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Longitudinal Change of Self-Perceptions of Aging and Mortality

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Objective. To understand the association between self-perceptions of aging (SPA) and mortality in late life.

Method. The sample (n = 1,507) was drawn from the Australian Longitudinal Study of Aging (baseline age = 65–103 years). We used joint growth curve and survival models on 5 waves of data for a period of 16 years to investigate the random intercept and slope of SPA for predicting all-cause mortality.

Results. The unadjusted model revealed that poor SPA at baseline, as well as decline in SPA, increased the risk of mortality (SPA intercept hazard ratio [HR] = 1.21, 95% confidence interval [CI] = 1.13, 1.31; SPA slope HR = 1.17, 95% CI = 1.02, 1.33). This relationship remained significant for the SPA intercept after adjusting for other risk factors including demographics, physical health, cognitive functioning, and well-being.

Conclusion. These findings suggest that a single measurement of SPA in late life may be very informative of future long-term vulnerability to health decline and mortality. Furthermore, a dynamic measure of SPA may be indicative of adaptation to age-related changes. This supports a "self-fulfilling" hypothesis, whereby SPA is a lens through which age-related changes are interpreted, and these interpretations can affect future health and health behaviors.

Key Words: Joint random effects—Mortality—Self-perceptions of aging—Time-to-event modeling.

SELF-PERCEPTIONS of aging (SPA), a measure of satisfaction with one's own aging, is hypothesized to reflect adaptation to age-related changes (Levy, 2009). SPA is associated with physical and cognitive functioning outcomes, well-being, and life satisfaction in late life, and it has been shown to be predictive of all-cause mortality for more than 23 years (Levy, Slade, Kunkel & Kasl, 2002; Uotinen, Rantanen, & Suutama, 2005). However, as the investigation of SPA and its influence on aging outcomes is a relatively new research area, it is not yet clear why SPA predicts mortality in older adults.

In the Stereotype Embodiment Theory, Levy (2009) proposes that SPA is a manifestation of internalized age stereotypes. SPA becomes a lens through which age-related changes are interpreted and their causes attributed, and it can result in a self-fulfilling prophecy, particularly surrounding health outcomes in late life. In support of the self-fulfilling pathway, Levy, Zonderman, Slade, and Ferrucci (2009) found that negative age stereotypes in early adulthood (aged 18–49 years) predicted cardiovascular events (including angina attacks, congestive heart failures, myocardial infarctions, strokes, and transient ischemic attacks) for a 38-year period. Negative age stereotypes heighten cardiovascular response to stress (Levy, Haursdorff, Hencke, & Wei, 2000) and adversely influence recovery from cardiovascular events (Levy, Slade, May, & Caracciolo, 2006). Furthermore, poor expectations and perceptions of aging are associated with reduced likelihood of performing preventive health behaviors in older adults (Levy & Myers, 2004; Sarkisian, Prohaska, Wong, Hirsch, & Mangione, 2005).

The self-fulfilling prophecy hypothesis therefore represents a developmental, life-span framework to guide investigation of the SPA–mortality relationship. Hence, when investigating, the predictive quality of SPA for mortality consideration should be given to temporal dependencies between measurement of SPA and event occurrence. Within a life-span framework, the notion of a reciprocal loop between perceptions of aging and experience of health change suggests that a dynamic model of SPA may be more appropriate in understanding the predictive nature of SPA. Cross-sectional and longitudinal studies suggest that SPA does not remain stable across the life span (Kleinspehn-Ammerlahn, Kotter-Grühn, & Smith, 2008; Sargent-Cox, Anstey, & Luszcz, 2012a); therefore, using a single-occasion measurement of SPA to predict mortality may not take into account the interactions of individuals' health trajectories and their attribution of change to aging processes. In support of the dynamic nature of SPA, the difference in SPA scores for a period of 4 years (i.e., SPA score at Time 2 minus score at Time 1) has been shown to predict mortality in older adults for a 16-year period (Kotter-Grühn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009).

Recent advances in longitudinal modeling provide the opportunity to jointly model longitudinal and time-to-event data (Muthén, Asparouhov, Boye, Hackshaw, & Naegeli,

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2009). The advantage of this approach over traditional time-to-event models is that it takes into account individual trajectories of the predictor variable and allows inferences to be made regarding the association of change in one variable on time-to-event status, such as death. Furthermore, these models have been argued to hold several advantages over a two-stage process (where fitted trajectories are subsequently incorporated into the time-to-event model), including the ability to address informative censoring that results from longitudinal observations, the ability to account for measurement error thereby reducing bias, and greater statistical efficiency as a result of the simultaneous modeling of the data (Wang, Shen, & Boye, 2012).

Therefore, the substantive aim of this study is to examine the dynamic hypothesis of SPA on mortality in late life. This investigation will make a unique contribution by using a joint latent growth and survival analysis model, whereby we can simultaneously model the random effects of the intercept and slope of SPA on mortality. We will include demographic, health, cognitive, and psychological indicators in a hierarchical model to examine the predictive quality of SPA above and beyond these known mortality risk factors. Based on the life-span framework of Levy's (2009) self-fulfilling prophecy, it is hypothesized that a decline in SPA over time (slope) will be a stronger predictor of mortality than a single measure at baseline (intercept).

Method

Sample

The sample was drawn from the Australian Longitudinal Study of Aging (ALSA); a large representative study whose sampling and design have been fully described elsewhere (Luszcz, Giles, Browne-Yung, & Hayles, 2007). Briefly, of the 2,703 individuals identified as eligible (at least 70 years as at June 30, 1992), 55% (n = 1,477) agreed to participate. Inclusion of partners (65 years and older) and coresidents (70 years and older) bought the total baseline sample size to 2,087. Data were collected through home-based interviews, self-completed questionnaires, and clinical assessments. The measurement occasions used in this study were collected at waves 1 (1992–1993), 3 (1994–1995), 6 (2000–2001), 7 (2003–2004), and 9 (2007–2008). Participants were included if they had at least one measure of SPA (n = 1,507).

Measures

Outcome measure.—Mortality status was established through searches of official death certificates conducted by the Epidemiological Branch of the Department of Health in South Australia and was confirmed by the South Australian Births, Deaths and Marriage bureau. During the period from 1992 to 2010, of the baseline sample selected here (n = 1,507), 1,058 deaths were recorded (70.2% of sample; 56.9% males). The average age at death was 87.43 (SD = 6.21) years and the mean distance to death from baseline was 8.73 (SD = 4.52) years.

Self-perceptions of aging.—SPA was measured with the Attitudes Toward Own Aging subscale from Lawton's (1975) Philadelphia Geriatric Centre Morale Scale at all five waves. Respondents indicated whether they agreed or disagreed with five items that include "Things keep getting worse as I get older" and "I am as happy now as I was when I was younger." Higher scores indicated more negative perceptions of aging. The scale has been used previously (Kleinspehn-Ammerlahn et al., 2008; Kotter-Grühn et al., 2009; Levy, Slade, & Kasl, 2002) and showed moderate internal consistency across measurement occasions in the current sample (Cronbach $\alpha = 0.61$–0.64).

Control variables.—Demographic variables included gender, age at baseline, number of years of education (≤14 years vs. ≥15 years education), and partner status (partnered vs. not).

An aggregate unweighted score of number of medical conditions was calculated for each respondent. Physical functioning was assessed using a version of the Older American Resources and Services (OARS) activities for daily living (ADLs) measure (Fillenbaum, 1988). Higher scores reflect more ADL difficulties. Global self-rated health (SRH) was measured with the question "How would you rate your overall health at the present time?" (1 = excellent to 5 = poor).

Cognitive functioning was measured with the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), which assesses orientation to place and time, attention and calculation, and memory recall. The MMSE has been shown to have satisfactory reliability and construct validity and displays a high degree of sensitivity for moderate-to-severe cognitive impairment (Tombaugh & McIntyre, 1992). Psychological functioning was measured with the Centre for Epidemiology Depression Scale (CES-D; Radloff, 1977). Higher summed scores are indicative of more depressive symptoms. The CES-D has been used widely for older adult samples to measure well-being and has been shown to have good criterion validity for sensitivity in identifying depression in older adult (Beekman et al., 1997). Internal validity for this scale is reported to be between $\alpha = 0.84$ and $\alpha = 0.85$ (Radloff, 1977).

Statistical Analysis

Joint growth and survival analysis was used to simultaneously predict mortality from the random effects (intercept and slope) of the linear growth model (see Muthén et al. [2009] for details of the model specifications). There are two linked subcomponents to the joint model—the longitudinal random effect growth model, whereby a trajectory is specified, and the survival model, which is a proportional-hazard Cox regression with a nonparametric baseline hazard function. The models subcomponents are linked through the latent trajectory. The model is defined as an alternate Xu and Zeger (2001) model by Muthén and colleagues (2009).

The model uses a maximum likelihood estimation algorithm to accommodate for missing data and unbalanced cluster sizes (Muthén & Asparouhov, 2008). The strength of this method is individuals with one observation are included in the model. Participants with relatively less data make a smaller contribution to the estimation of the SPA trajectory than those with more observed data. Number of years from baseline interview until death or censorship was the measure for survival time in the models. Covariates at baseline were introduced into models in a hierarchical approach to examine the inclusion of demographics, health variables, and cognitive and psychological variables on the relationship between the intercept and rate of change of SPA on survival. Mplus (version 6.11) was used for all analysis (Muthén & Muthén, 1998–2011).

Results

The sample descriptive statistics for the variables used in the models are shown in Table 1. To test sample bias created by exclusion as described previously, differences in predictors at baseline were tested. Excluded participants were more likely to be older at baseline ($t(2085) = 13.92$, $p < .001$, $d = 0.68$), have less education ($\chi^2(1) = 20.53$, $p < .001$, $\phi = .10$), no partner ($\chi^2(1) = 50.17$, $p < .001$, $\phi = 0.16$), poorer SRH ($t(2079) = -7.312$, $p < .001$, $d = -0.36$), poorer physical functioning ($t(2085) = 7.50$, $p < .001$, $d = 0.37$), greater number of depressive symptoms ($t(2062) = 7.43$, $p < .001$, $d = 0.37$), and poorer cognitive functioning ($t(2042) = -14.28$, $p < .001$, $d = -0.71$).

Table 2 shows the hazard ratios (HRs) estimated for the joint growth and survival models predicting mortality. Both the SPA intercept and slope were found to significantly predict mortality in the unadjusted model (Model 1). Including demographic variables in Model 2 attenuated the effect of change in SPA on mortality; however, initial SPA scores remained a significant predictor of mortality. Being older, male, and having less than 15 years education were all significant predictors of mortality in this model. The only other significant predictor within the models was SRH, with the estimates indicating that more positive SRH at baseline reduced the mortality risk over time.

Overall, a stronger association with mortality was found for the initial (intercept) level of SPA than for rate of change in SPA, with a one point higher score at baseline in SPA increasing the mortality risk for more than 16 years by 12% in the fully adjusted model (Model 4).

Discussion

Replicating previous research, we found that baseline SPA predicted mortality after adjusting for other mortality risk factors. Extending previous research, we showed that trajectories of SPA for a 16-year period predicted mortality, though the inclusion of demographic information into the models appeared to attenuate the predictive effect of SPA slope on mortality (Model 2). This is in contrast to previous research that has shown change scores in SPA between two time points is predictive of mortality after controlling for age, gender, socio-economic status (composite measure that included education), comorbidity, and dementia (Kotter-Grühn et al., 2009).

Differences in the modeling of SPA over time between this study and previous may contribute toward an explanation of these conflicting findings. The major contribution of this study was the advanced statistical approach that used a latent variable approach modeling change over five waves in SPA providing rich information on the longitudinal trajectories of SPA over time. This method extends Kotter-Grühn and colleagues (2009) work by capturing not only the between-person, but also the within-person change in the trajectories

Table 1. Sample Descriptive Statistics for Variables used in Joint Models

	Baseline (n = 1,507)	Wave 3 (n = 1,356)	Wave 6 (n = 726)	Wave 7 (n = 458)	Wave 9 (n = 210)
Male (%)	50.5	49.5	42.8	38.0	34.8
Age, years, *M* (*SD*)	76.95 (6.14)	78.69 (6.11)	83.27 (5.34)	57.78 (4.73)	87.99 (3.83)
≥ 15 years education (%)	46.6				
Partnered (%)	70.1	61.6	47.1	38.8	31.6
Number of medical conditions, *M* (*SD*)	2.90 (2.10)	4.00 (2.82)	4.03 (2.82)	5.29 (3.25)	4.19 (2.51)
Number of ADLs, *M* (*SD*)	0.27 (0.85)	0.84 (1.56)	1.25 (1.99)	0.85 (1.56)	1.42 (1.91)
Self-rated health, *M* (*SD*)	3.18 (1.11)	3.12 (1.04)	3.15 (1.056)	2.87 (0.96)	3.09 (0.92)
MMSE,[a] *M* (*SD*)	27.64 (3.08)	27.70 (2.29)	28.13 (2.15)	26.48 (2.71)	26.48 (2.71)
Depressive symptoms,[b] *M* (*SD*)	7.64 (7.02)	7.86 (7.11)	8.95 (6.67)	8.56 (7.47)	10.29 (7.32)
SPA, *M* (*SD*)	7.13 (1.47)	7.14 (1.55)	7.44 (1.54)	7.62 (1.48)	7.81 (1.51)

Notes. ADLs = activities for daily living; *M* = mean; MMSE = Mini-Mental State Examination; *SD* = standard deviation; SPA = self-perceptions of aging. Baseline data collected—Wave 1: 1992–1993; Wave 3: 1994–1995; Wave 6: 2000–2001; Wave 7: 2003–2004; and Wave 9: 2007–2008.

[a]MMSE was used as an indicator of cognitive functioning.

[b]Depressive symptoms—as measured by Center for Epidemiologic Studies Depression (CES-D) scale—was used as an indicator of psychological functioning.

Table 2. Model Estimates of the Effects of Self-Perceptions of Aging (SPA) Intercept and Slope Predicting Mortality

	Model 1	Model 2	Model 3	Model 4
	HR (95% *CI*)	HR (95% *CI*)	HR (95% *CI*)	HR (95% *CI*)
SPA intercept	1.21*** (1.13,1.31)	1.18*** (1.09, 1.28)	1.13* (1.04, 1.24)	1.12* (1.02, 1.23)
SPA slope	1.17* (1.02, 1.33)	1.15 (0.99, 1.33)	1.12 (0.96, 1.30)	1.11 (0.96, 1.30)
Age		1.04*** (1.03, 1.05)	1.04*** (1.03, 1.05)	1.04*** (1.03, 1.05)
Female		0.82** (0.73, 0.93)	0.80** (0.71, 0.91)	0.80** (0.71, 0.91)
≥ 15 years education		0.84* (0.75, 0.95)	0.87 (0.77, 0.98)	0.86* (0.76, 0.98)
Partnered		1.09 (0.96, 1.25)	1.08 (0.95, 1.23)	1.09 (0.95, 1.24)
Number of medical conditions			1.00 (0.97, 1.03)	1.00 (0.97, 1.03)
Number of ADLs			1.04 (0.98, 1.11)	1.04 (0.98, 1.11)
Self-rated health			0.91* (0.85, 0.97)	0.91* (0.86, 0.98)
Cognitive functioning				1.00 (0.99, 1.01)
Psychological functioning				1.01 (0.99, 1.02)
AIC	23,634	23,587	23,584	23,587
BIC	23,698	23,672	23,685	23,699

Notes. ADLs = activities of daily living; AIC = Akaike's information criteria; BIC = Bayesian information criteria; CIs = confidence intervals; HR = hazard ratio. **p* < .05. ***p* < .01. ****p* < .001.

of SPA. The implication of the differences between the two studies' findings are that the short-term change in SPA (as in Kotter-Grühn and colleagues study–change for a period of 4 years measured at two occasions) may be more indicative of an increased risk of mortality compared with the long-term change (for more than 16 years in this study). This is likely due to taking into account the within-person variability in SPA trajectories on more than five measurement occasions capturing the ongoing adaptation to the aging process and health changes that occurred in this late-life sample for a period of 16 years, which would not be captured when measuring only two time points.

Another consideration regarding the modeling of SPA over time is the reduced power for the slope effect found in this study, which is most likely related to attrition over the 16-year study period. This notion is supported by the relatively small decrement in the HRs of the intercept and slope across models (Table 2), contrasted against the broadening of the confidence intervals [CIs] of the slope estimates in the adjusted models to include one. This broadening of slope CIs indicates a lack of power to efficiently model the estimates when adjusting for covariates. As discussed by Shaw and Liang (2012), the number of time points per person is an important factor, with more waves per person increasing precision of estimates and power (Hertzog, von Oertzen, Ghisletta, & Lindenberger, 2008). Care should therefore be taken not to over interpret the attenuation of the slope estimates for predicting mortality, and further work is needed to fully understand how within-person variability of SPA may affect health outcomes in late life.

Trajectories of SPA in older adults have shown greater variability in level and change over time (Kleinspehn-Ammerlahn et al., 2008; Kotter-Grühn et al., 2009; Sargent-Cox et al., 2012a), suggesting that, although there is a general trend for SPA to decline in late life, not all older adults conform to this declining pattern. Therefore, there are older adults who can maintain, and possibly even improve, their SPA across time. Levy (2009) argues that SPA encapsulates beliefs about aging and internalized attributions of physical health changes, particularly those that are related to age-associated decline. Research has shown that positive perceptions and attitudes toward aging can influence health events and changes in health (Sargent-Cox, Anstey, & Luszcz, 2012b; Wurm, Tesch-Römer, & Tomasik, 2007). The current findings, along with this previous research, suggest that a reciprocal loop between SPA and health experience may be particularly dependent on initial SPA. That is, those who develop positive perceptions of aging over the life course enter late life with a distinct advantage that may be protective against negative consequences of health change.

The potential mechanisms behind the protective effects of SPA have been well argued by Levy (2009) and Wurm, Tomasik, and Tesch-Römer (2008, 2010). Levy proposes that SPA is a lens through which age-related changes are interpreted, and these interpretations can affect future health and health behaviors through psychological and behavioral pathways. For example, older adults with positive SPA are more likely to perform preventive health behaviors and adhere to medical advice, thus improving health outcomes in general (Levy & Myers, 2004; Sarkisian et al., 2005; Wurm et al., 2010). Although we did not directly measure how older adults attribute health changes, our findings that SPA measured at baseline was an independent predictor of mortality in adjusted models indicates that SPA may be important for understanding adaptive capacity and future vulnerability to (or protection against) poor health behaviors and health outcomes. Furthermore, a dynamic measurement of SPA may also be an important indicator of an overall sense of how well one is adapting to aging processes.

Consideration should also be given to the robust dynamic relationship between perceptions of health status (i.e., SRH) and mortality in older adults that is evident in the literature (Han et al., 2005; Sargent-Cox, Anstey, & Luszcz, 2010). It is feasible that the reciprocal loop hypothesized here regarding SPA and health may also be reflected in a dynamic measure of SRH in late life. For example, SPA could influence SRH, which in turn predicts mortality. Although the effect of the SPA slope on mortality in this study was reduced prior to the introduction of SRH (i.e., in the second model that adjusted for demographic variables); the inclusion of SRH (and other health factors) in the third model did further attenuate the HR of the SPA slope, providing tentative support for the SPA–SRH relationship. Future research would benefit from examining the potential dynamic relationship between SPA and SRH and subsequent effects on health outcomes in older adults.

The large sample size and the age range of the ALSA data set at baseline (65–103 years) addresses challenges of generalizability of findings due to specific cohort effects, and the long follow-up period allows for long-term effects of SPA to be evaluated than that has been done previously. Limitations include baseline selection effects and possible sample attrition due to mortality and other causes. For example, the significant differences in characteristics of the excluded participants suggest a possible bias. Although the latent variable models correct for missingness bias as previously discussed, attrition across waves reduced power for the detection of an SPA slope effect on mortality after controlling for other mortality factors (Singer & Willett, 2003). Therefore, the finding that baseline SPA remained predictive for mortality after adjusting for other mortality risk factors suggests that our results are more likely to be an underestimation of effects.

In conclusion, the major contribution of our study is the joint modeling of longitudinal SPA for predicting mortality. We have shown that baseline SPA is a valuable predictor of future mortality risk. It is less clear from our findings the usefulness of the SPA trajectories for predicting mortality, as the dynamic measure may reflect adaptation to age-related health decline. These findings extend our current knowledge of SPA and provide interesting insight into the dynamic relationship between self-perceptions and attitudes about aging in late life. The use of a simple psychosocial measure, such as SPA, to identify older adults at risk of mortality is particularly interesting as it indicates two immediate benefits. First, it provides clinical importance in that health professionals could identify older adults at risk. Second, it affords opportunities to implement interventions that may reduce older adult's risk by promoting positive SPA.

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