Published in final edited form as:
J Pers Soc Psychol. 2021 September ; 121(3): 691–706. doi:10.1037/pspp0000308.

Longitudinal Coupling of Momentary Stress Reactivity and Trait Neuroticism: Specificity of States, Traits, and Age Period

Cornelia Wrzus[1], **Gloria Luong**[2], **Gert G. Wagner**[3], **Michaela Riediger**[4]

[1]Department of Ruprecht Karls University Heidelberg

[2]Department of Colorado State University

[3]Department of Max Planck Institute for Human Development and German Institute of Economic Research (DIW Berlin), Berlin, Germany

[4]Department of Friedrich Schiller University Jena

Abstract

Personality traits like neuroticism show both continuity and change across adolescence and adulthood, with most pronounced changes occurring in young adulthood. It has been assumed, but insufficiently examined, that trait changes occur gradually over the years through the accumulation of daily experiences. The current longitudinal measurement burst study examined (a) how changes in average momentary stress reactivity are coupled with changes in trait neuroticism, (b) the extent to which this coupling is specific to stress reactivity and neuroticism, and (c) the extent to which there are age differences in the association between changes in stress reactivity and changes in neuroticism. Participants ($N = 581$; 50% male) between 14 and 86 years of age completed up to 3 waves (T1–T3) of Big Five trait questionnaires and experience-sampling assessments during 6 years. During each three-week experience-sampling period, participants reported their momentary affect and occurrences of hassles on average 55 times. Latent change models showed that increases over time in affective reactivity to daily hassles were associated with increases in neuroticism. This effect was consistent from T1 to T2 as well as from T2 to T3, and most pronounced in young adulthood. Importantly, the results were specific to associations between stress reactivity and neuroticism because changes in frequency of hassles in daily life did not predict changes in neuroticism, and stress reactivity did not consistently predict changes in the other Big Five traits. The findings help to inform theoretical models that outline how short-term states might contribute to gradual longer-term changes in traits like neuroticism.

Keywords

ambulatory assessment; Big Five; lifespan personality development; state-trait association; stress

By now it has been well documented that neuroticism and other personality traits change noticeably in their absolute mean-level over the life span, especially in young adulthood

Correspondence concerning this article should be addressed to Cornelia Wrzus, wrzus@psychologie.uni-heidelberg.de.

Publications based on the same samples addressed different research questions and are listed in the Method section. Materials and scripts are available on https://osf.io/65d2f/.

(e.g., Atherton et al., 2020; Damian et al., 2019; Roberts et al., 2006). Previous research linked such personality development to normative and non-normative life events (Bleidorn et al., 2018; Lüdtke et al., 2011); yet the specific processes underlying how self-perceptions of traits change over time have been theorized (Geukes et al., 2017; Roberts, 2006; Roberts & Jackson, 2008; Wrzus & Roberts, 2017), yet have scarcely been examined empirically.

The current study addresses this knowledge gap and the processes assumed to underlie changes in neuroticism. Specifically, we examine (a) how changes in momentary affective reactions to stressful situations in everyday life are coupled with longitudinal development of people's self-perceived neuroticism, that is, their respective trait self-concept, (b) the extent to which state-trait couplings are specific to affective reactivity and neuroticism or extend to other states and other Big Five traits, and (c) how the state-trait couplings differ from adolescence through young adulthood into middle and late adulthood when often less pronounced mean-level changes are observed (Atherton et al., 2020; Roberts et al., 2006). The study focuses on neuroticism and affective processes because cross-sectional associations between stronger momentary stress reactions with higher neuroticism are well-established (Barlow et al., 2014; Mroczek & Almeida, 2004; Suls & Martin, 2005). Furthermore, individual differences in neuroticism are highly relevant for people's health (e.g., Friedman et al., 2010; Stephan et al., 2017), thus shedding light on the processes that might contribute to longitudinal changes in neuroticism is also of practical relevance.

Development of Neuroticism Over the Adult Life Span

Neuroticism can be defined as relatively stable individual differences in the tendency to experience negative affect (e.g., anxiety, sadness), to more readily perceive situations as threatening or stressful, and to respond quickly and strongly to such situations with greater negative affect (e.g., Eysenck, 1947; Suls & Martin, 2005). Importantly, self-reported neuroticism refers to people's explicit self-concept of their predisposition to interpret and react to their environment in a certain way. Thus, self-reported neuroticism is thus not necessarily equivalent to peoples' actual everyday experiences of affective states, such as intense negative affect. If self-concepts and average momentary experiences were identical constructs, it would mean that people accurately aggregate their momentary responses to form and report on their self-concept, or that people always feel and behave according to their generalized self-concept. However, empirical evidence contradicts this assumption (Augustine & Larsen, 2012; Fleeson & Gallagher, 2009).

This distinction between states and traits is reflected also in the measurement of these constructs. States (thoughts, feelings, behavior) are measured using momentary reports or observations, whereas personality traits are often measured with questionnaires that capture the explicit, or propositional, representation of personality in general (Back & Nestler, in press; Robinson & Clore, 2002). Robinson and Clore (2002) demonstrate that momentary assessments of specific daily experiences obtained with experience sampling methodology (ESM) measures and global self-report measures, such as the neuroticism scale, tap representations of different memory systems (Robinson & Clore, 2002). Whereas assessments of momentary experiences measure representations in episodic memory, classic dispositional trait measures assess self-representations based in semantic memory. Thus, states and traits are theoretically and empirically distinct (Fleeson & Gallagher, 2009; Robinson & Clore, 2002; Steyer et al., 1990) but assumed to be linked such that individuals with specific trait levels are more likely to experience certain states in particular situations. For example, higher self-reported trait neuroticism is moderately associated with higher average negative affect in daily life (average correlation across 12 studies $r = .53$; Fleeson & Gallagher, 2009; see also Augustine & Larsen, 2012; Horstmann & Rauthmann, 2020). Aggregating across momentary assessments therefore not does yield measures that are conceptually equivalent to dispositional trait measures. As a consequence, the intriguing question is raised: How do repeated momentary affective experiences relate to (changes in) generalized self-concepts of neuroticism?

Although neuroticism is conceptualized as a relatively stable trait (Costa & McCrae, 1988; Eysenck, 1947), rank-order and mean-level changes can occur across the entire (adult) life span (Lucas & Donnellan, 2011; Roberts et al., 2006). For example, during adolescence no significant mean-level change is observed on average, yet significant interindividual variation in changes occurs with some adolescents increasing in neuroticism, whereas others remain stable or decrease (Borghuis et al., 2020; Göllner et al., 2017; Luan et al., 2017). During emerging adulthood, neuroticism decreases substantially, again with significant interindividual variation in change (e.g., Atherton et al., 2020; Lüdtke et al., 2011; Roberts et al., 2006). Furthermore, during middle and later adulthood, moderate decreases and stability in neuroticism occur (Allemand et al., 2008, 2010; Atherton et al., 2020; Roberts et al., 2006). Regarding old age, some studies report little change in neuroticism (Allemand et al., 2008), whereas other studies report increases (Graham et al., 2020; Kandler et al., 2015). Differences between studies might result from sample differences in health as health impairments have been linked to increased neuroticism among older adults (Mueller et al., 2017). In summary, although age trajectories in Big Five traits, including neuroticism, have been described often, research on the underlying developmental processes has largely focused on life events, but scarcely on daily life experiences.

Processes of Trait Development With a Specific Focus on Neuroticism

Changes in neuroticism have been linked to normative as well as idiographic stressful life events (e.g., Bleidorn, 2015; Jeronimus et al., 2013, 2014; Lüdtke et al., 2011; Neyer & Asendorpf, 2001; Riese et al., 2014). For example, experiencing stressful events such as work, college or relationship problems or severe illnesses is associated with increases in neuroticism during adolescence or young adulthood (Deventer et al., 2019; Jeronimus et al., 2013; Lüdtke et al., 2011). Most previous studies examined how life events are related to changes in neuroticism across several years (e.g., Bleidorn et al., 2018; Jeronimus et al., 2014; Le at al., 2014). These studies typically assessed general and retrospective reports of life events, such as whether a stable relationship began or ended (Lüdtke et al., 2011; Neyer & Asendorpf, 2001) or general stressful work conditions (Lüdtke et al., 2011). Thus, these studies could not rule out response biases, for example, rating oneself as higher in neuroticism when simultaneously reporting negative life events such as relationship problems. More importantly, the design of the previous studies on life events were not suited to test the theorized processes that repeated momentary daily life experiences may be associated with trait changes (e.g., Fleeson & Jayawickreme, 2015; Geukes et al., 2017;

Roberts, 2018; Wrzus & Roberts, 2017) because momentary daily experiences were not measured in those studies.

Recent theoretical accounts argue that personality traits such as neuroticism are dynamically and reciprocally linked to daily life experiences (Baumert et al., 2017; Geukes et al., 2017; Magnusson, 1990; Roberts et al., 2008; Wrzus & Roberts, 2017). That is, traits are not only viewed as dispositions that describe or contribute to the likelihood of certain experiences and behaviors in daily life, but such experiences and behaviors continuously contribute to trait development and thus the structure of personality traits (e.g., Baumert et al., 2017; Roberts, 2018; Wrzus & Roberts, 2017). For example, people higher in neuroticism generally experience more stressful situations in daily life (i.e., hassle occurrence or exposure; Suls & Martin, 2005; Suls et al., 1998) and respond with greater negative affect to such hassles (e.g., Bolger & Schilling, 1991; Bolger & Zuckerman, 1995; Mroczek & Almeida, 2004). Yet, much less is known from empirical studies regarding the theoretically postulated reverse directionality of daily experiences predicting trait changes.

Among adolescents, higher negative affect and conflicts with friends were associated with increases in neuroticism (Borghuis et al., 2020). Yet, this study is inconclusive as to which key components of the negative affect experience (i.e., general negative affect, negative affect reactivity to hassles, and/or more frequent experiences of daily hassles) could be the driving force(s) for changes in neuroticism. We argue that the occurrence of daily hassles alone, or more generally stressful life events, is not sufficient to elicit trait change because personality change presumably depends on the affective and behavioral response. Such responses likely differ among individuals because people appraise the same life events differently (Lüdtke et al., 2011). For example, experiencing a divorce seems to be inconsistently related to changes in neuroticism or extraversion (Bleidorn et al., 2018; Costa et al., 2000; Denissen et al., 2019). The inconsistency might result because some people (but not others) experience increased worries and sadness related to the relationship dissolution and some people (but not others) engage in more social activities. Previous research, which demonstrated effects of stressful life events on personality development (e.g., Jeronimus et al., 2013), could not disentangle the occurrence of stressful events from stress reactions because affective reactions to the stressful events were not assessed. Also, repeated states (e.g., negative affect) could change traits in a bottom-up process, without depending on specific situation-state contingencies. We thus examine whether general negative affect states (in the absence of hassles) are sufficient to predict changes in neuroticism. In doing so, we aim to clarify whether the experience of negative affect in general, the mere occurrence of hassles, and/or affective reactions to hassles are central for understanding long-term changes in neuroticism. Such knowledge would offer more precise insights on the potential processes underlying personality development.

Theoretically, experiencing negative affect and affective reactions to hassles should be specifically coupled with changes in trait neuroticism because these states are not indicative of other traits, such as open-mindedness (Baumert et al., 2017; Wrzus & Roberts, 2017). Yet, this assumption has not been tested empirically, as previous studies on state-trait couplings focused specifically on neuroticism (Borghuis et al., 2020; Denissen et al., 2020). Previous studies on retrospectively reported average conflict frequency in social relationships additionally observed associations with changes in agreeableness and conscientiousness (Deventer et al., 2019; Mund & Neyer, 2014). This lack of specificity in interpersonal conflicts-personality trait associations might be due to the fact that conflicts were assessed in these studies with retrospective reports and concurrently with personality traits. Shared report biases (e.g., negativity) might thus have contributed to both reports and increase the similarity in ratings.

Finally, the previous work in this area (e.g., Borghuis et al., 2020; Denissen et al., 2020) has focused primarily on late adolescence or young adulthood samples—leaving open to what extent results are specific to these age periods or if results can be generalized to other phases of the adult life span. Although adolescence and young adulthood are assumed to be particularly relevant phases for personality development (McCrae & Costa, 1999; Roberts & Davis, 2016; Roberts et al., 2006), further research is needed to elucidate the extent to which a state-trait coupling weakens across adulthood and old age as theoretical propositions on life span personality development suggest (Caspi et al., 2005; Wrzus & Roberts, 2017). Thus, life span samples are necessary to estimate the generalizability of, or differences in, the strength of the associations between changes in repeated negative affect in daily life and in trait neuroticism.

Age Differences in Coupling Between Stress Reactivity and Neuroticism Across the Adult Life Span

For most personality traits, developmental changes are more pronounced during young adulthood compared with middle adulthood (Roberts et al., 2006; Roberts & Mroczek, 2008). Personality change is still possible across middle to later adulthood, although the amount of change might be reduced for several reasons (for review: Wrzus & Roberts, 2017). For example, social roles and daily situations are assumed to be more established in middle adulthood compared with younger ages (Caspi et al., 2005; Hennecke et al., 2014; Roberts & Damian, 2018; Weber et al., 2020). More stable social roles and daily experiences are also assumed to contribute to more established identities and self-concepts because people behave more consistently. For example, switching jobs or romantic partners typically involves new experiences and behaviors that vary across contexts, whereas being in the same job and marital relationship involves more consistency in daily experiences and behaviors (Hennecke et al., 2014; Roberts & Wood, 2006; Roberts & Damian, 2018; Wrzus & Roberts, 2017). At the moment, these are theoretical considerations with limited empirical evidence (e.g., Denissen et al., 2014).

Examining patterns of age differences in mean-level change in neuroticism or stress reactivity offers no definitive conclusions on how changes in state-trait couplings differ across adulthood. Although empirical evidence quite consistently points toward age-related decreases in neuroticism in older adulthood (Atherton et al., 2020; Damian et al., 2019; Roberts et al., 2006), evidence on age differences and developmental changes in the occurrence of stressful situations and stress reactivity are mixed (Sliwinski et al., 2009; Stawski et al., 2019). To date, one study has examined age differences in the association between neuroticism and later stress reactivity and showed that the association between higher stress reactivity with higher neuroticism was more pronounced the older people were (Mroczek & Almeida, 2004). Yet, age differences in the coupling between daily stress reactivity and neuroticism over time have not been examined.

Theories postulate that older age is associated with more established (social) environments and self-concepts, as well as more pronounced personality-congruent states, so the coupling between momentary affective experiences and changes in personality traits could be less pronounced with older age (Wrzus & Roberts, 2017). Correspondingly, the sociogenomic theory (Roberts, 2018) also posits that young adulthood, but not adolescence or middle adulthood, might be a critical period for trait development. So far, empirical investigations are rare whether associations between experiences in daily life and personality trait changes differ with age. For example, changes in neuroticism related to daily negative affect have only been examined among adolescents (Borghuis et al., 2020). Longitudinal associations between changes in openness and retrospectively reported cultural activities, such as visiting a concert or theater play, did not vary with age in an adult life span sample (Schwaba & Bleidorn et al., 2018). However, the generalized retrospective reports of activities of this previous study and the multigroup approach to test age moderation might have limited the power to detect age moderation. For this last research question, which examines to what extent the strength of the associations between changes in repeated daily stress reactivity and in trait neuroticism differ across the adult life span, we thus derive our hypothesis based on theoretical grounds.

The Present Study

Although several theoretical and conceptual models postulate (e.g., Geukes et al., 2017; Roberts et al., 2017; Wrzus & Roberts, 2017) that momentary daily experiences are coupled with long-term developmental change in Big Five traits, comprehensive knowledge and strong empirical support for these models are still scarce. In the current study, we focus on momentary negative affective experiences and neuroticism and aim to contribute novel knowledge regarding their developmental coupling, as well as the specificity of the examined states, Big Five traits, and life span age period—complementing and extending previous work on affect-neuroticism couplings (Borghuis et al., 2020).

Proceeding from the outlined considerations, we derived the following hypotheses: Hypothesis 1: Increases in average affective reactivity to daily hassles are associated with corresponding increases in neuroticism over several years. Hypothesis 2: This association is less pronounced with older age. To test whether affective reactions to momentary hassles are central for neuroticism development, we examine hassle occurrence and habitual negative affect as alternative predictors of change in neuroticism. We predicted that merely experiencing hassles (i.e., hassle occurrence) would not be related to changes in neuroticism (Hypothesis 3a) and that habitual negative affect in daily life (in the absence of hassles) would be associated with changes in neuroticism rather weakly (Hypothesis 3b). To further examine the specificity of the stress reactivity–neuroticism coupling, we tested the effects of stress reactivity on the other Big Five traits, that is, extraversion, openness, agreeableness, and conscientiousness. Hypothesis 4: We expected that no consistent effects exist because stress reactivity is theoretically most closely linked to neuroticism. These hypotheses were tested in an age-heterogeneous, longitudinal experience-sampling study that repeatedly assessed Big Five traits as well as momentary affect and hassles in daily life over six years. Such a longitudinal measurement-burst design allowed us to examine coupling between momentary affective states and longitudinal changes in personality traits.

Method

Open Science Information

We embrace the values of openness and transparency in science (Schönbrodt et al., 2015; osf.io/4dvkw). We therefore report the determination of the sample size, assessed variables, further articles using the same data sets, exclusion of data (none), as well as adjustment of outliers, and its effects on the analyses.

The sample sizes were determined based on the research questions of previous publications (see next paragraph). For the current analyses, we used all available data. Documentation of assessed variables as well as scripts and outputs of data analyses are provided on https://osf.io/65d2f/. Data cannot be openly accessible because of missing permission from participants and ongoing work with the data set.

No previous publication based on this data set addressed the longitudinal development of Big Five traits. Previous publications used single waves of the project to examine age differences in hassle responsiveness (Wrzus et al., 2013, 2015), affective experiences (Luong et al., 2016; Riediger et al., 2009, 2011, 2014), or daily activities (Weber et al., 2020; Wrzus et al., 2016). Further details on previous publications are available on https://osf.io/65d2f/

Participants

The 581 participants were part of the longitudinal Multi-Method Ambulatory Assessment project (MMAA; e.g., Riediger, 2018) with three waves of assessments which occurred in 2007 (time 1 = T1), 2010 (time 2 = T2), and 2013 (time 3 = T3). At T1, a field-work agency recruited 378 participants from three German regions (Berlin, Duesseldorf, and Munich). Twenty-two trained interviewers, who later conducted the data collection, recruited participants from their neighborhoods and extended networks. Recruitment followed the predefined criteria of sample size (for T1 $n = 360$), stratifying the sample by age, gender, and educational level, and excluding family members to ensure independence of the participants. To replace dropouts and include younger adolescents into the study, new participants were recruited for T2 (2010; $n = 176$) and T3 (2013; $n = 27$). Altogether 581 participants (50.4% male) took part in at least two assessments. At T1, participants ranged in age from 14.0 to 86.5 years ($M = 42.5$, $SD = 19.0$). The number of participants per age decade was about balanced, with 15% of participants per decade, except for participants older than 70 years, which accounted for 7% of the T1 sample (see Figure S1 in the online supplemental materials for distribution of age across the sample); 24.1% of adult participants held a college or university degree.

Procedure

At each wave T1 to T3, participants completed computerized questionnaires to assess demographic information and personality traits, cognitive tests, and further questionnaires, and participants took part in a subsequent experience sampling methodology (ESM) period over three weeks (see Riediger, 2018). The average T1 and T2 interval was 3.3 years (*SD* = .2 years) and the average T2 and T3 interval was 2.5 years (*SD* = .2). During the ESM periods, participants were instructed to answer brief questionnaires on mobile phones six times a day for 9 days over the course of 3 weeks. During participants' waking hours, the mobile phones prompted participants to answer questions displayed on the phone approximately 2 hr apart—the exact timing was randomized so that participants were unaware when the next assessment would occur (see Riediger, 2018; Riediger et al., 2009 for further details on ESM assessments). Participants completed on average 54.9 (*SD* = 4.1), 55.1 (*SD* = 4.8), and 55.8 (*SD* = 4.8) ESM assessments at T1, T2, and T3, respectively. After each wave, participants received a reimbursement of 100 e(approximately US$135). The Ethics Committee of the Max Planck Institute for Human Development, Berlin, Germany approved all studies.

Measures

Big Five Personality Traits—The Big Five Inventory (BFI; John & Srivastava, 1999; German version: Lang et al., 2011) assesses the Big Five personality dimensions with three items per trait, with the exception of four items for openness, using a 7-point scale (1 = *does not apply* to 7 = *applies totally*). Neuroticism is measured with the items: I am someone who: "worries a lot," "gets nervous easily," and "remains calm in tense situations" (reversed). Considering the brevity of the scales and the breadth in content, the internal consistencies for neuroticism were acceptable for T1 ω = .63, T2 ω = .65, and T3 ω = .63. Coefficients for the other traits are reported in Table 1. We used latent factor score modeling to account for measurement error and the differences in reliabilities.

Momentary Negative Affect (ESM)—At each momentary assessment during the ESM periods, participants rated their current negative affect (disappointed, downcast, angry, nervous) on a 7-point scale (0 = *not at all* to 6 = *very much*). These four affect items were assessed in all waves T1 to T3 and were included in the analyses. At T2 and T3, but not T1, we additionally assessed *tense* as an indicator of tense arousal (Matthews et al., 1990) but did not include it in the analyses because of the missing at T1. For each wave T1 to T3, the person-average of negative affect at ESM assessments without preceding hassles served as indicator for average negative affect. We used assessments from even and odd days as separate indicators to be able to model negative affect as a latent predictor. The even-odd consistencies were: T1 α = .95; T2 α = .96; T3 α = .97.

Daily Hassles (ESM)—At each momentary assessment, participants also answered whether they had "experienced or thought about anything very unpleasant or joyless" (i.e., whether a hassle had occurred, 0 = *no*, 1 = *yes*) since the last assessment or since waking up for the first assessment in the morning.[1] For each wave T1 to T3, the person-specific proportion of assessments with reported hassles relative to all assessments served as an indicator for hassle occurrence. Again, we used assessments from even and odd days as indicators to specify hassle occurrence as latent variable (even-odd consistency: T1 α = .81; T2 α = .79; T3 α = .78).

Stress Reactivity Computed from Momentary Negative Affect and Daily Hassles (ESM)—Stress reactivity for each experience sampling period T1 to T3 was computed as the average difference in negative affect between assessments with preceding hassles and without preceding hassles. This approach is conceptually and empirically nearly identical to modeling stress reactivity using multilevel modeling (e.g., Sliwinski et al., 2009; Stawski et al., 2019; Wrzus et al., 2013), which has been the primary method for operationalizing stress reactivity in the literature (e.g., Luong et al., 2016). The stress reactivity aggregates used in the current analyses and multilevel estimates of stress reactivity showed nearly perfect agreement (average r = .98, range .98 - .99).[2] To also model stress reactivity as a latent variable, assessments from even and odd days served as indicators (even-odd consistency: T1 α = .47; T2 α = .36; T3 α = .49). We used aggregated data to represent the construct of repeated stress reactivity, to be able to model both stress reactivity and traits as latent factors, and to balance the broadness of stress reactivity and trait measurements.[3]

Attrition Analyses

To assess sample selectivity attributable to attrition, we compared T1 participants who continued participation (n = 174) with those who did not participate at T2 and/or T3 (n = 204). Participants who remained in the study did not differ from participants who dropped out with respect to: age, d = .15, p = .16; neuroticism, d = .14, p = .22; extraversion, d = –.06, p = .60; openness, d = .07, p = .53; agreeableness, d = .04, p = .96; conscientiousness, d = –.07, p = .50; the number of ESM assessments completed at T1, d = –.04, p = .70; the percentage of assessments with hassles reported at T1, d = .18, p = .08; or average negative affect during the T1 ESM-phase, d = .10, p = .36. Females were slightly more likely to continue the study (59% female in group of continuers compared with 43% female in group of dropouts, $t(376)$ = 3.13, p = .002).

We also tested whether the assumption that data were missing at random and not related to characteristics of participants is supported (MCAR = missing completely at random; Little,

[1]Participants also indicated whether the hassle concerned *work*, *other persons*, *health-issues*, *financial issues*, *the future*, *daily annoyances*, or *other*. We did not conduct analyses separately for these different types of hassles because the within-person change over time could not be estimated reliably based on the scarce occurrence of specific hassle types.

[2]We estimated stress reactivity in two-level multilevel models, where momentary experiences (Level 1) were nested within participants (Level 2). Momentary negative affect (NA) was predicted on the within-person level by a dummy-coded variable, whether a hassle had occurred (0 = no, 1 = yes) before the assessment (Bolger & Zuckerman, 1995; Stawski et al., 2019). The intercept of the model can be interpreted as average baseline negative affect when no previous hassle occurred, and the slope (i.e., coefficient of the dummy-variable) can be interpreted as average difference in negative affect when a hassle had occurred compared with the baseline affect. Modeling stress reactivity using a dummy-coded predictor of negative affect in multilevel models is conceptually and empirically nearly identical to our approach. In contrast to difference scores, dummy-coded predictors are not criticized and commonly used in pre–post designs (Hoffman & Rovine, 2007). The main critique pertaining to difference scores is that they obscure baseline differences (e.g., Edwards, 2001), and researchers have been advised to include baseline information. This baseline corresponds to the intercept in the case of dummy-coded predictors (Cohen et al., 2003). We were interested in the effect of the slopes, and we additionally analyzed whether any effects in changes in neuroticism were attributable to baseline differences (i.e., the intercept) instead of reactivity (Table 3).

[3]Previous research on personality-social relationship transactions concluded that personality traits are measured as generalizations across several situations on a more “aggregated” and abstract level compared with specific social relationships, which makes it difficult to find effects from specific relationships on abstract traits (Neyer & Asendorpf, 2001; Mund & Neyer, 2014). This consideration also applies for stress reactivity, and aggregation partly solves the problem of different levels of specificity.

1988). Using all items of every assessment T1 to T3 used in the main analyses, we found that the MCAR assumption was supported because the test for "nonrandomness" was not significant, $\chi^2(7770) = 7699.13$, $p = .71$.

Analytic Strategy

Our main hypotheses were that increases in momentary negative affect after hassle occurrences (i.e., stress reactivity) are associated with increases in neuroticism (Hypothesis 1), and that this effect is less pronounced with older age (Hypothesis 2). We tested the hypotheses by specifying a latent change-to-change bivariate model (Grimm et al., 2012), whereby mean-level changes in aggregated momentary measurements of stress reactivity were associated with changes in trait measurements of neuroticism, and age moderated the effects (see Figure 1). The inclusion of age as a moderator represents an extension of the original model (Grimm et al., 2012) and a test of how such state-trait couplings may differ with age, as postulated theoretically (Roberts, 2018; Wrzus & Roberts, 2017). Because the large age range of the sample (i.e., 14–86 years), we examined linear as well as combined linear and quadratic age effects and divided the age variable by 10. This linear transformation rescaled variances and coefficients and facilitated model convergence. Accordingly, the effects of age are interpreted as change by 1 decade.

As in the original model (Grimm et al., 2012), we modeled latent differences between adjacent time points to represent within-person changes in stress reactivity between time points (i.e., second-order latent change models, Figure 1). Instead of modeling change from T1 to T3 with one change factor (e.g., as in latent growth analyses, McArdle, 2009), we modeled change from T1 to T2 and from T2 to T3 separately to be able to replicate effects over time and to distinguish discontinuous change processes from continuous linear change. Internal replication should occur if changes in stress reactivity were coupled consistently with changes in neuroticism over the two assessment periods. We applied indicator-specific method factors for neuroticism and the other Big Five traits because such method factors are more parsimonious and have better psychometric properties compared with correlated residuals (Figure 1; Geiser & Lockhart, 2012). In addition, we conducted supplementary analyses using latent growth models with one continuous growth factor and report the results in Table S3 in the online supplemental materials.

In general, personality as well as hassle and affective measurements were modeled as latent factors at each wave T1 to T3 with factor loadings and indicator intercepts constrained to be equal across the three waves to measure "true change" instead of change in measurements (see Table S1 in the online supplemental materials for confirmation of strong or even strict measurement invariance). Using latent factors provides the advantage of controlling measurement error. Latent factors for stress reactivity and the other momentary ESM-based constructs were indicated by person-averages of odd and even days for stress reactivity (Hypothesis 1, 2, and 4), hassle occurrence (proportion of all assessments; Hypothesis 3a), or negative affect (Hypothesis 3b).

All models were computed using the MLR estimator in Mplus Version 6.1 to allow for missing data and provide robust standard errors (Muthén & Muthén, 1998–2010). Model fits of the measurement models were evaluated based on the full information maximum likelihood estimator (FIML) and the conventional criteria χ^2, root-mean-square errors of approximation (RMSEA), and comparative fit indices (CFI; Marsh et al., 2005). RMSEA values below .08 and .05 and CFI values greater than .90 and .95 are suggested as guidelines for acceptable and excellent fit to the data, respectively (Marsh et al., 2005). The structural models included latent interactions and therefore only comparative fit indices could be reported.

Distribution analyses demonstrated normal distribution and no outliers ($M \pm 3$ SD) in the central variables, except for a few outliers (< 1.5% of cases) in proportions of hassle occurrence. Therefore, we conducted all analyses with the original variables. For analyses using proportion hassle occurrence, three, two, and five outliers were winsorized ($M + 3$ SD) for T1, T2, or T3, respectively, which led to the same pattern of results as analyses with the original values. No participants were excluded from the analyses.

Results

Table 1 shows means, standard deviations, and zero-order correlations among the study variables at T1. Zero-order correlations for all three time points T1, T2, T3 are presented in Table S2 in the online supplemental materials. Mean level changes and temporal (in)stability based on manifest variables are reported in Table 2. For the current research question, individual differences (i.e., variance) in mean-level change were more important than the average changes in traits. The variances in mean-level change were statistically significant with $p < .05$ for neuroticism and significant with $p < .01$ for the other traits in both assessment periods. Figure S3 in the online supplemental materials displays spaghetti plots of individual change based on observed values. The rank-order correlation between assessments reached expected values for neuroticism given the three-year intervals of the assessments and the heterogeneity of the sample. Preliminary analyses showed that based on the criteria provided by Marsh and colleagues (2005), strong factorial invariance over time held for all latent models for neuroticism, momentary affect, and hassle measurements (see Table S1 in the online supplemental materials) and was therefore applied in the structural models.

Next, we report the results on Hypothesis 1, which predicted that increases in negative affect reactivity to momentary hassles would be associated with long-term increases in neuroticism, and that these effects would be weaker with older age (Hypothesis 2). We then describe results for Hypothesis 3a, that changes in the mere occurrence of daily hassles would not be related to changes in neuroticism, and Hypothesis 3b that changes in average negative affect when no hassles occurred would show weaker associations with changes in neuroticism compared with changes in stress reactivity. Finally, we tested the prediction that changes in stress reactivity would be associated with changes in neuroticism, but not in extraversion, openness, or conscientiousness, or agreeableness (Hypothesis 4).

Changes in Momentary Stress Reactivity Were Associated With Long-Term Change in Neuroticism, With Effects Being Less Pronounced With Older Age

To test Hypothesis 1, we specified bivariate latent change models, whereby changes in negative affect reactivity to daily hassles from T1 to T2 and from T2 to T3, predicted changes in neuroticism from T1 to T2 or T2 to T3, respectively. Age was included as a continuous moderator of these associations to test Hypothesis 2 (see Figure 1). In describing the results, we first focus on the coefficients central to the hypothesis and then explain further coefficients from the same model (see Figure 2).

As predicted in Hypothesis 1, people who increased (decreased) in negative affect stress reactivity over approximately three years, also increased (decreased, respectively) in self-reported neuroticism. This effect was moderated by age in both change periods: For the first period from T1 to T2, effect of changes in stress reactivity on changes in neuroticism $b_{T1T2} = .96$, 95% CI [–.47, 2.38], $p = .094$, age-by-stress reactivity $b_{T1T2} = –.09$, [–.17, –.004], $p = .020$ (see Figure 2). That is, for participants at the average sample age of 43 years, increases in stress reactivity of .10, which corresponds to the average increase in stress reactivity from T1 to T2 (see Figure 2), were associated with an average increase in neuroticism of .096 (.96*.10), that is, about .08 *SD* observed at T1 (Table 1, i.e., .096/1.23). With respect to the moderating effects of age, the change in neuroticism was by –.09 or about 10% less pronounced (i.e., –.09/.96) with each successively older age decade into middle and late adulthood.

The effects were internally replicated for the second period from T2 to T3: main effect stress reactivity $b_{T2T3} = 1.06$, 95% CI [.10, 2.03], $p = .015$, age-by-stress reactivity $b_{T2T3} = –.11$, [–.19, –.02], $p = .006$ (see Figure 2). That is, for this study period, an average increase of .10 in stress reactivity were associated with an average increase in neuroticism of .106 (1.06 × .10), that is, about .09 *SD* observed at T1 (Table 1; i.e., .106/1.23). With respect to the moderating effects of age, the change in neuroticism was by –.11 or again about 10% less pronounced (i.e., –.11/1.06) with each successively older age decade into middle and late adulthood. Estimation of simple slopes showed that the effects of stress reactivity on neuroticism were strongest for people around 29.8 years and then less pronounced with older age, generally consistent with Hypothesis 2.

Concerning further effects of neuroticism and stress reactivity, the higher neuroticism was at T1, the greater was the average negative affect stress reactivity at T1, $b = .13$, 95% CI [.04, .22], $p = .004$. On average, neuroticism increased somewhat from T1 to T2, intercept $b = .30$, 95% CI [.05, .52], $p = .019$, but did not change substantially on average between T2 and T3, $b = –.20$, 95% CI [–.44, .04], $p = .102$. Also, stress reactivity did not change on average: T1-T2 $b = –.11$, 95% CI [–.25, .01], $p = .145$; T2-T3 $b = .10$, 95% CI [–.05, .22], $p = .186$. Previous changes in affective stress reactivity between T1 and T2 did not significantly predict changes in affective stress reactivity between T2 and T3, $b = –.09$, 95% CI [–.25, .06]. Similarly, earlier changes in neuroticism did not predict further changes in neuroticism (b = –.04, 95% CI [–.45, .38], Figure 2).

Specificity of Predictors: Occurrence of Daily Hassles Did Not Predict Changes in Neuroticism

We computed similar latent change models as before (Figure 1, see the Analytic Strategy section) to test whether changes in the occurrence of hassles (Hypothesis 3a) or average negative affect in daily life (Hypothesis 3b) predict longer-term changes in neuroticism. Table 3 summarizes the unstandardized path coefficients for the two latent change models.

Hassle Occurrence

At T1, the occurrence of hassles in daily life was positively correlated with neuroticism: With higher scores in neuroticism, people reported more hassles in daily life (Table 3, first column, path a). As expected, changes in hassle occurrence did not significantly predict changes in neuroticism from T1 to T2 or T2 to T3 and age did not significantly moderate these effects (Table 3, first column, paths b–e). As before, changes in earlier neuroticism did not predict further changes in neuroticism (Table 3, first column, path h). In contrast, people, for whom hassle occurrence increased from T1 to T2 decreased after T2 in experiencing hassles (Table 3, first column, path i).

Negative Affect

At T1, with higher scores in neuroticism, people reported on average more intense negative affect in daily life situations without preceding hassles (Table 3, second column, path a). Increases in average negative affect predicted increases in neuroticism from T1 to T2, but not from T2 to T3 (Table 3, second column, paths b and c). There were no significant age moderation effects of the association between changes in average negative affect and neuroticism (Table 3, second column, paths d and f). Again, changes in earlier neuroticism did not predict further changes in neuroticism (Table 3, second column, path h). People, who increased in average negative affect from T1 to T2 decreased after T2 in experiencing negative affect (Table 3, second column, path i).

Specificity of Outcomes: Stress Reactivity Did Not Predict Changes in Extraversion, Openness, and Conscientiousness

Similar latent change models as before (Figure 1, see the Analytic Strategy section) were used to examine whether changes in the stress reactivity in daily life predict longer-term changes in the other Big Five traits (Hypothesis 4). Table 4 summarizes the unstandardized path coefficients.

Changes in stress reactivity in daily life did not significantly predict changes in extraversion, openness, or conscientiousness during the next six years, as we hypothesized in H4. This lack of evidence of these specific state-trait coupling was consistent across both study periods T1 → T2 and T2 → T3 (Table 4, paths b and c). In addition, the age of participants did not significantly moderate effects of stress reactivity on extraversion, openness, or conscientiousness (Table 4, paths d and e).

Replicating previous age differences and developmental changes in Big Five traits, with older age, extraversion and openness to new experiences were somewhat lower ($b = -.03$, 95% CI [–.05, –.01], $b = -.02$, 95% CI [–.05, .00], respectively) and conscientiousness was higher, $b = .02$, 95% CI [.01,.04]. Longitudinally, conscientiousness increased from T1 to T2, $b = .17$, 95% CI [.01, .33], $d = .31$, $p < .01$, and this increase was less pronounced with older age, (Table 4, path f). Longitudinal changes in hassles reactivity were generally small and more pronounced with older age (Table 4, path g).

Unexpectedly, people who increased in negative affect stress reactivity from T1 to T2 also increased in self-reported agreeableness, but less so with older age (Table 4, paths b and d). Simple slopes analyses revealed that increases in stress reactivity were associated with increases in trait agreeableness only for people between 14.7 and 44.8 years. For people, older than 69.4 years, increases in stress reactivity were associated with decreases in agreeableness. From T2 to T3, effects of stress reactivity on trait agreeableness were only significant for people older than 68.1 years (see Table 4).

Summary of Results

In sum, increases in affective reactivity to hassles were associated with increases in neuroticism over six years. The effects were evident for both of the three-year intervals and after young adulthood less pronounced with older age, that is, only statistically significant during adolescence and young adulthood. Importantly, the coupling between daily stress reactivity and neuroticism was rather specific for both states and traits: (a) Changes in the mere occurrence of hassles in daily life were not significantly associated with changes in neuroticism, and changes in average negative affect in daily life were associated with changes in neuroticism only moderately from T1 to T2. Yet confidence intervals of estimates overlapped both across time intervals and with confidence intervals of estimates for stress reactivity. (b) Stress reactivity in daily life did not significantly predict changes in extraversion, openness and conscientiousness during the next six years. For agreeableness, a small age-specific effect of stress reactivity occurred from T1 to T2.

Discussion

The current study examined age differences in longitudinal state-trait coupling of affective experiences and neuroticism over six years. The findings offer support for the theoretical predictions that average stress reactivity, that is, repeated short-term states that occur after trait-relevant situations (e.g., stressful situations) are one potential process of long-term personality development, such as for neuroticism (Borghuis et al., 2020; Fleeson & Jayawickreme, 2015; Roberts, 2018; Wrzus & Roberts, 2017) and that these couplings are most pronounced early in adulthood. Previous studies focused on the reverse effect that higher neuroticism predicts more frequent hassle experiences, and more intense negative affect reactivity to hassles in daily life (Bolger & Zuckerman, 1995; Mroczek & Almeida, 2004; Suls & Martin, 2005). We next discuss that changes in neuroticism were coupled specifically with affective reactivity to hassles in daily life and why this coupling could be most pronounced in young adulthood compared with later adulthood. Furthermore, we elaborate on the specificity of states, that is, affective experiences, for the development of neuroticism compared with other Big Five traits. We discuss that although our findings provide an important initial test of processes proposed in theories (e.g., Baumert et al., 2017; Geukes et al., 2017; Roberts, 2018, Wrzus & Roberts, 2017), the directionality or causality of effects cannot be definitively ascertained from the current observational findings and conclude with limitations of the current study and future directions.

Daily Life Stress Reactivity and Changes in Neuroticism Are Most Strongly Coupled in Young Adulthood

As hypothesized, increases in average stress reactivity were associated with increases in neuroticism among adolescents and young adults consistently across both study periods. A sample average increase in stress reactivity was associated with an estimated increase in trait neuroticism of about 1/10 *SD* Another study observed about one standard deviation change in neuroticism over 50 years (Damian et al., 2019). Thus, although the effect size observed in the current study may seem relatively small, it was observed over only three years. Regarding potential underlying mechanisms, it is possible that people reflect on how they responded to hassle situations–either stayed relaxed or became angry or disappointed–and adjust their self-perception accordingly of being more or less neurotic after repeatedly observing themselves responding differently than they did before. This idea is consistent with previous results on average daily negative affect being associated with longitudinal changes in neuroticism among adolescents and young adults (Borghuis et al., 2020). Similarly, daily negative affect predicted changes in self-concepts of neuroticism over one month among young adults (Denissen et al., 2020). Although one month may be too short to consider changes in neuroticism as stable developmental changes, the results also demonstrate the malleability of self-concepts through previous experiences beyond concurrent state influences (Denissen et al., 2020). In contrast to these two studies, the current study tested the specificity of both state predictors and trait outcomes and included not only adolescents or young adults, but a wider age-range to examine adult age differences in the state-trait coupling. Also, the current study focused on momentary assessments of hassles and negative affect instead of daily experiences as in previous studies (Borghuis et al., 2020; Denissen et al., 2020) to further reduce reporting biases in negative affective experiences (Robinson & Clore, 2002), which are especially pronounced among younger adults (Neubauer et al., 2020).

Based on theoretical assumptions that trait self-concepts and daily life contexts are more variable during young adulthood compared with later periods of adulthood (Caspi et al., 2005; Roberts, 2018; Roberts & Mroczek, 2008; Wrzus & Roberts, 2017), we assumed and observed that couplings between momentary stress reactivity and changes in neuroticism were most pronounced in young adulthood. The current study partly supports these contextual explanations because changes in hassle occurrence as one context feature were somewhat more pronounced among younger compared with older adults. In addition, momentary experiences might be less strongly related to personality traits with older age because people are assumed to be better able to select and create situations that match their trait levels, thus elicit states that correspond to and consolidate trait levels (e.g., Buss, 1987; Dickens & Flynn, 2001; Wrzus & Roberts, 2017). So far, empirical evidence supporting the assumption of higher personality-situation fit with older age is scarce (Mueller et al., 2019; Wrzus et al., 2016), likely because people of all ages experience constraints in selecting or avoiding situations, especially hassles. The current results do not necessarily generalize to very old age, that is, people older than about 80 years. Some studies observed increases in neuroticism (Graham et al., 2020; Kandler et al., 2015) and also higher stress reactivity in old age (Mroczek & Almeida, 2004; Sliwinski et al., 2009; Wrzus et al., 2013), which could suggest a closer coupling among stress reactivity and neuroticism again in this age period. In summary, the current study integrated multiple time scales of data from momentary affective experiences, to self-concept changes over three and six years, and age differences that span a large proportion of the human life span from adolescence to old age. The findings demonstrate that integrating such different time scales offers intriguing insights into how personality traits develop across the life span.

As expected, the mere occurrence of hassles was not associated with changes in neuroticism. This is congruent with the theoretical considerations that neuroticism specifically concerns affective reactivity to stressful situations (e.g., Costa & McCrae, 1992; Suls & Martin, 2005) and merely being in stressful situations does not increase neuroticism if people do not respond with distress (i.e., increased negative affect). This finding is especially noteworthy as previous studies linked changes in neuroticism to the occurrence of stressful life events (Jeronimus et al., 2013, 2014; Riese et al., 2014). The current findings suggest that the effects of stressful events might indicate that people experience repeated increased negative affect in daily life (i.e., stress reactivity), which might mediate effects of stressful life events on the development of neuroticism, but were not assessed in previous large-scale longitudinal panel studies.

The current and previous studies (Borghuis et al., 2020; Denissen et al., 2020) also found some predictive effects of general negative affect on increases in neuroticism. The previous studies did not control situational characteristics and thus increased negative affect might have partly occurred together with unmeasured situational hassles. In the current study, negative affect in situations without specific previous hassles also predicted changes in neuroticism. One explanation could be that negative affect was higher than usual because people were still occupied with an earlier hassle (Wrzus et al., 2015) or anticipated an upcoming hassle (Neubauer et al., 2018; Scott et al., 2019), and such prolonged or premature stress reactivity also contributes to changes in neuroticism. As specified in current frameworks on processes of personality development (Roberts, 2018; Wrzus, 2020; Wrzus & Roberts, 2017), situations and situation-state couplings need to be examined concurrently as predictors of trait development.

Consistent with previous studies (Bolger & Zuckerman, 1995; Suls & Martin, 2005), higher initial levels of neuroticism were associated with stronger average stress reactivity, with more frequent hassle occurrences, and with higher average negative affect at the first assessment occasion. We also tested, but did not find, that neuroticism predicted longitudinal changes in stress reactivity or hassle occurrences. This suggests that over the observed time frames neuroticism did not work as a self-reinforcing system, whereby higher self-perceived trait levels lead to increases in stress reactivity, which then again foster higher neuroticism. Instead, it seems that trait development might be a combination of transient and lasting changes (i.e., elastic & pliable patterns, Roberts, 2018; see discussion of Future Directions).

Specificity of Stress Reactivity for the Development of Neuroticism

Based on theoretical considerations of the relative independence among Big Five traits (Goldberg, 2001; Soto & John, 2017) and little correlated longitudinal change (Soto & John, 2017), we expected momentary stress reactivity to be a specific predictor for changes in neuroticism, with little associations with, and predictive value for, the other Big Five traits. As described initially, most studies assessed hassles, such as interpersonal conflicts, and behavior in retrospective reports together with trait ratings, which might have caused spill-over effects, that is enhanced similarity in reports of traits and behaviors. This methodological difference has to be considered when relating the current results to previous findings. For example, higher remembered conflict frequency with romantic partners, family, or friends was associated with lower concurrent levels of emotional stability (i.e., higher neuroticism), and also agreeableness, and conscientiousness (Deventer et al., 2019; Mund & Neyer, 2014). Yet, retrospective conflict frequency only predicted future increases in neuroticism, but not in the other Big Five traits (Deventer et al., 2019; Mund & Neyer, 2014).

Previous studies examining daily affect solely reported results for neuroticism, and therefore the specificity of results for neuroticism is unknown. In the current study, we found some evidence that increases in negative affect after hassles, which were mainly interpersonal conflicts (Wrzus et al., 2013), were only associated with increases in neuroticism, but also in agreeableness among adolescents at least for the first time period. We can only speculate on potential explanations: Perhaps increased stress reactivity especially in interpersonal situations facilitates interpersonal skills and empathy among adolescents and young adults. The items to measure agreeableness in the current study asked for considerate and nice interpersonal behavior as well as being able to forgive others (John & Srivastava, 1999; Lang et al., 2011). Clearly, because this finding was unexpected, it awaits further replication and explanation. We observed no significant associations for the other three Big Five traits, which suggests some specificity of the stress reactivity-neuroticism coupling. Specificity of states and traits is highly important from both a conceptual and a practical point of view: to inform researchers which experiences matter for specific personality traits, and to inform practitioners whether tackling stress reactivity might (accidently) change open-mindedness in addition to neuroticism.

Because momentary negative affect and stress reactivity seem less relevant for the further Big Five traits, other trait-specific states might predict their development (Quintus et al., 2020). For example, achievement behavior such as retrospectively assessed time spent studying at the end of high school was specifically related to increases in conscientiousness (Bleidorn, 2015). Among college first-year students, extraversion increased over the course of three months the more sociable the students behaved (van Zalk et al., 2020). Intervention studies that focus on volitional personality development also support the assumption that trait-specific behaviors are necessary to elicit the intended trait change and few cross-trait effects occur (e.g., Hudson et al., 2018; Stieger et al., 2020). Yet these studies typically covered few months and future studies are needed that examine the longer-term stability of trait changes.

Limitations and Future Directions

The current research linked changes in average momentary stress reactivity to long-term changes in trait neuroticism in a six-year longitudinal study with repeated experience sampling phases and a large age-heterogeneous sample. Still, some limitations need to be discussed. Future studies should focus on what causes increases in stress reactivity and might be additional factors contributing to changes in self-concepts of neuroticism. In the current study, initial levels of neuroticism were associated with more frequent reports of hassles and more pronounced stress reactivity initially, but neither initial neuroticism levels nor increases in stress reactivity during the first three years accounted for changes in stress reactivity over the next three years. In contrast, people initially lower in agreeableness or conscientiousness showed stronger increases in stress reactivity (Table S4 in the online supplemental materials). These associations might result from increased interpersonal or work problems due to being less cooperative or reliable than others. In addition, changes in what constitutes a hassle may drive changes in stress reactivity and consequently increases in neuroticism; that is, what has not been stressful before can be perceived as stressful a few years later. In the current study, age was nonlinearly associated with changes in stress reactivity with decreasing stress reactivity among adolescents and young adults, no substantial change in middle adulthood, and increases among older adults. Neither the current research nor previous self-report or observational research on hassles can rule out changes in perceptual or biological stress thresholds as alternative explanation for changes in stress reactivity (Mroczek & Almeida, 2004; Sliwinski et al., 2009; Wrzus et al., 2013). Yet, even in controlled laboratory settings, people appraise and respond to the same stressful event in different ways (e.g., Luong & Charles, 2014). This emphasizes the highly subjective nature of stress perception and stress responses (Lazarus, 1999).

Additionally, biological changes might contribute to stronger stress reactivity as well as to changes in neuroticism directly. For example, biological models of depression (McEwen, 2012; Slavich & Irwin, 2014) argue that inflammatory processes related to stress elicit “sickness behavior” such as withdrawal, resting, hypersomnia, and hyperalertness, which is highly comparable to depressivity (a facet of neuroticism). The current study assessed neuroticism with a short scale, which did not allow distinguishing between facets of neuroticism (e.g., depressivity/withdrawal, volatility; DeYoung et al., 2007). In this study, we did not assess hormonal or epigenetic markers of stress responses (Cacioppo et al., 1995; Denson et al., 2009; Provenzi et al., 2016) but focused instead on stress reactivity as one specific mechanism of neuroticism change, which is compatible with and might even explain effects of other influencing factors such as stressful life events (Jeronimus et al., 2013; Riese et al., 2014) and partnership transitions (Finn et al., 2015; Finn & Neyer, 2016; Lehnart et al., 2010; Neyer & Asendorpf, 2001; Wagner et al., 2015).

A potential methodological limitation is the relatively low odd–-even reliability of average stress reactivity, though these results are comparable to other studies (Neubauer et al., 2019). The low day-to-day reliability might result from affective responses being rather variable from day to day because of contextual (e.g., different types of hassles; Hay & Diehl, 2010), psychological (e.g., differences in emotion regulations efficacy, Bellingtier et al., 2020; Luong et al., 2016), and biological factors (e.g., different response thresholds), as well as measurement error. We addressed potential measurement error by specifying stress reactivity as a latent construct in SEM and observed evidence for the predicted associations between changes in average stress reactivity and neuroticism, despite the relatively lower reliability of this measure.

Despite using a strong longitudinal measurement burst design, we cannot determine the directionality or causal pathways because stress reactivity has not been altered under controlled experimental conditions. Future experimental studies could also examine more closely whether average stress reactivity (as in the current study), peak responses, most recent responses, or linear increases over time in states contribute most strongly to changes in self-concepts (e.g., see Denissen et al., 2020 for correlational effects over one month). Perhaps the states that most strongly predict subsequent changes in self-concepts would also differ across individuals or time, depending on other factors such as comparison standards, reflective processes, ease of habit formation, or characteristics of the hassles (for review see Wrzus, 2020; Wrzus & Roberts, 2017). For example, the TESSERA framework (Wrzus & Roberts, 2017) and the Social Signal Transduction Theory (Slavich & Irwin, 2014) both postulate that social situations or social hassles may lead to more pronounced changes in traits, and neuroticism in particular. In addition, it is possible that traits and states show continuous bidirectional effects: For example, stress reactions in one situation might not only be coupled with the current self-concept, but also slightly alter the self-concept, which then contributes to changes in subsequent stress reactions. Such immediate changes in self-concepts may not be long-lasting (especially if overwritten with later experiences) or detectable with trait questionnaires. Yet, if feasible approaches for measuring trait self-concepts on a microlevel are developed (e.g., changes from minute to minute or even shorter), bidirectional effects could be examined on smaller time scales than currently done with ESM and trait questionnaires.

Finally, despite covering two study periods of about three years, the current investigation cannot disentangle whether observed changes reflected elastic or pliable changes in neuroticism (Roberts, 2018). Elastic changes describe changes that are lasting for an extended period of time, but not permanently, whereas pliable changes refer to permanent changes (Roberts, 2018). It might be possible in the current study that for some people, decreased stress reactivity was accompanied by enduring decreases in neuroticism, whereas for other people, changes over three years reflected elastic but not lasting changes. Even if consistent change (i.e., development) could be observed over several years and decades, it would still be possible that trait development is multidirectional, for example, showing increases in neuroticism toward the end of life although neuroticism generally decreases across adulthood (Graham et al., 2020; Kandler et al., 2015). Thus, future studies on trait development are needed that examine which part of traits are changing and for how long as well as potential predictors and specific time scales of when changes correspond to fluctuating, elastic, or pliable processes (Roberts, 2018).

Conclusion

This study innovatively examined age differences in state-trait couplings, specifically in how changes in average momentary affective experiences in reaction to daily hassles are associated with long-term trait changes in neuroticism differently across adulthood. The results extend earlier findings on long-term trait changes by providing insight into potential short-term processes underlying long-term trait changes and how they might differ over the life span, although further empirical work is needed to find further evidence for the assumed causal mechanisms. Given the relevance of neuroticism for a broad range of health issues (Lahey, 2009), the current findings offer a potential route for interventions that target malleable daily experiences, which build the capacity for modifying traits, which are more difficult to alter directly.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We express our gratitude to Oliver Schilling and Brent Roberts for valuable comments and suggestions on this work. This research was financially supported by the Max Planck Society for the Advancement of Sciences as well as by Grants MPI001 and 01UW0706 of the German Federal Ministry for Education and Research. The authors declare no potential conflicts of interest with respect to the research, authorship, and publication of this article.

References

Allemand M, Gomez V, & Jackson JJ (2010). Personality trait development in midlife: Exploring the impact of psychological turning points. European Journal of Ageing, 7(3), 147–155. 10.1007/s10433-010-0158-0 [PubMed: 28798625]

Allemand M, Zimprich D, & Martin M (2008). Long-term correlated change in personality traits in old age. Psychology and Aging, 23(3), 545–557. 10.1037/a0013239 [PubMed: 18808244]

Almeida DM (2005). Resilience and vulnerability to daily stressors assessed via diary methods. Current Directions in Psychological Science, 14(2), 64–68. 10.1111/j.0963-7214.2005.00336.x

Atherton OE, Grijalva E, Roberts BW, & Robins RW (2020). Stability and change in personality traits and major life goals from college to midlife. Personality and Social Psychology Bulletin, Advance online publication. 10.1177/0146167220949362

Augustine AA, & Larsen RJ (2012). Is a trait really the mean of states? Similarities and differences between traditional and aggregate assessments of personality. Journal of Individual Differences, 33(3), 131–137. 10.1027/1614-0001/a000083

Back MD, & Nestler S (in press). Dual process approaches to personality. In Deutsch R, Gawronski B & Hofmann W (Eds.), Reflective and impulsive determinants of human behavior Psychology Press.

Barlow DH, Ellard KK, Sauer-Zavala S, Bullis JR, & Carl JR (2014). The origins of neuroticism. Perspectives on Psychological Science, 9(5), 481–496. 10.1177/1745691614544528 [PubMed: 26186755]

Baumert A, Schmitt M, Perugini M, Johnson W, Blum G, Borkenau P, Costantini G, Denissen JJA, Fleeson W, Grafton B, Jayawickreme E, Kurzius E, MacLeod C, Miller LC, Read SJ, Roberts B, Robinson MD, Wood D, Wrzus C, & Mõttus R (2017). Integrating personality structure, personality process, and personality development. European Journal of Personality, 31(5), 503–528. 10.1002/per.2115

Bellingtier JA, Luong G, Wrzus C, Wagner GG, & Riediger M (2020). Everyday emotion regulation flexibility across ages: Linking hassle domains to strategies (Submitted)

Bleidorn W (2015). What accounts for personality maturation in early adulthood? Current Directions in Psychological Science, 24(3), 245–252. 10.1177/0963721414568662

Bleidorn W, Hopwood CJ, & Lucas RE (2018). Life events and personality trait change. Journal of Personality, 86(1), 83–96. 10.1111/jopy.12286 [PubMed: 27716921]

Bolger N, & Schilling EA (1991). Personality and the problems of everyday life: The role of neuroticism in exposure and reactivity to daily stressors. Journal of Personality, 59(3), 355–386. 10.1111/j.1467-6494.1991.tb00253.x [PubMed: 1960637]

Bolger N, & Zuckerman A (1995). A framework for studying personality in the stress process. Journal of Personality and Social Psychology, 69(5), 890–902. [PubMed: 7473036]

Borghuis J, Bleidorn W, Sijtsma K, Branje S, Meeus WHJ, & Denissen JJA (2020). Longitudinal associations between trait neuroticism and negative daily experiences in adolescence. Journal of Personality and Social Psychology, 18, 348–363. 10.1037/pspp0000233

Buss DM (1987). Selection, evocation, and manipulation. Journal of Personality and Social Psychology, 53(6), 1214–1221. 10.1037/0022-3514.53.6.1214 [PubMed: 3320336]

Cacioppo JT, Malarkey WB, Kiecolt-Glaser JK, Uchino BN, Sgoutas-Emch SA, Sheridan JF, Berntson GG, & Glaser R (1995). Heterogeneity in neuroendocrine and immune responses to brief psychological stressors as a function of autonomic cardiac activation. Psychosomatic Medicine, 57(2), 154–164. 10.1097/00006842-199503000-00008 [PubMed: 7792374]

Caspi A, & Roberts BW (2001). Personality development across the life course: The argument for change and continuity. Psychological Inquiry, 12(2), 49–66. 10.1207/S15327965PLI1202_01

Caspi A, Roberts BW, & Shiner RL (2005). Personality development: Stability and change. Annual Review of Psychology, 56, 453–484. 10.1146/annurev.psych.55.090902.141913

Charles ST, Piazza JR, Mogle J, Sliwinski MJ, & Almeida DM (2013). The wear and tear of daily stressors on mental health. Psychological Science, 24(5), 733–741. 10.1177/0956797612462222 [PubMed: 23531486]

Cohen J, Cohen P, West SG, & Aiken LS (2003). Applied multiple regression/correlation analysis for the behavioral sciences Erlbaum.

Costa PT, & McCrae RR (1988). Personality in adulthood: A six-year longitudinal study of self-reports and spouse ratings on the NEO Personality Inventory. Journal of Personality and Social Psychology, 54(5), 853–863. 10.1037/0022-3514.54.5.853 [PubMed: 3379583]

Costa PT, & McCrae RR (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI) professional manual Psychological Assessment Resources.

Costa PT, Herbst JH, McCrae RR, & Siegler IC (2000). Personality at midlife: Stability, intrinsic maturation, and response to life events. Assessment, 7(4), 365–378. 10.1177/107319110000700405 [PubMed: 11151962]

Damian RI, Spengler M, Sutu A, & Roberts BW (2019). Sixteen going on sixty-six: A longitudinal study of personality stability and change across 50 years. Journal of Personality and Social Psychology, 117(3), 674–695. 10.1037/pspp0000210 [PubMed: 30113194]

Deegan J (1978). On the occurrence of standardized regression coefficients greater than one. Educational and Psychological Measurement, 38(4), 873–888. 10.1177/001316447803800404

Denissen JJ, Luhmann M, Chung JM, & Bleidorn W (2019). Transactions between life events and personality traits across the adult lifespan. Journal of Personality and Social Psychology, 116(4), 612–633. 10.1037/pspp0000196 [PubMed: 30047764]

Denissen JJ, Ulferts H, Lüdtke O, Muck PM, & Gerstorf D (2014). Longitudinal transactions between personality and occupational roles: A large and heterogeneous study of job beginners, stayers, and changers. Developmental Psychology, 50(7), 1931–1942. 10.1037/a0036994 [PubMed: 24866287]

Denissen JJ, Wrzus C, & Back MD (2020). Peak-end heuristics affect stable self-views of trait neuroticism Manuscript in preparation.

Denson TF, Spanovic M, & Miller N (2009). Cognitive appraisals and emotions predict cortisol and immune responses: A meta-analysis of acute laboratory social stressors and emotion inductions. Psychological Bulletin, 135(6), 823–853. 10.1037/a0016909 [PubMed: 19883137]

Deventer J, Wagner J, Lüdtke O, & Trautwein U (2019). Are personality traits and relationship characteristics reciprocally related? Longitudinal analyses of codevelopment in the transition out of high school and beyond. Journal of Personality and Social Psychology, 116(2), 331–347. 10.1037/pspp0000191 [PubMed: 29745690]

DeYoung CG, Quilty LC, & Peterson JB (2007). Between facets and domains: 10 aspects of the Big Five. Journal of Personality and Social Psychology, 93(5), 880–896. 0.1037/0022–3514.93.5.880 10.1037/0022-3514.93.5.880 [PubMed: 17983306]

Dickens WT, & Flynn JR (2001). Heritability estimates versus large environmental effects: The IQ paradox resolved. Psychological Review, 108(2), 346–369. 10.1037/0033-295x.108.2.346 [PubMed: 11381833]

Edwards JR (2001). Ten difference score myths. Organizational Research Methods, 4(3), 265–287. 10.1177/109442810143005

Eysenck HJ (1947). Dimensions of personality Kegan Paul.

Finn C, & Neyer FJ (2016). Love changes everything: How a cognitive account opens a window to our understanding of personality effects in romantic relationships In nn (Ed.), nn (pp. nn).

Finn C, Mitte K, & Neyer FJ (2015). Recent decreases in specific interpretation biases predict decreases in neuroticism: Evidence from a longitudinal study with young adult couples. Journal of Personality, 83(3), 274–286. 10.1111/jopy.12102 [PubMed: 24730422]

Fleeson W, & Gallagher P (2009). The implications of Big Five standing for the distribution of trait manifestation in behavior: Fifteen experience-sampling studies and a meta-analysis. Journal of Personality and Social Psychology, 97(6), 1097–1114. 10.1037/a0016786 [PubMed: 19968421]

Fleeson W, & Jayawickreme E (2015). Whole trait theory. Journal of Research in Personality, 56, 82–92. 10.1016/j.jrp.2014.10.009 [PubMed: 26097268]

Friedman HS, Kern ML, & Reynolds CA (2010). Personality and health, subjective well-being, and longevity. Journal of Personality, 78(1), 179–215. 10.1111/j.1467-6494.2009.00613.x [PubMed: 20433617]

Geiser C, & Lockhart G (2012). A comparison of four approaches to account for method effects in latent state–trait analyses. Psychological Methods, 17(2), 255–283. 10.1037/a0026977 [PubMed: 22309958]

Geukes K, vanZalk M, & Back MD (2017). Analyzing processes in personality development. In Specht J (Ed.), Handbook of personality development (pp. 455–472). Academic Press.

Goldberg LR (2001). Analyses of Digman's child-personality data: Derivation of Big-Five factor scores from each of six samples. Journal of Personality, 69(5), 709–744. 10.1111/1467-6494.695161 [PubMed: 11575511]

Göllner R, Roberts BW, Damian RI, Lüdtke O, Jonkmann K, & Trautwein U (2017). Whose "storm and stress" is it? Parent and child reports of personality development in the transition to early adolescence. Journal of Personality, 85(3), 376–387. 10.1111/jopy.12246 [PubMed: 26851070]

Graham EK, Weston SJ, Gerstorf D, Yoneda TB, Booth T, Beam CR, Petkus AJ, Drewelies J, Hall AN, Bastarache ED, Estabrook R, Katz MJ, Turiano NA, Lindenberger U, Smith J, Wagner GG, Pedersen NL, Allemand M, Spiro A, . . . Mroczek DK (2020). Trajectories of Big Five personality traits: A coordinated analysis of 16 longitudinal samples. European Journal of Personality, 34(3), 301–321. 10.1002/per.2259 [PubMed: 33564207]

Grimm KJ, An Y, McArdle JJ, Zonderman AB, & Resnick SM (2012). Recent changes leading to subsequent changes: Extensions of multivariate latent difference score models. Structural Equation Modeling, 19(2), 268–292. 10.1080/10705511.2012.659627 [PubMed: 23637519]

Hoffman L, & Rovine MJ (2007). Multilevel models for the experimental psychologist: Foundations and illustrative examples. Behavior Research Methods, 39(1), 101–117. 10.3758/bf03192848 [PubMed: 17552476]

Horstmann KT, & Rauthmann JF (2020). How many states make a trait? A comprehensive meta-analysis of experience sampling studies Manuscript in preparation.

Hudson NW, Briley DA, Chopik WJ, & Derringer J (2018). You have to follow through: Attaining behavioral change goals predicts volitional personality change. Journal of Personality and Social Psychology Advance online publication. 10.1037/pspp0000221

Hutteman R, Nestler S, Wagner J, Egloff B, & Back MD (2015). Wherever I may roam: Processes of self-esteem development from adolescence to emerging adulthood in the context of international student exchange. Journal of Personality and Social Psychology, 108(5), 767–783. 10.1037/pspp0000015 [PubMed: 25285967]

Jeronimus BF, Ormel J, Aleman A, Penninx BW, & Riese H (2013). Negative and positive life events are associated with small but lasting change in neuroticism. Psychological Medicine, 43(11), 2403–2415. 10.1017/S0033291713000159 [PubMed: 23410535]

Jeronimus BF, Riese H, Sanderman R, & Ormel J (2014). Mutual reinforcement between neuroticism and life experiences: A five-wave, 16-year study to test reciprocal causation. Journal of Personality and Social Psychology, 107(4), 751–764. 10.1037/a0037009 [PubMed: 25111305]

John OP, & Srivastava S (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. In Pervin LA & John OP (Eds.), Handbook of personality: Theory and research (2nd ed., Vol. 2, pp. 102–138). Guilford Press.

Kandler C, Kornadt AE, Hagemeyer B, & Neyer FJ (2015). Patterns and sources of personality development in old age. Journal of Personality and Social Psychology, 109(1), 175–191. 10.1037/pspp0000028 [PubMed: 25545842]

Lahey BB (2009). Public health significance of neuroticism. American Psychologist, 64(4), 241–256. 10.1037/a0015309

Lang FR, John D, Lüdtke O, Schupp J, & Wagner GG (2011). Short assessment of the Big Five: Robust across survey methods except telephone interviewing. Behavior Research Methods, 43(2), 548–567. 10.3758/s13428-011-0066-z [PubMed: 21424189]

Lazarus RS (1999). Stress and emotion: A new synthesis New York, NY: Springer.

Le K, Donnellan MB, & Conger R (2014). Personality development at work: Workplace conditions, personality changes, and the corresponsive principle. Journal of Personality, 82(1), 44–56. 10.1111/jopy.12032 [PubMed: 23336723]

Lehnart J, & Neyer FJ (2006). Should I stay or should I go? Attachment and personality in stable and instable romantic relationships. European Journal of Personality, 20(6), 475–495. 10.1002/per.606

Lehnart J, Neyer FJ, & Eccles J (2010). Long-term effects of social (de-)investment: The case of partnering in young adulthood. Journal of Personality, 78(2), 639–670. 10.1111/j.1467-6494.2010.00629.x [PubMed: 20433633]

Little RJ (1988). A test of missing completely at random for multivariate data with missing values. Journal of the American Statistical Association, 83(404), 1198–1202. 10.1080/01621459.1988.10478722

Luan Z, Hutteman R, Denissen JJ, Asendorpf JB, & van Aken MA (2017). Do you see my growth? Two longitudinal studies on personality development from childhood to young adulthood from multiple perspectives. Journal of Research in Personality, 67, 44–60. 10.1016/j.jrp.2016.03.004

Lucas RE, & Donnellan MB (2011). Personality development across the life span: Longitudinal analyses with a national sample from Germany. Journal of Personality and Social Psychology, 101(4), 847–861. 10.1037/a0024298 [PubMed: 21707197]

Lüdtke O, Roberts BW, Trautwein U, & Nagy G (2011). A random walk down university avenue: Life paths, life events, and personality trait change at the transition to university life. Journal of Personality and Social Psychology, 101(3), 620–637. 10.1037/a0023743 [PubMed: 21744977]

Luong G, & Charles ST (2014). Age differences in affective and cardiovascular responses to a negative social interaction: The role of goals, appraisals, and emotion regulation. Developmental Psychology, 50(7), 1919–1930. 10.1037/a0036621 [PubMed: 24773101]

Luong G, Wrzus C, Wagner GG, & Riediger M (2016). When bad moods may not be so bad: Valuing negative affect is associated with weakened affect-health links. Emotion, 16(3), 387–401. 10.1037/emo0000132 [PubMed: 26571077]

Magnusson D (1990). Personality development from an interactional perspective. In Pervin LA (Ed.), Handbook of Personality: Theory and measurement (pp. 193–222). Guilford Press.

Marsh HW, Hau K-T, & Grayson D (2005). Goodness of fit in structural equation models. In Maydeu-Olivares A & McArdle JJ (Eds.), Contemporary psychometrics: A festschrift for Roderick P. McDonald. Multivariate applications book series (pp. 275–340). Erlbaum.

Matthews G, Jones DM, & Chamberlain AG (1990). Refining the measurement of mood: The UWIST Mood Adjective Checklist. British Journal of Psychology, 81(1), 17–42. 10.1111/j.2044-8295.1990.tb02343.x

McArdle JJ (2009). Latent variable modeling of differences and changes with longitudinal data. Annual Review of Psychology, 60, 577–605. 10.1146/annurev.psych.60.110707.163612

McEwen BS (2012). Brain on stress: How the social environment gets under the skin. Proceedings of the National Academy of Sciences of the United States of America, 109(Supplement 2), 17180–17185. 10.1073/pnas.1121254109 [PubMed: 23045648]

McNeish D (2018). Thanks coefficient alpha, we'll take it from here. Psychological Methods, 23(3), 412–433. 10.1037/met0000144 [PubMed: 28557467]

Meredith W (1993). Measurement invariance, factor analysis and factorial invariance. Psychometrika, 58(4), 525–543. 10.1007/BF02294825

Mischel W, & Shoda Y (1995). A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. Psychological Review, 102(2), 246–268. 10.1037/0033-295x.102.2.246 [PubMed: 7740090]

Mroczek DK, & Almeida DM (2004). The effect of daily stress, personality, and age on daily negative affect. Journal of Personality, 72(2), 355–378. 10.1111/j.0022-3506.2004.00265.x [PubMed: 15016068]

Mueller S, Ram N, Conroy DE, Pincus AL, Gerstorf D, & Wagner J (2019). Happy like a fish in water? The role of personality–situation fit for momentary happiness in social interactions across the adult lifespan. European Journal of Personality, 33(3), 298–316. 10.1002/per.2198

Mueller S, Wagner J, Smith J, Voelkle MC, & Gerstorf D (2017). The interplay of personality and functional health in old and very old age: Dynamic within-person interrelations across up to 13 years. Journal of Personality and Social Psychology Advance online publication. 10.1037/pspp0000173

Mund M, & Neyer FJ (2014). Treating personality-relationship transactions with respect: Narrow facets, advanced models, and extended time frames. Journal of Personality and Social Psychology, 107(2), 352–368. 10.1037/a0036719 [PubMed: 25090133]

Muthén LK, & Muthén BO (1998–2010). Mplus (Version 6.1) [Computer Software]. Author.

Neubauer AB, Scott SB, Sliwinski MJ, & Smyth JM (2020). How was your day? Convergence of aggregated momentary and retrospective end-of-day affect ratings across the adult life span. Journal of Personality and Social Psychology, 119(1), 185–203. 10.1037/pspp0000248 [PubMed: 31070397]

Neubauer AB, Smyth JM, & Sliwinski MJ (2018). When you see it coming: Stressor anticipation modulates stress effects on negative affect. Emotion, 18(3), 342–354. 10.1037/emo0000381 [PubMed: 29154583]

Neubauer AB, Voelkle MC, Voss A, & Mertens UK (2019). Estimating reliability of within-person couplings in a multilevel framework. Journal of Personality Assessment, 102(1), 1–12.

Neyer FJ, & Asendorpf JB (2001). Personality-relationship transaction in young adulthood. Journal of Personality and Social Psychology, 81(6), 1190–1204. [PubMed: 11761317]

Neyer FJ, & Lehnart J (2007). Relationships matter in personality development: Evidence from an 8-year longitudinal study across young adulthood. Journal of Personality, 75(3), 535–568. [PubMed: 17489891]

Provenzi L, Giorda R, Beri S, & Montirosso R (2016). SLC6A4 methylation as an epigenetic marker of life adversity exposures in humans: A systematic review of literature. Neuroscience and Biobehavioral Reviews, 71, 7–20. 10.1016/j.neubiorev.2016.08.021 [PubMed: 27565518]

Quintus M, Egloff B, & Wrzus C (2020). Daily life processes predict long-term development in explicit and implicit representations of Big Five traits: Testing predictions from the TESSERA framework. Journal of Personality and Social Psychology Advance online publication. 10.1037/pspp0000361

Reitz AK, Motti-Stefanidi F, & Asendorpf JB (2016). Me, us, and them: Testing sociometer theory in a socially diverse real-life context. Journal of Personality and Social Psychology, 110(6), 908–920. 10.1037/pspp0000073 [PubMed: 26595714]

Riediger M (2018). Ambulatory assessment in survey research: The multi-method ambulatory assessment project. In Erlinghagen M, K. Hank, & Kreyenfeld M (Eds.), Innovation und Wissenstransfer in der empirischen Sozial-und Verhaltensforschung: Festschrift für Gert G. Wagner (pp. 85–100). Campus Verlag.

Riediger M, Schmiedek F, Wagner GG, & Lindenberger U (2009). Seeking pleasure and seeking pain: Differences in pro- and contrahedonic motivation from adolescence to old age. Psychological Science, 20(12), 1529–1535. 10.1111/j.1467-9280.2009.02473.x [PubMed: 19891749]

Riediger M, Wrzus C, & Wagner GG (2014). Happiness is pleasant, or is it? Implicit representations of affect valence are associated with contrahedonic motivation and mixed affect in daily life. Emotion, 14(5), 950–961. 10.1037/a0037711 [PubMed: 25151515]

Riediger M, Wrzus C, Schmiedek F, Wagner GG, & Lindenberger U (2011). Is seeking bad mood cognitively demanding? Contra-hedonic orientation and working-memory capacity in everyday life. Emotion, 11(3), 656–665. 10.1037/a0022756 [PubMed: 21534659]

Riese H, Snieder H, Jeronimus BF, Korhonen T, Rose RJ, Kaprio J, & Ormel J (2014). Timing of stressful life events affects stability and change of neuroticism. European Journal of Personality, 28(2), 193–200. 10.1002/per.1929

Roberts BW (2006). Personality development and organizational behavior. In Staw BM (Ed.), Research in organizational behavior (Vol. 27, pp. 1–40). Elsevier.

Roberts BW, & Davis JP (2016). Young adulthood is the crucible of personality development. Emerging Adulthood, 4(5), 318–326. 10.1177/2167696816653052

Roberts BW, & Jackson JJ (2008). Sociogenomic personality psychology. Journal of Personality, 76(6), 1523–1544. 10.1111/j.1467-6494.2008.00530.x [PubMed: 19012657]

Roberts BW, & Mroczek D (2008). Personality trait change in adulthood. Current Directions in Psychological Science, 17(1), 31–35. [PubMed: 19756219]

Roberts BW, Luo J, Briley DA, Chow PI, Su R, & Hill PL (2017). A systematic review of personality trait change through intervention. Psychological Bulletin, 143(2), 117–141. 10.1037/bul0000088 [PubMed: 28054797]

Roberts BW, Walton KE, & Viechtbauer W (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. Psychological Bulletin, 132(1), 1–25. 10.1037/0033-2909.132.1.1 [PubMed: 16435954]

Roberts BW, Wood D, & Caspi A (2008). The development of personality traits in adulthood. In John OP, Robins RW, & Pervin LA (Eds.), Handbook of personality: Theory and research (Vol. 3, pp. 375–398). Guilford Press.

Robinson MD, & Clore GL (2002). Episodic and semantic knowledge in emotional self-report: Evidence for two judgment processes. Journal of Personality and Social Psychology, 83(1), 198–215. [PubMed: 12088126]

Scott SB, Kim J, Smyth JM, Almeida DM, & Sliwinski MJ (2019). Additive effects of forecasted and reported stressors on negative affect. The Journals of Gerontology: Series B, 74(1), 29–37. doi: 10.1093/geronb/gby068

Slavich GM, & Irwin MR (2014). From stress to inflammation and major depressive disorder: A social signal transduction theory of depression. Psychological Bulletin, 140(3), 774–815. 10.1037/a0035302 [PubMed: 24417575]

Sliwinski MJ, Almeida DM, Smyth J, & Stawski RS (2009). Intra-individual change and variability in daily stress processes: Findings from two measurement-burst diary studies. Psychology and Aging, 24(4), 828–840. 10.1037/a0017925 [PubMed: 20025399]

Soto CJ, & John OP (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. Journal of Personality and Social Psychology, 113(1), 117–143. 10.1037/pspp0000096 [PubMed: 27055049]

Specht J, Egloff B, & Schmukle SC (2011). Stability and change of personality across the life course: The impact of age and major life events on mean-level and rank-order stability of the Big Five. Journal of Personality and Social Psychology, 101(4), 862–882. 10.1037/a0024950 [PubMed: 21859226]

Stawski RS, Scott SB, Zawadzki MJ, Sliwinski MJ, Marcusson-Clavertz D, Kim J, Lanza ST, Green PA, Almeida DM, & Smyth JM (2019). Age differences in everyday stressor-related negative affect: A coordinated analysis. Psychology and Aging, 34(1),91–105. 10.1037/pag0000309 [PubMed: 30550311]

Stephan Y, Sutin AR, Canada B, & Terracciano A (2017). Personality and frailty: Evidence from four samples. Journal of Research in Personality, 66, 46–53. 10.1016/j.jrp.2016.12.006 [PubMed: 28649150]

Steyer R, Schwenkmezger P, & Auer A (1990). The emotional and cognitive components of trait anxiety: A latent state-trait model. Personality and Individual Differences, 11(2), 125–134. 10.1016/0191-8869(90)90004-B

Stieger M, Wepfer S, Rüegger D, Kowatsch T, Roberts BW, & Allemand M (2020). Becoming more conscientious or more open to experience? Effects of a two-week smartphone-based intervention for personality change. European Journal of Personality, 34(3), 345–366. 10.1002/per.2267

Suls J, & Martin R (2005). The daily life of the garden-variety neurotic: Reactivity, stressor exposure, mood spillover, and maladaptive coping. Journal of Personality, 73(6), 1485–1509. 10.1111/j.1467-6494.2005.00356.x [PubMed: 16274443]

Suls J, Martin R, & David JP (1998). Person-environment fit and its limits: Agreeableness, neuroticism, and emotional reactivity to interpersonal conflict. Personality and Social Psychology Bulletin, 24(1), 88–98. 10.1177/0146167298241007 van Zalk M, Nestler S, Geukes K, Hutteman R, & Back M (2020). The codevelopment of extraversion and friendships: Bonding and behavioral interaction mechanisms in friendship networks. Journal of Personality and Social Psychology, 118(6), 1269–1290. 10.1037/pspp0000253 [PubMed: 31380681]

Wagner J, Becker M, Trautwein U, & Lüdtke O (2015). The first partnership experience and personality development: A propensity score matching study in young adulthood. Social Psychological & Personality Science, 6(4), 455–463. 10.1177/1948550614566092

Weber C, Quintus M, Egloff B, Luong G, Riediger M, & Wrzus C (2020). Same old, same old: Age differences in the diversity of daily life. Psychology and Aging, 35(3), 434–448. 10.1037/pag0000407 [PubMed: 31613136]

Wrzus C (2020). Processes of personality development: An update of the TESSERA framework. In Rauthmann J (Ed.), The handbook of personality dynamics and processes (pp. ●●●). Elsevier.

Wrzus C, & Roberts BW (2017). Processes of personality development in adulthood: The TESSERA framework. Personality and Social Psychology Review, 21(3), 253–277. 10.1177/1088868316652279 [PubMed: 27260302]

Wrzus C, Luong G, Wagner GG, & Riediger M (2015). Can’t get it out of my head: Age differences in affective responsiveness vary with preoccupation and elapsed time after daily hassles. Emotion, 15(2), 257–269. 10.1037/emo0000019 [PubMed: 25286070]

Wrzus C, Müller V, Wagner GG, Lindenberger U, & Riediger M (2013). Affective and cardiovascular responding to unpleasant events from adolescence to old age: Complexity of events matters. Developmental Psychology, 49(2), 384–397. 10.1037/a0028325 [PubMed: 22545845]

Wrzus C, Wagner GG, & Riediger M (2016). Personality-situation-transactions from adolescence to old age. Journal of Personality and Social Psychology, 110(5), 782–799. 10.1037/pspp0000054 [PubMed: 26167797]

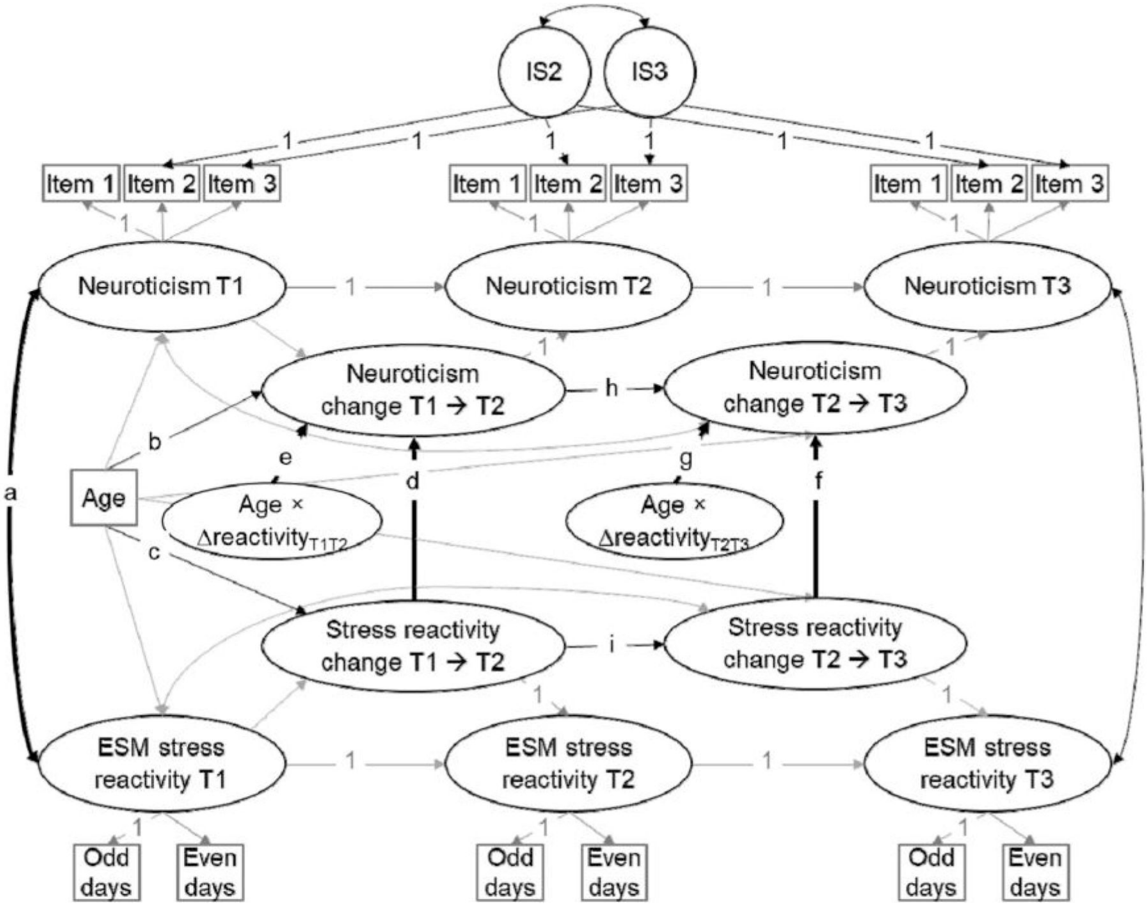

Figure 1.

Latent Change model Extended From Grimm et al. (2012) to Include Latent Age Moderation

Note. ESM = experience sampling method (i.e., repeated assessments per day); NA = negative affect; T = time; IS = Item-specific method factor (Grimm et al., 2012). Variances and residual variances are omitted in the figure to improve clarity but were estimated for all indicators and latent variables with the exception of negative residual variances, which were set to zero.

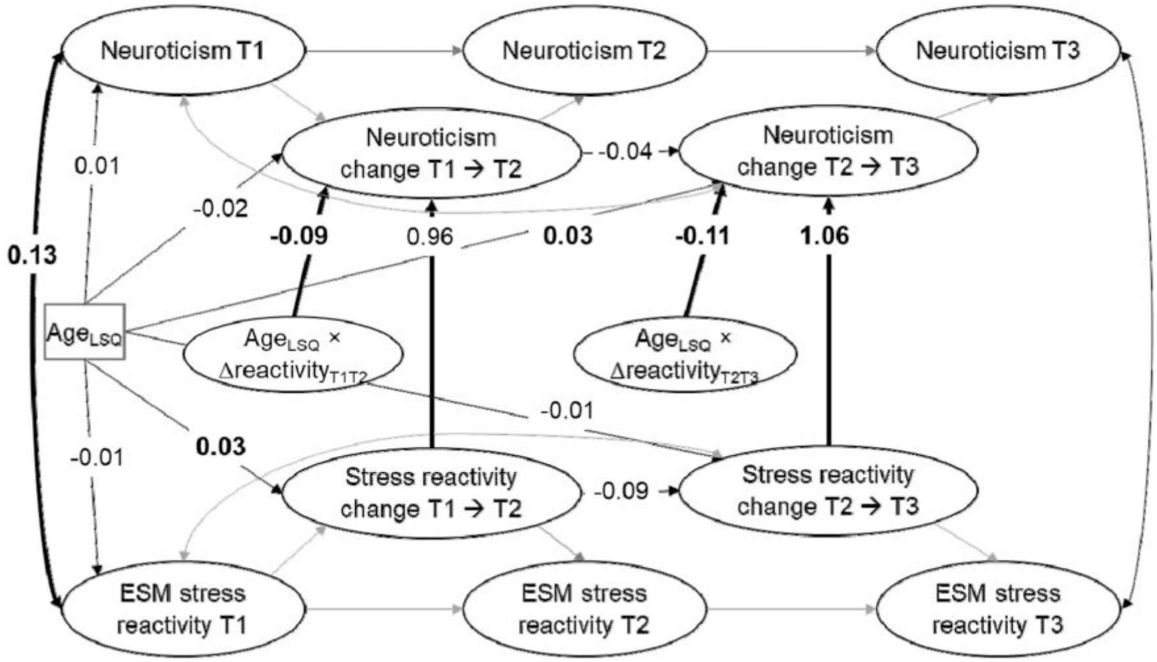

Figure 2.

Change in Neuroticism Predicted by Changes in Short-Term Negative Affect Reactivity to Daily Hassles, Age, and the Interaction

Note. Coefficients are unstandardized path coefficients. Indicators of latent factors and method factors are not depicted to enhance clarity but were estimated in the models. Age $_{LSQ}$ is modeled as linear combination of the linear and quadratic age effect. T = time. For coefficients in larger and bold font is $p < .05$.

Table 1

Descriptive Information and Intercorrelations at T1

Measure	T1*M* (*SD*)	ω	1	2	3	4	5	6	7	8
1. Hassle occurrence[a]	0.092 (0.086)	/								
2. Negative affect[b]	0.62 (0.56)	/	**.214**							
3. Stress reactivity[c]	1.07 (0.93)	/	−.001	−.090						
4. Neuroticism	3.40 (1.23)	.63	**.087**	**.230**	.078					
5. Extraversion	5.20 (1.13)	.71	**.119**	−.053	**.136**	**−.154**				
6. Openness to new experiences	5.10 (1.09)	.67	**.100**	−.070	**.129**	**−.185**	**.355**			
7. Agreeableness	5.19 (0.99)	.60	−.070	−.155	**.148**	**−.119**	.049	**.200**		
8. Conscientiousness	5.49 (1.11)	.74	−.043	−.166	.090	**−.218**	.077	**.316**	**.165**	
9. Age[d]	42.5 (19.0)	/	−.091	−.115	−.007	.024	**−.170**	**.086**	**−.133**	**.362**

Note. ω = internal consistency of items (McNeish, 2018). Correlations in bold are significant with $p < .05$.

[a] Person-average proportion (across an experience-sampling period) of occasions with reported hassles.

[b] Person-average (across an experience-sampling period) of negative affect at occasions without hassles.

[c] Person-average (across an experience-sampling period) of negative affect at occasions with hassles compared with occasions without hassles.

[d] Scatterplots depicting age differences at T1 are presented in Figure S2 in the online supplemental materials.

Table 2

Mean-Level and Rank-Order Changes of Average Daily Experiences and Big Five Traits

Measure	T1–T2*d*	T2–T3*d*	Stability r_{12}	Stability r_{23}
Hassle occurrence[a]	−0.08	**−0.25**	**.39**	**.50**
Negative affect[b]	0.10	**0.27**	**.50**	**.63**
Stress reactivity[c]	0.002	0.07	**.19**	**.26**
Neuroticism	0.11	−0.01	**.61**	**.63**
Extraversion	−0.02	**−0.26**	**.61**	**.65**
Openness to new experiences	**0.28**	**−0.32**	**.69**	**.65**
Agreeableness	0.19	**−0.30**	**.45**	**.55**
Conscientiousness	**0.31**	−0.08	**.63**	**.67**

Note. d = standardized mean difference; positive values represent an increase between time periods. r_{12} = correlation between T1 and T2. r_{23} = correlation between T2 and T3. Correlations in bold are significant with $p < .05$.

[a]Person-average proportion (across an experience-sampling period) of occasions with reported hassles.

[b]Person-average (across an experience-sampling period) of negative affect at occasions without hassles.

[c]Person-average (across an experience-sampling period) of negative affect at occasions with hassles compared with occasions without hassles.

Table 3

Unstandardized Path Coefficients Predicting Change in Neuroticism From the Occurrence of Hassles (Model 1) or Average Negative Affect in Daily Life (Model 2)

Measure	Model 1: Hassle Occurrence*b* [95% CI]	Model 2: Negative Affect*b* [95% CI]
Initial association *a* at T1	**0.16** [0.07,0.24]	**0.21** [0.14,0.28]
Age differences in change		
b Age → Change neuroticism	−0.03 [−0.06,0.00]	**−0.03** [−0.05,−0.001]
c Age → Change Hassle/NA	0.01 [−0.01,0.02]	**−0.01** [−0.02,−0.001]
State changes moderated by age predict trait changes		
d T1–T2 Hassle/NA change → Change neuroticism	0.03 [−0.34,0.40]	**0.43** [0.12,0.73]
e T1–T2 Age moderation	−0.002 [−0.04,0.04]	−0.02 [−0.06,0.01]
f T2–T3 Hassle/NA change → Change neuroticism	0.08 [−0.36,0.52]	0.16 [−0.20,0.52]
g T2–T3 Age moderation	−0.01 [−0.07,0.05]	−0.01 [−0.05,0.03]
Neighbor change T1–T2 → T2–T3		
h Neuroticism	−0.11 [−0.52,0.29]	−0.02 [−0.36,0.31]
i Hassle/NA	**−0.18** [−0.36,−0.01]	**−0.15** [−0.25,−0.06]
Model fit		
AIC	17,890.04	14,688.61
BIC	18,121.38	14,919.95

Note. Hassle = hassle occurrence; NA = negative affect; AIC = ●●●; BIC = ●●●. The table presents selected model coefficients. Loadings on latent factors are not presented. Letters *a*–*i* refer to the paths depicted in Figure 1. Bold coefficients $p < .05$.

Table 4

Unstandardized Path Coefficients Predicting Change in Big Five Traits From the Stress Reactivity in Daily Life

Measure	Extraversion[b] [95% CI]	Openness[b] [95% CI]	Agreeableness[b] [95% CI]	Conscientiousness[b] [95% CI]
a Initial association at T1	0.03 [−0.04,0.11]	0.03 [−0.06,0.12]	−0.01 [−0.11,0.09]	**0.07** [0.01,0.14]
Age differences in change				
b Age → Trait change	−0.01 [−0.03,0.03]	−0.004 [−0.03,0.02]	0.05 [0.01,0.11]	**−0.04** [−0.07, −0.001]
c Age → Change stress reactivity	**0.02** [0.003,0.04]	0.02 [−0.01,0.05]	**0.02** [0.002,0.03]	**0.03** [0.01,0.05]
State changes moderated by age predict trait changes				
d T1–T2 Change stress reactivity → Trait change	−0.59 [−1.86,0.69]	−0.75 [−2.34,0.84]	**1.97** [0.52,3.42]	0.09 [−0.97,1.16]
e Age moderation T1–T2	0.07 [−0.01,0.14]	0.09 [−0.06,0.24]	**−0.25** [0.49,0.02]	0.04 [−0.04,0.13]
f T2–T3 Change stress reactivity → Trait change	−0.31 [−1.41,0.79]	0.03 [−0.83,0.89]	−2.19 [4.85,0.47]	−0.44 [−1.30,0.43]
g Age moderation T2–T3	0.04 [−0.03,0.10]	−0.01 [−0.16,0.14]	**0.34** [0.09,0.59]	0.06 [−0.01,0.13]
Neighbor change T1–T2 → T2–T3				
h Trait change T1–T2 → T2–T3	−0.14 [−0.36,0.08]	−0.20 [−0.47,0.08]	−0.42 [−1.15,0.31]	0.02 [−0.18,0.21]
i Change Stress reactivityT1-T2 → T2-T3	−0.03 [−0.21,0.15]	−0.03 [−0.23,0.18]	0.07 [−0.07,0.20]	−0.12 [−0.30,0.06]
Model fit				
AIC	16,416.57	20,452.67	16,630.11	15,910.27
BIC	16,647.90	20,718.92	16,861.44	16,141.60

Note. AIC = ●●●; BIC = ●●●. Table presents selected model coefficients. Loadings on latent factors are not presented. Letters *a*–*i* refer to the paths depicted in Figure 1. Bold coefficients $p < .05$.