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Longitudinal Associations between Perceived Stress and Views on Aging: Evidence for
Reciprocal Relations

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Conflict of Interest

None.

Abstract

Views on aging (VoA) are meaningful predictors of well-being, health, cognitive impairment, and mortality. One underlying pathway could be that negative VoA promote perceived stress. However, little is known about the role of stress perceptions as an antecedent of personal VoA. In this study, we therefore investigated the longitudinal reciprocal association between perceived stress and three established constructs representing personal and self-referential VoA: (1) subjective age; (2) attitude toward own aging [ATOA]; and (3) aging-related cognitions comprising social loss, physical decline, and continuous growth. We also examined whether these associations are moderated by chronological age. Two adjacent measurement occasions (2014 and 2017) of the German Ageing Survey with 4,588 individuals aged between 40 and 95 years were analyzed. Cross-lagged models controlling for VoA and perceived stress at baseline, age, subjective health, depressive symptoms, education, gender, region of residence and year of individual study entry revealed significant reciprocal longitudinal relations between VoA and perceived stress. For three of the five VoA indicators, the pathway from perceived stress to subsequent VoA was of the same magnitude as the reversed pathway. With increasing chronological age, ATOA was less strongly associated with subsequent stress perceptions. Moreover, the impact of higher perceived stress on an older subjective age was weaker with advancing age. In conclusion, the trend in prior subjective aging research to conceptualize stress in midlife and old age exclusively as a consequence of VoA needs reconsideration, as higher perceived stress levels also seem to be a risk factor for less favorable personal VoA.

Key Words: subjective age, attitude toward own aging, aging-related cognition, views on aging, perceived stress scale (PSS-4)

8,125 Words

Longitudinal Associations between Perceived Stress and Views on Aging: Evidence for Reciprocal Relations

Personal views on aging, i.e., how individuals perceive, expect and evaluate their aging, have meaningful and manifold implications for well-being and quality of life, health, and longevity (Stephan et al., 2018a; Westerhof et al., 2014; Westerhof & Wurm, 2015; Wurm et al., 2017). Various mechanisms, including psychological, behavioral and physiological ones, seem to account for these associations of views on aging with major developmental outcomes (e.g., Levy, 2009). One of these pathways is that more negative views on aging and age stereotypes are related to stress, affecting, for instance, physiological stress responses (Levy & Bavishi, 2016; Levy, Ferrucci, et al., 2016; Levy et al., 2000; Levy, Moffat, et al., 2016; Levy et al., 2008). This is especially harmful since stress is “one of the biggest risks for mental and physical health” (Klaperski, 2018, p. 244) and negatively affects various outcomes of health, cognitive abilities, and well-being (Aldwin et al., 2021; Almeida et al., 2002; Charles et al., 2013; Jeong et al., 2016; Neupert et al., 2006; Thoits, 2010).

So far, most studies addressing the interplay of stress with views on aging have operationalized stress as physiological stress reaction, rather than as subjective stress appraisals. However, stress is not only a physiological phenomenon. According to theoretical stress frameworks such as the transactional model of stress and coping (Lazarus & Folkman, 1984) or the transdisciplinary stress model by Epel et al. (2018), it is also determined by subjective stress appraisals (Cohen et al., 1983). Stress has also mostly been considered exclusively as an outcome of views on aging, rather than as a predictor. Finally, most of the existing evidence assessed views on aging as “non-self-referential” (Faudzi et al., 2019), general views on aging such as age stereotypes (e.g., Levy et al., 2000; Levy, Moffat, et al., 2016; Levy et al., 2008), rather than as self-referential, personal views on aging. Yet higher stress does not only result from more negative views on aging, but potentially also precedes and predicts them. Moreover, stress could not only be related with age stereotypes, but also

with personal, “self-referential” views on aging. Due to their higher self-relevance, personal views on aging can even be expected to be more strongly related to health-related outcomes (Hu et al., 2020) and stress perceptions compared to general views on aging (Levy, 2009).

To our knowledge, a bidirectional perspective on longitudinal associations between stress appraisals and different indicators of personal views on aging has not been empirically addressed so far. Therefore, to address these gaps in prior research, the current study analyzes whether 3-year longitudinal associations between perceived stress and personal views on aging are reciprocal rather than unidirectional. Our study sample includes participants aged 40 to 95 years, thus comprising the entire second half of life. We include the three most common and established concepts of personal views on aging (Dutt et al., 2018; Westerhof & Wurm, 2015), namely subjective age (Kotter-Grühn et al., 2016; Stephan et al., 2018a), attitude toward own aging (Lawton, 1975), and the multidimensional aging-related cognitions with the subscales social loss, physical decline, and continuous growth (Steverink et al., 2001; Wurm et al., 2007). We will also analyze whether the associations between views on aging and stress are moderated by chronological age.

The Need for a Multi-Indicator Perspective on Views on Aging

Views on aging are multifaceted. They differ, for instance, with regard to their valence - gains or losses of the aging process –, and they reveal different age-related change trends (Kornadt et al., 2019; Westerhof & Wurm, 2015; Wurm et al., 2017). From a life-span perspective, this multidimensionality and -directionality of views on aging is in analogy to the tenets of life-span developmental psychology and to the developmental outcomes and processes they refer to (Baltes et al., 2006).

Given this multidimensionality of views on aging, one single measure of views on aging is not sufficient to cover the complexity of this construct. There is, so far, no consensus regarding the “via regia” of views on aging assessment. However, according to Westerhof and Wurm (2015), the “three most common conceptualizations” (p. 145) of views on aging are

age identity (i.e., subjective age), self-perceptions of aging, and self-perceptions of age-related growth and decline (see also Spuling et al., 2019).

First, *subjective age* is usually assessed by a single-item question such as “How old do you feel” (Gendron et al., 2018; Kotter-Grühn et al., 2016; Pinqart & Wahl, 2021; Westerhof & Wurm, 2015). This simple assessment format with only one question seems to be sufficient for a meaningful prediction of various developmental outcomes, including health, well-being and mortality (Alonso Debreczeni & Bailey, 2020; Stephan et al., 2018a, 2018b).

Second, *self-perceptions of aging* are usually assessed with multiple item scales. One of the most established and most frequently used scale in this area is the “Attitude Toward Own Aging” (ATOA) scale developed by Lawton (1975). ATOA is an important predictor of mental, physical and functional health (Levy, Slade, & Kasl, 2002; Sargent-Cox et al., 2012b; Tovel et al., 2017; Wettstein, Wahl, & Siebert, 2020) as well as of mortality (Kotter-Grühn et al., 2009; Levy, Slade, Kunkel, et al., 2002; Sargent-Cox et al., 2013).

Third, *self-perceptions of age-related growth and decline, or aging-related cognitions*, represent a views on aging construct that is, unlike measures such as subjective age or ATOA, conceptualized as a multidimensional construct. Steverink et al. (2001) developed a scale (also referred to as the AgeCog Scale; Wurm et al., 2007) of aging-related cognitions comprising three different domains of personal experiences of aging (social loss, physical decline, continuous growth). Like subjective age and ATOA, these aging-related cognitions meaningfully related to indicators of well-being and health in later life (Diehl et al., 2021; Jung et al., 2019; Spuling et al., 2019; Steverink et al., 2001; Wettstein, Wahl, & Spuling, 2020; Wurm et al., 2007).

As Westerhof and Wurm (2015) state, all three measures of views on aging certainly “do have some conceptual and empirical overlap” (p. 157; see also Spuling et al., 2019). However, each measure reveals characteristic associations with different outcomes of health and well-being (Spuling et al., 2019). It is therefore possible that each construct is related to

the experience of stress with a different magnitude of association. However, the evidence available so far with regard to associations with stress seems to be limited to single views on aging outcomes. A comparative approach integrating different measures of views on aging and their association with stress is thus still missing.

Views on Aging and Stress: A Reciprocal Association

Stress is defined as challenges or threats that outweigh a person's resources, resulting in socio-emotional and physiological dysregulation (Aldwin, 2007; Aldwin et al., 2021; Lazarus & Folkman, 1984). Stress has thus a strong subjective component, as it depends on an individual's appraisal whether personal resources are sufficient or not to deal with certain challenges or threats. Following the assumptions of the established transactional stress model (Lazarus & Folkman, 1984), such subjective stress appraisals, and not necessarily the objective event occurrence per se, determine which coping processes are activated and have an impact on long-term stress consequences such as physical or mental health: "Presumably, it is this level of appraised stress, not the objective occurrence of the events, that determines one's response to a stressor" (Cohen et al., 1983, p. 387). This is also in line with empirical findings demonstrating that associations with physical as well as depressive symptomatology are stronger for perceived stress than for global measures of objective stressors (e.g., Cohen et al., 1983).

Views on Aging Predict Perceived Stress

Negative views on aging, mostly general and non-referential views such as age stereotypes, are related with stress, and particularly with physiological stress reactions (Levy et al., 2000; Levy, Moffat, et al., 2016; Levy et al., 2008).

With regard to subjective age as an example of personal, rather than general, views on aging, there is some evidence suggesting that a younger subjective age is associated with a higher resilience to stress (Hoffman et al., 2015; Segel-Karpas et al., 2017; Shrira et al., 2014;

Shrira et al., 2016). Also, emotional reactivity to daily stressors was found to be greater among older adults with negative personal aging attitudes (Jennifer Bellington & S. D. Neupert, 2018).

Favorable views on aging, such as a younger subjective age, but also a positive attitude toward own aging (O'Brien et al., 2021), could thus contribute to a higher stress resilience, whereas negative views on aging could be one of the factors which, according to common diathesis-stress models (Hammen, 2004), increase an individual's vulnerability to stress and exert a "stress generation effect" (Hammen, 2004; Liu & Alloy, 2010).

This stress-inducing effect of negative views on aging might operate via different pathways. By undermining self-efficacy and motivational effort, for instance, unfavorable views on aging may cause stress by hindering older individuals in achieving important life goals (Diehl & Wahl, 2010). They may also lead to lowered self-esteem, which is associated with neuroendocrine stress responses in older adults (Seeman et al., 1995) and with more severe consequences of stress on health and well-being (Thoits, 2010). Moreover, negative views on aging could undermine older adults' resilience, which may result in heightened stress experiences (Levy, Moffat, et al., 2016). Higher stress, in turn, is a major risk factor for health restrictions, onset or progression of chronic diseases, and mortality (Aldwin et al., 2021; Jeong et al., 2016; Thoits, 2010). Increased stress could thus be one of the main mechanisms underlying the association of subjective aging with health, longevity, cognitive abilities, and well-being (Levy & Bavishi, 2016; Wurm et al., 2017). However, prior research mostly focused on general views on aging (such as age stereotypes), on physiological stress response, as well as on the role of views on aging as moderators in the association between stressors and stress response. In this study, we will consider different domains of *personal* and self-referential views on aging as well as *perceived* stress in order to investigate their longitudinal and potentially bi-directional associations.

Perceived Stress Affects Personal Views on Aging

A number of reasons suggests that perceived stress is not only a result of views on aging, but it might equally well precede and predict them via various pathways. For instance, experiencing higher stress in later life might be (mis)interpreted as a consequence and characteristic of the aging process per se and therefore undermine positive and increase negative views on aging. Stress might also affect how old or young individuals feel. Indeed, evidence from diary studies suggests that individuals feel older on days when they encounter more stressors (Bellintier et al., 2017; Kotter-Grühn et al., 2015). This could also be due to the fact that stress – particularly if chronic – accelerates aging (Yegorov et al., 2020). For instance “stress ... exacerbates, and sometimes accelerates the effects of aging to produce lasting and deleterious effects on immune functioning” (Hawkey & Cacioppo, 2004). In consequence, individuals affected by stress may not only biologically age faster, they might also – given the strong link between biological and subjective age (Kwak et al., 2018; Stephan et al., 2015; Thyagarajan et al., 2019) – subjectively age faster and thus feel older.

Additionally, the strong and negative impact of stress on individuals’ mental, cognitive, and physical health (Aldwin & Yancura, 2010; Almeida et al., 2002; Charles et al., 2013; Chrousos, 2009; Ensel & Lin, 2000; Jeong et al., 2016; McEwen, 2013; Thoits, 2010), for instance due to allostatic load characterized by activation of neural, neuroendocrine and neuroendocrine-immune mechanisms (McEwen, 1998), may undermine positive and promote negative views on aging. An individual affected by high levels of stress and its negative consequences on health will probably feel older, thus reporting a higher subjective age and less favorable views on aging in general. Functional and subjective health, onset of health events and diseases are indeed a major predictor of how views on aging develop over time, including subjective age (Barrett & Gumber, 2020; Hughes & Lachman, 2018; Kotter-Grühn et al., 2015; Schafer & Shippee, 2010), attitude toward own aging (Miche et al., 2014; Sargent-Cox et al., 2012a; Tovel et al., 2017), and aging-related cognitions (Diehl et al., 2021; Wettstein, Spuling, et al., 2020; Wurm et al., 2019).

Also, according to theories such as the stress exposure model of depression (Liu & Alloy, 2010), and supported by empirical evidence, stress is a risk factor for affective disorders, including depression (e.g., Charles et al., 2013), as stress-induced up-regulation of those immune system components involved in inflammation (proinflammatory cytokines) can induce behavioral changes and elicit depressive symptoms (Slavich & Irwin, 2014). Individuals with depressive symptoms and high negative affectivity, in turn, tend to display, according to Beck's cognitive theory of depression the negative cognitive triad (Beck et al., 1987), i.e. a negative view of themselves, of the world, and of the future, which potentially also includes the perceptions and anticipations of their aging. Indeed, higher negative affect as well as higher depressive symptomatology were found to predict less favorable views on aging (Diehl et al., 2021; Kotter-Grühn et al., 2015; Schönstein et al., 2021). Moreover, Bellingtier et al. (2017) indeed found that negative affect is a mediator of the association between stressors and subjective age.

Individuals who experience high levels of stress might also experience a depletion of psychosocial resources and in particular a loss of perceived personal control, which has been found to result in an older subjective age (Bellingtier & Neupert, 2019; Schafer & Shippee, 2010). Stress has also a negative impact on cognitive abilities (McEwen, 2013; Neupert et al., 2006; Sapolsky, 1996), and lower cognitive abilities as well as more cognitive complaints seem to promote more negative views on aging (Seidler & Wolff, 2017; Siebert et al., 2020).

In conclusion, it is very likely that perceived stress and views on aging are reciprocally interrelated. Adopting a psychological perspective on stress by focusing on the subjective experience of stress reported by individuals, we assume that stress acts both as a predictor and as an outcome of views on aging.

The Role of Chronological Age

From a life-span perspective, it is possible that, given that views on aging have a different meaning and role depending on different phases across the lifespan (Barrett &

Montepare, 2015) and that the implications and consequences of stress might also vary across different age phases (Lupien et al., 2009), chronological age moderates the association between stress and subjective aging. We will address the potentially moderating role of age by investigating an age-heterogeneous sample of individuals in their second half of life, including middle-aged, older, and very old adults.

With regard to theoretical frameworks from life-span psychology, the model of Strength and Vulnerability Integration (SAVI; Charles, 2010) predicts that across the adult life span, individuals gain and accumulate expertise in using strategies to avoid or minimize exposure to negative stimuli and stressors. However, the SAVI model also predicts that when older adults encounter high levels of sustained emotional arousal and stress, they need more time and have greater difficulties in returning to their normal adaptational level. This is in line with empirical evidence demonstrating that even in healthy older adults, the neuroendocrine and immune systems often require a longer time to normalize after stress activation compared to younger adults (Aldwin, 2007).

With regard to views on aging, it remains an open question whether perceived stress has a stronger impact on how individuals perceive aging with advancing chronological age. According to the SAVI model and empirical findings, the physical effects of stress might increase with age, which could in turn also result in a stronger impact on views on aging with advancing age. However, due to accumulated coping expertise and other factors, psychosocial stress consequences might also become less severe with advancing age. Empirical findings on the role of age in affective stress reactivity are mixed, ranging from reported differences in affective stress reactivity that are in favor of older adults (Schilling & Diehl, 2014; Schilling & Diehl, 2015; Stawski et al., 2019) to age differences in favor of younger individuals (Mroczek & Almeida, 2004).

As to the opposite effect leading from views on aging to subsequent stress perceptions, according to stereotype embodiment theory as another conceptual framework with a life-span

perspective, views on aging in general increase in salience and importance for the self with advancing age, i.e., from midlife to old age (Levy, 2009). This might also explain why, according to some evidence (Bergland et al., 2014; Brothers et al., 2015; Hubley & Russell, 2009; Levy, Moffat, et al., 2016; Miche et al., 2014; Stephan, Demulier, et al., 2012), the associations of different views on aging with health increase with advancing age. To our knowledge, whether predictive effects of views on aging on perceived stress vary by age has not been empirically addressed so far. Therefore, we will investigate in an exploratory way whether chronological age moderates these associations between perceived stress and views on aging.

Research Aims and Hypotheses

In this study, we will investigate the cross-lagged associations between perceived stress and views on aging based on longitudinal data over 3 years and using an age-heterogeneous sample of individuals in their second half of life, aged between 40 years and 95 years at baseline. Differentiating between three common concepts of views on aging (subjective age; attitude toward own aging; aging-related cognitions including social loss, physical decline, and continuous growth) to take the multidimensionality of age views (Klusmann et al., 2020; Spuling et al., 2019) into account, our predictions are as follows:

There is a general and robust longitudinal bidirectional association between perceived stress and views on aging across all views on aging domains included, that is (1) Less favorable views on aging at baseline predict higher perceived stress three years later, and (2) Higher perceived stress at baseline predicts less favorable views on aging three years later.

Associations in both directions are expected to be robust and remain statistically significant when controlling for autoregressive stability in both views on aging and perceived stress, as well for health-related and various socio-demographic covariates.

The strength of the investigated pathways might vary across multiple indicators of views on aging. Therefore, as part of additional exploratory analyses, we will compare the

size of the reciprocal associations with stress among the three different conceptualizations of views on aging. Finally, we will also investigate in an exploratory way if the associations between perceived stress and views on aging vary according to chronological age.

Method

Study Population and Sample Description

We used data from the German Ageing Survey (“Deutscher Alterssurvey”, DEAS), a cohort-sequential study of German community-dwelling adults aged 40 years and older at the time of their first study participation (Vogel et al., 2020). So far, six measurement occasions (T1: 1996, T2: 2002, T3: 2008, T4: 2011, T5: 2014; T6: 2017) have been completed. With the exception of 2011 and 2017, a new sample was drawn based on national probability sampling on each measurement occasion. These samples were systematically stratified by age, gender, and region of residence (i.e., former West or East Germany).

The present analyses were limited to the two most recent measurement occasions (2014 and 2017), because perceived stress was not assessed prior to 2014. 4,588 individuals¹ took part at both measurement occasions and provided valid data on all study variables, thus constituting the “core sample”². A sample description is shown in Table 1. Based on paired *t*-tests, we found no significant difference in means of perceived stress ($t(4522) = -0.40, p =$

¹ Each measurement occasion of the German Ageing Survey consists of two parts, namely a personal interview and a self-administered questionnaire. Not all individuals who take part in the interview also complete the questionnaire. Among the subjective age views, only subjective age was assessed as part of the interview, all other subjective age view measures were part of the questionnaire. Therefore, the sample size for subjective age ($n = 4,945$) is larger than the sample size for the other subjective age view measures ($n = 4,588$).

² For the latent cross-lagged regression models we computed, in addition to the study participants with valid data both in 2014 and 2017 ($n = 4,588$), also those individuals were included who only participated in 2014, but dropped out of the study thereafter ($n = 5,483$). For the sake of more precise estimates based on full information maximum likelihood, we decided not to exclude these individuals without longitudinal information because this would increase sample selectivity, reduce the sample representativeness and thus limit the generalizability of our findings. However, we repeated the cross-lagged panel analyses (as shown in Table 2) based on the smaller subsample, omitting all study dropouts. All cross-lagged effects between stress and views on aging remained significant, and standardized cross-lagged effects remained mostly unaltered, with differences in estimated standardized cross-lagged effects ranging between $|.01|$ and $|.03|$.

.66) and perceptions of social loss ($t(4586) = -1.85, p = .064$) in 2014 vs. 2017. In contrast, an increase was observed for subjective age ($t(4484) = -7.23, p < .001$) and perceptions of physical decline ($t(4586) = -2.10, p = .036$), whereas there was a mean decline in ATOA ($t(4506) = -8.10, p < .001$) and in continuous growth ($t(4585) = 4.24, p < .000$).

Intercorrelations between all study variables are displayed in the Supplemental Material (Table S1). The autocorrelation of perceived stress between 2014 and 2017 was $r = .54$, the autocorrelations of the views on aging measures were in a range between $r = .20$ (subjective age) and $r = .66$ (continuous growth). Correlations between perceived stress and views on aging ranged between $r = .40$ (perceived stress 2014 – social loss 2014) and $r = -.51$ (perceived stress 2017 – ATOA 2017).

(Insert Table 1 about here)

Measures

Views on Aging.

Subjective age was assessed by a single-item question (“How old do you feel?”). For a better interpretation of subjective age, a proportional discrepancy score between felt age and chronological age was computed (subjective age = [felt age – chronological age]/chronological age; Rubin & Berntsen, 2006).³

Attitude toward own aging (ATOA) was assessed by the subscale of the Philadelphia Geriatric Morale Scale (Lawton, 1975). This subscale comprises 5 items (e.g., “Things keep getting worse as I get older”) with a 4-point response scale ranging from (1) “strongly agree”

³ Some outliers were detected (e.g., a reported subjective age of 520 years) which distorted the distributions of subjective age. Therefore, subjective age scores that were more than 3 standard deviations above or below the mean were considered as outliers, in analogy to the cutoff ranges chosen in other studies on subjective age (Stephan et al., 2014; Wettstein, Spuling et al., 2020), and replaced with missing values for the present analyses. 7 values were replaced (in 2014, the subjective ages of 5, 194, 403, and 520; in 2017, the subjective ages of 640, 655, and 778).

to (4) “strongly disagree”. For the analyses, a latent ATOA variable was constructed, with higher scores on the latent factor indicating more favorable ATOA.

Aging-related cognitions (Steverink et al., 2001; Wurm et al., 2007) were assessed by three different subscales (all with a 4-point response format from 1 = “strongly agree” to 4 = “strongly disagree”), namely social loss (e.g., “Aging means to me that I am less needed”), physical decline (e.g., “Aging means to me that I am less energetic and fit”), and continuous growth (e.g., “Aging means to me that I can still learn new things”). Latent variables were estimated, with higher latent scores indicating perceptions of higher social loss, physical decline and continuous growth respectively.

Perceived Stress. We used the 4-item short-form of the Perceived Stress Scale (PSS-4; Cohen et al., 1983) which assesses facets of perceived helplessness and perceived self-efficacy as well as the “degree to which respondents found their lives unpredictable, uncontrollable, and overloading” (Cohen et al., 1983, p. 387). Participants provided their answers to 4 items (“In the last month, how often have you felt that you were unable to control the important things in your life?”; “In the last month, how often have you felt confident about your ability to handle your personal problems?”; “In the last month, how often have you felt that things were going your way?”; “In the last month, how often have you felt difficulties were piling so high that you could not overcome them?”) on a 5-point Likert scale with a range from “never” (1) to “very often” (5). A latent stress variable was specified based on the 4 items, with higher scores on that latent variable indicating higher perceived stress.

Covariates. We followed the approaches of related studies addressing the interplay between stress and views on aging (e.g., Jennifer Bellingtier & S. D. Neupert, 2018; Schafer & Shippee, 2010) and controlled for age, subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and – to take potential cohort effects as well as sample selectivity into account - for year of first study participation of each individual

(1996, 2002, 2008 or 2014). These covariates – particularly perceived health and depressive symptoms - might affect both perceived stress and views on aging, so that not controlling for them might result in biased, inflated and confounded estimates of associations between perceived stress and views on aging. Subjective health was assessed by a single-item question (“How would you rate your current health?”), with response options ranging from 1 (very good) to 5 (very poor). A 15-item German adaptation (Hautzinger & Bailer, 1993) of the Center for Epidemiological Studies Depression Scale (Radloff, 1977) was used to assess depressive symptoms (Cronbach’s $\alpha = .85$). Education was measured using the International Standard Classification of Education (ISCED) coding of the UNESCO (2012). Based on this coding scheme, four groups of school and professional education were distinguished (low, medium, elevated, and high education).

Statistical Analyses

To address the mutual longitudinal associations between views on aging and stress, latent cross-lagged models (see Fig. 1) were computed (Kenny, 2005; McArdle, 2008) using Mplus 8.4 (Muthén & Muthén, 2017). The major parameters that are estimated are the concurrent correlations between perceived stress and each domain of views on aging in 2014 (path a) and 2017 (path b), the autoregressive stability from 2014 to 2017 in views on aging (path c) and in perceived stress (path d), as well as the cross-lagged associations leading from views on aging to perceived stress (path e) and from perceived stress to views on aging (path f). We controlled for age, subjective health, depressive symptoms, education, gender, region of residence, and year of first study participation in the analyses. Perceived stress and all views on aging domains (except subjective age, which is based on a single-item question) were specified as latent variables, with the items of the respective scales (perceived stress, ATOA, social loss, physical decline, and continuous growth) representing the indicators of the respective latent construct. For all latent constructs specified, we assumed strong measurement invariance, constraining factor loadings of the indicators of stress, ATOA, and

the three aging-related cognitions as well as their intercepts and residual variances to be equal across both measurement occasions. Additionally, the correlation between the residual scores of each perceived stress item as well as of each views on aging item over time was freely estimated and not constrained, as well as the correlation between the two positively worded perceived stress items (i.e., “In the last month, how often have you felt confident about your ability to handle your personal problems?” and “In the last month, how often have you felt that things were going your way?”) and between the two negatively formulated ATOA items (i.e., “Things keep getting worse as I get older” and “As you get older, you are less useful”) at each measurement occasion.

(Insert Figure 1 about here)

Model fit of the specified models was evaluated based on recommended criteria and cutoff values (Hu & Bentler, 1999; Schermelleh-Engel et al., 2003). Specifically, CFI values exceeding the threshold of .90 and RMSEA scores close to or below the cut-off score of .08 were considered as indicating an acceptable model fit, and CFI scores of .95 or above as well as RMSEA scores of .05 or below indicated a good model fit.

To investigate whether chronological age moderates the cross-lagged associations between views on aging and stress, we considered age as a continuous variable (ranging from 40 to 95) and computed additional models with specifications of latent interactions (stress*age and views on aging *age) using the XWITH command (Maslowsky et al., 2014) for latent variable interactions in Mplus⁴.

Results

Cross-Lagged Associations Between Perceived Stress and Views on Aging

Results from latent cross-lagged analyses - controlling for age, subjective health, education, gender, region of residence, and year of first survey participation (1996, 2002,

⁴ Only for subjective age, which was assessed by a single-item question, the interaction with age was instead specified as a nonlatent interaction term between manifest, observed variables.

2008 or 2014) - are illustrated in Table 2. Model fit indicators for the different models are summarized in Table 3. CFI values of the models were in a range between .91 and .94 and thus acceptable. Moreover, all RMSEA values were below .05, thus indicating a good model fit. Proportions of variance accounted for in views on aging ranged between $R^2 = .33$ (subjective age) and $R^2 = .77$ (ATOA). With regard to perceived stress, proportions of variance accounted for varied between $R^2 = .61$ and $R^2 = .81$ across the different models.

(Insert Tables 2-3 about here)

All cross-lagged paths linking views on aging and perceived stress were significant ($p < .001$), indicating meaningful reciprocal longitudinal associations between perceived stress and views on aging consistently across all included domains of views on aging, supporting our main hypotheses of bidirectional longitudinal associations. While higher perceived stress was associated with less favorable views on aging three years later, views on aging that were more negative also predicted higher levels of perceived stress three years later. Standardized effects of cross-lagged paths in both directions were largest in the model including ATOA, with both coefficients indicating that an ATOA/perceived stress score higher by one standard deviation predicts a perceived stress/ATOA score that is lower by almost half of a standard deviation.

When comparing the cross-lagged paths within each model, the following pattern emerged: Constraining the unstandardized cross-lagged paths to be equal resulted in a significant model fit deterioration for ATOA ($\Delta\chi^2(1) = 789.71, p < .001$) and social loss ($\Delta\chi^2(1) = 4.68, p = .03$). The standardized paths from perceived stress to ATOA and to social loss were stronger than vice versa, although the standardized path coefficients were similar in size. In contrast, in the models including subjective age, physical decline and continuous growth, the cross-lagged paths could be set equal without a significant loss in model fit (subjective age: $\Delta\chi^2(1) = 0.53, p = .47$; physical decline: $\Delta\chi^2(1) = 1.82, p = .18$; continuous growth: $\Delta\chi^2(1) = 2.43, p = .12$).

Moderator Effects of Chronological Age

Results from the models with (latent) interactions of chronological age with views on aging and stress, respectively, are shown in Table 4. Proportions of variance accounted were similar in size compared to the models without age interactions, and they ranged between $R^2 = .35$ (subjective age) and $R^2 = .77$ (ATOA) for views on aging and between $R^2 = .61$ and $R^2 = .81$ for perceived stress across the different models.

(Insert Table 4 about here)

Two interactions of age and views on aging reached statistical significance in our sample of middle-aged and older adults (Figure 2): With advancing age, ATOA was less strongly associated with subsequent stress. That is, the association of less favorable ATOA scores with higher subsequent perceived stress was weaker with advancing chronological age, with the effect decreasing by 0.03 points with each additional year of age (see Table 4). No significant interaction with chronological age was found for subjective age as well as for perceptions of social loss and of continuous growth. Also the interaction of physical decline with age failed to reach statistical significance ($p = .051$).

(Insert Figure 2 about here)

Perceived stress as a predictor revealed one significant interaction with chronological age (Figure 3). Specifically, the association of higher stress with an older subjective age was weaker with increasing age, with the effect decreasing by 0.14 points with each additional year of age (see Table 4). The interactions terms of stress with chronological age were not significant for ATOA as well as for perceptions of social loss and continuous growth. Also, the interaction of perceived stress with chronological age failed to reach statistical significance ($p = .053$) when perceptions of physical decline were specified as outcome.

(Insert Figure 3 about here)

Discussion

In this study we investigated bidirectional longitudinal associations between major constructs of views on aging (subjective age, attitude toward own aging, and aging-related cognitions comprising physical decline, social loss, and continuous growth) and perceived stress across a 3-year observational period in middle-aged and older adults. We also analyzed the role of chronological age as a potential moderator of these associations. By using and comparing different constructs of the multidimensional construct of views on aging (Klusmann et al., 2020; Spuling et al., 2019) and by investigating bidirectional associations with stress appraisals, our intention was to contribute to a more differentiated perspective on the longitudinal and potentially bi-directional interplay between views on aging and perceived stress.

Reciprocal Associations between Views on Aging and Perceived Stress

Based on latent cross-lagged panel models, we found that all included views on aging indicators significantly predicted subsequent stress perceptions, with less favorable views on aging preceding higher perceived stress three years later. We controlled for subjective health, depressive symptoms as well as for various socio-demographic variables, so that these associations can be regarded as robust. Additionally, as expected, stress was not only predicted by prior views on aging, it was as well a significant predictor of subsequent views on aging: Consistently across all included constructs of views on aging, individuals with higher perceived stress levels at baseline reported more negative views on aging three years later.

Different domains of views on aging reveal different associations with outcomes such as health or well-being (Diehl et al., 2021; Spuling et al., 2019; Steverink et al., 2001). The findings of this study suggest that associations of views on aging with perceived stress, when considered longitudinally and in both directions, also vary in strength according to the views on aging indicator considered. The standardized cross-lagged effect from views on aging to stress was largest for ATOA, followed by perceptions of social loss. A general attitude toward

own aging that is negative, as well as perceiving one's aging as a process of getting increasingly lonely and less needed thus seems to be age views that predict higher subsequent stress, which might be seen in line with general findings demonstrating the various and severe detrimental health consequences of loneliness and social isolation (Cacioppo & Cacioppo, 2018; Hawkley & Cacioppo, 2010; Holt-Lunstad, 2018).

Comparing the cross-lagged associations within each views on aging indicator, the effect of stress appraisals on views on aging and the reversed pathway could be set equal for subjective age and perceptions of physical decline as well as of continuous growth. Thus for these indicators of views on aging, it seems that there is no "main pathway", but that stress and views on aging mutually influence each other with a comparable predictive impact of both paths. For ATOA and perceptions of social loss, however, the stronger pathway seems to lead from perceived stress to views on aging than vice versa.

Taken together, we found a consistent and robust effect of different personal views on aging on perceived stress, which extends prior studies demonstrating that negative views on aging and age stereotypes undermine stress resilience and affect stress reactions (e.g., Levy & Bavishi, 2016; Levy et al., 2000; Levy, Moffat, et al., 2016; Levy et al., 2008), whereas favorable views on aging act as stress buffers (Avidor et al., 2020; Hoffman et al., 2015; Kornadt et al., 2021; Losada-Baltar et al., 2020; Shrira et al., 2020; Shrira et al., 2016). However, subjective perceptions of higher stress are in turn also a predictor of less favorable views on aging over time, with a consistent effect across all views on aging constructs included. This also means that once either views on aging of an individual deteriorate or their perceived stress level increases, a downward spiral might follow, with stress and views on aging mutually affecting each other over time.

Moreover, this vicious circle will not be limited to the experience of stress and views on aging, because both domains are also meaningful predictors of other major developmental outcomes such as health, cognitive abilities, well-being and longevity (Aldwin, 2007; Cohen

et al., 1983; Stephan et al., 2018b; Westerhof et al., 2014; Westerhof & Wurm, 2015). Hence these outcomes can also be expected to become increasingly compromised once heightened stress levels and/or a deterioration in views on aging set in. Less favorable views on aging might mediate or reinforce the association of higher stress with these outcomes, and similarly, perceived stress might mediate or augment associations of views on aging with these outcomes (e.g., Levy & Bavishi, 2016). Future research should therefore investigate associations between stress and views on aging from a larger contextual and inter-systemic perspective that also considers additional developmental outcomes, such as well-being or health, or even more distal ones such as mortality.

Interventions to promote favorable views on aging, to improve stress management and to reduce stress, or ideally both aspects combined in one multi-component intervention format, could be a promising approach to prevent the described dynamics of a downward spiral that would in the long run also impair individuals' health and quality of life. Though there is already some evidence on the modifiability of views on aging (Kotter-Grühn, 2015), e.g. by means of experimental manipulation (Dutt & Wahl, 2017; Shao et al., 2020; Stephan, Chalabaev, et al., 2012) or intervention (Beyer et al., 2019; Brothers & Diehl, 2017; Klusmann et al., 2012; Wolff et al., 2014), more needs to be known about how and through which pathways (e.g., negative affect or psychosocial resources such as self-efficacy or control beliefs as mediators; Bellintier et al., 2017; Schafer & Shippee, 2010) views on aging affect stress and vice versa, as well as which moderating factors augment or reduce these associations.

The Role of Chronological Age

We found that chronological age moderated two of the longitudinal associations between views on aging and stress. Regarding the pathways from stress to views on aging, the main effect of higher perceived stress on an older subsequent subjective age decreased in size with advancing age, whereas the effect of perceived stress on all other views on aging was

independent of age. With regard to subjective age, we found individuals in early-old age (i.e., around 65 years) with stress levels that were one standard deviation above the mean reported feeling 8% younger than their age, whereas the subjective age of individuals with a stress level one standard deviation below the mean felt 18% younger than they were. In very old age (i.e., around 85 years), subjective age varied in a much narrower range according to stress, namely between 12% and 14% younger than the respective chronological age.

Stress might come with less detrimental psychosocial consequences as individuals age, because – also according to the SAVI model (Charles, 2010) – individuals learn to avoid or reduce exposure to stressors and minimize their negative effects (Aldwin & Yancura, 2010) when they get older. Additionally, coping strategies to deal with stressors might improve up to a certain age (Diehl et al., 2014) so that affective stress reactivity might decrease with age (Schilling & Diehl, 2014; Schilling & Diehl, 2015; Stawski et al., 2019). However, only one views on aging indicator, namely subjective age, was less affected by prior stress with advancing age. Subjective age is different from the other views on aging included as it is less evaluative and more “intuitive”. It is, when assessed as proportional discrepancy score, also relatively stable over time and age (Kleinspehn-Ammerlahn et al., 2008; Rubin & Berntsen, 2006; Uotinen et al., 2006; Wettstein, Spuling, et al., 2020), with individuals over 60 years feeling on average 13-18% younger than they are (Pinquart & Wahl, 2021). However, despite this age-related stability in subjective age, predictors of subjective age might still change in their impact with advancing age: With increasing age, associations of subjective age with health seem to become stronger (Bergland et al., 2014; Hubley & Russell, 2009; Stephan, Demulier, et al., 2012). In contrast, according to our study findings, stress might become less important as a predictor of subjective age from midlife to old age, which is in line with findings by Bellingtier and Neupert (2019) who found that average exposure to daily stressors was a significant predictor of daily subjective age among younger adults, but not among older

individuals. However, our sample did not include younger participants and thus did not allow for such age group comparisons.

Regarding the opposite direction, namely the paths from views on aging to stress, the associations of ATOA with perceived stress decreased in magnitude with advancing age. In contrast, an older subjective age, higher perceptions of social loss, physical decline as well as lower perceptions of continuous growth had a negative impact on subsequent perceived stress that was – in our sample of middle-aged and older adults - independent of age (although the age interaction effect for perceptions of physical decline was close to statistical significance, $p = .051$). Perceptions of continuous growth might be the domain among the aging-related cognitions with the least “age salience” (with items such as continuing to make plans, still learning new things etc.) and that is perhaps more dependent on factors such as positive affect (Diehl et al., 2021) or personality-related characteristics (e.g., optimism, self-efficacy, hope; Spuling et al., 2019; Steverink et al., 2001) than on chronological age. Subjective age might again be different from most other views on aging indicators in its relation to stress as subjective age ratings are usually not (or not only) based on a cognitive-evaluative process, other than ratings for the items of ATOA or of the aging-related cognitions.

Given that views on aging can be expected to become more salient and self-relevant as across the life span when individuals get older (Kornadt et al., 2019; Levy, 2009), it is remarkable that ATOA is a less strong predictor of subsequent perceived stress with advancing age across the second half of life, rather than revealing an age-related increase in its predictive impact on stress perceptions. However, a negative attitude toward own aging in general might be particularly stressful and stress-augmenting in midlife and early-old age, when such perceptions are more indicative of an “off-time experience” because most adults in this life phase still report and exhibit good health (Lachman, 2004; Lachman et al., 2014). However, with increasing age, there is a shift not only toward higher physical vulnerability (Baltes & Smith, 2003) but also toward a more negative attitude toward own aging in general

(Diehl et al., 2021; Kleinspehn-Ammerlahn et al., 2008; Kotter-Grühn et al., 2009; Miche et al., 2014). Therefore, less favorable ATOA might to some extent be more “normative” in old and very old age and in consequence less influential with regard to their impact on psychosocial outcomes such as perceived stress.

In conclusion, whether chronological age operates as moderator of the longitudinal associations between views on aging and perceived stress seems to depend on the direction of the pathway considered as well as the specific views on aging construct. Most age interaction effects, eight of ten, were not significant. For the two significant age interaction effects across both cross-lagged directions associations were found to be weaker with advancing age. It thus seems that – although not across all domains representing views on aging – the older individuals are, the smaller the impact of views on aging on perceived stress and vice versa. Therefore, the described vicious circle of higher stress and negative views on aging mutually impacting each other might – if not interrupted or counteracted - result in a particularly strong downward spiral in midlife and early-old age, whereas the reciprocal associations are to some extent reduced – but nevertheless still existent – in old and very old age.

Strengths and Limitations

Among the strengths of this study are the availability of a large, age-heterogeneous sample comprising the entire second half of life and of a broad set of personal views on aging (subjective age, ATOA, aging-related cognitions) assessed longitudinally over three years. This enabled us to compare different domains of views on aging with regard to their bidirectional longitudinal associations with perceived stress as well as to investigate the moderating role of chronological age across the broad age range of the study sample.

However, several limitations also deserve mentioning. Although our study sample was quite heterogeneous, comprising participants between 40-95 years, it did not include individuals in emerging or young adulthood. However, stress and subjective aging measures are also interrelated in this life phase (Jennifer Bellingtier & Shevaun D. Neupert, 2018). Our

findings do thus not cover the entire life span, but our study sample does at least comprise the full second half of life. Also, there may be – beyond the covariates controlled for - other factors that are associated with both stress and views on aging, such as neuroticism, which was not assessed in this study and which might be only partially and indirectly be controlled for by the inclusion of depressive symptoms as covariate. Moreover, as perceived stress was not assessed in the German Ageing Survey before 2014, only two measurement occasions could be used in the analyses. The age moderation effects identified in this study were based on inter-individual age differences and could thus indicate cohort effects, rather than aging effects. Cross-lagged panel analyses, which we applied in this study, have been criticized for different reasons (Hamaker et al., 2015; Mund & Nestler, 2019). However, alternatives such as the random intercepts cross-lagged panel model (Hamaker et al., 2015) or dual change score models require more than two measurement occasions so that, from our point of view, cross-lagged panel models are the best option for the available data structure and for our specific research questions. Future research should study the longitudinal interplay between views on aging and stress using alternative methods and based on datasets that comprise multiple measurement, longer observational time spans, and ideally also samples that comprise the entire life span from childhood or emerging adulthood to very old age.

About 90% of participants reported perceived stress levels in 2014 and 2017 that did not exceed the theoretical mean of the Perceived Stress Scale short-form. Inter-individual variability in perceived stress was thus mostly limited to a range between low and medium stress. Thus, based on our data, we cannot conclude how extreme levels of perceived stress (e.g., trauma-induced stress) affect views on aging. However, the mean stress scores we found correspond to other published mean scores based on the PSS-4 (Cohen et al., 1983; Warttig et al., 2013) – although these samples were younger, so that they are not directly comparable with our study sample – so that stress levels in our sample might not be unusually low, but rather typical for a non-clinical study sample. Moreover, according to our findings, even

perceived stress scores that are elevated, but not extremely high, seem to be sufficient to have a consistent and robust negative impact on various domains of views on aging.

Our measure of perceived stress, though frequently used and of good psychometric quality (Cohen et al., 1983), is based on a brief scale which does not allow differentiation between different types of stressors or between chronic vs. acute stressors. Specific stressors (such as cardiovascular events; Wurm et al., 2019) seem to have an impact on change in views on aging, even if considered over periods as short as three years. More research is thus needed to explore whether different stressors reveal differential associations with views on aging and whether the chronicity of stress has implications for relations of stress with view on aging. Also, both perceived stress and views on aging were based on self-reports in our study, so that they might share some common method variance. However, an advantage of the construct of perceived stress as a measure of “nonspecific appraised stress” (Cohen et al., 1983, p. 385) is that it integrates stressors of different kind and thus represents a measure of subjectively experienced global stress that is a stronger predictor of physical and depressive symptoms than operationalizations of objective stressors (Cohen et al., 1983). For instance, Cohen et al. (1983) point out that their Perceived Stress Scale “is sensitive to chronic stress deriving from ongoing life circumstances, to stress from expectations concerning future events, to stress not listed on a particular life-events scale, and to reaction to the specific events included on any scale” (p.387). With regard to the chronicity of perceived stress, the autoregressive stability estimate of stress obtained in our analyses suggest that stress is “trait-like” and remained quite stable over 3 years. Therefore, most of the individuals reporting stress at baseline can be assumed to be affected by chronic, rather than acute stress. However, we are aware that stress “is not a monolithic concept but rather, an emergent process that involves interactions between individual and environmental factors, historical and current events, allostatic states, and psychological and physiological reactivity” (Epel et al., 2018), so that more research is needed to understand the interplay between views on aging and different

processes and components (e.g., objective stressors, physiological indicators and stress reactions) of the broad stress concept.

Conclusion

In this study, bidirectional associations between different domains of views of aging and perceived stress were investigated in a German sample of middle-aged and older adults. Our findings suggest that associations between views on aging and perceived stress are reciprocal, with higher perceived stress resulting from less favorable views on aging, but also predicting more negative views on aging three years later. Notably, this reciprocal pattern was found for each of the five views on aging indicators included, and associations remained robust and significant when controlling for subjective health, depressive symptoms and various socio-demographic factors. Across different operationalizations of views on aging, perceived stress is thus both a predictor and an outcome of views on aging when considered in middle-aged and older adults across a 3-year period. This also implies that negative views on aging and high stress levels can reinforce each other, potentially resulting in downward spirals of ongoing deteriorations in views on aging and increasing stress levels that can in turn be expected to have further negative consequences (e.g., for health, well-being, and longevity). Prevention and intervention approaches to reduce stress and improve stress management in midlife and old age as well as to promote favorable views on aging could counteract such negative dynamics.

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Table 1

Sample Description

	<i>M</i> ± <i>SD</i> or <i>n</i> (%)
Age (2014)	64.15±10.66
Female Sex	2,331 (50.81%)
Education:	
Low	205 (4.47%)
Medium	2,280 (49.69%)
Elevated	661 (14.41%)
High	1,442 (31.43%)
Year of First Study Participation	
1996	377 (8.22%)
2002	480 (10.46%)
2008	1,488 (32.43%)
2014	2,243 (48.89%)
Region of Residence	
East Germany	1,505 (32.80%)
Self-Rated Health ¹ (2014)	2.42±0.80
Depressive Symptoms (2014)	6.23±5.70
Perceived Stress (2014)	2.31±0.64
Perceived Stress (2017)	2.31±0.64
Views on Aging	
Subjective Age (2014) ²	-0.13±0.11
Subjective Age (2017) ²	-0.11±0.12
ATOA (2014)	3.02±0.53
ATOA (2017)	2.96±0.54
Social Loss (2014)	1.79±0.53
Social Loss (2017)	1.80±0.54
Physical Decline (2014)	2.74±0.53
Physical Decline (2017)	2.76±0.55
Continuous Growth (2014)	2.94±0.54
Continuous Growth (2017)	2.92±0.57

M = mean; *SD* = standard deviation; ATOA = attitude toward own aging.

¹ Lower values indicate better self-rated health

² Subjective age was computed as proportional discrepancy score (Rubin & Berntsen, 2006), corresponding to the extent felt age deviates from chronological age (subjective age = [felt age – chronological age]/chronological age), with lower values indicating a younger subjective age.

Table 2

Overview of Standardized Path Coefficients in Cross-Lagged Models

Views on Aging	Correlation Stress T ₁ - Subjective View T ₁	Correlation Stress T ₂ - Subjective View T ₂	Autoregressive Path (Subjective Age View T ₁ → T ₂)	Autoregressive Path (Stress T ₁ → T ₂)	Subjective Age View T ₁ →Stress T ₂	Stress T ₁ →Subjective Age View T ₂	R ² Subjective Age Views T ₂	R ² Stress T ₂
Subjective Age	.21	-.14	.49	.70	.01 ^a	.18 ^a	.33	.81
ATOA	-.54	.33	.52	.39	-.39	-.42	.77	.67
Physical Decline	.35	-.16	.63	.47	.13 ^a	.27 ^a	.64	.61
Social Loss	.43	-.16	.65	.43	.23	.26	.67	.64
Continuous Growth	-.39	.19	.66	.44	-.19 ^a	-.23 ^a	.70	.62

Note. Covariates controlled for in all models: age, subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and year of first study participation (1996, 2002, 2008 or 2014). ATOA = attitude toward own aging. T1 = measurement occasion in 2014, T2 = measurement occasion in 2017. All coefficients are statistically significant ($p < .001$).

^a unstandardized cross-lagged paths set equal.

Table 3

Model-Fit Indices of the Latent Cross-Lagged Regression Models

Views on Aging	χ^2	df	<i>p</i>	CFI	RMSEA [90 % confidence interval]	<i>p</i>
Subjective Age	1,554.32	77	<.001	.922	.042 [.041; .044]	1
ATOA	3,393.9	239	<.001	.909	.038 [.037; .039]	1
Physical Decline	2,333.644	187	<.001	.941	.033 [.032; .034]	1
Social Loss	3,125.264	186	<.001	.912	.039 [.038; .040]	1
Continuous Growth	3,689.336	1187	<.001	.912	.042 [.041; .043]	1

Note. χ^2 = Chi square, df = degrees of freedom, *p* = significance value, CFI = comparative fit index, RMSEA = root mean squared error of approximation, ATOA = Attitude Toward Own Aging.

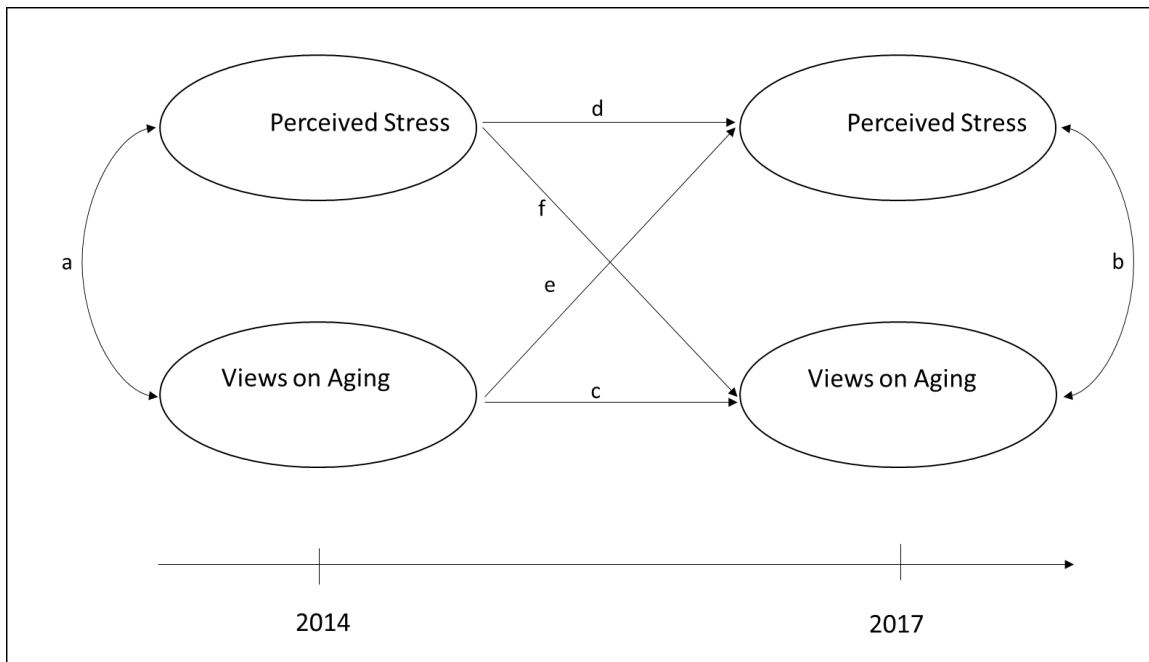
Table 4

Overview of Standardized Path Coefficients in Cross-Lagged Models Including Age Moderation Effects

Views on Aging	Autoregressive Path (Subjective Age View T ₁ → T ₂)	Autoregressive Path (Stress T ₁ → T ₂)	Subjective Age View T ₁ → Stress T ₂	Stress T ₁ → Subjective Age View T ₂	Subjective Age View*Age T ₁ → Stress T ₂	Stress*Age T ₁ → Subjective Age View T ₂	R ² Subjective Age Views T ₂	R ² Stress T ₂
Subjective Age	.48	.70	.00	.22	-.01	-.14	.35	.81
ATOA	.52	.38	-.40	-.42	.03	.01	.77	.67
Physical Decline	.64	.46	.15	.27	-.03	-.03	.64	.61
Social Loss	.65	.43	.24	.27	-.02	.00	.67	.64
Continuous Growth	.66	.44	-.19	-.24	.01	.00	.70	.62

Note. Covariates controlled for in all models: age, subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and year of first study participation (1996, 2002, 2008 or 2014). ATOA = attitude toward own aging. T1 = measurement occasion in 2014, T2 = measurement occasion in 2017. Significant effects ($p < .05$) are printed in bold.

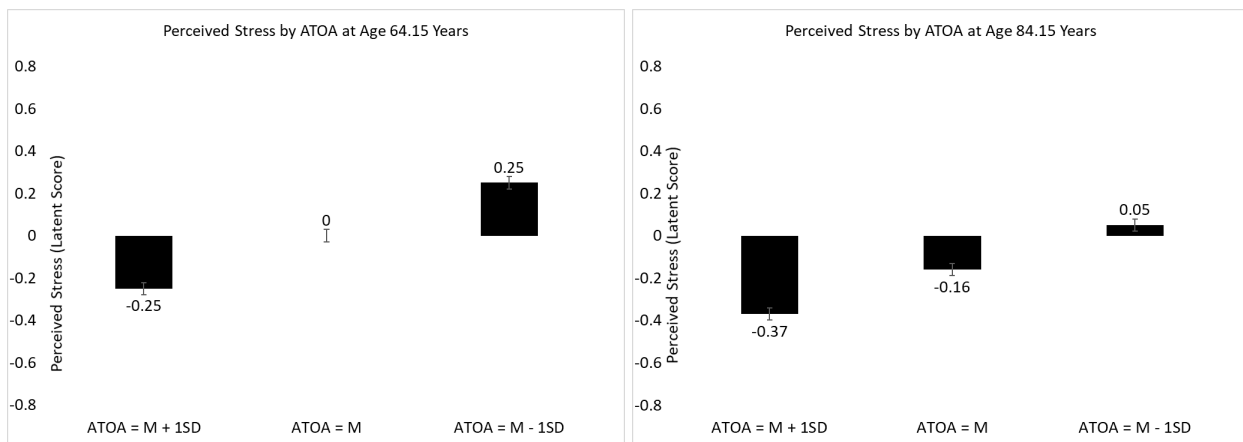
Figure 1
Illustration of The Cross-Lagged Panel Model



Note. Covariates controlled for in all models (not shown in Figure): age, subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and year of first study participation (1996, 2002, 2008 or 2014).

Figure 2

The Effect of Attitude Toward Own Aging (Assessed in 2014) on Perceived Stress (Assessed in 2017) by Chronological Age

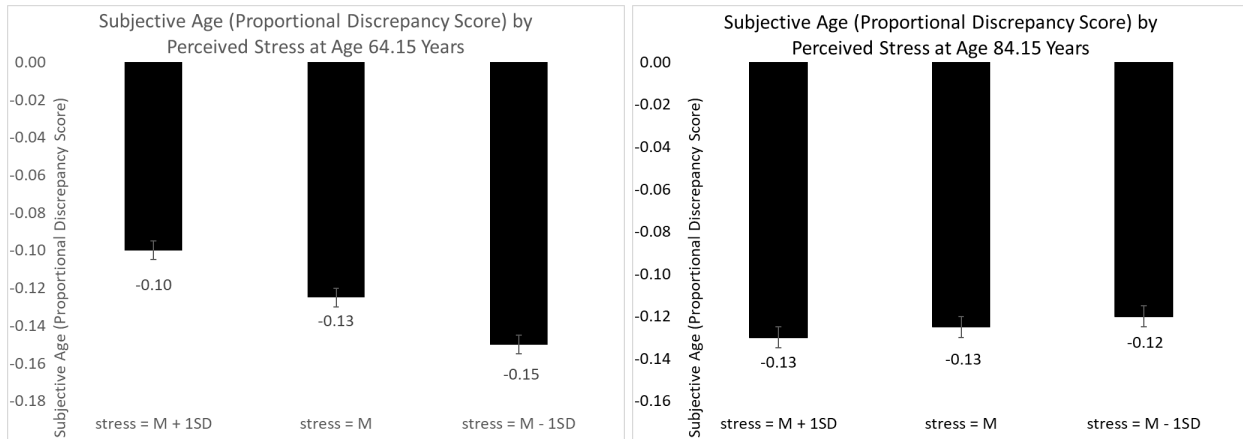


Note. ATOA = attitude toward own aging. Covariates controlled for: perceived stress (2014), subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and year of first study participation (1996, 2002, 2008 or 2014). Error bars indicate the standard error of the estimated effects.

Generally, perceived stress decreases with age and is higher among individuals aged 64.15 years (which corresponds to the grand-mean age) than among those who are 20 years older (i.e., 84.15 years, almost 2 standard deviations above the grand-mean age). In addition, the association of lower ATOA scores (assessed in 2014) with higher stress in 2017 is stronger at age 64.15 years (left figure) than at older ages (right figure).

Figure 3

The Effect of Perceived Stress (Assessed in 2014) on Subjective Age (Assessed in 2017) by Chronological Age



Note. Covariates controlled for: subjective age (2014), subjective health, depressive symptoms, education, gender, region of residence (West vs. East Germany), and year of first study participation (1996, 2002, 2008 or 2014). Error bars indicate the standard error of the estimated effects.

The association of perceived stress with subjective age is weaker at older ages. Among individuals aged 64.15 years (which corresponds to the grand-mean age), those whose stress level in 2014 is one standard deviation below the sample mean report feeling 15% younger than their age in 2017, whereas those with a 2014 stress level that is one standard deviation above the sample mean feel only 10% younger than their age (left figure). Among individuals who are 84.15 years (almost 2 standard deviations above the grand-mean age), that is 20 years older than the mean age, stress is less strongly related with subsequent subjective age: Independent of prior stress, these individuals feel 12-13 % younger than their age (right figure).