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Personality Trait Development at the End of Life: Antecedents and Correlates of Mean-Level Trajectories

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Empirical evidence over the past 20 years has documented that key aspects of personality traits change during adulthood. However, it is essentially an open question whether and how traits change at the very end of life and what role health, cognitive performance, perceived control, and social factors play in those changes. To examine these questions, we applied growth models to 13-year longitudinal data obtained from now-deceased participants in the Berlin Aging Study ($N = 463$; age at baseline $M = 85.9$ years, $SD = 8.4$; 51% men). Results revealed that neuroticism, on average, increases (about 0.3 *SD* in the last 10 years) and that this increase becomes even steeper at the end of life. In contrast, extraversion and openness decline rather steadily at the end of life (about −0.5 *SD* in the last 10 years). Additionally, poor health manifested as a risk factor for declines in extraversion and openness late in life but not neuroticism. Similar to earlier phases of life, better cognitive performance related to more openness. More loneliness was associated with higher neuroticism, whereas more social activity was associated with higher levels of extraversion and openness. Intriguing additional insights indicated that more personal control was associated with higher levels of extraversion and openness, whereas the feeling that one's life is controlled by others was associated with higher neuroticism but also with higher openness closer to death. We discuss potential pathways by which health, cognitive performance, control, and social inclusion resources and risk factors affect personality development late in life.

Keywords: personality development, chronological age and time to death, personal resources, old age, longitudinal data

Research over the last decades has repeatedly shown that personality trait development—herein defined as long-term mean-level changes of personality traits—in the second half of life is characterized by both continuity and change (Kandler, Kornadt, Hagemeyer, & Neyer, 2015; Lucas & Donnellan, 2011; Roberts & DelVecchio, 2000; Roberts, Walton, & Viechtbauer, 2006; Staudinger & Kunzmann, 2005). For example, Kandler and colleagues (2015) examined personality trait change among people in their 60s and 70s and reported average mean-level increases in neuroticism and deceases in extraversion. However, not much is known about personality trait development late in life and with approaching death. It is unclear, for example, whether the challenges and burdens that often accompany late life (Baltes & Smith, 2003,; Gerstorf & Ram, 2013) are associated with more pro-

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nounced personality trait changes. Research on earlier phases of adulthood has long shown that personality traits (understood as basic building blocks of human thinking, feeling, experience, and behavior) are closely linked with important outcomes of successful aging, including key aspects of health and physical limitations (Roberts, Smith, Jackson, & Edmonds, 2009; Takahashi, Edmonds, Jackson, & Roberts, 2013; Turiano, Pitzer, Armour, Karlamangla, Ryff, & Mroczek, 2012), and mortality hazards (Friedman, Tucker, Tomlinson-Keasey, Schwartz, Wingard, & Criqui, 1993; Turiano, Spiro, & Mroczek, 2012). However, we are only at the very beginning of understanding how health, social, and other resources constitute risk factors for and protective factors against less desirable personality trait change late in life.

In the present study, we move research on adult personality trait development to the last phase of life. To do so, we investigate developmental mean-level trajectories of neuroticism, extraversion, and openness to experiences in very old age and with approaching death and examine how these trajectories are related to individual differences in resources and risk factors such as health, cognitive performance, perceived control, and social inclusion. Specifically, we used 13-year longitudinal data from 463 now-deceased participants in the Berlin Aging Study (BASE). We consider only neuroticism, extraversion, and openness to experiences aspects of personality because only these dimensions were measured in the BASE.

Adult Personality Trait Development in Late Life

Age Differences in Development

Empirical research on age-related personality trait development has repeatedly revealed evidence for change across adulthood (Baltes, 1987; Helson, Jones, & Kwan, 2002; Roberts, Helson, & Klohnen, 2002; for an overview, see John & Srivastava, 1999). For example, in a recent longitudinal study using data from a representative German adult life-span sample, Lucas and Donnellan (2011) reported that mean levels of extraversion and openness decline across adulthood, whereas the mean level of neuroticism is relatively consistent in younger and middle-aged adults and decreases among people in their 60s and 70s (see also Allemand, Zimprich, & Hertzog, 2007; Specht, Egloff, & Schmukle, 2011). Concentrating on change trajectories in old age, Mroczek and Spiro (2003) reported in a seminal study that extraversion mean levels decline, whereas neuroticism substantially decreased up to age 80 and subsequently increased again (see also Kandler et al., 2015). Similarly, openness mean levels have been shown to decline late in life (Mõttus, Johnson, Starr, & Deary, 2012). Taken together, compared to middle and young adulthood, late life appears to be characterized by trajectories of personality trait development that would be described as less favorable; that is, mean-level increases in neuroticism and decreases in extraversion and openness. However, based on what we know of developmental trajectories in late life, we submit that such changes may describe adaptive developmental trajectories that adjust daily experience and behavior to available resources and risk factors of late life.

Time-to-Death Differences in Development

At the very end of life, many domains of functioning appear to be prone to terminal decline (Gerstorf, Ram, Lindenberger, & Smith, 2013). Terminal decline can be expected to reflect some combination of late-life neuropathology (e.g., Alzheimer's disease, Lewy bodies), deteriorating integrity of neurocognitive control systems, and a breakdown of overall system coordination and integrity. Such terminal decline processes at the end of life are often referred to as *mortality-related processes*. Drawing from seminal work published in the 1960s and 1970s (Kleemeier, 1962; Palmore & Cleveland, 1976; Riegel & Riegel, 1972; Siegler, 1975), empirical evidence has accumulated to suggest that progressive mechanisms leading toward death drag down functioning in many domains, including cognitive performance (for overviews, see Bäckman & MacDonald, 2006; Berg, 1996; Small & Bäackman, 1999), well-being (Berg, Hassing, Thorvaldsson, & Johansson, 2011; Diehr, Williamson, Burke, & Psaty, 2002; Gerstorf, Ram, Estabrook, et al., 2008; Gerstorf et al., 2010; Mroczek & Spiro, 2005; Palgi et al., 2010), physical function, and social function (Gerstorf & Ram, 2013). There is also initial evidence that such mortality-related decline processes contribute to change in constructs considered to be relatively stable (or trait like) such as self-esteem (Wagner, Gerstorf, Hoppmann, & Luszcz, 2013; Wagner, Hoppmann, Ram, & Gerstorf, 2015), although trajectories of decline are not as steep as those found in other domains.

To the best of our knowledge, there is no previous study that has examined the relation between personality trait change and proximity or time to death. However, there are several studies linking personality to mortality hazards or looking at personality profiles in centenarians. The literature linking personality traits with mortality hazards provides somewhat inconsistent evidence. Some studies found no (or little) predictive utility of the three traits of neuroticism, extraversion, and openness (e.g., Martin & Friedman, 2000), whereas other studies found reduced mortality hazards for people with lower neuroticism and higher extraversion (e.g., Fry & Debats, 2009; Terracciano, Löckenhoff, Zonderman, Ferrucci, & Costa, 2008). In a study by Mroczek and Spiro (2007), both higher average levels as well as increases in neuroticism were uniquely predictive of mortality in men. Studies examining personality among centenarians find a profile of low neuroticism, high extraversion, and high openness to be most prevalent (Andersen et al., 2013; Martin, Bishop, Poon, & Johnson, 2006; Masui, Gondo, Inagaki, & Hirose, 2006). This suggests that being less neurotic, more extraverted, and more open probably relates to a longer life. However, this latter set of empirical inquiry does not directly take into account the personality trait changes that presumably occur late in life.

Using the sum of these findings as a backdrop to formulate expectations about personality trait development at the very end of life, we would expect that as people approach death, neuroticism increases, whereas both extraversion and openness to experiences decrease. It is an open question, though, whether trajectories of change late in life are getting steeper in closer proximity to death.

Interindividual Differences in Development

Already based on the empirical findings of the seminal Baltimore Longitudinal Study of Aging, Shock and colleagues (Shock et al., 1984) considered differences between individuals to be more profound than developmental age effects across the life span. The existence of substantial interindividual differences both in level and change trajectories of personality trait development has been

shown in many studies and across the entire life span (Bleidorn, Kandler, Riemann, Angleitner, & Spinath, 2009; Helson et al., 2002; Kandler et al., 2014; Lucas & Donnellan, 2011; Mõttus et al., 2012; Mroczek & Spiro, 2003; Roberts & Mroczek, 2008). Thus, despite the description of age-related or age-moderated change trajectories, people obviously differ substantially in general developmental patterns.

The Role of Resources and Risk Factors for Personality Trait Development Late in Life

Life-span developmental theory suggests that life-span dynamics of an increasingly negative gain–loss ratio in the health and cognitive domains (Baltes & Baltes, 1990), as well as declines in perceived control (Heckhausen & Schulz, 1995; Lachman, 2006), constitute key risk factors for personality development. For example, even personality characteristics that used to be relatively stable across large parts of adulthood are shaped by broad-based functional declines late in life. To illustrate, compromised cognitive resources, as one particularly age-sensitive characteristic (Schaie, 1996), may constrain and contribute to declines in openness to new experiences and in seeking out novel contexts as well as to increases in feelings of anxiety and thus neuroticism. Thus, reduced reserve capacity can be expected to shape personality trait development later in life.

Given the convincing empirical results about considerable individual differences in level and change trajectories of personality traits, an important question to ask is whether different risk and/or protective factors contribute to individual differences in specific personality traits late in life. For the current study, we have selected variables that broadly represent central characteristics of individual functioning late in life and thus may serve as either protective factors (if available) or as risk factors (if not or only available to a limited extent) for late-life personality trait development: physical health, cognitive performance, perceived control, and social inclusion. Importantly, this selection of resource and risk factors includes both subjective perceptions such as perceived control that are perhaps closely related to self-reported personality and more objective and performance-based characteristics such as physician-diagnosed physical illnesses and cognitive performance, as well as context-related characteristics such as social activity. Thus, the multidomain measures included as correlates are expected to cover a broad spectrum of areas of life that are important for late-life functioning and development.

Physical Health

Functional limitations are known to increase with age (Spiro, 2001; Spiro & Brady, 2008) and would be expected to affect basic tendencies of thinking and behaving. For example, sudden health issues such as a stroke may lead people to feel more vulnerable and to become more self-conscious or fearful of further incidences, manifesting in higher neuroticism late in life. Similarly, limitations in physical health and functioning can be expected to reduce social activity and thereby result in lowered extraversion. Both such notions were (partially) supported by previous studies: First, using an adult life-span sample, associations between neuroticism and physical limitations were stronger among older adults than among younger adults (Canada, Stephan, Jaconelli, & Duberstein, 2014). Second, better health was related to higher levels of extraversion (Berg & Johansson, 2014; cf. Mroczek & Spiro, 2003). Finally, developing a chronic illness was related to lower openness (Sutin, Zonderman, Ferrucci, & Terracciano, 2013). Thus, suffering from physical illnesses and having more functional limitations could play a major role in personality trait development late in life.

Cognitive Performance

Age-related cognitive declines, specifically in the cognitive mechanics, are well established (Bäckman & MacDonald, 2006; Baltes, 1993; Schaie, 1993). The trait of openness to experiences, having a particularly strong cognitive component, thus can be expected to evince substantial declines in old age. Understanding cognitive resources as a protective factor, an intervention training to increase cognitive performance late in life showed that, as a side effect, openness to experiences increased in the intervention group but not in the control group (Jackson, Hill, Payne, Roberts, & Stine-Morrow, 2012). Also, questionnaire studies showed better cognitive performance to relate to a lower decline in openness as well as a lower increase in neuroticism (Graham & Lachman, 2012). In addition, Berg and Johansson (2014) found higher self-rated cognitive impairment to relate to being less extraverted. However, neither level nor change of extraversion was associated with administered tests of cognitive performance. Taken together, empirical results suggest that preserved cognitive performance relates to more stable personality trait development late in life.

Perceived Control

From a conceptual point of view, having the belief to be in control of what happens in one's life has been regarded as both an important outcome and an antecedent of successful aging in multiple domains of life (Lachman, 2006). Consistent with this line of reasoning, Kandler et al. (2015) found that perceptions of higher personal control were associated with lower neuroticism as well as higher extraversion and openness. Capitalizing on these initial results and understanding perceptions of control as a general-purpose mechanism, we expect people who perceive their lives to be under their control to also show more stable personality trajectories late in life.

Social Inclusion

Based on the notion of a fundamental human need to belong (Baumeister & Leary, 1995), social relationships and social embedding are important parts of human life. Specifically late in life, engaging in social contact and maintaining close relationships to family and friends are often associated with better health and higher well-being (Carstensen, 2006; Rook, Mavandadi, Sorkin, & Zettel, 2007). However, the known decreases in social role involvement (Freund, Nikitin, & Ritter, 2009) and generally smaller social networks (Wrzus, Hänel, Wagner, & Neyer, 2013) possibly manifest in fewer social activities and more feelings of loneliness. Such tendencies could be related to low levels of and declines in extraversion and openness late in life. Using an adult life-span sample, higher social well-being, as one possible indicator of social inclusion, was associated with being more extraverted, more open, and less neurotic (Hill, Turiano, Mroczek, & Roberts, 2012).

In a more relationship-specific approach, Wagner, Lüdtke, Roberts, and Trautwein (2014) found that increases in emotional closeness to stable social network ties related to lower neuroticism (see also Mund & Neyer, 2014). However, these findings are based on samples of young adults. Instead, a study concentrating on social engagement in late life found no associations with neuroticism but did not test for extraversion and openness effects (Lodi-Smith & Roberts, 2012). Thus, overall we hypothesize that higher levels of social inclusion relate to higher extraversion and openness, whereas we do not have specific hypotheses about associations with neuroticism.

In sum, previous research was largely concerned about the effect of personality on important life outcomes later in life, including mortality hazards (Friedman et al., 1993; Turiano et al., 2012). However, little is known about how risk and protective factors of functioning actually relate to levels and changes in personality traits late in life. Based on life-span theoretical notions, we expect risk and protective factors of functioning to evince trait-specific associations late in life. First, we expect that the general tendency of increase in neuroticism in the oldest old mirrors the availability of fewer resources late in life, specifically in health and perceived control. Second, more functional limitations, less perceived control, and being less socially active might take a toll on the sociable and assertive part of a person and thus relate to a decrease of extraversion. Finally, low performance on the perceptual speed measure, less perceived control, and reduced feelings of social inclusion are each expected to relate to a decline in openness to experiences. With respect to possible moderator effects of age versus mortality, we think that our analyses are highly exploratory. However, because health and cognitive performance often evince steep declines close to death (Gerstorf & Ram, 2013), these factors may be key predictors of late-life personality trait development. Importantly, our study estimates effects of all of these covariates in one conjoint model, testing the unique effect over and above the other resources.

The Present Study

The current research investigated change trajectories of three personality characteristics—neuroticism, extraversion, and openness to experiences—in old and very old age and the last years of life using multiwave longitudinal data obtained over up to 13 years. We pursued two specific aims: First, intraindividual change trajectories of personality traits were modeled as within-person processes unfolding with respect to time in study (time as process), with between-person differences in two time-related resources—(a) chronological age and (b) time to death—serving as moderators of within-person change (see Ram, Gerstorf, Fauth, Zarit, & Malmberg, 2010). We hypothesized that neuroticism would, on average, increase across time in this very old sample and that the extent of those changes would be linked with chronological age and time to death. In complement, both extraversion and openness to experiences were expected to decrease across time, with older age and closer proximity to death being associated with lower levels and steeper declines. Second, we examined how interindividual differences in intraindividual change of personality traits were related to four different aspects of individuals' functioning: physical health, cognitive performance, perceived control, and social inclusion. Finally, in exploratory analyses, we tested whether associations were moderated by age or proximity to death. To address these research questions, we applied growth models to data obtained from 463 deceased participants of the BASE study.

Method

This report is based on five waves of data obtained from now-deceased participants of the interdisciplinary BASE sample. Most of the variables used in this study have been extensively introduced in earlier publications (Baltes & Mayer, 1999; Smith & Delius, 2003). Below, we provide details relevant for the current analysis.

Participants and Procedure

At baseline in 1990, the BASE sample comprised 516 participants stratified by age and gender into six age brackets (70–74 years, 75–79 years, 80–84 years, 85–89 years, 90–94 years, and 95+ years; age: $M = 84.92$, $SD = 8.66$, range = 70–103). Based on updates in city registries, 89.7% or $n = 463$ of the original participants were known to have died by October 2012 (age at death $M = 91.9$, $SD = 7.0$). This sample of decedents used in the present analysis were, on average, aged 85.9 years ($SD = 8.4$, 51% men), and about 29% were married.

For the following analyses, we use up to five waves of personality data collected over up to 13 years. As is common for longitudinal studies of very old individuals, sample attrition was sizable and primarily due to mortality. Personality was first assessed at baseline (Time 1, between 1990 and 1993), with all $n = 463$ individuals providing data. Personality was next assessed at Time 3 with $n = 173$ (1995–1996) of these individuals providing data. Assessments continued at Time 4 in 1997–1998 with $n = 105$, at Time 5 in 2000 with $n = 59$, and at Time 6 in 2004–2005 with $n = 26$. Personality traits were not assessed at Time 2 (see Appendix Table A2). On average, participants contributed about two waves of personality data ($M = 1.92$, $SD = 1.24$). We quantified the longitudinal selectivity by describing how individuals who survived and participated longitudinally in three and more waves ($n = 164$) differed from the original BASE sample at T1 ($n = 516$; for details, see Lindenberger, Singer, & Baltes, 2002). This comparison of selectivity showed that participants who provided longitudinal data were slightly less neurotic ($d = -0.11$), more extraverted ($d = 0.20$), and more open ($d = 0.31$) than the average T1 participant. In addition, there were slightly more women than men in this group ($d = -0.10$), and at baseline the longitudinal participants were younger ($d = -0.74$), more educated ($d = 0.16$), had fewer diagnosed chronic illnesses ($d = -0.31$), reported fewer disabilities ($d = -0.14$), performed better on cognitive tests ($d = 0.62$), did not differ in perceived self-control ($d = -0.04$), felt less controlled by others ($d = -0.36$), and were more socially active ($d = 0.65$) and less lonely ($d = -0.24$). This pattern of selectivity indicates that participants who provided the most change (i.e., longitudinal) information represent a positively selected subset of the initial sample.

Measures

Personality traits. Neuroticism, extraversion, and openness to experience were assessed using the NEO Personality Inventory

(Costa & McCrae, 1985), with six items used to measure each of the personality traits (example item for neuroticism: "I rarely feel fearful or anxious"; example item for extraversion: "I like to be where the action is"; example item for openness: "I have a lot of intellectual curiosity"; for the entire included questionnaire, see Appendix Table A1; cf. Lieβmann, 2004). Participants rated the degree to which the items described themselves on a 5-point Likert scale ranging from 1 (*almost always true*) to 5 (*never true*). Means were calculated for each of the personality trait scales and then converted to *T* scores using the T1 ($N = 516$) sample of the BASE study. Freund and Smith (1999) illustrated high test–retest reliability across an 8-week time span ($r_N = .87$, $r_E = .87$, $r_E = .77$). The reliability of all three traits was acceptable or found to be along the bottom line of acceptable (Cronbach's α_N ranged from .68 to .79 across waves; α_E from .57 to .69; α_O from .54 to .67). Further details on measurement properties can be found in Smith and Baltes (1999). Descriptive statistics and correlations of all available measurement points can be found in Appendix Table A2.

Time metrics. Making use of both the longitudinal and cross-sectional dimensions of the study design, time was used in two ways—as a marker of the within-person developmental process and as a marker of between-person differences in time-related resources (Ram et al., 2010).

Within person: time as process. At the within-person level, time serves as a proxy for the developmental process. As such, intraindividual development of personality is modeled as changes that accrue over 13 years of time in study ($M = 2.88$ years, $SD = 3.86$, range = 0–13), with $time_{ti}$ centered at the middle of each person's repeated measures (cf. Hülür, Hertzog, Pearman, Ram, & Gerstorf, 2014; Wagner et al., 2015). This enables interpretation of parameters and between-person differences with respect to the average very old individual in the sample, as described above, and more robust estimation in the data midpoint.

Between person: time as resource. At the between-person level, time serves as a proxy for individual differences in resources that accrue and/or are spent across the life span (Heirich, 1964). Following life-span literature emphasizing that changes and differences among the very old reflect a combination of age-related and mortality-related processes, Ram and colleagues (2010) demonstrated the use of chronological age and time to death as variables that provide for examination of cross-sectional, developmental differences in intraindividual change. Accordingly, chronological age described the distance between day of birth and the respective measurement point, whereas time to death described the distance between the respective measurement point and the day of death. With death being an approaching future event, time to death is represented as a negative difference. In the present study, we use cross-sectional differences in both age and time to death to examine systematic differences in personality changes that may be related to position in the life span. For convenience of interpretation of parameters with respect to the average very old person in the sample, person-level, time-as-resource variables were centered at sample means ($M_{age} = 85.87$; $M_{ttd} = -5.97$).

Correlates. Interindividual differences in intraindividual change of personality were also examined in relation to time-invariant differences in four aspects of individual functioning—health, cognitive performance, perceived control, and social inclusion—and controlling for a set of demographic characteristics, including gender, marital status (married vs. not married), and years of education.

Health was measured using one objective health indicator and one functional health indicator. As an objective health index, *comorbidities* were assessed as the number of current physician-observed diagnoses (based on a clinical observation and blood and saliva laboratory assessments) of moderate to severe chronic illnesses (for details, see Steinhagen-Thiessen & Borchelt, 1999). As a functional health index, *disability* was measured as whether or not the participant reported needing help in carrying out basic activities of daily living (e.g., getting up, getting dressed, eating; see Lawton & Brody, 1969) at any time throughout the course of the study.

Cognitive performance was operationally defined by processing speed, as assessed with the Digit Letter Test (for details, see Lindenberger & Baltes, 1997). Similar to the Digit Symbol Substitution Test (Wechsler, 1981), participants had to substitute letters corresponding to digits from 1 to 9 as rapidly as possible into a randomly ordered array. Performance was scored as the number of correct responses in 3 min ($\alpha = .96$).

Perceived control was operationally defined by two indicators of *personal control* and *others' control*. The assessment included seven items: three items measuring personal control (e.g., "I can make sure that good things come my way") and four items measuring perceived others' control (e.g., "The good things in my life are determined by other people"). Participants used a 5-point Likert scale ranging from 1 (*does not apply to me at all*) to 5 (*applies very well to me*; for details, see Gerstorf & Ram, 2013; Kunzmann, Little, & Smith, 2002). Thus, higher scores indicate perceiving more personal control and more control through others (Cronbach's $\alpha_{Personal} = .64$; $\alpha_{Others} = .78$), respectively.

Social inclusion was measured in two ways. *Social participation* was assessed using a combination of items from multiple scales. The Yesterday Interview (Moss & Lawton, 1982) measured the type, frequency, and duration of social activities, and the Activity List (Mayer, Maas, & Wagner, 1999) assessed social activities outside the residence of participants. To create a global measure of social participation, the two instruments were then combined into a unit-weight composite (see Lövdén, Ghisletta, & Lindenberger, 2005, for more detailed descriptions). *Loneliness* was assessed using four items from the University of California Los Angeles Loneliness Scale (Russell, Cutrona, Rose, & Yurko, 1984; e.g., "I feel isolated from others"). Participants were asked to indicate how well these items described them based on a 5-point Likert scale labeled as 1 (*does not apply to me at all*) to 5 (*applies very well to me*; $\alpha = .70$).

As per usual BASE protocol, the variables were rescaled into a *T* metric ($M = 50$, $SD = 10$) based on the $N = 516$ T1 sample. Descriptive statistics and intercorrelations of all variables at T1 are presented in Appendix Table A3.

Data Preparation and Statistical Procedure

We estimated separate multilevel and latent growth models for each of the three personality traits, with age and time to death as between-person moderators of intraindividual change (Ram & Grimm, 2015; Raudenbush & Bryk, 2002; Singer & Willett, 2003). Models were specified in the following form. At the within-person level (Level 1),

$$neuroticism_{ti} = \beta_{0i} + \beta_{1i}(time_{ti}) + e_{ti}, \quad (1)$$

where person i's neuroticism score at time t, $neuroticism_{ti}$, is modeled as a function of an individual-specific intercept coefficient, β_{0i}; an individual-specific linear slope coefficient, β_{1i}, that indicates the linear rates of change per year of time in the study; and residual error, e_{ti}. At the between-person level (Level 2), individual differences in the intercept, β_{0i}, and linear slope, β_{1i}, were modeled as

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(age_i) + \gamma_{02}(time\ to\ death_i) + u_{0i}, \text{ and} \quad (2)$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(age_i) + \gamma_{12}(time\ to\ death_i) + u_{1i}, \quad (3)$$

where γ_{00} and γ_{10} indicate the expected intercept and the linear slope across time in the study for the prototypical person in the study, respectively; γ_{01} and γ_{11} (or γ_{02} and γ_{12}) reflect sample-level associations of between-person differences of age (or time to death) and differences in person-specific intercepts and linear rates of change, respectively; and u_{0i} and u_{1i} are individual deviations unrelated to age and time to death that are assumed to be multivariate normally distributed, correlated with each other, and uncorrelated with residual errors, e_{ti}. As might be expected given the sparsity of repeated measures, quadratic slopes, as well as Age × Time To Death interactions, were not reliably different from zero and were thus not included in the final models.

Finally, we included the health, cognitive performance, perceived control, and social resource and risk factors as additional Level 2 predictors of between-person differences in personality level, β_{0i}, and rates of change, β_{1i}. All correlates were grand mean centered such that regression parameters indicated the average trajectory (across all individuals). In addition, to examine the moderating effect of age and time to death, we tested all possible interaction effects in both Level 2 equations. The final model included only those age and time-to-death interaction effects that were significant at $p < .05$. We note that our data distribution is particularly sparse for people in their early 70s and for those aged 95 and older and thus caution against overinterpreting moderation effects outside the ages of 75 to 95. All models were fit to the data using SAS (Proc Mixed; Littell, Miliken, Stoup, & Wolfinger, 1996), with incomplete data treated using usual missing at random assumptions.

Results

As a precondition for further analyses, we estimated three unconditional models to differentiate the proportion of between-person and within-person variability in all three personality traits. These models showed that the intraclass correlation (as a measure for the ratio of between-person and within-person variance; Raudenbush & Bryk, 2002) was .69, .69, and .65 for neuroticism, extraversion, and openness, respectively, suggesting that 69% of the total variance in neuroticism, 69% in extraversion, and 65% in openness was between-person variance and the remainder (31%, 31%, and 35%) was within-person variance (or measurement error). With substantial variance at both the within-person and between-person levels, we proceeded to model interindividual differences in intraindividual personality trait change.

Personality Trait Development Late in Life

Within-person change in personality traits. The left-hand side of Table 1 summarizes the three growth models of personality trait development. General change trajectories across time supported our expectations that the prototypical very old adult would exhibit an increase in neuroticism across time ($\gamma_{10} = 0.30$, $p = .002$), a decrease of extraversion ($\gamma_{10} = -0.46$, $p < .001$), and a decrease in openness to experiences ($\gamma_{10} = -0.48$, $p < .001$).

Between-person differences in personality trait change by age and time to death. The right-hand side of Table 1 summarizes the three multilevel growth models of personality traits with chronological age and time to death as moderators of intercept and time slope. Above and beyond the general tendency of change, time to death was related to the rate of change in neuroticism ($\gamma_{12} = 0.07$, $p = .045$). Thus, with closer proximity to death, people showed steeper increases in neuroticism (Figure 1a). There was no age moderation of the level or time slope of neuroticism. In contrast, age was related to the level of extraversion ($\gamma_{01} = -0.21$, $p = .001$) and openness ($\gamma_{01} = -0.15$, $p = .019$) but not to the rate of change in either extraversion or openness (Figures 1b and 1c). This means that being older at the data midpoint was related to lower extraversion and lower openness, but the steepness of change in both traits was unrelated to the participant's chronological age. Neither intercept nor slope of extraversion and openness was moderated by time to death.

Age and time-to-death selection effects. We tested age selectivity by estimating the differences of between-person and within-person age effects (Sliwinski, Hoffman, & Hofer, 2010) to see if within-person age effects are the same as between-person age effects. To do so, we included individual age as a within-person change variable and as a between-person variable. Based on these formal tests, selectivity was not reliably different from zero for neuroticism ($b = -0.13$, $p = .167$), but selectivity was operating on extraversion ($b = 0.27$, $p = .005$) and openness ($b = 0.27$, $p = .006$). Thus, the substantial effect of the between-person age variable shows that older participants have substantially higher levels of extraversion and openness than would be expected based on the change trajectories of their younger peers. This pattern underscores the positive selection of the longitudinal sample already reported in the Method section.

Similar to the age model, we applied the formal test of selectivity regarding time-to-death effects (Sliwinski et al., 2010). Again, these models included time to death as a within-person predictor as well as a between-person variable. In these models, the differences of between-person and within-person time-to-death effects were not reliably different from zero for neuroticism ($b = -0.04$, $p = .795$) or openness ($b = 0.24$, $p = .122$). However, the within-person changes and between-person differences in extraversion were not congruent ($b = 0.32$, $p = .038$), indicating a positive selection of the sample with respect to this personality trait. We will return to this point in the Discussion section.

The Role of Resources and Risk Factors for Personality Trait Development Late in Life

Tables 2, 3, and 4 show results from models where the changes in neuroticism, extraversion, and openness to experiences, respectively, are conditioned on demographic characteristics; four areas of functioning (health, cognitive performance, perceived control, and social inclusion); and both chronological age and time to death (with nonsignificant interactions trimmed). Notably, including all correlates into the age- and time-to-death-moderated models revealed that neither the effect of time to death on the linear slope of neuroticism nor

Table 1
Growth Model of Personality Change Over Time in Study and Moderation by Chronological Age and Time to Death

	Change by time in study						Moderation by age and time to death					
	Neuroticism		Extraversion		Openness		Neuroticism		Extraversion		Openness	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Fixed effects												
Intercept γ_{00}	50.47	[49.6, 51.3]	49.06	[48.2, 49.9]	48.95	[48.1, 49.8]	50.27	[49.4, 51.2]	49.28	[48.4, 50.2]	49.17	[48.3, 50.1]
Age γ_{01}							0.07	[−0.06, 0.19]	−0.21*	[−0.34, −0.09]	−0.15*	[−0.28, −0.03]
Time to death γ_{02}							0.12	[−0.17, 0.40]	0.06	[−0.22, 0.35]	−0.03	[−0.32, 0.25]
Time slope γ_{10}	0.30*	[0.11, 0.48]	−0.46*	[−0.61, −0.30]	−0.48*	[−0.65, −0.31]	0.44*	[0.23, 0.65]	−0.43*	[−0.63, −0.23]	−0.47*	[−0.68, −0.26]
Age γ_{11}							0.03	[−0.01, 0.06]	−0.01	[−0.04, 0.02]	−0.01	[−0.04, 0.02]
Time to death γ_{12}							0.07*	[0.00, 0.13]	0.02	[−0.04, 0.08]	−0.00	[−0.06, 0.06]
	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Random effects												
Intercept	73.81*	6.43	73.90*	6.50	71.23*	6.55	73.56*	6.41	71.28*	6.35	69.82*	6.46
Linear slope	0.47*	0.23	0.10	0.12	0.18	0.14	0.43*	0.21	0.10	0.12	0.18	0.14
Intercept, linear slope	1.62	1.04	0.42	0.79	2.01*	0.90	1.32	1.03	0.36	0.79	1.95*	0.89
Residual	23.69*	2.64	27.53*	2.51	30.42*	2.74	23.54*	2.54	27.58*	2.52	30.41*	2.74
Model fit												
AIC	5,843		5,867		5,901		5,850		5,863		5,902	

Note. CI = confidence interval; AIC = Akakie Information Criteria. Unstandardized estimates and 95% CIs (in brackets) are presented for fixed effects. Age and time to death centered at sample means of 85.88 years and 5.97 years, respectively. $N = 463$ participants provided 826 observations ($M = 1.92$, $SD = 1.24$). *T* scores standardized to cross-sectional Berlin Aging Study sample at Time 1 ($N = 516$, $M = 50$, $SD = 10$).
* $p < .05$.

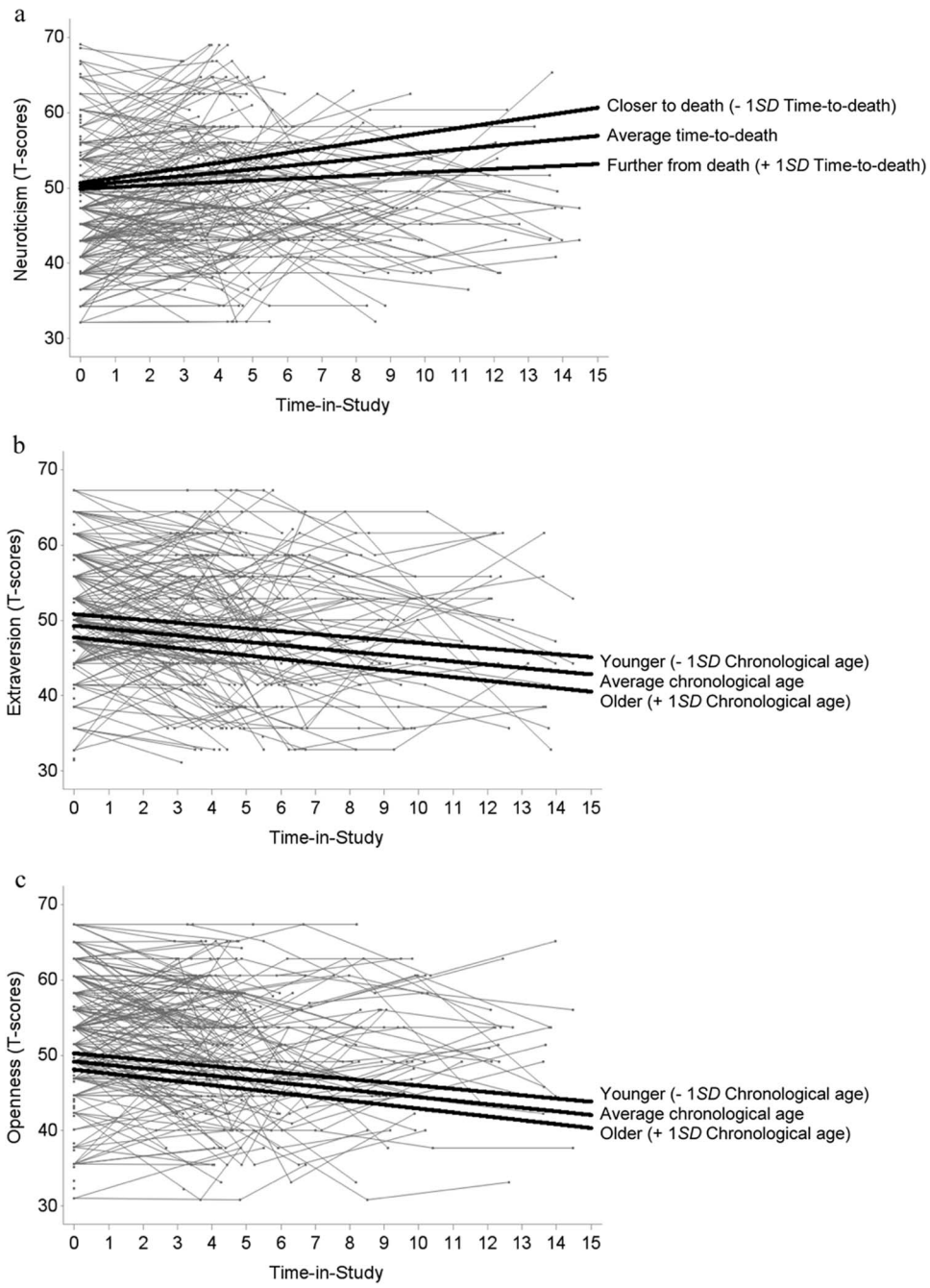

Figure 1. Average trajectories and raw data of the three personality traits neuroticism (a), extraversion (b), and openness (c) over time in study. Neuroticism, on average, increases, particularly for those with closer proximity to death (about 0.3 *SD* in the last 10 years). In contrast, extraversion and openness, on average, decline (about −0.5 *SD* in the last 10 years).

the age effects on the intercepts of extraversion or openness remained substantial.

Physical health. Unexpectedly, results did not support associations between either the physician-diagnosed or subjective health indicators and neuroticism trajectories ($\gamma_{16} = 0.01$, $p = .503$; $\gamma_{17} = 0.09$, $p = .669$). Yet, more self-reported disabilities related to steeper declines in extraversion ($\gamma_{17} = -0.40$, $p = .020$) and in openness to experiences ($\gamma_{17} = -0.83$, $p = .001$). Finally, we found two moderation effects for health. First, associations between the number of comorbidities and rates of change in extraversion were moderated by age ($\gamma_{113} = -0.004$, $p = .012$). To better understand this associations, we probed the interaction using the Johnson–Neyman region of significance method (Johnson & Neyman, 1936; Preacher, Curran, & Bauer, 2006). Specifically, this technique is used to identify the range

Table 2
Conditional Growth Model of Neuroticism Over Time

	Neuroticism			
	Intercept		Linear time slope	
	Estimate	95% CI	Estimate	95% CI
Fixed effects				
	50.69*	[49.9, 51.5]	0.42*	[0.14, 0.70]
Age	−0.12*	[−0.24, −0.002]	0.03	[−0.01, 0.07]
Time to death	0.03	[−0.23, 0.28]	0.07	[−0.001, 0.14]
Men	−2.33*	[−4.11, −0.55]	0.30	[−0.20, 0.80]
Married	0.99	[−0.98, 2.96]	−0.02	[−0.53, 0.48]
Education	−0.04	[−0.12, 0.04]	0.00	[−0.02, 0.02]
Physical health				
Comorbidities	0.07	[−0.01, 0.15]	0.01	[−0.02, 0.03]
Disabilities	0.73	[−0.91, 2.37]	0.09	[−0.33, 0.51]
Cognitive performance				
Digit Symbol Substitution Test	0.05	[−0.05, 0.14]	0.01	[−0.02, 0.03]
Perceived control				
Personal control	0.03	[−0.05, 0.10]	0.00	[−0.02, 0.02]
Others' control	0.14*	[0.06, 0.22]	−0.02*	[−0.04, −0.001]
Social inclusion				
Social participation	−0.05	[−0.15, 0.05]	−0.02	[−0.04, 0.01]
Loneliness	0.42*	[0.33, 0.51]	−0.02	[−0.04, 0.01]
Moderation				
Time To Death × Loneliness	0.03*	[0.01, 0.06]		
Random effects				
Variance	41.55*	4.36	0.39*	0.19
Covariance	1.74*	0.75		
Residual	22.67*	2.39		
Model fit				
AIC	5,369			

Note. CI = confidence interval; AIC = Akakie Information Criteria. Unstandardized estimates are presented.
* $p < .05$.

(or region) of the moderator variable with which the focal predictor and outcome variables were significantly associated. Accordingly, we identified the age range for which a substantial association between the number of comorbidities and change in extraversion is to be expected. The probing suggested that a higher number of physician-assessed comorbidities related to stronger decreases in extraversion at ages 83 years and older. For younger participants (<83 years), the number of comorbidities was not associated with rates of change in extraversion. However, this effect was very small and should be regarded with caution. Second, time to death moderated the association between self-reported disabilities and rates of change in openness. With approaching death, more disabilities related to an accelerated decline in openness ($\gamma_{113} = -0.20$, $p = .002$). Johnson–Neyman probing suggested that this negative association is present only within the last 7 years of life.

Cognitive performance. As expected, results showed that higher cognitive performance abilities related to higher levels of openness ($\gamma_{08} = 0.14$, $p = .011$). Unexpectedly, cognitive performance was not associated to rates of change in openness. However, we found an unexpected negative relation between cognitive performance abilities and the linear slope of extraversion ($\gamma_{18} = -0.03$, $p = .008$). Region of significance analyses (Johnson & Neyman, 1936; Preacher et al., 2006) showed that lower cognitive performance (−1 *SD*) was unrelated to the change in extraversion. However, individuals with higher levels of cognitive performance had steeper decreases in extraversion. We will address this unexpected finding in the Discussion.

Perceived control. Results of the conditional models consistently revealed that higher personal control related to higher extraversion ($\gamma_{09} = 0.33$, $p < .0001$) and higher openness ($\gamma_{09} = 0.13$, $p = .004$). In contrast, individuals who perceived higher control by others consistently showed higher levels of neuroticism ($\gamma_{010} = 0.14$, $p = .001$). Unexpectedly, we found that more perceived others' control also related to higher levels of openness starting at about seven years prior to death ($\gamma_{014} = 0.03$, $p = .048$). However, again, this effect is small and needs to be considered with caution.

Social inclusion. Living a socially active life was related to higher extraversion and higher openness. Furthermore, those who reported feeling less lonely were more extraverted and less neurotic. Additionally, the association between loneliness and neuroticism was moderated by time to death. Lonely individuals reported higher levels of neuroticism when they were closer to death ($\gamma_{014} = 0.03$, $p = .007$; cf. Figure 2). Applying the Johnson–Neyman technique showed that the mortality moderation held for participants starting at 13 years prior to death and closer.

Discussion

The current study modeled personality trait development at the end of life and examined how individual differences in personality trait change are related to individual differences in four resource and risk factors. Four major results emerged: First, neuroticism, on average, increases in very old age (about 0.3 *SD* in the last 10 years), particularly at the end of life. Second, extraversion and

Table 3
Conditional Growth Model of Extraversion Over Time

	Extraversion			
	Intercept		Linear time slope	
	Estimate	95% CI	Estimate	95% CI
Fixed effects				
	48.82*	[47.9, 49.7]	−0.30*	[−0.55, −0.04]
Age	−0.10	[−0.23, 0.04]	−0.02	[−0.05, 0.02]
Time to death	0.21	[−0.06, 0.49]	−0.01	[−0.07, 0.05]
Men	0.25	[−1.74, 2.24]	−0.38	[−0.81, 0.05]
Married	−0.97	[−3.18, 1.24]	0.33	[−0.10, 0.75]
Education	0.03	[−0.06, 0.12]	0.01	[−0.01, 0.02]
Physical health				
Comorbidities	0.02	[−0.07, 0.10]	−0.01	[−0.03, 0.01]
Disabilities	1.44	[−0.40, 3.27]	−0.40*	[−0.74, −0.06]
Cognitive performance				
Digit Symbol Substitution Test	0.06	[−0.05, 0.16]	−0.03*	[−0.05, −0.01]
Perceived control				
Personal control	0.33*	[0.24, 0.41]	−0.00	[−0.02, 0.01]
Others' control	0.07	[−0.02, 0.16]	0.01	[−0.01, 0.03]
Social inclusion				
Social participation	0.22*	[0.11, 0.33]	−0.00	[−0.03, 0.02]
Loneliness	−0.15*	[−0.24, −0.05]	0.00	[−0.02, 0.02]
Moderation				
Age × Comorbidities	0.00	[−0.01, 0.01]	−0.004*	[−0.008, −0.001]
Random effects				
Variance	53.75*	5.19	0.00	0.00
Covariance	0.52	0.65		
Residual	26.59*	2.00		
Model fit				
AIC	5,472			

Note. CI = confidence interval; AIC = Akakie Information Criteria. Unstandardized estimates are presented.
* $p < .05$.

openness decline rather steadily with advancing age and approaching death (about −0.5 *SD* in the last 10 years), with older participants reporting lower levels of extraversion and openness. Third, intriguingly, health constraints were related to steeper declines in extraversion and openness but not neuroticism. Cognitive performance revealed the expected positive association with levels of openness but, unexpectedly, not with its rates of change. Fourth, personal control and perceived others' control showed the expected associations with all three personality traits. Similarly, being socially active and/or feeling less lonely appeared to be consistent sources of lower levels of neuroticism and higher levels of extraversion and openness in very old age. These findings further our understanding of late-life personality development and suggest potential pathways by which personal resources affect individual differences in personality trait development late in life.

Personality Trait Development Late in Life

The current study contributes to the existing considerations of personality trait development until late in life (Lucas & Donnellan, 2011; Roberts & DelVecchio, 2000; Roberts et al., 2006; Staudinger & Kunzmann, 2005). Our results are in line with conceptual notions and empirical evidence that personality traits change across adulthood and that patterns of change differ across personality traits. Our study extends previous findings by examining personality trait change in very old age and at the very end of life. Corroborating and extending earlier reports (Kandler et al., 2015; Lucas & Donnellan, 2011), we found that mean levels of extraversion and openness are lower at older ages. Thus, our results for these two traits suggest that trends of decline observed earlier in adulthood generalize into late life. Interestingly, general trends of mean-level increases in neuroticism across time were not affected by chronological age in our sample.

There is a solid body of empirical evidence suggesting that processes related to pathology and mortality shape developmental trajectories across a myriad of functional domains (Bäckman & MacDonald, 2006; Gerstorf & Ram, 2013). To the best of our knowledge, our study is the first to model mortality-related development in personality traits; that is, mean-level trajectories being moderated by proximity to death. Our results showed that being closer to death was related to stronger increases in neuroticism. In contrast, levels and rates of decline in extraversion and openness were unaffected by proximity to death. In our view, these findings converge with previous reports in the literature and suggest that the maturation of neuroticism (i.e., decreases across the adult life) comes to an end by late life (Mroczek & Spiro, 2003). That is, across adulthood, neuroticism shows a steady mean-level decrease but appears to increase again late in life and specifically with approaching death.

Such results inform our knowledge about personality trait development in at least two important ways: First, across these three selected personality traits, developmental processes late in life appear to differ not only with respect to mean levels and rank-

Table 4
Conditional Growth Model of Openness Over Time

	Openness			
	Intercept		Linear time slope	
	Estimate	95% CI	Estimate	95% CI
Fixed effects				
	48.41*	[47.5, 49.3]	−0.35*	[−0.62, −0.08]
Age	0.04	[−0.10, 0.18]	0.02	[−0.02, 0.05]
Time to death	0.23	[−0.06, 0.52]	−0.03	[−0.10, 0.03]
Men	1.05	[−0.99, 3.09]	0.15	[−0.32, 0.62]
Married	−0.57	[−2.82, 1.69]	0.13	[−0.34, 0.59]
Education	0.13*	[0.04, 0.22]	0.01	[−0.01, 0.02]
Physical health				
Comorbidities	0.01	[−0.08, 0.10]	0.00	[−9.02, 0.03]
Disabilities	0.24	[−1.69, 2.16]	−0.83*	[−1.31, −0.34]
Cognitive performance				
Digit Symbol Substitution Test	0.14*	[0.03, 0.25]	−0.01	[−0.03, 0.02]
Perceived control				
Personal control	0.13*	[0.04, 0.21]	0.00	[−0.02, 0.02]
Others' control	0.01	[−0.09, 0.10]	0.01	[−0.02, 0.03]
Social inclusion				
Social participation	0.21*	[0.10, 0.32]	0.00	[−0.03, 0.03]
Loneliness	−0.05	[−0.15, 0.05]	0.01	[−0.01, 0.03]
Moderation				
Time To Death × Others' Control	0.03*	[0.0003, 0.05]		
Time To Death × Disability	0.04	[−0.48, 0.56]	−0.20*	[−0.32, −0.07]
Random effects				
Variance	56.01*	5.56	0.10	0.10
Covariance	1.10	0.76		
Residual	27.77*	2.47		
Model fit				
AIC	5,523			

Note. CI = confidence interval; AIC = Akakie Information Criteria. Unstandardized estimates are presented.
* $p < .05$.

order stability coefficients (Lucas & Donnellan, 2011) but also with respect to their vulnerability to mortality-related processes. With approaching death, not only decreases in the area of physical functioning and cognitive performance show but also neuroticism appears to be affected by mortality-related processes. Possibly, being closer to death accelerates feelings and expectations of anxiety such as fear of falling or concern for severe health limitations. This change in thinking and feelings possibly leads to an increase of trait neuroticism. In contrast, levels and trajectories of neither extraversion nor openness were affected by proximity to death. This suggests that development of both of these personality traits is not associated to mortality-related processes.

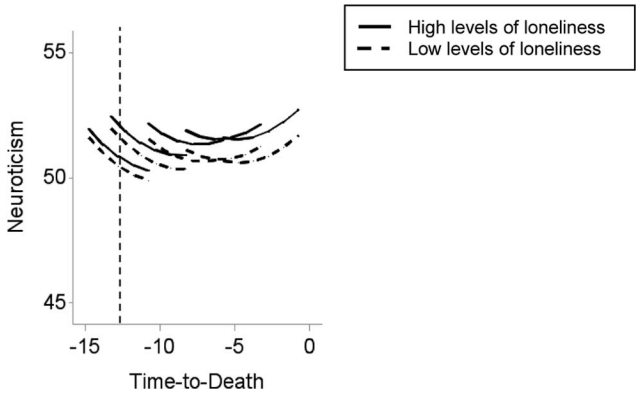

Figure 2. Average trajectories of neuroticism mean-level increase over time to death (for 5-year bins of time to death) are moderated by emotional loneliness. Lower levels of loneliness (−1 *SD*) relate to lower neuroticism approximately starting thirteen years prior to death. *Note*. The dashed vertical line indicates the region of significance for the moderation effect (to the right).

Second, the effect of time to death on neuroticism development, although significant, was relatively small. This result of small or no effects of time to death sets personality traits apart from most previous studies in this field with strong effects of mortality on other variables of psychological functioning (Gerstorf & Ram, 2013). However, these findings for personality traits resemble initial findings on self-esteem development (Wagner et al., 2013, 2015), where we also found no or only small effects on mean-level change trajectories. What sets these variables apart? One possible explanation may be that mortality-related processes are simply unable to notably affect the relatively stable basic building blocks of human thinking, feeling, and behaving. The often gradual decline with approaching death late in life may exercise a less profound effect on personality traits compared with the effects on less trait-like variables such as affect or well-being. In contrast, gradual decline may instead trigger adaptive developmental processes that are more likely linked to specific resources and risk

factors but not to mortality-related processes per se. More research is clearly needed to understand these interdependencies. One possible route of such research may be to explore sources of variability and change in daily ways of thinking and behaving (see Hutteman, Nestler, Wagner, Egloff, & Back, 2015, for an empirical example in adolescence). For example, Hutteman and colleagues (2015) found that, in adolescence, changes in trait self-esteem related to changes in state self-esteem. Such changes in state self-esteem were reciprocally related to social inclusion. Similarly, it is suggested that personality developmental processes occur in the context of repeated short-term, situational processes (Wrzus & Roberts, 2015). Thus, changes in daily health-related or social loss triggers, for example, could manifest in long-term personality development. Further research is clearly needed to address this topic empirically (see also Limitations and Outlook).

As an additional side note: Our analyses only focused on mean-level changes. In addition, rank-order stabilities are an important part of understanding development (Hertzog & Nesselroade, 1987). In our study, substantial mortality-related dropout characterized later measurement points, and thus the much smaller sample size may not be very informative as comparison with earlier measurement points. Previous studies showed increasing instability with respect to extraversion and neuroticism after the age of 70 (Lucas & Donnellan, 2011). Further studies with participants in later life are needed to also understand this important characteristic with approaching death.

The Role of Resources and Risk Factors for Personality Trait Development Late in Life

In addition to age and time to death, our set of final models addressed interindividual differences in personality trait level and change associated with four resource and risk factors. Our findings both corroborate and extend previous results. First, health showed the expected negative association with rates of change in extraversion and openness but did not show the expected relationship with neuroticism. More self-reported disabilities late in life related to steeper decreases in extraversion and openness. Two interesting aspects additionally characterize these findings: First, not the physician-assessed comorbidity indicator but the subjective report of number of disabilities showed associations with rates of change. This supports previous research that also found self-perceived health to be related to self-reported change in personality traits (Sutin et al., 2013; Takahashi et al., 2013). The only exception was the age-moderated effect on extraversion rates of change. This suggests that physician-diagnosed health issues might accelerate the decrease of extraversion by about age 83 and beyond. Second, health was one of the very few risk factors related to the rates of change in personality and not only the levels. Thus, it appears that increasing functional limitations account for profound decreases in extraversion and openness. With respect to the second trait, this negative effect even increased with approaching death. This may support our earlier argument that it is not mortality processes per se that affect extraversion and openness but, rather, decreasing resources in health. Together, these mixed findings are consistent with recent reports from a Swedish study of the oldest old that also found that functional capacity and self-reported health were unrelated to changes in extraversion and neuroticism (Berg & Johansson, 2014). More research is clearly needed to understand the complex associations between health and personality development late in life.

Second, as expected, cognitive performance was related to higher levels of openness. Unexpectedly, rates of change in extraversion were also substantially steeper for those with average and higher cognitive performance late in life. What could be the possible reasons for such findings? Previous research suggested that associations between extraversion and cognitive performance differ depending on objective versus subjective measures (Berg & Johansson, 2014; Luchetti, Terracciano, Stephan, & Sutin, 2015). For example, Luchetti and colleagues (2015) also found higher extraversion to be related to lower cognitive performance. In addition, their study illustrated that more extraverted individuals were more likely to report higher self-rated memory, which is contrary to their actual cognitive performance. Because we only assessed cognitive performance, models in the present study were restricted to this factor. Future studies are needed to test the interdependency of extraversion with diverse measures of cognitive performance late in life. Whereas openness and extraversion were related to cognitive performance, we found no relationship with neuroticism. This finding is contrary to previous studies that suggested that mean-level consistency in neuroticism was related to better cognitive performance (Graham & Lachman, 2012). Looking at the zero-order correlation (Appendix Table A3), neuroticism and cognitive performance illustrated the expected substantial negative association. However, this association was not substantial in the conditional model including all covariates. This may suggest that, over and above the substantial effect of perceived others' control and loneliness, cognitive performance explained no additional variance in level and change in neuroticism in the very old. Our results with respect to neuroticism suggest that in combination with other resource and risk factors, cognitive performance may not be the only or most important resource of developmental trajectories for all personality traits.

Third, findings support the view that perceived control is an important resource of personality trait development (Lachman, 2006). Associations were found for all three traits. Differences in associations with perceived personal control and perceived others' control extend previous findings (Kandler et al., 2015) and are in accord with extant proposals about resources and risk factors of development. As described by Kunzmann and colleagues (2002), for example, control may be regarded as having two faces: On the one hand, it can play out as a pivotal resource of development as in perceived personal control. On the other hand, perceptions of others' control have to be regarded as a risk factor. That may be particularly the case late in life when people are faced with general declines of personal control (Heckhausen, Wrosch, & Schulz, 2010). At the same time, perceived others' control has been regarded as a potential resource late in life when individuals may need assistance and support from others in order to continue to live in the community and/or deal with activities of daily life (Baltes, 1996). In this context, perceptions of supportive control by others may actually be something positive. Our finding regarding openness illustrates such effects: When approaching death, perceived others' control was increasingly associated with higher levels of openness. With the burdens and challenges that often occur with end-of-life dynamics, the connotations of typical resources and risk factors may change. In particular, perceptions of being controlled by other people may, at that point in life, mimic an available support

network as well as the individual ability to actually use and accept the help of this network (see also Johnson & Barer, 1997).

This directly takes us to the fourth and also very consistent resource for late-life personality trait development. Living a socially active or engaged life related to higher levels of extraversion and openness. Plus, individuals who felt less lonely were more extraverted and less neurotic. This second association even increased with age. Despite having smaller social networks in old age (Wrzus et al., 2013), the emotional meaning of social inclusion is not smaller but simply fulfilled by fewer but emotionally closer social relationship partners (Charles & Carstensen, 2010; Lang, Wagner, Wrzus, & Neyer, 2013). Becoming older reduces resources, and this is also true with respect to social activities and social contacts. However, those who remain at a certain level of activity and stay socially engaged show substantially more beneficial personality trait levels and slopes. To follow up on this, late-life personality research might be informed by recent developments in the field of personality and social relationship transaction (Back et al., 2011) and proposals about vulnerability in later life. Both theoretical and empirical results support a strong interdependency of the development of personality and social relationships in the first half of life. Based on more fine-grained data that allow more process-oriented research, we may take further important steps in understanding this dynamic association late in life. We would expect that the inclusion of social behaviors and interpersonal perceptions into late-life studies could shed new light on which types of interactions (e.g., daily or one time) or interaction partners (e.g., spouse, friend, stranger) are actually able to impact the development of personality traits.

Importantly, the fully conditional models still revealed the change trajectories of an increase in neuroticism and a decrease in extraversion and openness. However, none of the previously reported effects of time to death or age on intercepts or slopes remained significant. Thus, personality change in late life appears to be driven by processes that are not merely driven by chronological age or proximity to death per se. Rather, availability of personal resources appears to explain developmental trajectories of personality traits at the end of life. Such findings support life-span theories about the role of gain–loss dynamics for developmental trajectories (e.g., Baltes, 1987, 1997). The increasingly negative gain–loss ratio may be one factor to move personality trait development from patterns of maturation to patterns of adaptation. Notions of realistic limitations could request the adjustment of general and daily thinking, feeling, and behaving. Such late-life adjustments have been shown with respect to other psychological constructs such as in motivational or socioemotional development (Charles & Carstensen, 2010; Heckhausen et al., 2010). Future research should be concerned with identifying possible interrelationships of these adaptive processes in late life.

Limitations and Outlook

The current study has a number of strengths, including the use of a community-dwelling late-life longitudinal sample and the availability of self-report, objective, and performance indicators of four central late-life resource and risk factors. However, our study also has a number of important limitations. First, the BASE study included only three of the Big Five personality traits, and we are thus unable to examine agreeableness and conscientiousness. Specifically regarding the latter, recent empirical findings and theoretical approaches suggest that this personality trait may play an important role in successful aging (for an entire special section, see Reiss, Eccles, & Nielsen, 2014). Thus, replication is needed regarding the three traits in the present study and, most importantly, an extension to the two other Big Five personality traits to provide a fuller picture. In addition, it will be important to extend this research to other, more in-depth measures of personality traits. The present study used only six items per trait. This short measure restricted the subfacets assessed for each trait and likely contributed to a reduction in reliability (for further details on measurement properties, see Smith & Baltes, 1999). At the same time, we are unaware of other studies with such a late-life and end-of-life sample that have examined the effects of the broad scope of antecedent and correlated resources and risk factors included in the present study.

Second, personality traits were assessed only as a self-report measure and were based on a 5-point Likert scale. The use of diagnostic assessments designed for tracking of individual differences in stable traits complicates tracking of within-person change. The 5-point scale might not be sensitive enough to capture within-person changes (Ram, Gerstorf, Fauth, Zarit, & Malmberg, 2010), and some items may not capture changes perceived by the reporting individual. Although research with young adults indicates the validity of self-reports of personality traits (Vazire, 2010), transferability to such a late-life sample from Germany may be questioned. In a general sense, additional peer report or behavioral information could inform and strengthen our knowledge on late-life personality change.

As a third limitation, longitudinal studies of late life are always confronted with mortality-related dropout. Our selectivity analyses suggest that our report suffers from the typical patterns (amount and direction) seen in most longitudinal studies of the very old. Of key concern is the lack of convergence (Sliwinski et al., 2010) between the within-person changes and age (and time to death) differences in extraversion and openness. The nonconvergence suggests that a person of 75 years at the first assessment who is aging within the study shows less favorable personality trajectories than a person who is 90 years of age at the first assessment and ages within the study. The 75-year-old person does not "turn into" the 90-year-old. Thus, despite the negative time slope, we need to consider that certain segments of the population have been missed (e.g., older individuals with lower levels of extraversion and openness). With that said, our results may suggest a more positive developmental picture (i.e., lower increase in neuroticism mean levels and lower decrease in extraversion and openness) than what would be found in a representative population sample. However, such selectivity bias may also basically represent selectivity processes of late life where those with lower personal resource capacities and more physical limitations die earlier. Further research on end-of-life dynamics is clearly needed to get a better understanding of the interdependency of psychological and physical processes for this very specific phase of life. One possible route for future research is that longitudinal assessments of individuals should cover a broad range of functioning and thus reduce reliance on between-person inference. Such data will extend the opportunities to evaluate and understand within-person developmental processes and interdependencies late in life. In addition, our developmental trajectories are based on assessments obtained at relatively long intervals (e.g., roughly every three years). Thus, the precision with which to model fine-grained within-person change

in personality traits is limited. Future research should integrate multiple time-scale (short interval and long interval) assessments to be able to connect (or possibly explain) the developmental trajectories with more fine-grained change processes of personality trait change (Hutteman et al., 2015; Ram & Diehl, 2015; Roberts & Jackson, 2008).

Finally, our sample represents a quite specific group of late-life individuals. Including only residents of West Berlin in the late 1980s und early 1990s, these results may not apply to all parts of the Western world or beyond. At the same time, results with respect to late-life dynamics of subjective well-being and affect have been found in the BASE study (Gerstorf & Ram, 2013; Gerstorf, Ram, Röcke, Lindenberger, & Smith, 2008) and replicated in several other more representative and heterogeneous samples (Gerstorf, Ram, Estabrook, et al., 2008; Vogel, Schilling, Wahl, Beekman, & Penninx, 2013; Windsor, Gerstorf, & Luszcz, 2015). We would also like to add that such specific samples with a multidisciplinary approach and fairly long-term follow-up are definitely needed to understand the interdependencies of late-life dynamics. In that the BASE sample represents a very specific sample enabling particular insight into end-of life processes.

As a final note, it is important to mention the possible practical implications that may be drawn out of our results. In general, the findings illustrate that personality trait development appears to be minimally affected by mortality-related processes. Nevertheless, we see clear signs that decreasing personal resources affect developmental trajectories. Thus, one major implication may be that, over and above the objective (and possible inevitable) decrease of health and cognitive performance, perceptions of control and social inclusion are pivotal to sustaining personality development. The maintenance of perceived control over one's life as well as continued involvement in social activities and relationships in daily life may be especially important at the end of life.

Taken together, the current study examined intraindividual change trajectories of neuroticism, extraversion, and openness to experiences during very old age and showed that age and closeness to death are differentially related to developmental trends in personality traits. At the same time, the study highlighted the substantial role of interindividual differences in diverse resource and risk factors that reflect the challenges of an increasingly negative gain–loss ratio in late life. The investigation furthers our understanding of the diversity of processes underlying personality trait development at the end of the life course. It also points to the need for further research into the complex puzzle of developmental change in each of the Big Five traits in late life.

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(*Appendix follows*)

Appendix

Item Information and Descriptive Statistics

Table A1
Original Items and the German Translation Used in the Berlin Aging Study (BASE)

Original items	German translation
1. I like to have a lot of people around me.	Ich habe gerne viele Leute um mich herum.
2. I don't like to waste my time daydreaming.	Ich träume gerne am Tage vor mich hin.
3. Once I find the right way to do something, I stick to it.	Wenn ich erst einmal den richtigen Weg gefunden habe, etwas zu tun, dann bleibe ich dabei.
4. When I'm under a great deal of stress, sometimes I feel like I'm going to pieces.	Wenn ich unter starkem Stress stehe, fühle ich mich manchmal, als ob ich zusammenbräche.
5. I rarely feel fearful or anxious.	Ich empfinde oft Furcht oder Angst.
6. I really enjoy talking to people.	Ich unterhalte mich wirklich gerne mit anderen Menschen.
7. I often feel tense and jittery.	Ich fühle mich oft angespannt und nervös.
8. I like to be where the action is.	Ich stehe gerne im Mittelpunkt.
9. Poetry has little or no effect on me.	Gedichte beeindrucken mich.
10. I laugh easily.	Ich bin leicht zum Lachen zu bringen.
11. I often try new and foreign foods.	Ich probiere gerne etwas Neues aus.
12. I often get angry at the way people treat me.	Ich ärgere mich oft darüber, wie mich andere Leute behandeln.
13. I am a cheerful, high-spirited person.	Ich bin ein fröhlicher, gut gelaunter Mensch.
14. I have a very active imagination.	Ich habe ein lebhaftes Vorstellungsvermögen.
15. I often feel helpless and want someone else to solve my problems.	Ich fühle mich oft hilflos und wünsche mir jemanden, der meine Probleme löst.
16. I am a very active person.	Ich bin ein sehr aktiver Mensch.
17. I have a lot of intellectual curiosity.	Ich bin wissbegierig.
18. Sometimes I feel completely worthless.	Manchmal fühle ich mich völlig wertlos.

Table A2
Descriptive Statistics and Intercorrelation of All Available Personality Assessments Across Time

	Personality	*n*	*M*	*SD*	α	Neuroticism	Extraversion
Time 1	Neuroticism	463	50.02	10.02	.75		
	Extraversion	463	49.74	10.07	.64	−.12*	
	Openness	463	49.55	10.16	.54	.00	.37*
Time 2	Neuroticism	173	50.52	9.88	.79		
	Extraversion	173	49.31	10.24	.66	−.03	
	Openness	173	50.20	9.80	.61	.06	.55*
Time 3	Neuroticism	105	49.59	8.69	.74		
	Extraversion	105	49.07	9.90	.68	−.14	
	Openness	105	49.55	9.54	.55	.08	.45*
Time 4	Neuroticism	59	47.92	7.04	.68		
	Extraversion	59	48.69	8.32	.57	−.09	
	Openness	59	50.02	8.61	.56	.16	.39*
Time 5	Neuroticism	26	48.39	7.04	.74		
	Extraversion	26	47.74	9.27	.69	−.05	
	Openness	26	48.25	9.68	.67	.07	.61*

* $p < .05$.

(*Appendix continues*)

Table A3
Descriptive Statistics and Correlations of Neuroticism, Extraversion, Openness, Chronological Age, Time to Death, and Correlates at Baseline

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Neuroticism	50.02	10.02														
2. Extraversion	49.74	10.07	−.12*													
3. Openness	49.55	10.16	.00	.37*												
4. Age	85.88	8.37	.08	−.18*	−.17*											
5. Time to death	−5.97	4.55	.09*	−.12*	−.15*	.55*										
Correlates																
6. Men	0.51	0.50	−.23*	.03	.08	−.05	.07									
7. Education	50.06	10.15	−.21*	.08	.23*	−.16*	−.09	.23*								
8. Married	0.29	0.46	−.20*	.07	.09	−.22*	−.05	.51*	.24*							
9. Comorbidities	50.60	10.04	.20*	−.07	−.09	.18*	.27*	−.14*	−.17*	−.14*						
10. Disabilities	0.41	0.49	.13*	−.02	−.08	.28*	.11*	−.14*	−.11*	−.15*	.16*					
11. Digit Symbol Substitution Test	49.44	9.95	−.13*	.21*	.30*	−.51*	−.43*	.05	.31*	.23*	−.20*	−.28*				
12. PC—personal	49.93	10.14	.01	.32*	.12*	.01	.03	.08	−.12*	.00	−.01	−.04	−.03			
13. PC—others	50.49	10.05	.26*	−.03	−.09*	.29*	.23*	−.12*	−.17*	−.12*	.10*	.28*	−.30*	.04		
14. Social participation	49.09	9.91	−.20*	.27*	.31*	−.51*	−.43*	.08	.30*	.18*	−.19*	−.33*	.54*	−.00	−.33*	
15. Emotional loneliness	50.33	9.00	.56*	−.21	−.15*	.26*	.20*	−.17*	−.22*	−.29*	.20*	.12*	−.26*	−.06	.19*	−.27*

Note. $N = 463$. PC = perceived control.
* $p < .05$.

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