

# Level and Change in Perceived Control Predict 19-Year Mortality: Findings From the Americans' Changing Lives Study

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Perceived control plays an important role for health across adulthood and old age. However, little is known about the factors that account for such associations and whether changes in control (or control trajectory) uniquely predict major health outcomes over and above mean levels of control. Using data from the nationwide Americans' Changing Lives Study (House et al., 1990;  $N = 2,840$ ,  $M$  age at T2: 56.32 years, range: 28–99, 64% women), we examined the extent to which mean levels and rates of change in perceived control over 16 years predict all-cause mortality over a 19-year follow-up period. Shared growth-survival models revealed that higher levels of and more positive changes in perceived control were associated with longer survival times, independent of sociodemographic correlates. We found that level effects of control were accounted for by well-being and health factors, whereas the change effects of control were not. Analyses also indicated an age-differential pattern, with the predictive effects of both levels and trajectories of control declining in old age. We discuss possible pathways through which perceived control operates to facilitate key health outcomes and consider how their malleability and effectiveness may change with increasing age.

*Keywords:* sense of control, longevity, adulthood and old age, Americans' Changing Lives Study, growth-survival models

Perceived control facilitates positive health outcomes across adulthood and old age (Baltes & Baltes, 1986; Bandura, 1997; Lachman, 2006; Rowe & Kahn, 1987; Skaff, 2007; Uchino, 2006). Empirical evidence suggests that perceiving more control over one's life is protective against declines in physical functioning (Caplan & Schooler, 2003; Gerstorf, Röcke, & Lachman, 2011; Lachman & Agrigoroaei, 2010; Seeman, Unger, McAvay, & Mendes de Leon, 1999), progression of disease burden (Infurna, Gerstorf, & Zarit, 2011; Thompson & Spacapan, 1991), cardio-

vascular disease incidence (Boehm & Kubzansky, 2012; Rosengren et al., 2004; Stürmer, Hasselbach, & Amelang, 2006) and mortality (Infurna, Gerstorf, Ram, Schupp, & Wagner, 2011; Krause & Shaw, 2000; Penninx et al., 1997; Seeman & Lewis, 1995; Surtees et al., 2006, 2010). Conceptual models of control suggest that emotional, behavioral, social, and health pathways account for control–health associations (Bandura, 1997; Lachman, 2006; Rodin, 1986), but research testing the pathways in a conjoint manner is largely lacking. As well, empirical research linking control to mortality in adulthood and old age has not made use of longitudinal assessments of control (for a notable exception, see Eizenman, Nesselroade, Featherman, & Rowe, 1997). Using data from the adult sample of the nationwide Americans' Changing Lives (ACL) study (House et al., 1990), we examine whether levels and rates of change in perceived control predict all-cause mortality over a 19-year follow-up period and test whether psychosocial and health factors account for this association. We also consider whether levels and rates of change in perceived control show differential associations with mortality across chronological age.

## Associations Between Perceived Control and Mortality

Perceptions of control are individuals' beliefs about their capability to exert influence over and shape one's life circumstances (Pearlin & Schooler, 1978; Skinner, 1996). Empirical evidence from large panel surveys of middle-aged and older adults suggests that more perceived control is linked to greater probability of

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survival over follow-up periods ranging from 2.5 years (Penninx et al., 1997) and 4.8 years (Surtees et al., 2006) to 11.3 years (Surtees et al., 2010) and 14 years (Infurna, Gerstorf, et al., 2011). Similarly, in various patient populations, such as those diagnosed with coronary artery disease, cancer, or amyotrophic lateral sclerosis, and those on dialysis, higher levels of perceived control are associated with an increased likelihood of survival (Brown, Levy, Rosberger, & Edgar, 2003; Helgeson, 2003; Kutner, Brogan, & Fielding, 1997; McDonald, Wiedenfeld, Hillel, Carpenter, & Walter, 1994).

Conceptually, perceived control partially overlaps with conscientiousness and its facets (Chapman, Roberts, & Duberstein, 2011; Costa & McCrae, 1992). For example, competence and self-discipline map onto conceptual depictions of perceived control (Lachman, Neupert, & Agrigoroaei, 2011; Skinner, 1996), such that people who perceive themselves in control over their lives are more likely to report feelings of competence (i.e., capacity beliefs) and contingency (i.e., strategy beliefs). Empirical findings suggest that conscientiousness and perceived control are moderately correlated ( $r$ s range from .19 to .40; see Hirschi, 2008; Rossier, Rigozzi, & Berthoud, 2002; Trautwein, Lüdtke, Roberts, Schnyder, & Niggli, 2009), signifying that there is some overlap, but the constructs tap into distinct sources of information. Research linking perceived control to survival across different study populations dovetails with research linking conscientiousness to survival in adulthood and old age (Chapman et al., 2011; Deary, Weiss, & Batty, 2010). Empirical evidence suggests that people who perceive more control as well as those who are more conscientious have an increased likelihood of taking part in health-promoting behaviors (Bogg & Roberts, 2004; Lachman & Firth, 2004) and living a longer life (Caspi, Roberts, & Shiner, 2005; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007). A meta-analysis by Kern and Friedman (2008) demonstrated that people who reported more conscientiousness, achievement (i.e., persistent, industrious), and orderliness (i.e., organized, disciplined) were more likely to live a longer life. Similarly, research from the Terman sample (Friedman et al., 1995) showed that both higher levels of and stability in conscientiousness over time were associated with survival (Martin, Friedman, & Schwartz, 2007).

### Factors Underlying Associations Between Perceived Control and Mortality

Conceptual frameworks suggest that perceived control facilitates positive health through a variety of mechanisms, including emotion regulation, engagement in health-promoting behaviors, social support, and subjective and cardio-metabolic health (Bandura, 1997; Lachman, 2006; Uchino, 2006). First, perceived control may support positive health through emotion regulation. In particular, feeling in control often helps people adapt to critical life events and setbacks and down-regulate negative emotions (Lang & Heckhausen, 2001; Windsor & Anstey, 2010), processes that impact biological health and distal health outcomes such as mortality (Danner, Snowdon, & Friesen, 2001; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; Pressman & Cohen, 2005). Second, perceived control likely supports individuals' view that their health as controllable and thus facilitates adoption and maintenance of health-promoting behaviors such as exercising regularly, engaging in preventive care, and eating a proper diet (Infurna, Gerstorf, &

Zarit, 2011; Lachman & Firth, 2004; White, Wójcicki, & McAuley, 2012). Third, control beliefs may allow people to mobilize social support, particularly in times of strain, thereby serving as a buffer against the effects of stress (see Antonucci, 2001; Cohen & Wills, 1985; Heckhausen & Schulz, 1995; Lang, Featherman, & Nesselrode, 1997). Finally, perceived control may distally impact mortality through self-perceptions of health and physical functioning and direct modulation of biological function, such as cardio-metabolic risk (Roepke & Grant, 2011). In sum, higher levels of perceived control have been linked to better functional health and lower cardio-metabolic risk in children, caregivers, and middle-aged and older adults (Gale, Batty, & Deary, 2008; Infurna & Gerstorf, 2012; Nabors, McGrady, & Kichler, 2010; Roepke et al., 2011).

### Change in Perceived Control and Mortality

Previous research using facets of control to predict mortality has primarily focused on individuals' level of perceived control at one point in time. A notable exception is research from the Cornwall Manor Study, where researchers used 26 weekly assessments of perceived control to compute overall within-person mean and variability (within-person standard deviation) scores to predict 5-year mortality (Eizenman et al., 1997). In particular, this study found that greater week-to-week variability in perceived control was uniquely associated with higher mortality risk, beyond the risks associated with individuals' mean levels of perceived control. The prevailing interpretation is that greater week-to-week variability in perceived control reflects inconsistencies in an individual's ability (or the perceptions thereof) to shape life circumstances. Even though the mechanisms underlying week-to-week fluctuations in perceived control may differ from those underlying fluctuations or changes in perceived control across other time scales, these findings illustrate the importance of examining how changes in perceived control are related to health outcomes.

We examine whether the extent to which perceptions of control change over 16 years, labeled *control trajectory*, is uniquely associated with mortality risk. Perceptions of control assessed at one point in time can be taken to represent the culmination of one's prior and current (and anticipated future) perceptions of experiences, interactions, contexts, health, and life events (Pearlin, Nguyen, Schieman, & Milkie, 2007). Over and above level assessments and within-person variability in perceived control, positive or negative control trajectories that manifest across several years may reflect meaningful shifts in individuals' perceived ability to attain desired outcomes in the context of changing living conditions. We argue that control trajectory captures additional information relevant to the prediction of mortality. For example, individuals who experience a positive control trajectory may have the impression that they have better chances to attain desired outcomes. This is likely to occur in earlier stages of the lifespan, such as in adolescence and young adulthood, when perceptions of control are often fostered through mastery experiences and goal achievements (Dweck & Leggett, 1988; Heckhausen, Wrosch, & Schulz, 2010; Skinner, 1995). In contrast, age-related declines in perceived control over time (i.e., a negative control trajectory) may indicate that individuals perceive fewer and fewer possibilities to actually exert influence over life circumstances, whereas the importance of external factors or constraints, such as powerful others

or chance, are on the rise (Lachman, Rosnick, & Röcke, 2009). For example, individuals approaching old age may perceive that health declines are not preventable and one cannot do anything to protect against them (cancer diagnosis; Ranchor et al., 2010). Common control-threatening experiences in midlife are job loss or becoming a caregiver for a loved one (Skaff, Pearlin, & Mullan, 1996).

There may be several pathways for why changes in perceived control over time have health implications in adulthood and old age. First, increases in individuals' ability to view their health as controllable and acknowledgment that health is a lifelong process may lead to persistent engagement in health-promoting behaviors and better management of health over time. Second, declines in perceived control may be a proxy for reduced social network integration (Gerstorf et al., 2011; Infurna, Gerstorf, et al., 2011). As a consequence, individuals may not be able to mobilize social support that would buffer against stress and protect against vulnerabilities arising from health decrements. Third, declines in perceived control may result in viewing the world as being fatalistically ruled and not contingent on one's behaviors, resulting in poorer mental health (e.g., increased depressive symptoms and negative affect), which would also undermine health (Peterson & Seligman, 1984). In sum, changes in perceived control may have substantial health implications distinct from individuals' level of perceived control. Where people are headed or have come from makes a difference. To test this notion, we examine whether rates of change in perceived control or control trajectory is uniquely predictive of mortality risk, beyond individuals' levels of perceived control and a variety of other factors.

### Age Differences in Associations Between Perceived Control and Mortality

Cross-sectional and longitudinal reports reveal that perceptions of control follow a nonlinear pattern across adulthood and old age. Initial cross-sectional research showed that compared to people in young adulthood and midlife, people in old age, on average, reported lower levels of perceived control (Lachman & Firth, 2004; Ross & Mirowsky, 2002). Longitudinal evidence has confirmed cross-sectional findings showing that perceived control increases in young adulthood, remains relatively stable in midlife, and shows declines in old age (Lachman et al., 2009; Mirowsky & Ross, 2007; Specht, Egloff, & Schmuckle, 2012). Differences in the developmental pattern of perceived control may have implications for its health consequences. Along the lines suggested by Lachman (2006) and Rodin (1986), the control–health association may be stronger in older ages where maintenance of perceived control is an adaptive capacity to help buffer against health challenges and chronic illnesses leading to death. For example, empirical evidence from adult lifespan samples suggests that the protective effect of perceived control on health declines is stronger in older ages (Caplan & Schooler, 2003; Lachman & Agrigoroaei, 2010). Conversely, in earlier phases of the lifespan, growth or fostering of one's control beliefs may be an important step that sets a person on a positive health trajectory for later in life through its influence on mechanisms linking perceived control to health (Infurna, Gerstorf, & Zarit, 2011; Smith & Infurna, 2011). For example, research from the 1970 British Cohort study and Dunedin study showed that higher locus of control in adolescence was associated with lower psychological stress, cardio-metabolic risk,

inflammation, and likelihood of obesity in young adulthood (Gale et al., 2008; Moffitt et al., 2011).

The direction and antecedent conditions for within-person change in perceived control may differ depending upon where a given person is located in his or her lifespan. For example, Gatz and Karel (1993) examined changes in perceived control over 20 years of time and found that young adults were more likely to experience increases in internal control as they progressed into middle age. In contrast, external control was found to increase over time for older adults. In young adulthood and midlife, increases in perceived control may be due to educational context, transitioning into the workforce and social investment in relationships, which constitute key sources of perceived control (Eccles & Wigfield, 2002; Heckhausen et al., 2010; Pearlin, 2010; Roberts, Wood, & Smith, 2005). Furthermore, changes in perceived control may be the result of various life events and health-related illness. For example, perceived control has been shown to decline in individuals diagnosed with cancer (Ranchor et al., 2010) and in caregivers caring for a loved one with dementia (Infurna, Gerstorf, & Zarit, 2012; Skaff et al., 1996). Over a 1-year time frame, Wolinsky, Wyrwich, Babu, Kroenke, and Tierney (2003) observed that perceived control showed gradual declines among patients from two medical centers. It may be that in young adulthood and midlife, individuals have more control-enhancing opportunities, whereas in old age, individuals encounter more control-restricting circumstances (Wolinsky et al., 2003). Less is known, however, about the significance and functional implications arising from these differential change trajectories in perceived control. We aim to extend these earlier reports by examining whether levels and trajectories of perceived control have differential implications for survival across the adult lifespan.

### The Present Study

Our objective is to examine the extent to which levels of and trajectories of perceived control predict all-cause mortality, uniquely from other psychosocial and health factors. We also examine the extent to which levels of and trajectories of perceived control show age-differential associations with survival. To do so, we use data from the nationwide adult lifespan sample of the Americans' Changing Lives (ACL) study. First, we test whether levels of and trajectories of perceived control predict mortality over a 19-year follow-up period and examine whether indicators of well-being (life satisfaction, depressive symptoms), physical activity, social support, and health (self-rated health, functional limitations, number of health conditions) account for such associations. Consistent with previous research, we hypothesize that higher levels of perceived control are associated with lower mortality hazards, independent of sociodemographics (Infurna, Gerstorf, et al., 2011; Penninx et al., 1997; Surtees et al., 2006, 2010). We expect that well-being, physical activity, social support, and health factors will largely account for links between levels of perceived control and mortality. We also expect that control trajectories will provide unique predictive ability for mortality, independent of known correlates of mortality. Second, we test the extent to which level and rates of change in perceived control (control trajectory) provide differential predictive utility across chronological age, over and above known correlates of mortality. We hypothesize that levels of perceived control will be more

strongly linked to survival in older ages, whereas control trajectory will show stronger associations with survival in midlife.

## Method

### Participants and Procedure

We analyzed data from the ACL study, which assessed a wide range of sociological, psychological, and physical health measures from a nationally representative stratified probability sample of U.S. residents aged 25 years and older (House et al., 1990) with oversampling of African Americans and individuals age 60 years and older. The study spans 16 years with four repeated measures collected in 1986 ( $n = 3,617$ ), 1989 ( $n = 2,867$ ), 1994 ( $n = 2,653$ ), and 2002 ( $n = 1,787$ ).

For the present study, we analyzed data from the 2,840 participants who provided valid responses on (a) the measure of perceived control at Waves 1 and 2 and (b) the covariates at Wave 2. Table 1 shows descriptive statistics for all measures under study at Wave 2. Participants in the analysis sample were at Wave 2, on average, 56 years of age ( $SD = 17.08$ , range 28–99), had attained 11.48 years of education ( $SD = 3.37$ , range 0–17), 64% were women, and 67% were White (with the remainder 30% African American, 1% American Indian, 1% Asian, and 1% Hispanic). Relative to participants who did not provide data at Wave 2 and those not included because of incomplete data on some of the target variables, our subsample was younger at Wave 1 ( $M = 52.31$ ,  $SD = 17.07$  vs.  $M = 56.31$ ,  $SD = 19.27$ ),  $F(1, 3615) = 22.86$ ,  $p < .05$ ; included more women (64% vs. 57%),  $\chi^2(1, 3615) = 10.81$ ,  $p < .05$ ; had attained more years of education ( $M = 11.72$ ,  $SD = 3.36$  vs.  $M = 10.54$ ,  $SD = 3.71$ ),  $F(1, 3615) = 71.67$ ,  $p < .05$ ; and were more likely to be White (67% vs. 55%),  $\chi^2(1, 3615) = 35.30$ ,  $p < .05$ . The relatively small differences in substantive terms ( $\eta^2 < .02$  for all comparisons) suggest that the study sample is reasonably comparable to the population from which it was drawn. The ACL study has continually tracked mortality status, with the latest update obtained in 2008. Over the 19-year follow-up period, 993 participants (or 35%) in our subsample died.

### Measures

**Mortality.** Timing of death for deceased participants was obtained through the National Death Index by ACL staff (House, 2002). The 993 deceased participants were, on average, 70.12 years of age in Wave 2 ( $SD = 12.33$ , range 29–99) and died 8.26 years later ( $SD = 4.64$ , range 0–17). At the time of death, seven participants (0.70%) were in young adulthood (aged 30–39), 172 participants (17.30%) were in midlife (aged 40–69), and 814 participants (82.00%) were in old age (aged 70 and older). This mortality by age distribution is in line with population-wide mortality hazards, which are generally low for population segments aged 70 years and younger (Arias, 2010). Information on specific causes of death was not available.

**Perceived control.** Perceived control was assessed at each of the four waves using six items from the Pearlin Mastery Scale (Pearlin & Schooler, 1978;  $\alpha$  at each wave ranged from .64 to .67). Items asked participants to rate the extent to which they believe their life is under their own control (e.g., “I can do just about anything I really set my mind to do”) using a 4-point Likert scale (1 = *strongly agree* to 4 = *strongly disagree*). Negatively valenced items were reverse coded so that higher scores indicated more feelings of control. On average, participants contributed 3.32 ( $SD = 0.79$ ) longitudinal observations, with each participant providing two or more repeated measures.

**Covariates.** Sociodemographic, psychosocial, and health variables, as assessed at Wave 2, were included in our models to examine whether those factors accounted for any noted associations between levels of and changes in perceived control and mortality risk. Life satisfaction was measured with a single item, “How satisfied are you with life as a whole?” that was answered on a 5-point Likert scale (1 = *completely satisfied* to 5 = *not at all satisfied*) and reverse coded so that higher scores reflect more positive assessments of one’s life. Depressive symptoms were measured as the average of responses to 11 items from the Center for Epidemiologic Studies–Depression Scale (CES-D; Radloff, 1977). Participants rated how often they had experienced each feeling during the previous week using a 3-point Likert scale (1 = *hardly ever* to 3 = *most of the time*;  $\alpha = .83$ ). Physical activity

Table 1  
Means, Standard Deviations, and Intercorrelations Between the Constructs Included in the Analyses

Construct	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11	12
1. Perceived control	3.31	0.54	—											
2. Age	56.32	17.08	-.08*	—										
3. Gender (0 = men)	0.64	0.48	-.08*	.11*	—									
4. Education	11.48	3.37	.22*	-.37*	-.06*	—								
5. Ethnicity (1 = White)	0.67	0.47	.12*	.06*	-.05*	.23*	—							
6. Life satisfaction	3.68	0.80	.19*	.14*	.003	-.07*	.08*	—						
7. Depressive symptoms	1.40	0.35	-.54*	-.01	.09*	-.21*	-.18*	-.22*	—					
8. Physical activity	2.58	0.79	.19*	-.23*	-.17*	.26*	.19*	.06*	-.25*	—				
9. Emotional support	4.04	0.74	.26*	.04*	.10*	.05*	.05*	.18*	-.28*	.12*	—			
10. Self-rated health	3.36	1.09	.35*	-.26*	-.10*	.29*	.11*	.13*	-.40*	.31*	.13*	—		
11. Functional limitations	1.52	0.87	-.26*	.40*	.14*	-.31*	-.07*	-.05*	.32*	-.39*	-.05*	-.52*	—	
12. Health conditions	1.39	1.40	-.23*	.49*	.15*	-.33*	-.09*	.003	.26*	-.25*	-.03	-.53*	.53*	—

Note.  $N = 2,840$ . Gender: men = 1,027; women = 1,813. Ethnicity: Other = 946, White = 1,894. All of the listed constructs were taken at the Wave 2 assessment.

\* $p < .05$ .



was measured with three items asking participants how often they work in the garden, engage in active sports, and take walks (see Parslow, Jorm, Christensen, & Mackinnon, 2006). Responses were given on a 4-point Likert scale (1 = *often* to 4 = *never*;  $\alpha = .46$ ) and reverse coded so that higher scores indicate more physical activity. Social support was measured using six items that assessed the degree of emotional support participants received from children, their spouse, and friends or relatives (see Fiori, Antonucci, & Cortina, 2006). Responses were provided using a 5-point Likert scale (1 = *not at all* to 5 = *a great deal*), with higher scores indexing more positive support ( $\alpha = .64$ ). Self-rated health was assessed using a single item, "How would you rate your health at the present time?" that was answered using a 5-point Likert scale (1 = *excellent* to 5 = *poor*) and reverse coded so that higher scores reflect more positive assessments of one's health. Functional limitation was measured as the average of responses to four items assessing the degree of difficulty individuals have completing everyday activities of daily living, including bathing, climbing stairs, walking several blocks and heavy housework. Participants rated how much difficulty they have completing each task using a 5-point Likert scale (0 = *no difficulty* to 5 = *cannot do*), with higher scores indicating more difficulty with everyday activities ( $\alpha = .77$ ). Number of *health conditions* was measured as the total number of conditions participants reported they were diagnosed with during the past year or were currently experiencing from a list of 10 health conditions: arthritis/rheumatism, lung disease, hypertension, heart attack and heart trouble, diabetes, cancer/malignant tumor, foot problems, stroke, fractures or broken bones, and loss of urine beyond one's control (see Shaw & Krause, 2001).

## Data Analyses

To examine whether levels of and trajectories of perceived control were predictive of 19-year between-person differences in hazards for all-cause mortality, we applied shared growth-survival models that simultaneously model longitudinal change in the targeted variable (i.e., perceived control) and the survival process (see Guo & Carlin, 2004; Henderson, Diggle, & Dobson, 2000; McArdle, Small, Bäckman, & Fratiglioni, 2005; Wang & Taylor, 2001). This shared parameters model simultaneously models the fixed and random effects for longitudinal change in perceived control with the survival process, which allows us to analyze data for all individuals (not just complete cases), consider unequal follow-up intervals, and estimate random effects of intercept and change, and allows for the intercept and slope parameters to be correlated with the outcome of interest (i.e., survival; Ghisletta, McArdle, & Lindenberger, 2006; Guo & Carlin, 2004; McArdle et al., 2005). Using Mplus (Asparouhov, Masyn, & Muthén, 2006; Muthén & Muthén, 1998–2007), we estimated a continuous-time survival analysis using a Cox regression model, where we modeled perceived control using two latent variables, intercept or levels at Wave 2, and slope or control trajectory, which represents 16-year time-related linear change.

The shared growth-survival model simultaneously estimates longitudinal change in perceived control and the survival process. The longitudinal model was specified as

$$y_{it} = \beta_{0i} + \beta_{1i}(\text{time in study}_{it}) + e_{it}, \quad (1)$$

where person  $i$ 's level of perceived control at time  $t$ ,  $y_{it}$ , is a function of an individual-specific intercept parameter that represents levels at Wave 2,  $\beta_{0i}$ ; an individual-specific slope parameter,  $\beta_{1i}$ , that captures rates of linear change per decade; and residual error,  $e_{it}$ . To facilitate interpretation, scores for perceived control were  $z$  standardized ( $M = 0$ ,  $SD = 1$ ) and change was modeled over time-in-study (−3, 0, 5, and 13 years) and divided by 10, so that linear change is interpreted as change per decade.

Following standard multilevel or latent growth modeling procedures (e.g., McArdle & Nesselroade, 2003; Ram & Grimm, 2007; Singer & Willett, 2003), individual-specific intercepts and slopes ( $\beta$ s from the Level 1 model given in Equation 1) were modeled as

$$\begin{aligned} \beta_{0i} &= \gamma_{00} + u_{0i}, \\ \beta_{1i} &= \gamma_{10} + u_{1i}, \end{aligned} \quad (2)$$

(i.e., Level 2 model), where  $\gamma_{00}$  and  $\gamma_{10}$  are sample means and  $u_{0i}$  and  $u_{1i}$  are individual deviations from those means. These between-person differences are assumed to be normally distributed, correlated with each other, and uncorrelated with the residual errors,  $e_{it}$ .

The survival model for Model 2 in Table 2 was specified as

$$\begin{aligned} h(t_{ij}) &= h_0(t_j) \times \exp(\alpha_1(\beta_{0i}) + \alpha_2(\beta_{1i}) + \alpha_3(\text{Age}_i) \\ &+ \alpha_4(\text{Gender}_i) + \alpha_5(\text{Education}_i) + \alpha_6(\text{Ethnicity}_i) \\ &+ \alpha_7(\text{Age}_i \times \beta_{0i}) + \alpha_8(\text{Age}_i \times \beta_{1i}) + \alpha_9(\text{Age}_i \times \text{Ethnicity}_i)). \end{aligned}$$

In Equation 3,  $h(t_{ij})$  is the hazard of individual  $i$ 's risk of dying at time  $t$ .  $h_0(t_j)$  is the general baseline hazard function, which is the likelihood of dying when all other predictors are set to 0.  $\alpha_1$  is the independent effects of (between-person) variations in levels of perceived control on hazards of mortality;  $\alpha_2$  is the independent effects of (between-person) variations in control trajectory on hazards of mortality;  $\alpha_3$  through  $\alpha_6$  represent the independent effects of age, gender, education, and ethnicity on hazards of mortality;  $\alpha_7$  through  $\alpha_9$  is the age moderation of the effects of levels of and trajectories of perceived control and ethnicity on hazards of mortality. Because levels of perceived control and control trajectory were estimated as latent variables within Mplus, the XWITH command was used to obtain the age interactions (see Muthén & Muthén, 1998–2007). In sum, the shared growth-survival model (or joint longitudinal and survival model) simultaneously modeled 16-year change in perceived control and estimated whether variations in levels of and rates of change in perceived control predicted 19-year mortality.

We fit seven models to examine (a) if level of perceived control and control trajectory were significant predictors of mortality hazard (Model 1), (b) if these predictive effects were independent of sociodemographics (Model 2), and (c) if these effects were accounted for by psychosocial and health factors (Models 3–7). Age interactions were tested for each predictor, and only interactions that were reliably different from zero were retained. To facilitate interpretation of the hazard ratios (HR) reported in Table 2, age, gender, education, and ethnicity were grand mean centered and scores for life satisfaction, depressive symptoms, physical activity, emotional support, self-rated health, functional limitations, and number of health conditions were  $z$  standardized ( $M =$

Table 2  
19-Year Mortality Risk as a Function of Levels of Perceived Control and Control Trajectory

Construct	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
				Hazard ratio [95% CI]			
Level perceived control	0.70* [0.62, 0.78]	0.74* [0.62, 0.87]	0.87 [0.72, 1.04]	0.77* [0.66, 0.91]	0.77* [0.65, 0.90]	0.96 [0.79, 1.17]	1.01 [0.82, 1.25]
Control trajectory	0.22* [0.13, 0.35]	0.27* [0.16, 0.47]	0.25* [0.14, 0.46]	0.32* [0.19, 0.56]	0.27* [0.16, 0.47]	0.21* [0.11, 0.44]	0.23* [0.11, 0.48]
Age		1.10* [1.09, 1.11]	1.14* [1.11, 1.17]	1.10* [1.09, 1.10]	1.10* [1.09, 1.11]	1.10* [1.09, 1.11]	1.14* [1.11, 1.17]
Gender		0.63* [0.55, 0.72]	0.61* [0.53, 0.70]	0.57* [0.49, 0.65]	0.64* [0.56, 0.74]	0.56* [0.49, 0.65]	0.54* [0.47, 0.62]
Education		0.96* [0.94, 0.97]	0.96* [0.94, 0.98]	0.96* [0.94, 0.98]	0.96* [0.94, 0.97]	0.97* [0.95, 0.99]	0.97* [0.95, 0.99]
Ethnicity		0.50* [0.41, 0.61]	0.52* [0.42, 0.63]	0.55* [0.45, 0.67]	0.51* [0.42, 0.61]	0.52* [0.42, 0.64]	0.55* [0.44, 0.67]
Life satisfaction			1.04 [0.94, 1.16]				1.08 [0.97, 1.21]
Depressive symptoms			1.21* [1.13, 1.30]				1.06 [0.98, 1.15]
Physical activity				0.78* [0.73, 0.83]			0.85* [0.79, 0.91]
Emotional support					0.92* [0.87, 0.98]		0.95 [0.89, 1.01]
Self-rated health						0.82* [0.76, 0.89]	0.85* [0.79, 0.92]
Functional limitations						1.30* [1.16, 1.45]	1.26* [1.13, 1.41]
Total number of health conditions						1.08* [1.002, 1.17]	1.09* [1.01, 1.18]
Age × Level perceived control		1.01* [1.003, 1.02]	1.01* [1.003, 1.02]	1.01* [1.004, 1.02]	1.01* [1.002, 1.02]	1.01 [0.998, 1.02]	1.01 [0.997, 1.020]
Age × Control trajectory		1.10* [1.07, 1.13]	1.10* [1.07, 1.13]	1.09* [1.07, 1.12]	1.10* [1.07, 1.13]	1.11* [1.07, 1.14]	1.11* [1.07, 1.15]
Age × Ethnicity		1.03* [1.02, 1.04]	1.03* [1.02, 1.04]	1.03* [1.02, 1.04]	1.03* [1.02, 1.04]	1.03* [1.02, 1.04]	1.03* [1.02, 1.04]
Age × Life satisfaction			0.99* [0.985, 0.997]				0.99* [0.984, 0.996]
Age × Functional limitations						0.99* [0.988, 0.999]	0.99* [0.986, 0.998]
Level perceived control	-0.02 (0.02)	-0.01 (0.02)	-0.01 (0.02)	Fixed effects: Estimate (SE)			
Control trajectory	-0.12* (0.02)	-0.07* (0.02)	-0.07* (0.02)	-0.01 (0.02)	-0.01 (0.02)	-0.01 (0.02)	-0.01 (0.02)
				-0.07* (0.02)	-0.07* (0.02)	-0.06* (0.02)	-0.06* (0.02)
Level perceived control	0.51* (0.02)	0.51* (0.02)	0.50* (0.02)	Random effects: Estimate (SE)			
Control trajectory	0.12* (0.02)	0.12* (0.02)	0.11* (0.02)	0.51* (0.02)	0.51* (0.02)	0.50* (0.02)	0.50* (0.02)
Covariance	-0.01 (0.01)	-0.02 (0.01)	-0.02 (0.01)	0.12* (0.02)	0.12* (0.02)	0.11* (0.02)	0.11* (0.02)
Residual variance	0.48* (0.01)	0.48* (0.01)	0.48* (0.01)	-0.02 (0.01)	-0.02 (0.01)	-0.02 (0.01)	-0.02 (0.01)
				0.48* (0.01)	0.48* (0.01)	0.48* (0.01)	0.48* (0.01)
Number of free parameters	8	15	18	Model fit statistics			
AIC	33,413	32,179	32,152	16	16	19	24
BIC	33,460	32,268	32,259	32,130	32,175	32,075	32,051
				32,225	32,270	32,188	32,194

Note.  $N = 2,840$  in total. Of those, 993 participants had died over the 19-year follow-up period. CI = confidence interval; AIC = Akaike information criterion; BIC = Bayesian information criterion. \* $p < .05$ .

0,  $SD = 1$ ). Therefore, the hazard ratios reported in Table 2 are interpreted with respect to a 1  $SD$  change.

## Results

### Associations Between Perceived Control and Mortality

Results from the shared growth–survival models of 19-year mortality incidences are shown in Table 2. First, we observed that perceived control was relatively stable over the course of the study, and there were substantial between-person differences in levels of perceived control and control trajectory (i.e., fixed and random effects in the bottom portion of Table 2). Furthermore, on the basis of the random effects parameters, the estimated correlation between levels of perceived control and control trajectory was  $r = -.04$ , suggesting that these two aspects of the trajectories were relatively orthogonal. At the zero-order level (Model 1), we found that higher levels of perceived control and a positive control trajectory were associated with lower hazard for mortality. Each one standard deviation increase in levels of perceived control was associated with an approximately 30% decreased likelihood of death. Each one standard deviation increase in control trajectory per decade was associated with an approximately 78% decreased likelihood of death. Figure 1 illustrates that perceiving more control over life circumstances (A) and experiencing more positive control changes over time (B) was associated with lower risks for dying.

### Factors Underlying Associations Between Perceived Control and Mortality

In Model 2, we included sociodemographic predictors of the mortality hazard. Results revealed that level of perceived control and control trajectory remained significant predictors of mortality, independent of age, gender, education, and ethnicity. Of note, we observed that the interactions between age and levels of perceived

control and age and control trajectory were reliably different from zero, indicating that levels of and trajectories of perceived control were more likely to be protective against mortality in younger ages, relative to older ages. Figure 2 illustrates the hazard ratios of levels of perceived control (A) and control trajectory (B) across chronological age, illustrating that the association of both level and trajectories of control with mortality is stronger in younger ages.

Subsequently, in Models 3, 4, 5, and 6, we included well-being, physical activity, social support, or health variables to assess whether and which of these factors accounted for associations between levels of perceived control and control trajectory with mortality. We observed that the inclusion of life satisfaction and depressive symptoms (Model 3) and self-rated health, functional limitation, and total number of health conditions (Model 6) attenuated the association between levels of perceived control and mortality to nonsignificance, suggesting that well-being and health factors may account for control–mortality associations. In contrast, the inclusion of physical activity (Model 4) and emotional support (Model 5) only slightly attenuated associations between levels of perceived control and mortality. The age by levels of perceived control interaction was attenuated to nonsignificance with the inclusion of health factors (Model 6). We also found that effect of control trajectory and its age interaction remained reliably different from zero with the inclusion of well-being, physical activity, social support, or health factors. In the final analysis (Model 7), we included all of the covariates to examine whether levels of perceived control and control trajectory (and their respective age interactions) uniquely predicted mortality risks over and above the other predictors. Results revealed that levels of perceived control and its age interaction were not independently related to mortality hazard. However, we observed that control trajectory and its age interaction remained reliably different from zero, suggesting that these constructs uniquely predict mortality hazards, independent of known correlates of mortality. Other significant predictors of

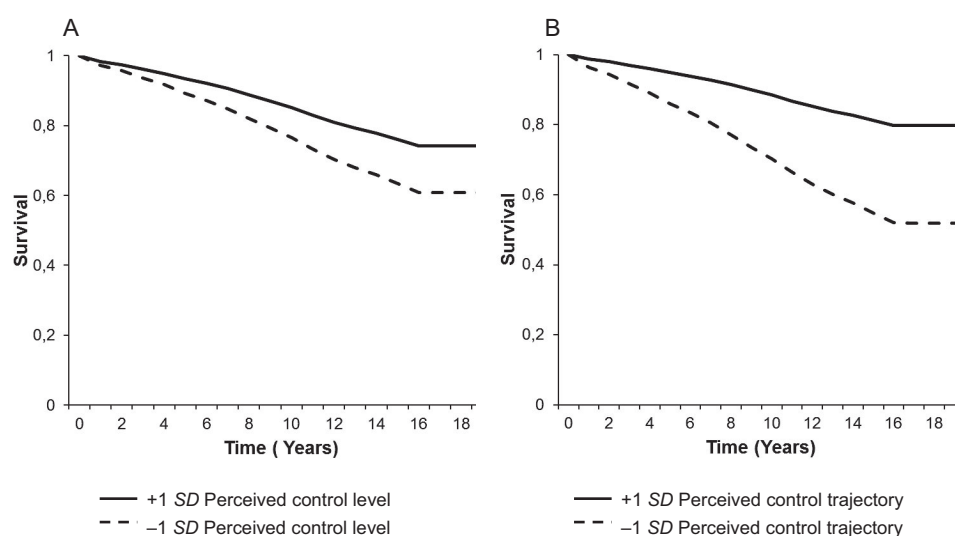


Figure 1. Illustration of the predictive effects of levels of perceived control (A) and control trajectory (B) for survival over 19 years among participants in the Americans' Changing Lives study. Higher levels of perceived control and more positive control changes were associated with a lower risk for mortality.

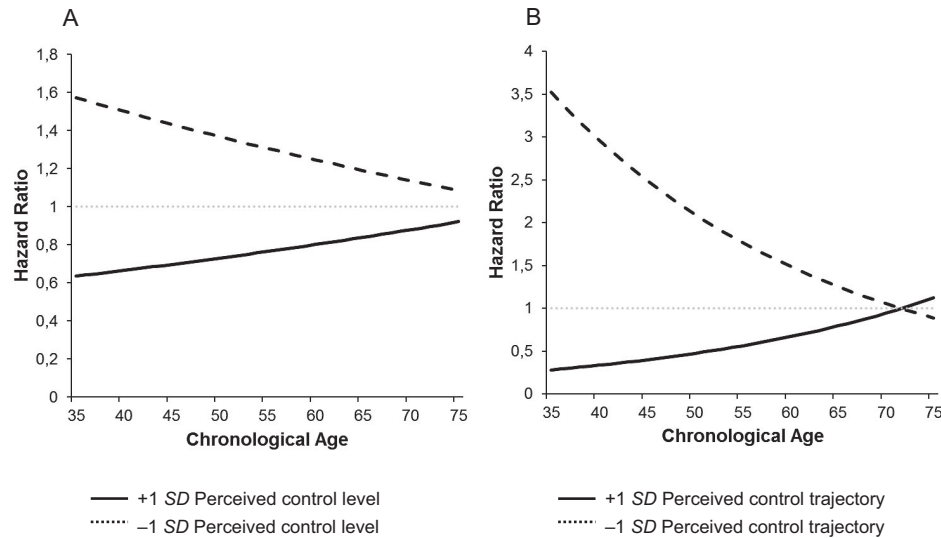


Figure 2. Illustration of interaction effects of age by levels of perceived control (A) and age by control trajectory (B) in predicting survival over 19 years among participants of the Americans' Changing Lives study. With increasing age, the predictive effects of both levels and trajectories of perceived control declines.

higher hazard of mortality in Model 7 included: older age, being a man, lower education, not being White, lower physical activity, lower self-rated health, and reporting more functional limitations and health conditions. Additionally, the age interactions with ethnicity, life satisfaction, and functional limitations were each reliably different from zero, suggesting that older people who are White and report lower life satisfaction and younger people who report fewer functional limitations have an increased likelihood for mortality.

Finally, we note that the Akaike information criterion (AIC) and Bayes information criterion (BIC) for Models 3–7 were lower compared to Model 2, indicating that these models provided a better fit to the data. Of the seven models tested, according to the AIC, Model 7 provided the most parsimonious fit to the data. In follow-up analyses, we tested whether the proportionality assumption held in our models. Cox regression models assume that the effect of each predictor is consistent or proportional over time (for discussion, see Cox, 1972; Singer & Willett, 2003). To do so, we included time interaction terms for the variables of interest and levels and trajectories of perceived control to determine whether the effects for each predictor from Model 7 differed over time (see Singer & Willett, 2003). We did not find evidence to suggest that the proportionality assumption was not met, suggesting that the effects of levels of perceived control and control trajectory were consistent over time.

## Discussion

The objective of the present study was to examine the extent to which levels of and trajectories of perceived control predicted 19-year mortality in adulthood and old age and whether the association was accounted for by differences in well-being, physical activity, social support, and health. We also investigated whether and how levels and trajectories of perceived control showed differential associations with survival across chronological age. Our

growth-survival analyses revealed that levels and trajectories of perceived control were indeed predictive of long-term mortality risks, independent of sociodemographics. The association for levels of perceived control was accounted for by differences in well-being and health factors, whereas control trajectory was predictive of mortality hazards, over and above known correlates of mortality. We also found that levels and trajectories of perceived control were more likely to be protective against mortality for people in young adulthood and midlife, relative to old age. Our findings suggest that well-being and especially health factors play an important role in control-mortality associations, that rates of change in control provides unique predictive utility over and above known correlates of mortality, and that the association of levels of and trajectories of perceived control with survival declines in old age.

## Associations Between Perceived Control and Mortality

Our first task was to examine the extent to which levels of perceived control predicted 19-year hazards for mortality in an adult lifespan sample. Corroborating previous research involving panel surveys (Infurna, Gerstorf, et al., 2011; Surtees et al., 2006, 2010) and patient populations (Brown et al., 2003; Helgeson, 2003; Kutner et al., 1997; McDonald et al., 1994), we found that, independent of sociodemographics, higher levels of perceived control were associated with a decreased likelihood of mortality. These findings are also consistent with studies showing that perceived control is protective against other adverse health outcomes, including disability, poor physical functioning, and disease incidence (Boehm & Kubzansky, 2012; Caplan & Schooler, 2003; Gerstorf et al., 2011; Infurna, Gerstorf, & Zarit, 2011; Rosengren et al., 2004; Seeman et al., 1999). In a similar vein, our findings are consistent with research within the personality and epidemiological literatures showing the importance of various personality and motivation factors for health outcomes in adulthood and old age



(Chapman et al., 2011; Deary et al., 2010; Roberts et al., 2007). For example, our findings that levels and trajectories of perceived control are linked to survival in an adult lifespan sample are similar to results from the Terman sample showing that not only are levels of conscientiousness linked to survival but also change (Martin et al., 2007). Within our set-up we were able to extend previous findings by making use of more thorough change information to assess the relationship between trajectories of perceived control and mortality.

In sum, our results demonstrate the importance of one's attitudes, beliefs, and motivations for survival in adulthood and old age and contribute to the growing interest in and discussion of risk and protective factors for health (for discussions, see Berkman, 2009; Blumenthal, Michos, & Nasir, 2007; Miller, Chen, & Cole, 2009; Rozanski, Blumenthal, Davidson, Saab, & Kubzansky, 2005). To further those discussions, we interpret the findings with respect to the possible pathways through which perceived control may facilitate survival.

### Factors Underlying Associations Between Perceived Control and Mortality

Conceptual frameworks of control and empirical evidence indicate that perceived control promotes longevity through emotional, behavioral, social, and health mechanisms (Lachman, 2006; Rodin, 1986; Skaff, 2007; Uchino, 2006). We found that the health salutary effects of levels of perceived control could be accounted for by differences in well-being and health. Our findings are consistent with the theory that control facilitates a longer life by enhancing mental health and emotion regulation (Lang & Heckhausen, 2001; Windsor & Anstey, 2010; Wolinsky et al., 2003). Individuals who perceive more control may be better able to compensate for failures and down-regulate negative emotions that contribute to inflammatory and endocrine processes, which are in turn linked to mortality (Danner et al., 2001; Kiecolt-Glaser et al., 2002; Steptoe, Wardle, & Marmot, 2005). Additionally, viewing one's life as controllable and predictable has been shown to protect against accumulating anxiety, stress, and depressive symptoms, which would have downstream consequences for survival (Peterson & Seligman, 1984; Seligman, 1975). Second, we found that self-rated health and reports of functional limitations accounted for associations between levels of perceived control and mortality. Individuals with higher levels of perceived control were more likely to perceive fewer constraints on their ability to perform health behaviors and report better self-rated health. Also, stronger perceptions of control provide individuals with the motivational resources needed to engage in health and rehabilitation behaviors that prevent from experiencing functional limitations (Verbrugge & Jette, 1994). Future studies are needed to further examine relations among perceived control, well-being, and health. For example, more closely spaced assessments would allow for mechanism-oriented inquiry about the moderating and mediating pathways among levels and rates of change in health, perceived control, and well-being, and their implications for mortality (Diehl & Hay, 2010).

In contrast to our expectations, we found little evidence that physical activity and social support accounted for associations between perceived control and mortality. Other studies have found that people who report more perceived control have an increased

likelihood of taking part in health-promoting behaviors (Lachman & Firth, 2004; White et al., 2012), and we expected that this would account for associations between levels of perceived control and mortality. It is possible that the contributing role of physical activity for control–health associations is specific to indicators of functional and physical health (e.g., activities of daily living, disability incidence, and disease incidence) or to circumscribed causes of death, but not necessarily all-cause mortality. In the present study, we also observed that social support did not account for control–mortality associations. It may be that the buffering effects of social support are better captured in an event-contingent design that allows targeting when and how people need to adjust to particular stressors and major life events (Cohen & Wills, 1985). For example, when confronted with the onset of major diseases, people who perceive more control would be more likely to activate their social network for various kinds of support (e.g., emotional, informational, instrumental) that help mitigate accrued burdens on functioning.

### Change in Perceived Control and Mortality

We found that 16-year changes in perceived control were associated with 19-year mortality hazards, such that more positive control trajectories were protective against mortality risk. Our findings corroborate reports that incorporating variability and change components of development are important to consider when predicting successful aging outcomes such as longevity (Eizenman et al., 1997; Mroczek & Spiro, 2007). Previous results from Eizenman et al. (1997) suggested that week-to-week variability in perceived control has health implications, and our study adds to those findings. We demonstrated that perceived control changes spanning several years of time were uniquely linked to long-term survival, over and above known correlates of mortality. Our approach and findings should provide impetus for researchers to go beyond solely including level assessments of constructs for predicting aging-related outcomes, such as longevity, to examine how rates of change in various indices (i.e., perceived control, personality, or cognitive functioning) can provide unique predictive validity. Researchers have previously used these set-ups to examine whether rates of change in cognitive functioning are associated with dementia incidence and survival (see Ghisletta et al., 2006; McArdle et al., 2005), as well as linking personality change to survival (see Mroczek & Spiro, 2007). Longitudinal data sets are available to examine such research questions and coupled with contemporary statistical modeling frameworks should help researchers examine how rates of change in the construct of interest influence aging-related outcomes. This can also help broaden one's theoretical or conceptual model by taking into consideration how rates of change, not just level, contribute to developmental outcomes. For example, we observed that the association between trajectories of perceived control and survival was stronger in young adulthood and midlife than in old age, suggesting that fostering perceived control in early adulthood may be particularly beneficial and effective.

Associations between control trajectory and survival may arise from changes in one's sense of effectiveness in carrying out goal-related activities and an altered view on external factors that interfere with reaching those goals. In particular, trajectories of perceived control may impact survival through several pathways.

First, declines in perceived control may undermine one's views regarding the predictability of life, thereby increasing levels of stress, anxiety, and depressive symptoms (Peterson & Seligman, 1984; Skinner, 1995). Second, increases in perceived control may modify one's attitudes and beliefs regarding the controllability of one's health, leading to an altered participation in health-promoting behaviors (Jette et al., 1999; Lachman et al., 1997). In a similar vein, increases in perceived control may help people manage to actively seek out social support (Lang et al., 1997). Finally, reporting declines in perceived control may reflect increases in perceived constraints that limit one's ability to persist in the face of challenging tasks. For example, onset of a chronic illness may impede an individual's ability to complete activities of daily living and result in behavioral constraints to attain desired outcomes.

We note that these are only preliminary insights on the mechanisms that link control trajectories to survival and that to fully understand the pathways through which changes in control exert influence on health and mortality, more mechanism-oriented study designs are needed. One avenue would be to examine how perceived control may (or may not) change in relation to major life events (e.g., unemployment, welfare, and transitions in caregiving) or health-related events (disability, disease onset, and partner illness). For example, research suggests that perceived control declines with cancer incidence and that greater stability in perceived control with the experience of cancer relates to lower levels of psychological distress 6 and 12 months postdiagnosis (Ranchor et al., 2010). Additionally, it is important to consider that one's point in the lifespan (i.e., midlife vs. old age) may have differential implications for how life events impact perceived control. For example, onset of chronic illness may have a less pronounced effect on one's sense of control in old age, compared to midlife, because this may be seen as an "on-time" event (Neugarten & Hagstad, 1976). A second avenue to unpacking relations among levels and trajectories of perceived control with hypothesized mechanisms is using longitudinal data to examine time-ordered associations between these constructs. For example, declines in perceived control over time may lead to disengagement in one's social network. At the same time, research also suggests that higher quality social relationships predict enhancement of one's sense of control (e.g., Gerstorf et al., 2011). Similarly, volumes of research suggest that facets of control and well-being are moderately correlated (Cheng, Cheung, Chio, & Chan, 2012; Peterson & Seligman, 1984). In follow-up analyses, we examined whether perceived control at Wave 1 predicted well-being and health at Wave 2 and vice versa. Results revealed evidence for bidirectional associations, with more perceived control at Wave 1 predicting higher well-being (fewer depressive symptoms and higher life satisfaction) and better health (higher self-rated health and fewer functional limitations), and better well-being and health at Wave 1 predicting more perceived control at Wave 2.

Lastly, control trajectory represented changes in perceived control over 16 years of time, whereas change over shorter time frames may show similar or dissimilar associations with survival. To examine this, we tested whether changes in perceived control in adjacent waves have similar predictive validity for mortality. We found that positive short-term perceived control change along each adjacent wave (e.g., Wave 2–Wave 1, 3 years; Wave 3–Wave 2, 5 years; and Wave 4–Wave 3, 8 years) was protective against

mortality. These findings suggest that short-term changes as well as long-term changes in perceived control have predictive validity for mortality.

### Age Differences in Associations Between Perceived Control and Mortality

We observed that levels and trajectories of perceived control may have differential implications for survival depending on the point in the lifespan (e.g., midlife vs. old age). Our models found that higher levels of perceived control and experiencing increases in perceived control over time were more likely to be protective against mortality for people at younger ages. Our findings are in slight contrast to conceptual models of control that have delineated control–health associations grow stronger with age (Lachman, 2006; Rodin, 1986), as well as previous empirical evidence that has documented the association between perceived control and health declines may be stronger in old age (Caplan & Schooler, 2003; Infurna, Gerstorf, & Zarit, 2011; Lachman & Agrigoraeci, 2010). Discrepant findings could be due to the health outcome of interest; in this study we examined survival, whereas previous research has examined physical functioning. It may be that in old age, perceived control is an adaptive capacity used to protect against declines in physical functioning or disease incidence. Second, in old age, there may be other contributing factors to mortality hazard (i.e., differences in health, social support, and well-being) and perceived control may not have as direct an effect. Third, individuals who report low levels of and declines in perceived control in young adulthood might be part of a high-risk group. For example, they could suffer from poor health (e.g., disability or cancer incidence) or experience psychological stress in childhood (Miller, Chen, & Parker, 2011), resulting in the nonfostering of perceived control during this point in the lifespan. Especially within the context of such high-risk groups, perceptions of control can help protect against further health declines and increase one's likelihood for survival (Hall, Chipperfield, Heckhausen, & Perry, 2010).

Our study extended previous research by observing that trajectories of control were more likely to be protective against mortality at younger ages, relative to people in old age. Our findings suggest that in young adulthood and midlife, the development of beliefs in one's ability to exert control over life is especially critical and has implications for survival. Conversely, the inability to foster one's perceptions of control may have health consequences as people approach and enter old age. In earlier stages of the lifespan, perceived control may be especially important in its associations with factors underlying control–health associations, such as well-being and partaking in health-promoting behaviors, which accumulate over time and ultimately result in perceived control being linked to survival (Gale et al., 2008; Infurna, Gerstorf, & Zarit, 2011; Moffitt et al., 2011). Previous research has largely focused on how levels of perceived control in adolescence are associated with health factors in young adulthood (see Gale et al., 2008; Moffitt et al., 2011), but as we have shown here, time-related changes in perceived control during earlier phases of the lifespan have health implications later in life. It is up to future research to delve deeper into earlier portions of the lifespan (i.e., adolescence and young adulthood) to examine factors underlying why levels and trajectories of perceived control have long-term health impli-

cations and also examine antecedents of developmental changes in perceived control during these phases of the lifespan.

Our findings provide impetus for community health and intervention programs that target control beliefs to help promote healthy profiles of living across the lifespan (Bandura, 2004; Estabrooks et al., 2011). Perceived control has the capacity to change, which implies programs that focus on the maintenance or enhancement of perceived control across the lifespan can contribute to optimizing perceived control in hopes of facilitating positive aging-related outcomes. Recent years have seen increasing interest in advocating for the importance of fostering psychological factors, such as perceived control and self-esteem across the lifespan (for discussion, see Beddington et al., 2008; Duckworth, 2011; Heckman, 2006; Moffitt et al., 2011). For example, providing children the means for fostering their motivational resources through enhancing perceived control can give them the tools and resources for later life, such as making better educational and work decisions, as well as viewing their health as controllable, leading to better lifelong health (Eccles & Wigfield, 2002; Heckman, Stixrud, & Urzua, 2006). Furthermore, our findings that control–health associations become weaker in old age suggest that the opportunity window to change perceived control is relatively smaller at older ages or their efficiency in changing health outcomes is decreasing. The age by functional limitations interaction may provide further evidence for the importance of fostering one’s perceptions of control in earlier phases of the adult lifespan, such as in young adulthood. Once functional limitations have set in during later stages of the lifespan, perceived control may make less of a difference because the opportunity period to intervene for health implications is smaller and smaller. Despite decline in old age of the window to change perceived control, previous research focusing on people in old age has shown that public health programs aimed at maintaining and fostering perceived control are still effective and result in a more positive health profile (Bandura, 2004; Lachman et al., 1997).

### Limitations and Outlook

We note several limitations. First, causes of death likely differed with age. The most common causes of death among young adults include accidents and suicide, whereas older adults tend to die as a result of cardiovascular diseases and cancer (Centers for Disease Control and Prevention, 2005). The implications of perceived control may or may not vary by cause of death. For example, Surtees and colleagues (2006, 2010) found that facets of control are more likely to be associated with cardiovascular but not with cancer-specific mortality. Unfortunately, we did not have access to decedents’ specific causes of death. Future studies with such information can identify the specific types of deaths that (change in) perceived control is associated with. Second, our analysis made use of indicators of only a few of the pathways through which perceived control may affect health; a more detailed analysis with biological processes, such as indicators that represent cardiovascular, immune, and metabolic systems, will be instructive to disentangle particular pathways that underlie control–health associations. Additionally, we note that the associations between perceived control and the emotional, behavioral, social, and health factors were tested at one point in time (i.e., Wave 2), which may raise concerns regarding biased estimates when using cross-

sectional approaches for longitudinal mediation (see Lindenberger, von Oertzen, Ghisletta, & Hertzog, 2011; Maxwell & Cole, 2007; Yuan & MacKinnon, 2009). Mediation processes typically unfold over time; therefore, in order to disentangle the factors underlying control–health associations, future research will need to incorporate multivariate approaches that include longitudinal assessments of mediators. Third, the small number of occasions and the long and unevenly spaced assessment intervals did not permit use of within-person approaches for examining associations between perceived control and mortality. Combining micro- and macrolongitudinal designs (i.e., measurement-burst design) would complement our findings by assessing processes that emerge over the course of days or weeks, then probably accumulate over a longer time frame, and eventually affect health change taking place over the course of years (for discussions, see Nesselrode, 1991; Ram & Gerstorf, 2009). For example, more perceived control at the daily level may be associated with an increased likelihood of performing strenuous exercise or eating a healthier diet, which in turn has implications for health and survival. Lastly, measures of control potential and goal (dis)engagement would help qualify and extend our analyses. For example, perceived control may be adaptive in situations with high control opportunities but less adaptive in situations that afford few opportunities to exert a positive influence on health outcomes (see Hall et al., 2010).

Our study demonstrates the health implications of levels and trajectories of perceived control across adulthood and old age. Consistent with conceptual frameworks of control (Bandura, 1997; Heckhausen & Schulz, 1995; Lachman, 2006; Skaff, 2007), our study provides evidence that several emotional and health factors that account for associations between levels of perceived control and mortality. As an extension of previous reports linking levels of perceived control to mortality (Infurna, Gerstorf, et al., 2011; Surtees et al., 2006, 2010), our results revealed that control trajectory provides an added and distinct contribution to mortality and that this is likely to be stronger in younger ages (e.g., young adulthood and midlife). These findings provide impetus for future research to more thoroughly examine what contributes to short-term and long-term changes in perceived control, how experiential and behavioral components of change contribute to aging-related outcomes, and the mechanisms through which changes in perceived control operate to facilitate health outcomes.

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