates of paths 'f' (Stability), 'x' (Initial association Neu.~Daily exp.), 'a' (Neu. → Daily exp.), and 'b' (Daily exp. → Neu.) of Figure 4.1 and Figure 4.2. The two contingency variables reflect individual differences in adolescents' contingency (i.e., dependency, coupling) between their level of daily relationship conflict with mother/friend and their level of daily negative affect.

[a] We removed the Level 3 random intercepts of 'conflict with friend' and 'contingency (mother)' from the model, which alters the substantive interpretation of some of the parameter estimates of these models.

[b] All stability effects were allowed to change linearly over time. The reported coefficients refer to the stability between the first and second year.

Bold coefficients: $p < .01$.

carry-over effect of neuroticism (Model 1) increased linearly ($p < .001$) in magnitude across the five trait measurements, from $\beta = .15$ ($SE = .05$) to $\beta = .53$ ($SE = .05$). The within-person carry-over effect of the contingency between daily conflict with friend and negative affect increased linearly ($p < .001$) from $\beta = .75$ ($SE = .09$) to $\beta = 1.59$ ($SE = .04$).[16]

The stability effects of conflict with mother (Model 3) and the contingency between conflict with mother and negative affect (Model 4) represent rank-order stability effects, because we removed the random intercepts of these variables. The rank-order stability effect of the contingency variable increased linearly ($p < .001$) from $\beta = .56$ ($SE = .06$) to $\beta = 1.05$ ($SE = .05$). We found no evidence for linear changes in the stability effects of negative affect, conflict with mother, and conflict with friend.

Cross-lagged effects. We found evidence for bidirectional longitudinal effects between neuroticism and daily negative affect (Model 1; see paths 'a' and 'b' in Figure 4.1). That is, higher-than-typical levels of neuroticism were preceded and followed by higher-than-typical levels of daily negative affect. We found no within-person associations between neuroticism and daily conflict with mother (Model 2), nor between neuroticism and adolescents' contingency between daily conflict with friend and daily negative affect (Model 5).

Furthermore, in the models with only one Level 3 random intercept (Models 3 and 4), we estimated longitudinal associations between yearly within-person changes in neuroticism and yearly rank-order differences in daily experiences. Within-person changes in neuroticism did not predict subsequent rank-order differences in conflict with friend and in the contingency between conflict with mother and negative affect. However, rank-order differences in conflict with friend (Model 3) and rank-order differences in adolescents' contingency between conflict with mother and negative affect (Model 4) were positively associated with subsequent within-person changes in neuroticism. In other words, adolescents who in a particular year reported relatively high levels of daily conflict with their friend, and adolescents whose contingency between their daily experiences conflict with mother and negative affect was relatively high, showed a greater increase in neuroticism than adolescents who scored low on these daily experience variables.

Sensitivity Analysis: Releasing Equality Constraints on Error Variances

We conducted a sensitivity analysis by means of rerunning Models 1 to 5 while releasing the equality constraints on the residual variances of the neuroticism variables and the daily experience variables (Table S4.3). The unstandardized cross-lagged parameter estimates (paths 'a' and 'b' in Figures 4.1 and 4.2) remained similar, and the statistical inferences

16 If standardized coefficients exceed 1, this does not necessarily imply that the model is inaccurate (Jöreskog, 1999). Other studies have reported standardized coefficients exceeding 1 (e.g., Wrzus et al., 2017). In our case, the result might be related to the fact the random slopes were less reliable and to the linear constraint that we imposed on these stability effects to ensure model convergence.

based on the *p*-values regarding these estimates remained identical, to the results reported in Table 4.5.

Exploratory Analysis: Linear Change of the Cross-Lagged Effects

Finally, we explored whether the magnitude of any of the cross-lagged effects changed during the study period. We ran Models 1 to 5 again, this time allowing both the stability effects ('e' and 'f') and cross-lagged effects ('a' and 'b') to change linearly over time. Using a Bonferroni-corrected significance level equal to $\alpha = .05/10 = .005$, we found evidence for linear change of one cross-lagged parameter: The within-person effect of daily negative affect on subsequent neuroticism decreased significantly ($p = .002$) over time, from $b = .09$ ($SE = .02$, $p < .001$) in the 1st time lag to $b = .01$ ($SE = .01$, $p = .26$) in the 5th time lag. The effect was statistically significant ($p \leq .001$) in all time lags other than the 5th.

Discussion

The goal of this measurement burst study was to examine the longitudinal associations between neuroticism and daily experiences of negative affect and interpersonal problems with parents and peers during adolescence. Using RI-CLPMs, we differentiated covariance at the level of constant between-person differences from dynamic processes that occurred within persons. The most parsimonious, best-fitting models contained random intercepts indicating constant between-person differences (for the duration of the study) in neuroticism, negative affect, conflict with mother, and the contingency between conflict with friend and negative affect – but not for conflict with friend and the contingency between conflict with mother and negative affect. At the level of constant between-person differences, neuroticism was associated with more negative daily experiences. At the level of yearly within-person changes, we found bidirectional longitudinal effects between neuroticism and daily negative affect.

Constant Between-Person Differences

We found that the random intercepts that accounted for constant between-person differences in our study variables across the study period significantly improved model fit. Our evidence for constant between-person differences in neuroticism is consistent with theory (Roberts, 2018) and previous longitudinal research (Anusic & Schimmack, 2016; Fraley & Roberts, 2005) that indicated that personality traits are influenced by constant factors. These constant factors could reflect constancy in response styles, constancy in genetic influences, and/or constancy in environmental influences on individual differences in our measures (Briley & Tucker-Drob, 2014; Fraley & Roberts, 2005). In contrast, we

found no evidence for constant between-person differences in daily conflict with friend and adolescents' contingency between daily conflict with mother and negative affect when constant between-person differences in neuroticism were also included in the model. This is surprising, particularly because according to the ICC1 coefficient, approximately 50% of the variance of yearly mean levels of conflict with friend was attributable to between-person differences. Most likely, our daily relationship conflict data contained too many missing values (see Table 4.1) and/or too few yearly waves to enable the model to accurately differentiate constant stability from temporal (i.e., rank-order) stability (Hamaker et al., 2015). These models indeed had very high year-to-year stability coefficients, which effectively functioned as a constant random intercept factor. The inclusion of additional time points is likely necessary to differentiate these two sources of personality stability (see also the limitations section below).

Consistent with previous research (Côté & Moskowitz, 1998; Lopes et al., 2003; Mroczek & Almeida, 2004; Wrzus et al., 2017), we found evidence for positive correlations between the constant variance of our neuroticism measure and the constant variance of our negative daily experience variables. These zero-order between-person correlations could be manifestations of overlapping constant genetic influences, overlapping constant environmental influences (e.g., neighborhood characteristics might have exerted constant effects on neuroticism and daily experiences), and/or overlapping influences of constant response styles. In addition, the correlations may reflect past unidirectional or bidirectional effects between neuroticism and negative daily experiences that were preserved across time (Roberts, 2018). For example, interpersonal problems during childhood might have had an enduring influence on adolescents' level of neuroticism and on their relationship experiences with close others. To gain more insight into the developmental processes that gave rise to constant between-person associations in adolescence, future research may extend the longitudinal study period to include childhood.

Within-Person Effects between Neuroticism and Negative Daily Experiences

The statistically significant variance of the yearly residuals indicated that adolescents differed from each other by how they deviated each year from their own constant level. This suggested that the yearly within-person changes in neuroticism and negative daily experiences at least partly reflected changes that were not attributable to random measurement error. Consistent with predictions of both endogenous and dynamic personality theories, we found that within-person changes in neuroticism were positively associated with subsequent within-person changes in daily negative affect. This association may be explained by the small but consistent influences that increased neuroticism might have had on adolescents' affect across situations (Costa & McCrae, 1980). For example, changes in neuroticism might have influenced adolescents' daily experiences of negative affect because high neuroticism

is positively associated with affective reactivity to stressful situations (Gunthert et al., 1999; Leger et al., 2016) and the extent to which people pay attention to negative and threatening stimuli (Ormel, Bastiaansen, et al., 2013).

Notably, we also found that within-person changes in daily negative affect predicted subsequent within-person changes in neuroticism. This finding supports a key tenet of dynamic personality theories that personality traits can change gradually due to the accumulation of everyday psychological experiences (Baumert et al., 2017; Geukes et al., 2018; Roberts, 2018; Roberts & Jackson, 2008; Wrzus & Roberts, 2017). Future research may shed light on the question whether this effect was driven by biological mechanisms (e.g., changes in gene expressions and neuroanatomical structures), associative mechanisms (e.g., implicit learning, reinforcement learning, and habit formation), or reflective mechanisms (e.g., conscious memories about one's past states; Baumert et al., 2017; Buss & Craik, 1983; Roberts, 2018; Wrzus & Roberts, 2017).

The within-person effects of negative affect on neuroticism are more difficult to reconcile with the assertion of endogenous personality theories that personality traits are immune to the effects of psychological experiences (McCrae & Costa, 2008; McCrae & Sutin, 2018). However, in defense of endogenous theories, one could argue that people's temporary fluctuations around their constant neuroticism level are not true personality trait changes. These fluctuations may reflect temporary changes in self-perceptions, induced by past negative affect experiences, rather than enduring changes in true trait levels. We encourage scholars to explicate recommendations how to conceptualize and measure personality trait changes (for a recent example, see Roberts, 2018).

Our evidence for symmetrical, bidirectional within-person effects between neuroticism and daily experiences of negative affect is consistent with the corresponsive principle of personality development (e.g., Roberts et al., 2008). Especially during the formative period of adolescence, the corresponsive, mutually reinforcing effects between neuroticism and daily experiences of negative affect may have long-term consequences for individuals' emotional well-being (Costa & McCrae, 1980). People who are in detrimental spirals might become increasingly neurotic, resulting in increasingly negative daily experiences, and so forth. Conversely, people who are in upward spirals might become increasingly emotionally stable, resulting in decreasing negative experiences. In addition to their theoretical value, these results may aid in designing interventions. For example, practitioners may be able to reduce adolescents' neuroticism and daily emotional difficulties by intervening in their daily experience patterns or by offering to help them to regulate their emotions. Future intervention studies may test whether such trainings indeed facilitate socially desirable decreases in neuroticism and negative affect.

We found no evidence that within-person changes in neuroticism were longitudinally associated with within-person changes of daily conflict in established relationships with

close others. However, we did find that, compared to other adolescents who reported little conflict, adolescents who reported higher levels of daily conflict with their friend tended to show stronger subsequent within-person increases in their level of neuroticism. The lack of evidence for longitudinal effects of neuroticism on relationship conflict is inconsistent with the widely established notion that neuroticism negatively affects people's relationship experiences, for example, through negative interpretations of ambiguous relationship cues (Finn et al., 2013) and enhanced emotional reactivity to relationship problems (Suls et al., 1998). One explanation for this somewhat surprising finding is that neuroticism may be more relevant during the early stages of peer relationships (Selfhout et al., 2010) than in the development of relatively stable, well-established relationships that we investigated. More research is needed to gain insights into the processes through which neuroticism is associated with interpersonal problems (Branje et al., 2004; Kelly & Conley, 1987; Lopes et al., 2003; Sturaro et al., 2008).

Strengths and Limitations

Important strengths of this study are that we used a statistical approach that differentiated constant between-person differences from time-specific within-person changes, and that we examined dynamic transactions during the formative and sometimes turbulent period of adolescence. In addition, we measured negative affect and interpersonal problems in daily life by means of a 5-year measurement burst design, and we used a relatively large sample of target adolescents and their friends. However, we also note some important limitations that may be addressed in future studies.

First, we cannot infer from our correlational design that the longitudinal within-person associations between neuroticism and daily negative affect reflect a causal relation. Although one benefit of our statistical approach was that the longitudinal within-person associations were controlled for all possible time-invariant covariates (Berry & Willoughby, 2017; Hamaker et al., 2015), we cannot rule out that time-varying covariates confounded our results. For example, it is possible that the effect of negative affect on changes in neuroticism was driven by underlying biological processes (e.g., hormonal changes or epigenetic changes) or other psychological experiences (e.g., feelings of depression, loneliness, or low self-esteem) that influenced adolescents' feelings of negative affect as well as their level of neuroticism. To gain more insight into causality, future research may examine the mechanisms that drive the effects of daily experiences on personality traits (Baumert et al., 2017; Geukes et al., 2018; Wrzus & Roberts, 2017) and use experimental designs. For example, intervention studies could test whether random assignment of participants to a control condition or a treatment condition aimed at improving people's daily affective experiences (e.g., though emotion regulation training or by repeatedly sending unexpected small gifts and complements; Ogedegbe, 2012) is associated with differential changes in personality traits (Sih et al., 2015).

Second, we measured daily experiences and personality traits by means of self-report questionnaires. Although self-reports do justice to the subjective nature of negative affect and interpersonal problems, they can be inconsistent with additional information sources, such as reports from informants and behavioral observations of relationship conflicts. For example, in our study, agreement between friends' reports about their level of conflict with each other was only moderate. Future research may re-examine our research questions using informant-reports and behavioral observations to investigate the extent to which constant between-person differences reflected response styles and to investigate the extent to which yearly within-person changes in neuroticism reflected meaningful personality changes.

Third, we focused on negative daily experiences and relationship experiences with mother and best friend during the period of adolescence. Future research may provide more insight into the boundary conditions of dynamic state-trait transactions by also focusing on positive daily experiences (e.g., do positive affective and interpersonal experiences also predict changes in neuroticism?; Soto, 2015), on other social relationships (e.g., do interpersonal problems with a father, sibling, and romantic partner also predict changes in neuroticism?), and on other periods (e.g., childhood and young adulthood). For example, interpersonal problems with a best friend and parent may have a smaller impact on neuroticism in adulthood than in adolescence because in adulthood these relationships may be more stable and conflicts in these relationships may pose a lower threat to individuals' access to resources, their social status, and their need to belong (Reitz et al., 2014).

Fourth, we used within-person contingencies between interpersonal problems and negative affect as an indicator of adolescents' affective reactivity to interpersonal problems. However, the reliability and validity of this indicator was limited because some participants showed little variance in their daily experiences over time (which hampers the estimation of covariation), because the random slopes were estimated based on relatively few data points, and because we estimated the contingencies not lagged but concurrently (i.e., conflict on day t predicted negative affect on day t rather than on day t+1). In order to address these concerns, future research may use experience sampling to estimate contingencies based on multiple data points per day (e.g., Wrzus et al., 2017).

Fifth, despite our relatively large sample size and the frequent measurement of neuroticism and daily experiences, we experienced some modelling issues that might be alleviated by including additional waves of data. For example, some of the Level 3 random intercepts had no significant random component, and in the contingency models, some of the standardized stability coefficients exceeded 1. For some models, we solved convergence issues by using starting values and removing participants with many missing data points. While this is not problematic per se, it does suggest the need for future studies to replicate our results.

Finally, a comparison between the yearly Cronbach's alpha values of the neuroticism measure and the yearly ICC2 coefficients of the daily negative affect measure suggested that

the Level 2 random intercepts of negative affect were more reliable than the measurements of neuroticism. Therefore, the regression coefficients of neuroticism and negative affect should be compared with caution. Future research using larger samples may use more complex statistical models that include a measurement model to account for measurement error.

Conclusions

A large body of research has established that trait neuroticism is positively associated with emotional and interpersonal problems. The present study replicated these well-established between-person correlations. However, our aim was to move beyond previous findings at the between-person level by also investigating how changes in neuroticism and changes in negative daily experiences were related within persons over time. Using RI-CLPMs, we found evidence for bidirectional within-person effects between neuroticism and daily experiences of negative affect. The within-person effect of daily negative affect on neuroticism is consistent with dynamic theories of personality development. However, this finding is difficult to reconcile with the position of endogenous personality theories that personality traits are immune to the effects of psychological experiences.

The use of RI-CLPM helped to gain a deeper understanding of the associations between neuroticism and negative daily experiences during adolescence. Model fit measures suggested that, compared to the CLPM, the RI-CLPM provided a better representation of the underlying processes that gave rise to the data. This finding is consistent with theory and previous research suggesting that personality traits partly reflect constant between-person differences (Fraley & Roberts, 2005; Roberts, 2018). The cross-lagged estimates of the RI-CLPMs were better representations of within-person processes than the cross-lagged estimates of the CLPMs. Corroborating results from simulation studies (Berry & Willoughby, 2017; Hamaker et al., 2015), we found that the CLPMs sometimes revealed significant effects that were not present at the within-person level (see Table S4.3). We encourage future researchers to apply models that differentiate between constant between-person differences from temporary within-person changes.

Supplemental Materials

Table S4.1. Model summary statistics of initial CLPMs and RI-CLPMs

Model	Dyads	IDs	Obs.	Para.	χ^2	*df*	*p*	CFI	RMSEA	SRMR
CLPM										
Negative affect	550	1,020	57,690	27	261.13	65	<.001	0.95	0.01	0.08
Conflict with mother		530	25,159	27	202.22	65	<.001	0.94	0.01	0.08
Conflict with friend	492	878	24,298	27	229.96	65	<.001	0.93	0.01	0.09
Contingency mother)		530	56,366	34	-	-	-	-	-	-
Contingency (friend)	492	878	71,059	34	-	-	-	-	-	-
RI-CLPM										
Negative affect	550	1,020	57,690	30	131.22	62	<.001	0.98	0.01	0.04
Conflict with mother		530	25,159	30	114.84	62	<.001	0.98	0.01	0.04
Conflict with friend	492	878	24,298	30	116.08	62	<.001	0.98	0.01	0.05
Contingency mother)		530	56,366	37	-	-	-	-	-	-
Contingency (friend)	492	878	71,059	37	-	-	-	-	-	-

Note. Dyads = number of friendship dyads; IDs = number of participants; Obs. = number of daily diary and yearly neuroticism reports; Para. = number of freely estimated parameters; CFI, RMSEA, and SRMR are model fit measures.

Table S4.2. Main parameter estimates of initial CLPMs and RI-CLPMs

	Stability[a]		Initial association Neu.–Daily exp.				Neu. → Daily exp.				Daily exp. → Neu.			
Model	β	*SE*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*	β	*b*	*SE*	*p*
CLPM														
Negative affect	**.89**	.03	**.31**	.98	.13	<.001	**.04**	.11	.03	.001	**.10**	.04	.00	<.001
Conflict with mother	**.86**	.03	**.23**	.40	.09	<.001	.02	.02	.02	.299	**.06**	.05	.01	<.001
Conflict with friend	**.83**	.04	**.17**	.23	.06	<.001	.01	.01	.02	.635	**.04**	.04	.01	.002
Contingency (mother)	**.60**	.05	-.05	-.02	.02	.490	.04	.01	.01	.172	**.05**	.18	.05	.001
Contingency (friend)	**.87**	.03	.11	.04	.02	.090	.01	.00	.01	.534	**.02**	.08	.03	.004
RI-CLPM														
Negative affect	**.78**	.08	.05	.08	.09	.399	**.06**	.18	.06	.004	**.07**	.03	.01	.001
Conflict with mother	**.58**	.28	.11	.10	.07	.192	.04	.05	.05	.364	.06	.05	.04	.238
Conflict with friend	**.80**	.16	.09	.08	.06	.154	-.01	-.02	.05	.707	.04	.03	.03	.397
Contingency (mother)	**.52**	.13	-.17	-.04	.02	.051	.00	.00	.02	.883	.07	.17	.08	.047
Contingency (friend)	**.75**	.09	-.14	-.01	.02	.652	-.02	.00	.02	.739	.00	.04	.04	.404

Note. The standardized and unstandardized regression coefficients are estimates of paths 'f' (Stability), 'x' (Initial association Neu.–Daily exp.), 'a' (Neu. → Daily exp.), and 'b' (Daily exp. → Neu.) of Figure 4.1 and Figure 4.2. Results were obtained from 10 separate statistical models.

[a] The stability effect of neuroticism (Model 1; not tabulated) was β = .61 (*SE* = .02) in the CLPM and β = .15 (*SE* = .05) in the RI-CLPM. All stability effects were allowed to change linearly over time. The reported coefficients refer to stability between the first and second year.

Bold coefficients: $p < .01$.

Table S4.3. Sensitivity analysis: Unstandardized cross-lagged effects after releasing equality constraints on the error variances

	Neu. → Daily exp.			Daily exp. → Neu.		
Model	*b*	*SE*	*p*	*b*	*SE*	*p*
Negative affect	**.18**	.06	.003	**.03**	.01	<.001
Conflict with mother	.04	.04	.367	.04	.03	.246
Conflict with friend[a]	.02	.04	.576	**.06**	.02	<.001
Contingency (mother)[a]	.01	.02	.644	**.21**	.07	.004
Contingency (friend)	.00	.01	.747	.08	.04	.057

[a] We removed the non-significant Level 3 random intercepts of 'conflict with friend' and 'contingency (mother)' from the model, which alters the substantive interpretation of some of the parameter estimates of these models.
Bold coefficients: $p < .01$.


5

Chapter 5

Summary and General Discussion

The goal of this dissertation was to gain more insight into the structure and predictors of personality trait development during adolescence and middle adulthood. I conducted research on (i) the development of rank-order stability and mean levels of the Big Five personality traits, (ii) the extent to which individuals differ in their personality trait development, and (iii) the associations between adolescents' personality trait changes and the personality of their best friends and siblings, and (iv) the associations between personality trait changes and people's affective and interpersonal experiences in daily life. In this chapter, I first summarize and then discuss the most important findings of this dissertation. Table 5.1 provides an overview of the main results.

Summary of Main Findings

In **Chapter 2** I investigated stability and change in the rank-ordering and mean levels of the Big Five personality traits from adolescence through early adulthood. To do so, I combined data from two large cohorts in which participants completed up to 7 yearly personality questionnaires (N = 2,230). The 1-year rank-order stability of the Big Five traits increased strongly during early and middle adolescence (age 12-18) but remained rather stable during late adolescence and early adulthood (age 18-22). During early adolescence, mean levels of some traits temporarily declined (i.e., girls' emotional stability and extraversion and boys' conscientiousness). By contrast, mean-level changes during late adolescence and early adulthood were in the direction of greater psychological maturity, defined by high conscientiousness, high agreeableness, and high emotional stability. Adolescents differed substantially from each other in the extent and direction of personality change, particularly with respect to extraversion, emotional stability, and conscientiousness. Finally, using dyadic latent growth curve modelling and cross-lagged panel modelling, I found no evidence for dyadic personality trait codevelopment among best friends and siblings. That is, personality trait changes of adolescents were not associated with the personality traits of their best friends and siblings.

In **Chapter 3** I investigated personality trait changes across 6 years among middle-aged mothers (N = 483, M age = 44 years at the first assessment). On average, mothers increased in their levels of conscientiousness, extraversion, agreeableness, and emotional stability during the study period. However, participating mothers differed substantially in their degree and direction of personality change, particularly with respect to emotional stability and openness. I used multilevel cross-lagged panel models to investigate the longitudinal associations between individual differences in positive daily experiences and individual differences in personality traits changes. I found little evidence that the Big Five traits were associated with subsequent rank-order changes in daily experiences of positive affect and

relationship support. However, rank-order differences in yearly mean levels of daily positive affect and relationship support were highly stable, even more stable than the Big Five traits. In contrast, I found much evidence for daily experience effects on personality traits. High levels of positive affect and relationship support from one's partner and adolescent child predicted rank-order increases in all Big Five traits. For some of these associations, positive daily experiences demonstrated incremental validity in predicting rank-order changes in personality traits over and above their statistical overlap with daily experiences of negative affect and relationship conflict.

In **Chapter 4** I investigated the longitudinal associations between neuroticism (the inverse of emotional stability) and daily experiences of negative affect and relationship conflict across 6 years during adolescence (N = 1,046). I used multilevel random intercept cross-lagged panel models to differentiate constant between-person differences in neuroticism and daily experiences from year-specific within-person changes in these variables. At the level of constant between-person differences, neuroticism was associated with more negative daily experiences. At the within-person level, yearly changes in neuroticism were bidirectionally associated with yearly changes in daily negative affect. I found no evidence for within-person effects between neuroticism and daily relationship conflicts, nor between neuroticism and adolescents' affective reactivity to daily conflicts.

Conclusions and General Discussion

In this section, I discuss the theoretical and practical implications of the results regarding the structure of personality development, dyadic co-development, and the longitudinal associations between personality traits and daily experiences. Furthermore, I discuss strengths and limitations of the studies and suggest directions for future research.

The Structure of Big Five Personality Trait Development

Changes in rank-order stability. During early and middle adolescence, the 1-year rank-order stability of the Big Five traits increased substantially. This finding supports the cumulative continuity principle, which posits that the rank-order stability of personality traits increases during adolescence and adulthood (Roberts & Mroczek, 2008; Roberts et al., 2008). This result suggests that early and middle adolescence are important, formative periods during which rank-order differences are becoming more settled. Therefore, this period is well-suited to study the mechanisms of rank-order stability and change of personality traits. Moreover, this finding suggests that therapeutic interventions aimed at modifying personality traits may be more effective during early adolescence, when rank-order differences are still relatively fluid, than during late adolescence or early adulthood, when rank-order differences have become more settled.

Table 5.1. Overview of the main findings of this dissertation

Chapter	Research questions	Main findings
2	How does the 1-year rank-order stability of the Big Five change from adolescence through early adulthood?	– Rank-order stability increased strongly from early through middle adolescence but remained rather stable during late adolescence and early adulthood.
	How do people change on average on the Big Five from adolescence through early adulthood?	– Mean-levels increased linearly for some traits (girls' conscientiousness, both genders' agreeableness, and boys' openness). – Mean-levels changed curvilinearly (U-shaped) for other traits (girls' emotional stability and extraversion and boys' conscientiousness).
	To what extent do adolescents differ from each other with respect to long-term changes on the Big Five?	– Adolescents showed substantial individual differences in change, particularly on extraversion, emotional stability, and conscientiousness. – Adolescents changed relatively homogeneously on agreeableness.
	Are the Big Five traits of best friends and siblings longitudinally interrelated during adolescence?	– Changes in the Big Five traits were not related to the personality traits of their best friends and siblings.
3	How do middle-aged mothers change on average on the Big Five?	– Mean-levels increased for conscientiousness, extraversion, agreeableness, and emotional stability.
	To what extent do middle-aged mothers differ from each other with respect to their development on the Big Five?	– Middle-aged mothers showed substantial individual differences in change, particularly on emotional stability and openness.
	How are individual differences in the Big Five longitudinally related to individual differences in positive daily experiences during middle adulthood?	– The Big Five traits were not associated with rank-order changes in daily experiences. – Daily experiences of positive affect and relationship support from partners and children predicted rank-order increases in all Big Five traits. – For some of these associations, positive daily experiences demonstrated incremental predictive validity over and above negative daily experiences.
4	How is neuroticism longitudinally related to negative daily experiences during adolescence?	– At the level of constant between-person differences, neuroticism was associated with more negative daily experiences. – Yearly within-person changes in neuroticism were bidirectionally associated with yearly within-person changes in daily negative affect. – Within-person changes in neuroticism were not longitudinally associated with within-person changes in daily relationship conflicts, nor with adolescents' contingency between daily experiences of conflict and negative affect.

Surprisingly, I found no evidence for further increases in rank-order stability during late adolescence and early adulthood. This result suggests that there are periods during which rank-order differences may not become increasingly stable, which contradicts the cumulative continuity principle. However, replication of this finding is warranted, because this finding is inconsistent with a previous study (Klimstra et al., 2009) that found that the 1-year rank-order stability of the Big Five continued to increase between the ages 17 to 21.

Mean-level changes. During late adolescence and early adulthood, mean-level changes in the Big Five mainly reflected increasing personality maturity. In contrast, during early and middle adolescence, mean-level changes mainly reflected absence of personality maturation and temporal decreases of personality maturity. Why were mean-level changes during early and middle adolescence not in line with the maturity principle of personality development (Roberts & Mroczek, 2008)? At least in Western nations, early and middle adolescents are quickly becoming physically mature (Marshall & Tanner, 1969, 1970), but they are usually not yet granted the benefits of an adult life, such as being independent and having access to significant financial and material resources (Moffitt, 1993). This temporal discrepancy between physical maturity and reaping the benefits of an adult life may attenuate pressures from adults on adolescents to develop a mature personality (Denissen, Van Aken, Penke, et al., 2013). Moreover, this discrepancy may give rise to youth norms that counteract adult pressures (Moffitt, 1993). More research is needed to better understand the mechanisms that drive mean-level changes in adolescence (Denissen, Van Aken, Penke, et al., 2013; Soto & Tackett, 2015).

Individual differences in personality change. The evidence for substantial individual differences in change of most traits during adolescence and middle adulthood implies that mean-level change estimates are not always accurate representations of individual development. Furthermore, large individual variation in long-term personality change suggests that experiences that are broadly shared in the population have either little influence on personality traits, or they affect individuals differently. For example, if general norms exists of how people should change in their level of emotional stability during particular life stages, adolescents and middle-aged mothers either do not adhere to this norm, or they respond differently to it, perhaps because they differ in their capacity to keep up with these norms (Hennecke et al., 2014; Hudson & Fraley, 2015, 2016b). A deeper understanding of personality trait development requires moving beyond stability and change at the population level in order to understand and account for individual variation in development (Asendorpf, 1992; Baltes & Nesselroade, 1979; Lönnqvist, Mäkinen, Paunonen, Henriksson, & Verkasalo, 2008; Roberts & Mroczek, 2008; Roberts et al., 2008).

Personality Trait Codevelopment among Best Friends and Siblings

I found no evidence that personality trait changes were associated with the personality of adolescents' best friends and siblings. The lack of evidence for codevelopment among peers is consistent with previous studies that found no evidence for personality trait codevelopment among college students (Anderson et al., 2003; Selfhout et al., 2009) and among interacting dyads that were sampled in public spaces (Bahns, Crandall, Gillath, & Preacher, 2017). However, our results contrast with studies that found evidence for codevelopment of temperament traits among preschool playmates (Neal, Durbin, Gornik, & Lo, 2017), of personality values and attitudes among married couples (Caspi et al., 1992), and of extraversion among college-aged friends (Nelson, Thorne, & Shapiro, 2011). More research is needed to uncover the underlying conditions of personality trait codevelopment.

The lack of evidence for correlated change among dyad members suggests that those experiences that are shared among friends and siblings (e.g., having the same hobby, being exposed to the same peer group norms or parenting style) either have no effect on adolescents' personality traits or they tend to affect each dyad member differently. The inference that shared experiences among siblings do not make siblings more alike in their personality traits is consistent with behavioral genetic research, which suggests that growing up in the same household does not make the personality traits of siblings more alike (Bouchard & Loehlin, 2001). It thus seems that personality trait changes are likely driven by unique environmental influences rather than by shared environmental influences (Plomin, Asbury, & Dunn, 2001).

Future research may investigate whether processes of role differentiation and social niche specialization counteract the effects of shared experiences (Bergmüller & Taborsky, 2010; Harris, 2007). Besides that, unique influences may also reflect environmental noise; that is, stochasticity (i.e., randomness) with respect to environmental experiences that people are being exposed to (Frankenhuis, Nettle, & McNamara, 2018). For example, by chance, Lisa may encounter more harsh and unpredictable events (e.g., a robbery, traffic accident) than her best friend Rose, who lives in the same neighborhood. Assuming that observing harsh and unpredictable events affects the development of self-control, Lisa would be expected to decrease more on trait self-control than Rose. Similarly, unique influences on personality traits may constitute developmental noise; that is, stochasticity with respect to how brains develop (McCrae & Sutin, 2018).

Longitudinal Associations Between Daily Affective and Interpersonal Experiences and Personality Traits

I examined dynamic transactions between personality traits and daily affective and interpersonal experiences using (multilevel adaptations) of the often-used CLPM and the relatively novel RI-CLPM. These two statistical models led to different conclusions about

how personality traits were related to people's everyday experiences. Results of the CLPMs in Chapters 3 and 4 showed little evidence of personality effects on daily experiences and much evidence of daily experiences effects on personality. However, results of the RI-CLPMs of Chapter 4 provided a more balanced picture, with some evidence for personality effects and some evidence for daily experiences effects.

There are conceptual and statistical reasons to believe that the RI-CLPMs provided a more accurate and informative picture of the longitudinal relation between personality traits and daily experiences than the CLPMs. First, the RI-CLPMs accounted for constant (i.e., time-invariant) between-person differences in personality traits (Anusic & Schimmack, 2016; Fraley & Roberts, 2005; Roberts, 2018), thereby providing better fit to our data. Second, the cross-lagged estimates of the RI-CLPMs reflected within-person longitudinal effects, which is in line with the theoretical processes that I aimed to test (e.g., 'do within-individual changes in negative affect lead to within-individual changes in neuroticism?'). By contrast, as we saw in Chapter 4, the cross-lagged estimates derived from the CLPMs might have reflected a blend of constant between-person differences and within-person changes (Berry & Willoughby, 2017). However, statistical methods develop fast, and the RI-CLPM is relatively novel. More research is needed to evaluate the strengths and limitations of this model. For example, little is known about the statistical power of this model and about the reliability of its different variance components.

Overall, the evidence reported in Chapter 3 and Chapter 4 suggest that everyday experiences contribute to personality trait changes in adolescence and in middle adulthood. The evidence is consistent with dynamic theories of personality development, which postulate that personality trait changes unfold gradually through the accumulation of daily experiences and through people's responses to these experiences (Baumert et al., 2017; Endler & Parker, 1992; Geukes et al., 2018; Magnusson, 1990; Roberts, 2018; Roberts et al., 2008; Wrzus & Roberts, 2017). However, these results are more difficult to reconcile with the postulate of endogenous theories that personality traits are immune to the effects of psychological experiences (McCrae & Costa, 2008; McCrae & Sutin, 2018). Especially during the formative period of adolescence, the mutual reinforcements between negative affect experiences and neuroticism may have long-term consequences for individuals' emotional well-being (Costa & McCrae, 1980). Practitioners may be able to stimulate socially desirable personality trait changes by intervening in people's daily experience patterns.

Strengths, Limitations, and Future Directions

Important strengths of the studies in this dissertation are that I used data that contained frequent measurements of the Big Five (i.e., up to 7 yearly trait measurements) among a large sample of target adolescents, their mothers, their siblings, and their best friends. In addition,

our data contained up to 75 assessments of participants' daily affective and interpersonal experiences. Furthermore, I used advanced statistical techniques that accounted for various complexities of the data, such as measurement error and lack of measurement invariance (Chapter 2), the multilevel structure of the measurement burst data (Chapter 3 and 4), and constant between-person differences on our variables (Chapter 4).

However, the studies of this dissertation were not without limitations, which may be addressed by future studies. First, I only used self-report measures. Although self-report questionnaires do justice to the fact that most people know themselves quite well (Vazire, 2010; Vazire & Mehl, 2008), self-reports are prone to certain biases and inaccuracies. Despite the presence of trained interviewers, it seems likely that participants did not fully understand all questions (Schwarz, 1999). For example, a reliability analysis indicated that adolescents experienced difficulties understanding the items "systematic" (conscientiousness) and "sympathetic" (agreeableness). Moreover, it is possible that the same questionnaire items (e.g., "light-hearted") activated different semantic networks in different participants (e.g., a loss of behavioral control vs. feeling tension), resulting in answers that are not fully comparable between individuals (Kagan, 2005; McCrae & Sutin, 2018). Furthermore, participants might not have accurately recalled relevant experiences and states while filling out the questionnaires (Funder, 1995).

To increase the reliability and validity of the personality trait measurements, future research may complement self-reports with informant reports and behavioral observations (Eid & Diener, 2006; Hofstee, 1994). In addition, future research may measure Big Five personality traits by means of semi-continuously assessing Big Five personality states over a longer period (Roberts, 2018). In this way, researchers would be able to extract even more aspects of the personality system than the two aspects I extracted in Chapter 4. For example, researchers may extract constant, slow-changing, and fluctuating variance components of the Big Five, and investigate how these different components are longitudinally associated with people's daily experiences (Roberts, 2018).

Another limitation associated with the self-report questionnaires of this dissertation is that there might have been systematic group differences in the norms that participants compared themselves to when making judgements about their personality (Schmitt et al., 2007). For example, when asked to rate the extent to which the characteristic "worried" applied to them, adolescent girls might have been more likely to compare themselves with other adolescent girls than with adolescent boys or adults. If the norm that people use to judge their trait levels indeed varied by age and gender (Luan, Hutteman, Denissen, Asendorpf, & van Aken, 2017), Chapter 2 might have underestimated the actual magnitude of mean-level changes and gender differences in the Big Five. Therefore, I suggest that future research attempts to uncover whether different subpopulations (consciously or unconsciously) compare themselves to different norms when answering personality questionnaires. If this

is indeed the case, future research should develop tools that can prevent or statistically correct for bias introduced by group differences in the norms people compare themselves to.

Second, RADAR participants were not representative of the Dutch population (Van Lier et al., 2011). Specifically, participants were recruited from schools in the western and central regions of The Netherlands, adolescents who were at risk of developing delinquent behaviors and adolescents with a Moroccan ethnic background were oversampled, and participating adolescents and their parents on average had a higher socio-economic status than the general Dutch population (Keijsers et al., 2012; Neumann et al., 2011; Van Lier et al., 2011). Therefore, it remains unclear to what extent our results generalize to the general population of Dutch adolescents and their mothers. The fact that our results on mean-level personality trait changes during adolescence were consistent with a similar cohort-sequential study among Dutch adolescents (Klimstra et al., 2009) suggests that mean-level changes replicate well among studies that use similar methods and investigate similar populations.

Compared to the period of adulthood (Bleidorn et al., 2013; McCrae et al., 1999), we know relatively little about cross-cultural variability in mean-level personality changes during adolescence. Studies on mean-level personality development during adolescence have mainly used samples from Western, Educated, Industrialized, Rich, and Democratic (WEIRD) countries, particularly from the USA (Durbin et al., 2015; Soto, 2016; Soto et al., 2011; Tackman, Srivastava, Pfeifer, & Dapretto, 2017), The Netherlands (Borghuis, Denissen, et al., 2017; Branje et al., 2007; Klimstra et al., 2009; Van den Akker et al., 2014), and Belgium (De Fruyt et al., 2006; de Haan, De Pauw, van den Akker, Deković, & Prinzie, 2017). An exception is a study on Japanese adolescents (Kawamoto & Endo, 2015). This study did not find evidence for U-shaped changes in personality traits between age 12 and 18. This suggest that the often-found temporal declines in personality maturity may be attributable to cultural norms, such as behavioral expectations by parents (Denissen, Van Aken, Penke, et al., 2013). I recommend that personality psychologists conduct more cross-cultural research and more comparative research (King, Weiss, & Sisco, 2008; Weiss & King, 2015) to increase insight into cultural influences on the development of personality traits (Apicella & Barrett, 2016). For example, are temporal dips in personality maturity during adolescence specific to contemporary Western societies, or general to all human societies? Moreover, are temporal dips in personality maturity characteristic to humans, or general to all great apes? More insight into these questions would advance our theoretical understanding of personality development and may be used to formulate policy recommendations regarding the psychosocial development of youth.

Third, the studies in this dissertation did not cover the early years of adolescence (i.e., ages 10 and 11). Previous research found that temporal dips in personality maturity were particularly pronounced during the earliest years of adolescence (Denissen, Van Aken, Penke, et al., 2013; Durbin et al., 2015; Soto, 2016; Soto et al., 2011). The omission of

ages 10 and 11 prevented a replication of these findings. Future studies may cover the period from late childhood to late adolescence to gain more insight into temporal dips in personality maturity.

Fourth, the correlational design of our studies did not allow us to draw strong conclusions regrading causal associations between personality traits and daily experiences. For example, it is possible that the within-person effects of negative affect on neuroticism were confounded by underlying biological process (e.g., hormonal changes or epigenetic changes) or other psychological experiences (e.g., feelings of depression, loneliness, or low self-esteem). In addition, it is possible that past negative daily experiences temporarily changed participants' self-perceived level of neuroticism, but not their actual level of neuroticism (Roberts, 2018).

Fifth, I did not focus on the potential influence of group-level dynamics on personality development. In this dissertation, I focused on individual dispositions (i.e., the personality of dyad members) and relationship dispositions (i.e., perceived relationship conflict and support of dyad members) in dyadic relationships with close others (Back et al., 2011; Reitz et al., 2014). However, interpersonal effects on personality traits may also occur at the group level. Harris (1995, 2007) argued that the way people are seen by the generalized other (i.e., one's reputation) is more consequential for personality development than people's relationship-specific experiences (see also Hogan, 1996; Hogan & Roberts, 2004). Indeed, particularly during adolescence, being popular or unpopular and being generally liked or rejected has profound consequences for people's everyday social experiences (Newcomb, Bukowski, & Pattee, 1993). Research found that popularity and likability reputations predict changes in for example aggression (Prinstein & Cillessen, 2003; A. J. Rose, Swenson, & Waller, 2004) and self-esteem (Reitz, Motti-Stefanidi, & Asendorpf, 2016). However, few studies have investigated how people's reputations and the characteristics of their social network are related to changes in broad personality traits (for exceptions, see Asendorpf & van Aken, 2003; Asendorpf & Wilpers, 1998; Baker & Daniels, 1990; Shiner, Masten, & Tellegen, 2002). Therefore, I recommend that future research investigates personality development not only in the context of dyadic experiences, but also in the context of people's reputations within their broader social network.

General Conclusions

The aim of this dissertation was to gain more insight into the structure and predictors of personality trait development during adolescence and middle adulthood. Five empirical findings stand out. First, the 1-year rank-order stability of the Big Five traits increased strongly during early and middle adolescence, but remained rather stable during late adolescence and early adulthood. Second, I found different patterns of mean-level personality change in different life phases. Mean-level development during early and middle adolescence mainly

reflected absence of personality maturation and temporal decreases in personality maturity. However, mean-level development during late adolescence, early adulthood, and middle adulthood were characterized by increases in personality maturity. Third, adolescents and adults showed substantial individual differences in long-term personality trait changes. Fourth, personality trait changes were unrelated to the personality traits of adolescents' best friends and siblings. Fifth, consistent with dynamic theories of personality development, I found evidence that everyday experiences influence personality traits. I found this evidence among adolescents as well as among mothers, and by means of two alternative statistical models (the CLPM and the RI-CLPM). Some psychologists believe that psychological experiences have no influence on personality traits. However, contrary to this view, the findings of this dissertation suggest that personality trait changes are driven by people's everyday affective and interpersonal experiences.

Effects of psychological experiences on personality traits have been proven difficult to demonstrate conclusively (Costa et al., 2018). Nonetheless, this dissertation adds to evidence suggesting that personality is an open system that is shaped by everyday psychological experiences. More research is needed to corroborate this evidence. In particular, multi-informant research is needed to examine whether psychological experiences really affect personality traits or whether they only affect people's self-perceptions or self-presentations. Furthermore, more research is needed to better understand whether the effects of daily psychological experiences on personality traits are temporary or enduring. Finally, we need more research to better understand the mechanisms through which daily experiences may influence personality traits. For example, do daily experiences influence personality traits by means of biological mechanisms, such as changes in gene expressions and neuroanatomical structures (Roberts, 2018)? Or by mean of associative mechanisms, such as implicit learning, reinforcement learning, and habit formation (Baumert et al., 2017; Wrzus & Roberts, 2017)? Or by means of reflective mechanisms, such as conscious memories about past states (Baumert et al., 2017; Wrzus & Roberts, 2017)?

Personality traits are important predictors of desirable personal and societal outcomes. Therefore, gaining a better understanding of how and why personality traits develop is worth considerable research efforts. As new experience sampling data and statistical techniques are becoming available, I am confident that future research will contribute to a better understanding of how daily psychological experiences may affect personality trait levels.


A

Appendices

– Nederlandse samenvatting (Dutch summary)
– References
– Acknowledgements (Dankwoord)
– List of Publications
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Nederlandse samenvatting (Dutch summary)

Hoe veranderlijk zijn persoonlijkheidseigenschappen? Hoe ontwikkelen persoonlijkheidseigenschappen zich gedurende verschillende levensfases? En hebben alledaagse emotionele en sociale ervaringen invloed op onze persoonlijkheidseigenschappen? In dit proefschrift heb ik geprobeerd antwoord te geven op deze vragen. Het verkrijgen van meer wetenschappelijk inzicht in persoonlijkheidsontwikkeling is van groot belang. Persoonlijkheidseigenschappen hebben immers invloed hebben op allerlei kenmerken van ons leven, zoals hoe gelukkig, gezond en productief we zijn. Meer kennis over hoe mensen zich ontwikkelen in hun persoonlijkheid, kan gebruikt worden om wenselijke en onwenselijke ontwikkelingspatronen vast te stellen. Daarnaast kan meer kennis over persoonlijkheidsontwikkeling door psychologen, beleidsmakers en gewone mensen mogelijk gebruikt worden om gewenste persoonlijkheidsontwikkeling te bevorderen en ongewenste ontwikkeling te voorkomen.

Persoonlijkheidseigenschappen worden gedefinieerd als relatief stabiele patronen van gedachten, gevoelens en gedragingen waarin individuen van elkaar verschillen. Mijn onderzoek richtte zich op de persoonlijkheidseigenschappen die onderdeel zijn van het veelgebruikte 'Big Five-model': extraversie, vriendelijkheid, zorgvuldigheid, emotionele stabiliteit en openheid. Mensen die hoog scoren op *extraversie* zijn sociaal, uitbundig, warm, assertief en energiek, terwijl mensen die hier laag op scoren juist terughoudend, stil, gesloten, schuchter en teruggetrokken zijn. De dimensie van *vriendelijkheid* geeft de mate aan waarin mensen over het algemeen aardig, vriendelijk, behulpzaam, sympathiek en empathisch zijn. Mensen die hoog scoren op *zorgvuldigheid* zijn zorgvuldig, ordelijk, systematisch, nauwkeurig, netjes en gedisciplineerd. De persoonlijkheidseigenschap *emotionele stabiliteit* beschrijft de mate waarin mensen de neiging hebben om negatieve emoties te ervaren. Mensen die laag scoren op emotionele stabiliteit zijn neurotisch: ze maken zich vaak zorgen, zijn gevoelig voor mogelijke gevaren en ze zijn snel geraakt, nerveus en angstig. Tenslotte reflecteert *openheid* de mate waarin mensen nieuwsgierig, vernieuwend, intellectueel, fantasierijk, artistiek en creatief zijn.

Enkele decennia geleden dacht men dat mensen normaal gesproken niet veranderen in hun persoonlijkheidseigenschappen. Tegenwoordig weten we dat mensen wel degelijk veranderen. De grootste veranderingen vinden plaats tijdens de adolescentie (10-20 jaar) en de vroege volwassenheid (20-25 jaar). Het is echter nog onduidelijk hoe de ontwikkeling van persoonlijkheidseigenschappen er precies uitziet in verschillende levensfasen. We weten dat persoonlijkheidseigenschappen voor een groot deel worden bepaald door onze genen,

maar het is nog onduidelijk of psychologische ervaringen - zoals gevoelens en de sociale interacties - invloed hebben op onze persoonlijkheidseigenschappen.

Het doel van mijn proefschrift was daarom om meer inzicht te verkrijgen in:

1. de stabiliteit van persoonlijkheidseigenschappen tijdens de adolescentie,
2. gemiddelde veranderingen in persoonlijkheidseigenschappen tijdens de adolescentie en midden-volwassenheid,
3. de mate waarin adolescenten en volwassenen van elkaar verschillen in hun persoonlijkheidsontwikkeling,
4. de vraag of de persoonlijkheidseigenschappen van vrienden en broers en zussen invloed hebben op de persoonlijkheidsontwikkeling van adolescenten, en
5. de vraag of alledaagse gevoelens en sociale ervaringen invloed hebben op de persoonlijkheidseigenschappen van adolescenten en volwassenen.

Voor het beantwoorden van deze vragen heb ik gebruik gemaakt van bestaande data (de 'RADAR' dataset). Twee cohorten van Nederlandse jongeren en hun broers en zussen, hun moeders en hun beste vrienden hebben in maximaal zeven achtereenvolgende jaren vragenlijsten ingevuld over onder andere hun persoonlijkheid en hun dagelijkse ervaringen. Ik heb onderzoek gedaan naar persoonlijkheidsontwikkeling onder zowel adolescenten als moeders. De totale steekproefgrootte betrof 2.230 adolescenten en 483 moeders. Hieronder volgen de belangrijkste bevindingen en implicaties van mijn onderzoek.

1. Hoe Stabiel zijn Persoonlijkheidseigenschappen Tijdens de Adolescentie?

Een manier om de ontwikkeling van persoonlijkheidseigenschappen te onderzoeken is het schatten van de zogenaamde rangschikking-stabiliteit van persoonlijkheidseigenschappen. Participanten die een persoonlijkheidsvragenlijst hebben ingevuld, kunnen gerangschikt worden naar de hoogte van hun score op een bepaalde eigenschap. Als de rangschikking van participanten op bijvoorbeeld hun score op extraversie grotendeels hetzelfde blijft over de tijd, betekent dit dat participanten die eerder relatief extravert (of introvert) waren, op een later meetmoment nog steeds relatief extravert (of introvert) waren. Als de stabiliteit van de rangschikking 1 is, dan behouden alle participanten hun exacte positie in de rangschikking. Als de stabiliteit van de rangschikking 0 is, dan is de rangschikking op twee meetmomenten compleet verschillend en bestaat er geen enkele continuïteit in de persoonlijkheidseigenschappen van individuen.

Mijn onderzoek naar rangschikking-stabiliteit toonde aan dat persoonlijkheidseigenschappen al behoorlijk stabiel waren ($\beta = .69$) tussen de leeftijden van 12 en 13 jaar. Tot de leeftijd van 18 jaar nam de stabiliteit behoorlijk toe (tot een waarde van $\beta = .83$). In de periode van 18 tot 22 jaar nam de stabiliteit echter niet verder toe. Deze laatstgenoemde bevinding weerspreekt de algemeen geaccepteerde aanname dat rangschikkingen op

persoonlijkheidseigenschappen voortdurend stabieler worden tijdens de adolescentie en vroege volwassenheid.

2. Hoe Veranderen Mensen Gemiddeld op Persoonlijkheidseigenschappen?

Persoonlijkheidsontwikkeling kan ook onderzocht worden door te onderzoeken hoe een groep mensen gemiddeld veranderde. Tijdens de vroege adolescentie (leeftijd van 12 tot 15 jaar) lieten adolescenten gemiddeld een tijdelijke afname zien op sommige persoonlijkheidseigenschappen. Meisjes werden in deze periode gemiddeld minder emotioneel stabiel en minder extravert. Jongens werden gemiddeld minder zorgvuldig in diezelfde periode. In de leeftijdsperiode van 17 tot en met 22 jaar lieten deelnemers juist vooral toenames zien: zowel jongens als meisjes werden gemiddeld zorgvuldiger, vriendelijker en extraverter, en meisjes werden in deze periode emotioneel stabieler.

Gemiddeld namen de deelnemende moeders (met een gemiddelde leeftijd van 44 jaar op het eerste meetmoment) toe in hun niveau van zorgvuldigheid, extraversie, vriendelijkheid en emotionele stabiliteit. Deze toenames waren echter gering en vonden vooral plaats in de eerste jaren van het onderzoek.

3. In Welke Mate Verschillen Individuen van Elkaar in Persoonlijkheidsontwikkeling?

Een derde manier om persoonlijkheidsontwikkeling te onderzoeken, is het in kaart brengen van individuele verschillen in ontwikkeling. De individuele verschillen in persoonlijkheidsontwikkeling waren over het algemeen groot. Adolescenten verschilden sterk van elkaar in hun ontwikkeling op de eigenschappen extraversie, emotionele stabiliteit en zorgvuldigheid. Deze grote individuele verschillen in ontwikkeling impliceren dat slechts weinig participanten het gemiddelde ontwikkelingspatroon op deze eigenschappen volgden. Adolescenten varieerden beduidend minder in hun ontwikkeling op vriendelijkheid: de meesten volgenden het gemiddelde patroon van toenemende vriendelijkheid. Moeders verschilden onderling ook sterk in hun persoonlijkheidsontwikkeling, met name in de ontwikkeling van emotionele stabiliteit en openheid.

4. Wordt de Persoonlijkheidsontwikkeling van Adolescenten Beïnvloed door Persoonlijkheidseigenschappen van Vrienden en Broers en Zussen?

Hoe kunnen we individuele verschillen in persoonlijkheidsontwikkeling verklaren? Ik onderzocht de hypothese dat individuele verschillen in persoonlijkheidsontwikkeling van adolescenten gerelateerd zijn aan de persoonlijkheidseigenschappen van hun beste vrienden en broers of zussen. Hiervoor heb ik geen bewijs gevonden. Ten eerste hing de persoonlijkheidsontwikkeling van adolescenten niet samen met de Big Five persoonlijkheidseigenschappen van hun beste vrienden en broers of zussen. Met andere

woorden: adolescenten met een vriend, broer of zus die hoog scoorden op bijvoorbeeld emotionele stabiliteit, ontwikkelden zich niet anders op deze eigenschap dan adolescenten met een vriend, broer of zus die laag scoorden op emotionele stabiliteit. Ten tweede gingen de persoonlijkheidseigenschappen van adolescenten en hun vrienden, broers en zussen niet steeds meer op elkaar lijken. En ten derde vond ik geen bewijs dat vrienden, broers en zussen tijdens het onderzoek overeenkomsten vertoonden in hun ontwikkeling op persoonlijkheidseigenschappen.

Dit laatste resultaat impliceert dat de ervaringen die goede vrienden en broers en zussen met elkaar deelden (bijv. blootgesteld worden aan dezelfde vriendenkring en het beoefenen van dezelfde hobby) geen (of geen eenduidige) invloed hadden op hun persoonlijkheidsontwikkeling. Vervolgonderzoek naar de verklaring van individuele verschillen in persoonlijkheidsontwikkeling kan zich daarom waarschijnlijk beter niet op gedeelde maar op unieke invloeden richten, zoals de mogelijke invloed van iemands unieke sociale status of reputatie binnen een groep.

5. Hebben Alledaagse Ervaringen een Invloed op Persoonlijkheidseigenschappen?

Het is bekend dat persoonlijkheidseigenschappen gerelateerd zijn aan de alledaagse ervaringen die mensen opdoen. Neurotische mensen ervaren bijvoorbeeld meer negatieve emoties en problemen in sociale relaties dan emotioneel stabiele mensen. Psychologen nemen over het algemeen aan dat correlaties tussen persoonlijkheidseigenschappen en alledaagse ervaringen ontstaan doordat persoonlijkheidseigenschappen onze ervaringen beïnvloeden. Maar hebben alledaagse ervaringen ook invloed op persoonlijkheidseigenschappen? Hier zijn persoonlijkheidspsychologen het nog niet over eens. Volgens 'endogene theorieën' zijn persoonlijkheidseigenschappen immuun voor de invloed van psychologische ervaringen, zoals emoties en conflicten met anderen. Volgens 'dynamische theorieën' vinden er echter continue wederzijdse beïnvloedingen plaats tussen persoonlijkheidseigenschappen en onze ervaringen. Deze tegenstrijdige hypothesen, over hoe persoonlijkheidseigenschappen en alledaagse ervaringen met elkaar samenhangen door de tijd heen, heb ik onderzocht.

De resultaten van mijn onderzoek zijn niet consistent met endogene theorieën, maar wel met dynamische theorieën. Ten eerste vond ik dat moeders die in het dagelijkse leven relatief veel positieve emoties en relatiekwaliteit ervaarden, sterker toenamen in de Big Five-persoonlijkheidseigenschappen dan moeders die relatief weinig positieve emoties en relatiekwaliteit ervaarden. Ten tweede vond ik onder adolescenten bewijs voor wederzijdse beïnvloedingen tussen de persoonlijkheidseigenschap emotionele stabiliteit en het ervaren van negatieve gevoelens. Dat wil zeggen: adolescenten die op een bepaald meetmoment minder emotioneel stabiel waren dan normaal, rapporteerden in de maanden daarna doorgaans meer negatieve gevoelens dan voor hen gebruikelijk was. En wanneer adolescenten

in een bepaald jaar meer negatieve gevoelens ervaarden dan normaal, werd hun emotionele stabiliteitsscore vervolgens lager dan gebruikelijk.

De belangrijkste conclusie van dit proefschrift is dat alledaagse sociale en emotionele ervaringen een invloed lijken te hebben op persoonlijkheidseigenschappen. Veel mensen willen graag toenemen in hun niveau van extraversie, vriendelijkheid, zorgvuldigheid, emotionele stabiliteit, en openheid. Mogelijk bevorderen we gewenste persoonlijkheidsontwikkeling bij onszelf en bij elkaar als we ervoor zorgen dat we vaker positieve emoties en meer relatiekwaliteit ervaren in het alledaagse leven.

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List of Publications

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* Manuscript is included in this dissertation.

Curriculum Vitae

Nederlands: Jeroen Borghuis is op 18 oktober 1986 geboren in Waalwijk. Hij heeft Integrale Veiligheid (Avans Hogeschool; 2004-2008), Sociologie (een pre-master en master aan Tilburg University; 2008-2010), en Social and Behavioral Sciences (research master aan Tilburg University; 2012-2014) gestudeerd. De laatste twee van deze studies heeft hij 'Met Genoegen' behaald. Zijn HBO afstudeerscriptie (geschreven met Danny Berkers) is verkozen tot Nerderlands' beste afstudeerproject op het gebied veiligheid, en zijn research master scriptie is geselecteerd als beste scriptie van de Faculteit Sociale Wetenschappen van Tilburg University. Tussen de studies Sociologie en Social and Behavioral Sciences heeft Jeroen drie maanden gereids door Zuid-Oost Azië en bijna anderhalf jaar als assistant-onderzoeker gewerkt bij het NIVEL in Utrecht. De afgelopen vier jaar heeft Jeroen als promovendus aan het huidige proefschrift gewerkt (Tilburg University, departement Ontwikkelingspsychologie; 2014-2018). Naast het uitvoeren en publiceren van wetenschappelijk onderzoek bestonden zijn werktaken uit het begeleiden van studenten, het verzorgen van werkgroepen voor studenten, en het presenteren van zijn onderzoeksresultaten op nationale en internationale conferenties. Sinds okbober 2018 werkt Jeroen als statistisch onderzoeker bij het Centraal Bureau voor de Statistiek in Den Haag.

English: Jeroen Borghuis was born on 18 October 1986 in Waalwijk, The Netherlands. He studied Safety and Security Management (bachelor at Avans Hogeschool; 2004-2008), Sociology (pre-master and master at Tilburg University; 2008-2010), and Social and Behavioral Sciences (research master at Tilburg University; 2012-2014). He graduated With Distinction from his last two studies. His first thesis (written with Danny Berkers) has been awarded a prize for being The Netherlands' best graduation thesis in the field of safety and security management, and his research master thesis has been selected as the best thesis of the Tilburg School of Social and Behavioral Sciences. In-between his study Sociology and his study Social and Behavioral Sciences, Jeroen travelled for three months through South-East Asia and worked for almost one and a half year as an assistant-researcher at NIVEL in Utrecht (2011-2012). During the past four years, Jeroen worked as a PhD student on the present dissertation (at Tilburg University, department of developmental psychology; 2014-2018). Besides conducting and publishing scientific research, his tasks also included teaching work groups, supervising students, and presenting his research on national and international conferences. Since October 2018, Jeroen works as a statistical researcher at Statistics Netherlands (Centraal Bureau voor de Statistiek) in The Hague, The Netherlands.