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Social Resource Correlates of Levels and Time-to-Death-Related Changes in Late-Life Affect

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Abstract

Little is known regarding how well psychosocial resources that promote well-being continue to correlate with affect into very late life. We examined social resource correlates of levels and time-to-death related changes in affect balance (an index of affective positivity) over 19 years among 1,297 by now deceased participants (aged 69 to 103 at first assessment, *M* = 80 years; 36% women) from the Australian Longitudinal Study of Aging. A steeper decline in affect balance was evident over a time-to-death metric compared with chronological age. Separating time-varying social resource predictors into between- and within-person components revealed several associations with level of affect balance, controlling for age at death, gender, functional disability and global cognition. Between-person associations revealed that individuals who were more satisfied with family, and more socially active, expressed greater positivity compared with those who were less satisfied, and less socially active. Within-person associations indicated that participants reported higher positivity on occasions when they were more socially active. Having a partner was associated with higher positivity (although this association became non-significant after adjustment for covariates), whereas having a confidant was not. Less frequent contact with children was related to increasing positivity over time.. Our results suggest that social engagement and satisfying relationships confer benefits for affective well-being that are retained into late life. However our findings do not provide evidence to indicate that social resources protect against terminal decline in well-being.

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Recent years have seen an increasing interest in developmental changes in subjective well-being that occur during adulthood and old age. Numerous studies provide support for the "stability despite loss paradox" which indicates that quality of affective experience (typically operationalized in terms of positive and negative affect, or affect balance, e.g., Pinquart, 2001) is largely maintained, or improves between young adulthood and the third age (Charles & Carstensen, 2009; Windsor, Burns, & Byles, 2013). However, research also points to a subsequent decline in the quality of affective experience during the fourth age (e.g., Charles, Reynolds, & Gatz, 2001; Pinquart, 2001).

Emerging evidence based on mortality data has helped to further elucidate the nature of late life changes in subjective well-being. Recently, researchers have begun to examine longitudinal changes in well-being using time metrics representing both chronological age and time-to-death. These studies have repeatedly reported that both evaluative (i.e., life satisfaction) and affective components of subjective well-being show steep end-of-life deteriorations (Berg, Hassing, Thorvadsson, & Johansson, 2011; Burns, Mitchell, Shaw, & Anstey, 2014; Carmel, Shrira, & Shmotkin, 2013; Diehr, Williamson, Burke, & Psaty, 2002; Gerstorf, Ram, Röcke, et al., 2008; Mroczek & Spiro, 2005; Palgi et al., 2010; Schilling, Wahl, & Wiegering, 2013; Vogel, Schilling, Wahl, Beekman, & Penninx, 2012). For example, steeper declines in life satisfaction over time-to-death compared with chronological age have been reported in samples of older German adults (Gerstorf, Ram, Estabrook, et al., 2008; Gerstorf, Ram, Roecke, Lindenberger, & Smith, 2008). Gerstorf et al. (2010) reported steep declines in affective well-being around 3 to 5 years from death among deceased participants in the British Household Panel Study and the Health and Retirement Study. Palgi et al. (2010) found a stronger linear increase in negative affect (NA) with impending death

than with advancing age, but did not find associations of positive affect (PA) with age or time-to-death. Schilling et al. (2013) reported an increase in NA from around 6 years out from death, followed by an abrupt drop in NA closer to death. PA showed a weak decline with chronological age, but was not associated with time-to-death. Vogel et al. (2013) used 15-year longitudinal data to examine changes in affective well-being using the CES-D. Their results indicated worsening affect (i.e., increases in NA and decreases in PA) with impending death, with time-to-death accounting for more variance in PA and NA than chronological age. Tests of quadratic effects also pointed to steeper declines in well-being close to death.

Taken together, the literature paints a sobering picture of the quality of emotional experience near the end of life. However, it is also the case that developmental studies of affect, including those reviewed above, point to substantial inter-individual heterogeneity in trajectories of change in well-being (for overview, see Gerstorf & Ram, 2013). For example, a recent study identified a substantial minority (29%) among a sample of oldest-old adults who reported consistently low levels of depressive symptoms over a 36 month interval (Schilling, Wahl, & Reidick, 2013). Identifying social-contextual factors that contribute to delay or acceleration of rates of change in affect at the end-of-life represents an important next step in developing a better understanding of emotional experience in older adulthood. In the present study we focused on social resource correlates of late life changes in positivity, operationalized as affect balance (PA – NA), which to our knowledge has not been used in previous studies examining mortality-related changes. The presence of positive and absence of negative emotions is consistent with conceptual models of emotion optimization and hedonic well-being (e.g., Labouvie-Vief, Diehl, Jain, & Zhang, 2007; Meeks, Van Haitsma, Kostiwa, & Murrell, 2012) and deriving affect balance scores represents a standard approach when PA and NA measures are substantially correlated (e.g., Riediger & Freund, 2008) as was the case in our data (Time 1 r = -.54). Our first aim was to examine longitudinal changes

in late life affect balance, comparing average trajectories over chronological age and time-to-death metrics. This enabled us to corroborate earlier reports in a very old, independent sample, and to add to previous findings by considering the shifting balance of PA and NA over time. Our second aim was to further extend the literature on late life changes in well-being by examining the extent to which different social network resources buffer late life declines in affect balance.

Social relations and late life well-being

Supportive social relationships are widely recognised as an important resource for good physical and mental health across the lifespan (Berkman, Glass, Brissette, & Seeman, 2000; Holt-Lundstad, Smith, & Layton, 2010). During late life, social resources can become diminished through the deaths of network members and limits to social engagement resulting from reduced income or poor health; at the same time, older adults may become more reliant on their social networks for help or care (Pinquart & Sorensen, 2000). Thus, late life can bring about specific challenges to the maintenance of supportive social relationships at a time when they are most needed.

Older adults' vulnerabilities to social and other losses and the likely implications of these losses for emotional experience are reflected in The Strength and Vulnerability Integration (SAVI) model (Charles & Piazza, 2009; Charles, 2010). SAVI provides an integrative perspective that recognises how normative processes of development result in both aging-related advantages and disadvantages for affective well-being. According to SAVI, motivational changes resulting from perceived limits to future time (Carstensen & Lockenhoff, 2003), and the accumulation of skills in managing emotions and relationships over many years (Charles & Carstensen, 2009) means that older adults become adept at navigating their environments in ways that enable the avoidance of experiences likely to elicit negative emotions. However advancing age also brings with it a loss of flexibility in the

biological systems needed for effective emotion regulation. For example, decreased speed of processing could lead to less effective use of emotion-regulation strategies in response to stress. Moreover, reduced physiological flexibility is thought to prolong older adults' activation levels under conditions of prolonged physiological arousal (Charles & Piazza, 2009). As a result, when exposed to unavoidable stressors, older adults are less able to regulate their emotions, resulting in a reversal of age-related advantages for affective well-being.

The loss of social belonging resulting from widowhood, the death of other (non-spouse) social network members, and/or poor functional health limiting social engagement represent key sources of stress that increase in prevalence during late life. Thus, in the context of the biological vulnerabilities and associated diminished capacities for emotion regulation described by SAVI, social losses may be an important factor contributing to steeper declines in affective positivity near the end of life. Conversely, those who are able to maintain high quality supportive relationships into oldest-old age might be better able to manage other aging-related stressors such as declining health (Cohen & Wills, 1985), and in turn may be better placed to maintain hedonic well-being in the years immediately preceding death. Despite the large body of literature supporting direct and indirect benefits of social networks for mental health, little is known about whether social resources continue to contribute to emotional health into very late life when regulatory capacities are often compromised. As Taylor (2011) pointed out, the benefits of social resources for health may be reduced at high levels of distress. As a result, the extent to which social support acts as an effective protective resource might dissipate in late life when compromised regulatory capacities and other pathology- and mortality-related processes produce unique challenges for maintaining positivity.

The Present Study

In the present study, we examined the extent to which different social network characteristics predicted trajectories of change in affect balance over time-to-death using 18 year longitudinal data from deceased participants in the Australian Longitudinal Study of Aging (ALSA). Consistent with previous research (e.g., Cohen & Wills, 1985; Holt-Lundstad et al., 2010) social relations were assessed using measures of network structure (i.e., degree of integration in networks), and network function (i.e., the resources provided by networks such as social support). We also extended previous studies of mortality-related changes in well-being by including time-varying predictor variables in our analyses. By de-composing time-varying predictors into their separate between- and within-person components (see *statistical analysis*) we were able to determine whether or not associations of affect balance with more stable individual differences were consistent with associations representing within-person processes (Hoffman & Stawki, 2009). More specifically, we examined whether (1) individuals with more social resources overall showed more positivity compared with individuals with fewer social resources (between-person associations), and (2) whether intra-individual changes in social resources over time were coupled with changes in affect balance (within-person associations).

Our initial analysis focused on comparing changes in affect balance over time metrics representing chronological age, and time-to-death. Consistent with previous research (e.g., Vogel et al., 2013) we expected to find (a) more pronounced patterns of decline in affect balance over time-to-death relative to chronological age, and (b) a steeper decline in affect balance in the years immediately preceding death. Next, we examined whether older adults with greater access to social resources showed slower rates of decline in affect balance. In keeping with the extensive literature showing positive associations of social resources with well-being prior to very late life (e.g., Berkman et al., 2000), we expected that structural and

functional social network characteristics would be associated with higher levels of affect balance, and more shallow rates of decline in affect balance nearing death.

We considered associations of social network characteristics with affect balance before and after adjustment for additional sources of vulnerability that increase in prevalence with advancing age, and have particular relevance to late life well-being (Charles, 2010). These included functional disability and global cognitive ability (MMSE) as a proxy measure of neurological dysfunction. We also controlled for gender in light of women's greater relative social integration (Antonucci & Akiyama, 1987), and education, as previous studies have shown that those with more education report better mental health (e.g., Williams, Yu, Jackson, & Anderson, 1997). Finally, we controlled for age at death, as surviving to an older age has been associated with poorer late life psychosocial functioning (Gerstorf, Ram, Lindenberger, & Smith, 2013).

Method

Participants and procedure

Our sample originated from the 1477 primary participants in the Australian Longitudinal Study of Ageing (ALSA; Luszcz, 2007) drawn from the South Australian electoral roll. Analysis was restricted to those who had deceased as of September 2012. This resulted in a total of 1297 participants (834 men and 463 women) who ranged in age from 69 to 103 at baseline (M = 80.46, SD = 6.33). Participants provided data on up to 6 occasions (1992 (baseline): n = 1297; 1994: n = 1011; 2000: n = 374; 2003: n = 179; 2008: n = 40; 2011: n = 12) over a measurement interval of up to 19 years (M = 4.00, SD = 4.24). Just over half the sample (51.3%) were married or partnered at baseline, 57.2% reported leaving school aged 14 years or younger, and 8% reported having no children.

Consistent with previous studies (Gerstorf, Ram, Estabrook, et al., 2008; Wagner, Gerstorf, Hoppmann, & Luszcz, 2013) we examined longitudinal selectivity by comparing

the characteristics of those who participated over multiple repeated assessments with those of the total analysis sample at baseline using an effect size metric described by Lindenberger, Singer, and Baltes (2002) (*SD* denominator derived from the 1297 deceased participants of the total analysis sample). Most of the differences were modest, with participants who provided observations at 3 or more assessments (n = 391) differing from the analysis sample by 0.08 *SD* units for gender, 0.13 *SD* for partner status, 0.10 *SD* for contact with children, 0.11 *SD* for satisfaction with family, 0.16 *SD* for satisfaction with friends, 0.06 *SD* for confidant availability, and 0.11 *SD* for age left school. Higher levels of affect balance (0.20 *SD*), social activity (0.24 *SD*), younger chronological age (-0.36 *SD*), lower disability (-0.28 *SD*) and lower likelihood of cognitive impairment (-0.28 *SD*) were each associated with lower mortality/higher participation rates. To further quantify longitudinal selectivity, we also compared the baseline characteristics of participants who provided less longitudinal change information (participating at two or three assessments, n = 857) with those who provided more information (participating at four or more assessments, n = 162). Compared with those who provided less longitudinal information, those providing data at four or more assessments were younger (M = 76.49 years, SD = 4.67, vs. M = 80.63, SD = 6.22, $t(1017) = 8.06$, $p < .001$), more socially active (M = 2.17, SD = 0.67, vs. M = 1.91, SD = 0.62, $t(1007) = -4.84$, $p < .001$), reported more contact with children (M = 8.51, SD = 1.82, vs. M = 7.70, SD = 2.63, $t(872) = -3.57$, $p < .001$), were more satisfied with friendships (M = 3.72, SD = 0.77, vs. M = 3.57, SD = 0.80, $t(989) = -2.24$, $p < .05$), had lower disability (M = 1.99, SD = 1.87, vs. M = 2.79, SD = 2.15, $t(995) = 4.40$, $p < .001$), and higher affect balance (M = 2.22, SD = 0.86, vs. M = 2.02, SD = 0.92, $t(1002) = -2.50$, $p < .05$). Those providing more longitudinal data were also more likely to be partnered (59.6% vs. 50.4%, $\chi^2(1) = 4.61$, $p < .05$) and less likely to have probable cognitively impaired (6.2% vs. 14.9%, $\chi^2(1) = 8.81$, $p < .01$). The two groups

did not differ in satisfaction with family, gender, education, or confidant availability.

Less than 4% of participants had missing data on each of the time-invariant (Level 2) independent variables with the exception of contact with children (13.6% missing) reflecting the fact that not all participants had children. Participants with missing data on the independent variables were excluded analysis-by-analysis. Missing data on the dependent variables was handled under missing-at-random assumptions (Little & Rubin, 1987). A table showing the structure of the data in terms of the available observations over the two time metrics is provided in the online supplementary materials. Bivariate associations among the study variables, and sample descriptive statistics at Time 1 are shown in Table 1.

Measures

Affect balance

Affect balance was assessed using the four-item PA (α = .61 - .73) and seven-item NA (α = .70 -.81) subscales of the Centre for Epidemiological Studies Depression Scale (CES-D; Hertzog, Van Alstine, Usala, Hultsch, & Dixon, 1990; Radloff, 1977). Consistent with previous approaches to the assessment of affect balance (Bradburn, 1969), a single measure of affective positivity was derived by subtracting participants' NA (mean of 7 items) scores from their PA (mean of 4 items) scores. The affect balance scores were standardised using T1 scores for the current sample as a reference, and converted to T scores (M = 50, SD = 10).

Social resources

Details of the social network variables included in the ALSA are provided by Giles, Metcalf, Anderson, & Andrews (2002). For the current analysis, measures of structural social network characteristics included *contact with children,* calculated by summing ratings of (a) frequency of face-to-face contact and (b) contact via telephone. Responses were provided on

5-point scales ranging from 1 (*Never*) to 5 (*More than weekly*). *Partner status* contrasted those who were not partnered at all assessments (0) with those who reported being married or partner at one or more assessments (1). *Social activity* was assessed using the sum of four items from the Adelaide Activity Profile (Clark & Bond, 1995) that represented frequency of (a) having invited others to one's home, (b) making phone calls to friends and family, (c) attending social activities at a centre such as a club, church or community centre, and (d) taking part in outdoor social activities. Responses were provided on four-point scales with higher scores indicating more frequent activity engagement. These items have been used to assess social activity in previous research with ALSA, with each loading strongly on a single factor at T1 (Hoppmann, Gerstorf, & Luszcz, 2008). Scores were based on a mean of the four items (range 1 – 4) with mean replacement used where participants had missing data on one of the four items.

Functional network measures included *confidant availability*, which was assessed by asking participants whether or not they had access to someone with whom they felt close, could share confidences with, and could depend upon. Responses were coded 0 (had no confidant at any assessment) or 1 (had a confidant at one or more assessments). Single item measures assessed *satisfaction with family life* and *satisfaction with friendships*. Responses were provided on five-point scales ranging from 1 (*extremely satisfied*) to 5 (*very dissatisfied*). The items were reversed so that higher scores represented greater satisfaction.

Scale level time-varying social resource variables were decomposed into separate between- (BP) and within-person (WP) components for analysis. BP components consisted of the centred person-mean across assessments, and within-person components consisted of deviations from the person mean at each assessment (Hoffman & Stawski, 2009). The two network satisfaction variables were not included in the second (T2) assessment. Therefore, to maximise data points included in the model, we calculated person-specific means across all

available assessments and modelled these correlates at the BP level in the main analysis. We also report BP and WP associations of network satisfaction with affect balance (based on a model that excludes T2 observations).

Covariates

Consistent with Wagner et al. (2013), *functional disability* was measured using the sum of two mobility items assessing walking ability (Rosow & Breslau, 1966) and five disability items capturing difficulties with physical movement and lifting/handling objects (Nagi, 1976). For each item, participants received a score of 1 if they reported any degree of difficulty. The items were summed to produce a total score with higher values representing more functional disability. To reduce complexity of our models and retain the time-varying nature of the variable, we modelled functional disability as a between-person variable defined as the maximum disability score reported across all available assessments. Global *cognitive ability* was assessed using the mini-mental state examination (MMSE; Folstein, Folstein, & McHugh, 1975). In keeping with previous studies (e.g., Anstey & Luszcz, 2002) we classified those scoring 24 or above as not impaired, and those scoring 23 or below as having possible cognitive impairment. Cognitive ability was modelled at the between-person level, contrasting those classified as not impaired (0) , with those classified as possibly impaired (1) at one or more assessments across the six waves. Additional covariates included *gender* (male = 0, female = 1), and *age at death*. Education was assessed as *age left school* with those having left school aged 14 years or younger (0) contrasted with those who left school aged 15 or older (1).

Statistical analysis

For our initial comparison of changes in affect balance over age and time-to-death metrics, chronological age (centred at 80 years for analysis) represented years since birth, whereas time-to-death represented years remaining in life, and was mean centred at 6.45

years, and reversed (so that higher scores corresponded with closer proximity to death) for analysis. Consistent with recent examinations of terminal decline, we used multilevel modelling procedures (e.g., Singer & Willett, 2003) to examine changes in affect balance over chronological age and time-to-death metrics. Multilevel models facilitate examination of inter- and intra-individual associations among variables by partitioning variance in the dependent variable into between-person (Level 2) and within-person (Level 1) components. We initially fitted linear growth models that included affect balance as the dependent variable, with time in study (either chronological age or time-to-death) included as an independent variable to quantify average rates of change. Random effects (for the intercept and for the slope for time) were modelled to account for individual deviations in level, and rates of change in affect balance. We subsequently examined non-linearity in average rates of change by adding a quadratic term to the models (Model 2). The quadratic models took the form of:

$$Affect\ balance_{ti} = \beta_{0i} + \beta_{1i}\,(time_{ti}) + \beta_{2i}\,(time^2_{ti}) + r_{ti},$$

where affect balance for a given individual *i*, at a given time point *t*, $affect\ balance_{ti}$ is a combination of an individual-specific intercept, β_{0i}; individual-specific slope parameters representing linear, β_{1i}, and quadratic, β_{2i}, growth, over either chronological age or time-to-death, and a residual term, r_{ti}. Inclusion of fixed and random effects in the model specifications allowed estimation of sample mean values (fixed effects) for the intercept (γ_{00}), and linear (γ_{10}) and quadratic slopes (γ_{20}), as well as variance components (random effects) that represented individual deviations from the mean intercept (u_{0i}), mean linear slope (u_{1i}), and mean quadratic slope (u_{2i}). Where inclusion of the quadratic term, and/or the random effects did not enhance model fit, these parameters were excluded for the sake of parsimony. We based our evaluation of whether changes in affect were more efficiently described by chronological age or time-to-death on the Akaike information criterion (AIC) and change in

residual (within-person) variance explained based on calculation of pseudo R^2 following recommendations by Singer and Willett (2003).

Next, we examined social resource correlates of BP differences and WP changes in affect balance by including the social resource variables described above as predictors of level (intercept) and linear and quadratic change (slope) in affect over time-to-death. To minimise loss of data we first conducted the analysis without inclusion of the BP and WP contact with children variables (to retain those without children in the models), then repeated the analysis also assessing the associations of contact with children and affect balance. A final model adjusted for functional disability, global cognition, gender, age at death, and age left school. Analyses were conducted using Stata (xtmixed; Rabe-Hesketh & Skrondal, 2008). We also tested for interactions between any of the social variables and the quadratic rate of change; in the final models reported, we retained only those interactions with quadratic time-to-death that reliably differed from zero.

Results

Chronological age vs. mortality related changes in affect balance

We first examined trajectories of change in affect balance over chronological age. Comparison of nested models with and without a random slope revealed that allowing for individual deviations from the average linear slope did not contribute to better model fit ($\chi^2\Delta$ (2) = 4.23, *ns*); thus we treated the slope for chronological age as a fixed parameter. Results are shown in Table 2 (Model 1). A statistically reliable slope for chronological age indicated that with a one year increase in age, affect balance decreased on average by approximately 0.2 T-score units. In a subsequent model we included a quadratic term for chronological age, however the quadratic effect was not reliably different from zero (Age^2 Estimate = - 0.001, *ns*), and values for the AIC (19146.45 for fixed quadratic; 19149.41 for quadratic with random slope) also indicated inferior model fit. Taken together, the results pointed to a fixed

linear effect as providing the most parsimonious means of capturing within-person change in affect balance over chronological age.

Table 2 also shows the results of a comparable model (Model 1: with fixed linear slope) that assesses longitudinal change in affect balance over time-to-death. The results indicated a reliable linear change, with participants on average showing a decline in affect balance of 0.4 T-score units with each year approaching death. The variance in affect balance accounted for was marginally higher in the mortality-related model (5%) relative to the chronological age model (4%), and a comparatively lower AIC value also pointed to superior fit of the mortality-related model. Additional analyses indicated that change in affect balance was best captured by a model that also included a quadratic term for time-to-death, and a random effect capturing interindividual variation in the linear growth term. Results are shown in Table 2 (Model 2), with the negative quadratic effect indicating an accelerated pattern of decline in affect balance over distance to death. Figure 1 shows raw data for 122 (10%) randomly selected individual ALSA participants and sample average trajectories of change in affect balance based on the best fitting models for chronological age (Model 1) and time-to-death (Model 2). Decline is evident over both time metrics, with the slightly accelerated decrease in affect balance over time-to-death consistent with terminal decline. The more pronounced decline over time-to-death compared with chronological age was also consistent with our hypotheses.

Additional analyses. We also conducted follow-up analyses equivalent to those described above, but including the component PA and NA scores as dependent variables to examine whether changes in affect balance were primarily a result of declining PA, increasing NA, or both. Results for PA indicated average declines over chronological age (Linear slope = -0.21, SE = 0.03, $p < .05$) and time-to-death (Linear slope = -0.50, SE = 0.05, $p < .05$; Quadratic slope = -0.02, SE = 0.01, $p < .05$) of similar magnitudes to those found in

the affect balance models. For NA, the magnitude of average change over time was somewhat smaller; however the results were consistent in showing declining quality of affective experience (i.e., increasing NA) over both chronological age (Linear slope = 0.15, *SE* = 0.03, $p < .05$) and time-to-death (Linear slope = 0.29, *SE* = 0.05, $p < .05$; Quadratic slope = 0.03, *SE* = 0.01, $p < .05$).

Social resource correlates of time-to-death related change in affect balance

Next, we examined whether levels and rates of change in affect balance over time-to-death were reliably associated with social resources. We began by adding the structural and functional social resource variables (excluding contact with children) as predictors to the best fitting model described above (Model 2) with cross-product terms included to test interactions of BP and WP social resource characteristics with linear and quadratic time. None of the interactions of social resources with quadratic time were significant, so these terms were excluded from the model. Results are shown in Table 3.

Participants who were partnered at one or more assessments reported higher affect balance compared with those who were consistently not partnered However a significant negative association of partner status with the linear slope also indicated that the advantage conferred by being partnered at one or more assessments became less evident with increasing proximity to death. This may have been due to more steeply declining affect among the sub-group of participants who became widowed over the study interval. Indeed, post-hoc models indicated steeper linear declines in affect balance over time to death (Linear slope = -0.68, *SE* = 0.14, $p < .05$) among those who were partnered at baseline and became unpartnered at one or more subsequent assessments, relative to those who were partnered at all assessments (Linear slope = -0.56, *SE* = 0.53, *ns*).

Consistent with predictions, several of the additional social resource variables were reliably and positively correlated with level of affect balance. Participants who reported

higher levels of social activity showed more positivity overall than those reporting lower social activity (BP association). Participants also showed higher affect balance on occasions when they were more socially active, relative to occasions when they were less socially active (WP association).Among the functional social resource variables, participants with higher levels of satisfaction with their family, and their friendships showed higher affect balance than those with relatively lower network satisfaction. Figure 2 illustrates the association of family satisfaction with level of affect balance by showing prototypical trajectories of affect balance over time-to-death for individuals scoring lower (-1 *SD*) and higher (+1 *SD*) in family satisfaction. To further examine WP associations of network satisfaction with affect balance, we repeated the model with inclusion of WP terms (deviations from the person-mean) for family, and friend satisfaction (though this resulted in loss of 911 data points from the model due to these variables not being assessed at T2). The WP associations with levels were positive for family (Estimate = 0.87, *SE* = 0.66, *ns*) and friend satisfaction (Estimate = 1.02, *SE* = 0.68, *ns*); however both fell short of statistical significance. Confidant availability was not reliably associated with affect balance. Apart from partner status, none of the associations of social resources with mortality-related change in affect balance (slopes) were statistically reliable.

Next, we included the covariates (functional disability, cognitive impairment, gender, education, and age at death) as additional predictors of the intercept, and linear and quadratic slopes for affect balance over time-to-death (Table 3). Adjustment for covariates resulted in the associations of partner status with level and slope in affect balance becoming non-significant. The positive associations of BP and WP social activity with level were reduced in magnitude and fell just short of significance in the adjusted model (*p*s < .06). Associations of network satisfaction with levels of affect balance remained statistically reliable. Social resources were not reliably associated with rates of change in affect balance in the adjusted

model. To quantify the overall contribution of the social resource variables to prediction of levels of affect balance using an effect size-type metric, we calculated the proportion reduction of unexplained variance in the intercept comparing a model that included just the covariates, with a model that also included the social resource variables (i.e., the adjusted model shown in Table 3; see Gerstorf et al., 2013). Inclusion of the social resource variables accounted for an additional 12% of the variance in the intercept.

Among the covariates, both of the age-related vulnerability factors were reliably associated with levels of affect balance. Those identified as having likely cognitive impairment at any assessment, and those with higher functional disability scores reported lower affect balance. Functional disability was also a reliable predictor of linear change, with steeper declines in affect balance over time-to-death evident among those with higher levels of disability (Figure 2, panel b). Gender was a reliable predictor of quadratic change. Men showed a small linear decrease in affect balance, whereas women showed a curvilinear pattern with an initial increase in positivity followed by a decrease in the years closer to death (Figure 2, panel c). Age at death and age left school were not reliable correlates.

In a final model, we added BP and WP contact with children variables to test their associations with affect balance among the subset of 1072 participants with children who responded to these items. Results are shown in Table 4. WP contact with children was reliably negatively associated with the intercept, indicating that levels of affect balance tended to be lower on occasions when contact with children was more frequent, relative to occasions when contact with children was less frequent. At the BP level, contact with children was not associated with levels of affect balance, but was associated with rates of change, with participants reporting greater frequency of contact with children showing a small average decrease, and participants reporting less frequent contact showing a small average increase in positivity nearing death. (Figure 2, panel d).

Additional analyses. We ran follow-up models to examine associations of the social resource variables with affect balance using chronological age (as opposed to time-to-death) as the time metric. The pattern of findings (details available in online supplementary materials) was generally consistent with those from the time-to-death model, with network satisfaction variables showing the most robust positive associations with levels of affect balance, and the BP and WP activity variables also showing positive associations which were attenuated after adjustment for covariates. Addition of contact with children also produced similar results to those found in the time-to-death model.

Discussion

We examined age- and mortality-related changes in affect balance in a sample of 1297 deceased primary respondents from the ALSA, who provided data on up to 6 occasions over 18 years. Consistent with our predictions, and with several recent investigations focusing on both subjective well-being (Gerstorf, Ram, Estabrook, et al., 2008; Gerstorf, Ram, Roecke, et al., 2008; Schilling, Wahl, & Wiegering, 2013; Vogel et al., 2013) and additional bio-psychosocial characteristics subject to ageing-related decline (Gerstorf, Ram, et al., 2013), changes in affect balance were better captured using a time-to-death metric, than a chronological age metric. A non-linear association in the time-to-death model also pointed to an accelerated rate of decline in affective positivity in the few years immediately preceding death. Our results showing stronger declines over time-to-death relative to time-from-birth (chronological age) are in keeping with theoretical perspectives on terminal decline, and a growing body of literature indicating that the precipitous end-of-life declines that have been demonstrated in studies of cognitive aging are also evident for affective well-being. Several possible mortality-related mechanisms underlying terminal decline have been identified previously, including the accumulation of neuropathologies, compromised central nervous system functioning, and more general declines in physiological systems. It has also been

postulated that these interrelated processes of late-life decline could compromise effective self-regulation, resulting in available system resources becoming increasingly devoted to the maintenance of basic physiological processes, and less available to support the psychological regulatory processes (e.g., accommodative coping; Brandtstader & Renner, 1990) thought to underpin affective well-being in late life (Gerstorf, Ram, et al., 2013; Kotter-Gruhn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009). These possible mechanisms also complement the SAVI perspective, which outlines the extent to which emotion-regulation capacities are likely to become compromised in the context of aging-related vulnerabilities and decreasing biological flexibility (Charles, 2010).

Social network correlates of affect balance

Our primary focus was to extend the recent research on mortality related decline by examining whether levels and mortality-related changes in affect balance were associated with BP differences and WP changes in structural, and functional social network resources. The results provided mixed support for our hypotheses. Consistent with predictions, several reliable associations of social resource variables with the level of affect balance at 6 years before death were found. Engagement in social activities was associated with levels of affect balance both BP (i.e., participants who were more socially engaged reported higher positivity relative to those less engaged) and WP (i.e., participants reported more positivity at occasions on which they were more engaged relative to occasions on which they were less engaged), although these associations were reduced to marginal significance after adjustment for covariates. These findings highlight the importance of remaining socially active for affective well-being in later life, consistent with conceptual models of successful aging (Rowe & Kahn, 1997). The findings are also in keeping with recent empirical research that found social activity engagement to be a reliable predictor of PA and health among older adults (Huxhold, Fiori, & Windsor, 2013).

Whereas greater satisfaction with family relationships was associated with higher positivity, frequency of contact with children was associated with lower positivity at the within-person level, and those who reported less contact with children also showed a marginally steeper increase in positivity relative to those who reported more frequent contact with children. These inconsistent findings may have arisen from the different implications of perceived quality and/or availability of family support (as broadly reflected by satisfaction ratings) and the extent to which contact with children represent received support. Researchers have highlighted the importance of support resources effectively matching the individual's support needs, in order for social support to be effective (Cohen & Wills, 1985). Higher ratings of network satisfaction are suggestive of an adequate match between needs and resources, which is likely to translate into effective stress buffering, and in turn greater affective positivity. Frequency of contact with children reflects an important structural aspect of the network, but does not provide information on the extent to which the level of contact (support resources) provides an effective match to support needs. Interpersonal exchanges can be sources of conflict as well as support (e.g., Newsom, Nishishiba, Morgan, & Rook, 2003; Rook, Luong, Sorkin, Newsom, & Krause, 2012), and even well-intentioned efforts at support provision can be regarded as over-controlling by the support recipient (Taylor, 2011). Such complexities of close family relationships might become especially relevant in late life when frequency of contact with children can become increasingly linked with a parent's level of dependency. For example, Uchino (2009) highlights the extent to which involuntary close family ties have the potential to be a source of conflict, and notes that higher levels of received support can be linked to lower self-esteem and eroded perceptions of independence in later life. Finally, the results could reflect children's responses to parental need, with children (and parents) potentially more likely to initiate contact at times when aging parents are perceived to be at low emotional ebb.

Satisfaction with friendships was related to higher affect balance in unadjusted models; however unlike satisfaction with family, the association was reduced in magnitude after adjustment for covariates. The more robust association of family, relative to friend satisfaction with levels of affect balance could reflect the particular importance of close family relationships for well-being in the context of the motivational changes described by socio-emotional selectivity theory (Carstensen & Lockenhoff, 2003). Bivariate correlations among our variables also indicated that satisfaction with friendships was more strongly related to disability and cognition than was satisfaction with family. Thus friendships may become more difficult to maintain than family relationships in the context of declining health, which could have contributed to our findings. The findings could also be due to the central role played by spouses in facilitating coping with chronic illness (Berg & Upchurch, 2007), and the significance of the spousal dyad as a social context for late life development (Hoppmann & Gerstorf, 2009; Windsor, Ryan, & Smith, 2009).

Contrary to expectations, having a confidant was not related to level of affect balance. These results run counter to a substantial body of literature indicating that confidants act as stress buffers (Cohen & Wills, 1985), and promote health-related quality of life in older adults (Lawler, Mold, & McCarthy, 2013). One possible explanation for the null findings is a lack of variability in confidant status in the ALSA sample, as less than 5% of participants reported not having a confidant across all of the assessments in which they participated. Being partnered at any time over the study interval was associated with higher levels of affect balance. Partnered individuals also showed steeper rates of decline in affect balance over time (possibly as a result of lower positivity at later waves among those who became widowed), although neither association was significant in the adjusted analysis. These findings are broadly consistent with the literature indicating that being partnered is related to higher well-

being in older adulthood, particularly for men (e.g., Kiecolt-Glaser & Newton, 2001; Schone & Weinick, 1998; Umberson, Wortman, & Kessler, 1992).

In contrast to our predictions, social resources were not reliably associated with slower rates of decline in affect balance over time-to-death. We were specifically interested in whether the maintenance of structural network resources and/or satisfying social relationships would be associated with maintaining positivity nearing the end of life. The findings are consistent with the idea that social resources do not play a central role in shaping trajectories of affect in the few years preceding death. This could be due to the pervasive nature of the biological processes of degradation thought to underlie terminal decline (e.g., Kotter-Gruhn et al., 2009), and the extent to which these processes are likely to compromise regulatory functioning even in the presence of supportive others (Baltes & Smith, 2003; Charles, 2010). In short, there may be limits to the extent to which social support buffers emotional well-being against stress (Taylor, 2011), and very late life could represent a time when these limits are more likely to be exceeded. As a caveat, it should also be noted that the absence of protective effects in our data are not unusual in the context of previous research. Effect sizes for correlates of individual well-being are typically small, and previous studies have often failed to identify reliable associations of individual-difference characteristics with rates of change in well-being (Gerstorf & Ram, 2013).

It is also important to consider our findings in relation to social resource correlates of both levels and slopes of affect balance together in order to inform a broader understanding of the significance of social resources to late life well-being. Specifically, allowing for generally similar overall rates of decline in positivity irrespective of social network characteristics (as suggested by our results), the associations of several social resource variables (particularly network satisfaction) with higher average levels of positivity may be maintained across the years preceding death. This is analogous to the *preserved*

differentiation hypothesis (Salthouse, 2006) developed in the context of cognitive aging, and suggests that accumulated benefits to well-being conferred by social resources might not directly protect against terminal decline, but might result in those with more social resources retaining accumulated advantages for well-being up until the end of life.

Finally, several associations of the covariates with affect balance merit some discussion. Cognitive ability and functional disability represent late life vulnerabilities identified by Charles (2010) as being likely to compromise quality of affect. Our results indicated that poorer cognition, and greater functional restrictions were associated with lower levels of positivity. Moreover, disability was also associated with rates of change, with those who reported greater restrictions showing a steeper decline in affective well-being approaching death. As the closest proxy for functional health included in our analysis, the results pertaining to disability provide indirect support for the centrality of the compromised biological system for declines in the quality of late life emotion (Baltes & Smith, 2003; Kotter-Gruhn et al., 2009).

Limitations and future directions

Through a comprehensive examination of social resource correlates of mortality related levels and changes in affect balance in a large sample of deceased older adults followed over almost 20 years, the present study contributes to our understanding of the social context of late life changes in emotional experience. It is, however, important to acknowledge several limitations. First, we were not able to establish the specific timing of key relationships transitions such as widowhood (or re-partnering) that can have important implications for well-being. Based on previous findings (Guiaux, Van Tilburg, & Broese Van Groenou, 2007), we would speculate that levels of social resources would increase shortly before and after widowhood before eventually returning to pre-loss levels, with these changes also having implications for affect. Limitations were also evident in the available measures of

family and friendship satisfaction ratings, which were based on single items. Single item measures of global life satisfaction have been shown to have acceptable reliability (Lucas & Donnellan, 2012), however use of more established measures of social support across domains (including specific assessment of partner support, e.g., Windsor, Gerstorf, Pearson, Ryan, & Anstey, 2014) may have produced more robust findings.

The fact that relatively few participants provided data at four or more assessments (*n* = 69, 5.3% of the sample) meant that we were limited in our capacity to model correlates of quadratic change in affect balance. However, gender emerged as a reliable predictor of quadratic change over time-to-death, with women showing more pronounced increases in positivity, followed by steeper declines nearing death relative to men. One possible reason for the difference is that women are more likely to take on caring roles in late life, which can be a significant source of stress (Son et al., 2007). However, given that men and women are each subject to the same processes of biological degradation thought to underlie terminal decline, the finding also raises the possibility of gender differences in late life emotion regulation (see Urry & Gross, 2010). A more detailed examination of gender differences in late life socio-emotional functioning represents a promising area for future research.

We acknowlegde that over the 19 years of our study, a large amount of missing data has accumlated. To accommodate violations of missing-at-random assumptions, our models incorporated a number of attrition-relevant variables: Age, gender, education, cognitive functioning, and functional disability, thereby alleviating problems associated with non-random attrition. At the same time, however, we note that results reported in our study probably do not generalize to less positively select segments of the population. Positive sample selectivity may have also resulted in under-representation of older adults living with more severe functional restrictions, and relying more heavily on social networks for care and support. This may have resulted in an under-estimation of associations between social

resources and positivity. Finally, characteristics of our data that are common to many longitudinal studies of aging including relatively few repeated assessments, long intervals between assessments, and less than optimal reliability of measures may be one of the reasons why our report is consistent with previous studies that have tended to find few associations between individual difference characteristics and rates of terminal decline in well-being (Gerstorf & Ram, 2013).

To conclude, our findings indicate that several indicators of social resources- particularly activity engagement and relationship satisfaction- are related to higher levels of affective positivity in late life, whereas participants reported lower positivity on occasions when they had more contact with children relative to occasions when they had less contact with children. Taken together, our findings suggest that some social resource may confer a cumulative advantage for well-being, but do not play a central role in influencing rates of decline in positivity in the years preceding death. Further studies are needed to determine the extent to which late life declines in emotion are modifiable, and whether other psychosocial characteristics (e.g., personality, self-regulatory tendencies cf. Brandtstader & Renner, 1990) have a role to play in preserving affective well-being in the face of pervasive biological decline.

Text word count: 7505

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Table 1. Bivariate correlations and descriptive statistics at Time 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	-													
2. Time-to-death	0.39*	-												
3. Age at death	0.70*	-0.38*	-											
4. Female	0.14*	-0.08*	0.20*	-										
5. Age left school	-0.06	-0.07	-0.00	0.07	-									
6. Contact children	-0.12*	-0.11*	-0.04	0.09*	-0.03	-								
7. Partnered	-0.33*	-0.10*	-0.26*	-0.37*	0.03	0.11*	-							
8. Social activity	-0.20*	-0.20*	-0.04	0.12*	0.09*	0.24*	-0.06	-						
9. Confidant	-0.01	-0.03	0.02	0.02	-0.03	0.07	0.08*	0.08*	-					
10. Satisfaction family	-0.06	-0.11*	0.02	-0.02	0.03	0.33*	0.18*	0.19*	0.13*	-				
11. Satisfaction friends	-0.11*	-0.16*	0.01	0.06	0.11*	0.09*	0.00	0.26*	0.11*	0.39*	-			
12. Functional disability	0.28*	0.27*	0.07	0.29*	-0.06	0.00	-0.17*	-0.14*	0.01	-0.09*	-0.15*	-		
13. MMSE	0.20*	0.21*	0.04	0.07	-0.11*	-0.10*	-0.08*	-0.19*	-0.03	-0.08*	-0.14*	0.15*	-	
14. Affect balance	-0.07	-0.15*	0.05	-0.05	0.06	0.07	0.13*	0.16*	0.06	0.29*	0.20*	-0.36*	-0.17*	-

M/%	80.46	7.46	87.92	7.80	1.92	3.87	3.56	2.83	50.00
SD	6.33	4.85	6.28	2.55	0.64	0.91	0.80	2.20	10.00

Note. *$p < .01$

Table 2. Multilevel growth models for affect balance over chronological age and time-to-death

	Chronological age		Time-to-death			
	Model 1		Model 1		Model 2	
Variable	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Fixed effects						
Intercept	49.52*	0.24	49.59*	0.24	50.12*	0.28
Linear slope	-0.23*	0.03	-0.40*	0.04	-0.49*	0.05
Quadratic slope					-0.03*	0.01
Random effects						
Intercept	44.57*	3.22	43.37*	3.12	43.01*	3.08
Linear slope					0.21*	0.08
Intercept & slope covariance					1.01*	0.33
Residual	54.59*	3.03	53.87*	2.95	50.08*	2.16
Goodness of fit: AIC	19144		19099		19080	
Pseudo R^2 Level 1	.04		.05		.12	

Note. AIC = Akaike Information Criterion. Pseudo R^2 represents proportional change in residual variance compared with an unconditional means model. Estimates are unstandardized. Chronological age is centered at 80 years; time-to-death is centered at 6 years from death. Significance of random effects is based on 95% CIs. *$p < .05$.

Table 3. Social resource correlates of level and linear change in affect balance over time-to-death with and without adjustment for covariates (adjusted model n = 1214).

	Unadjusted model						Adjusted for covariates					
	Intercept		Linear slope		Quadratic slope		Intercept		Linear slope		Quadratic slope	
	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Fixed effects	48.09*	1.37	-0.35	0.33	-0.02*	0.01	47.70*	1.38	-0.16	0.33	-0.01	0.01
Social resources - structural												
Partnered	1.39*	0.48	-0.17*	0.09			0.56	0.50	-0.10	0.09		
WP social activity	1.01*	0.48	0.07	0.11			0.93†	0.48	0.02	0.11		
BP social activity	1.23*	0.45	0.01	0.09			0.84†	0.44	-0.10	0.08		
Social resources - functional												
Satisfaction family	1.89*	0.30	-0.01	0.06			1.99*	0.29	-0.02	0.06		
Satisfaction friends	1.22*	0.35	0.02	0.07			0.70*	0.33	0.05	0.07		
Confidant	1.28	1.38	0.03	0.34			2.18	1.34	-0.17	0.33		
Covariates												
Functional disability							-1.14*	0.11	-0.05*	0.02		
Global cognition							-1.46*	0.53	-0.05	0.10		

Female				0.87	0.60	0.16	0.11	-0.03*	0.02
Age at death				0.05	0.04	-0.01	0.01		
Age left school				0.04	0.45	-0.10	0.08		
Random effects									
Intercept	36.74*	2.95		29.73*	2.61				
Linear slope	0.14*	0.08		0.06*	0.06				
Intercept & slope covariance	0.81*	0.31		0.50	0.27				
Residual	49.79*	2.20		49.91*	2.18				
Goodness of fit: AIC	17935			17632					

Note. AIC = Akaike Information Criterion. WP = within-person. BP = between-person. Estimates are unstandardized. Time-to-death is centered at 6 years from death. Significance of random effects is based on 95% CIs. *$p < .05$. $^{\dagger}p < .06$.

Table 4. Social resource correlates of level and linear change in affect balance over time-to-death, including contact with children, adjusted for covariates (n = 1072)

	Intercept		Linear slope		Quadratic slope	
	Estimate	SE	Estimate	SE	Estimate	SE
Fixed effects	47.88*	1.51	0.06	0.35	-0.01	0.01
Social resources - structural						
Partnered	0.97	0.54	-0.12	0.10		
WP social activity	1.13*	0.50	-0.00	0.11		
BP social activity	1.06*	0.48	-0.10	0.09		
WP contact children	-0.37*	0.16	-0.05	0.04		
BP contact children	-0.10	0.11	-0.06*	0.03		
Social resources - functional						
Satisfaction family	2.21*	0.32	-0.05	0.07		
Satisfaction friends	0.45	0.36	0.10	0.07		
Confidant	1.66	1.47	-0.35	0.35		
Random effects						
Intercept	30.69*	2.76				

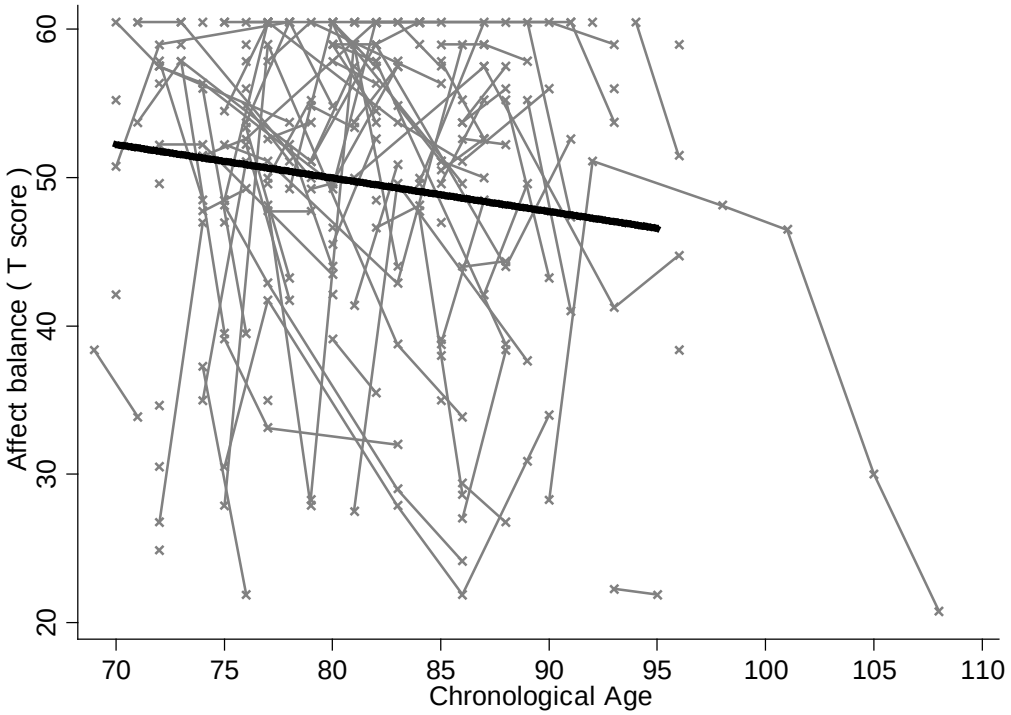
Linear slope	0.08*	0.07
Intercept & slope covariance	0.44	0.30
Residual	46.80*	2.23
Goodness of fit: AIC	15363.43	

Note. Estimates are adjusted for functional disability, global cognition, gender, age at death, and age left school. AIC = Akaike Information Criterion. WP = within-person. BP = between-person. Estimates are unstandardized. Time-to-death is centered at 6 years from death. Significance of random effects is based on 95% CIs. *$p < .05$.

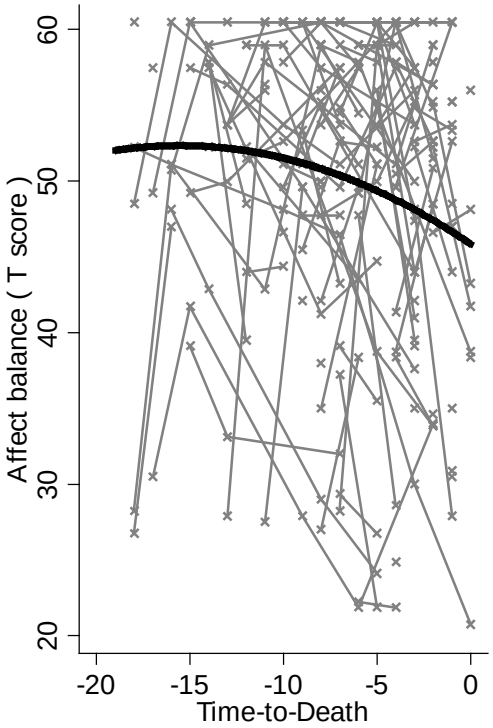
Figure Caption

Figure 1. Individual (grey lines) trajectories for a random subset of 122 (10%) participants and sample average (black lines) trajectories of change in affect balance over (a) chronological age and (b) time-to-death. Affect balance showed a steeper average decline over time-to-death compared with chronological age.

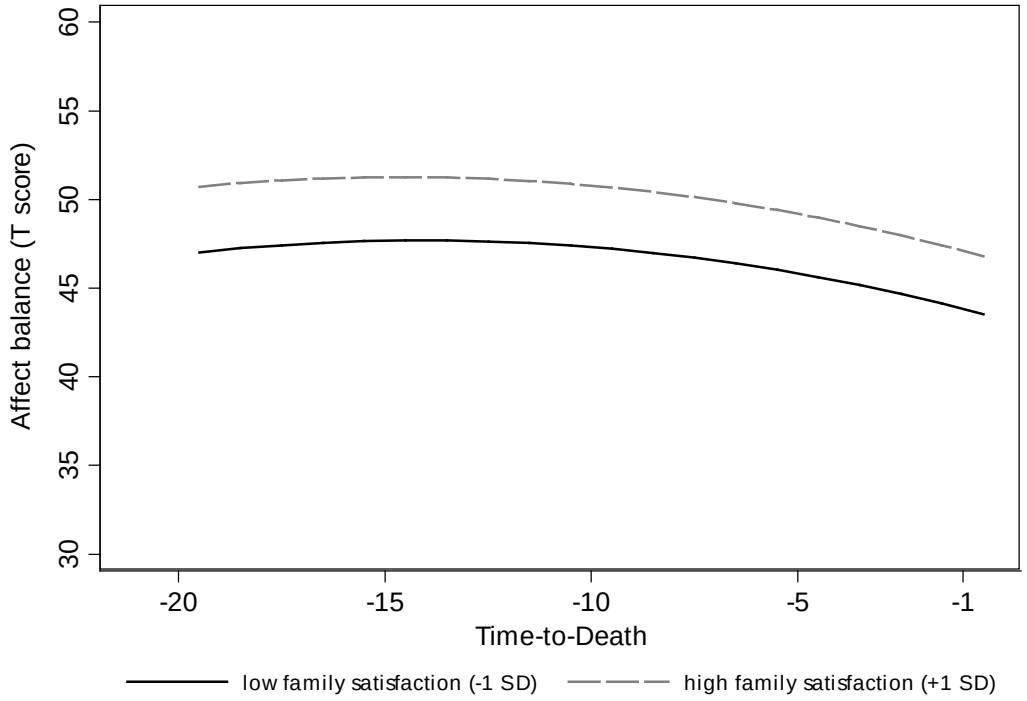
Figure 2. Predicted trajectories of affect balance over time-to-death for hypothetical individuals (a) scoring high (+1 *SD*) or low (-1 *SD*) on satisfaction with family, (b) scoring high (+1 SD) or low (-1 SD) on functional disability, (c) for men and women, and (d) for individuals scoring high and low on contact with children. Satisfaction with family was associated with level, but not rate of change in affect balance. Participants with more disabilities had lower affect balance, and showed steeper rates of decline in affect balance over time-to-death. Men showed relatively stable affect balance on average, whereas women showed a pattern of curvilinear change. Having less frequent contact with children was associated with a marginally steeper increase in affect balance over time-to-death.


Affect balance (T score)
20
30
40
50
60
70
75
80
85
90
95
100
105
110
Chronological Age

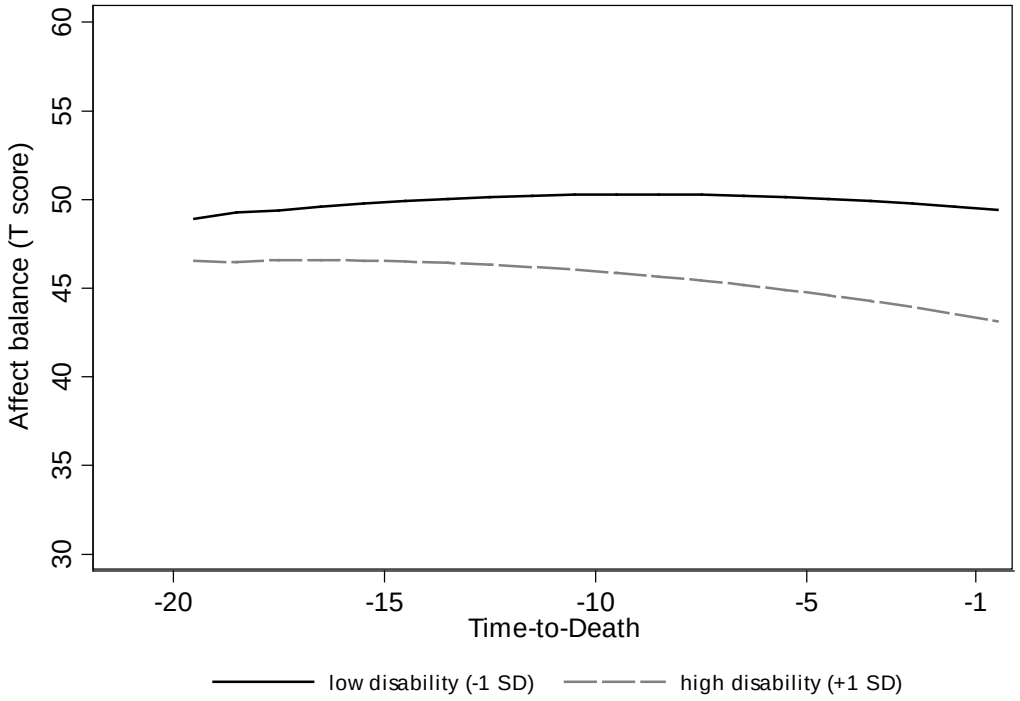
(a)


Affect balance (T score)
20
30
40
50
60
-20
-15
-10
-5
0
Time-to-Death

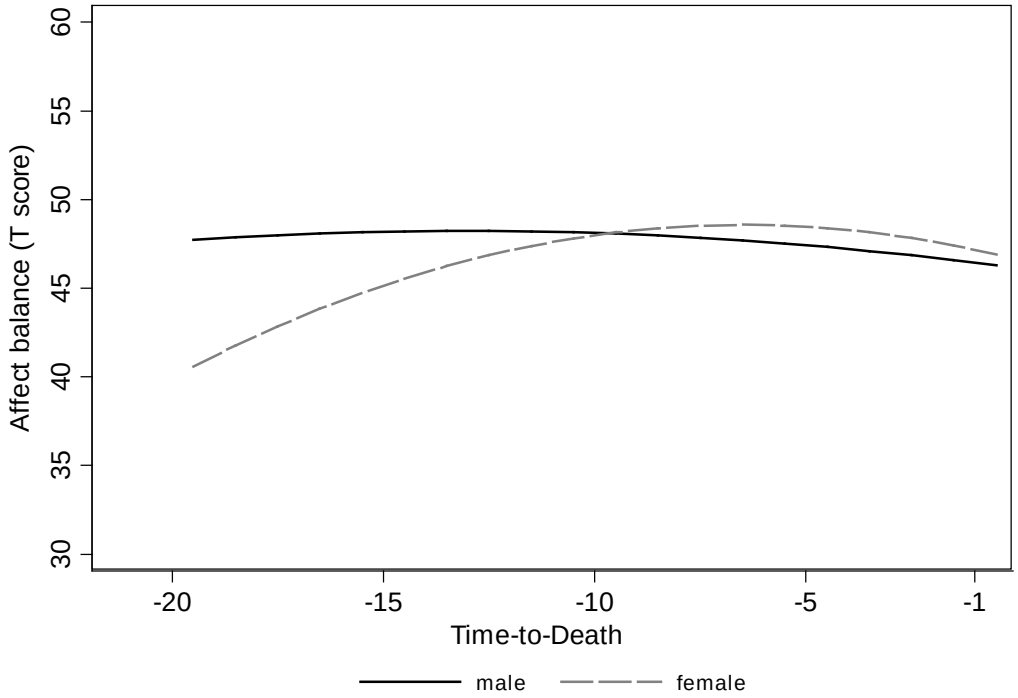
(b)


Affect balance (T score)
60
55
50
45
40
35
30
-20
-15
-10
-5
-1
Time-to-Death
low family satisfaction (-1 SD)
high family satisfaction (+1 SD)

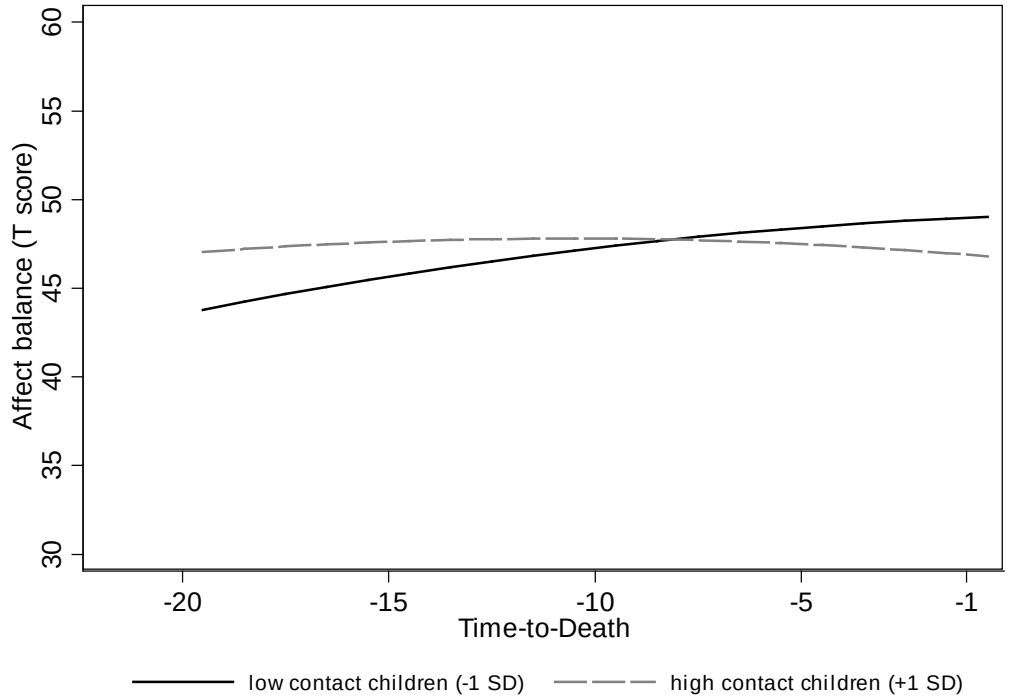
(a)


Affect balance (T score)
60
55
50
45
40
35
30
-20
-15
-10
-5
-1
Time-to-Death
low disability (-1 SD)
high disability (+1 SD)

(b)


Affect balance (T score)
60
55
50
45
40
35
30
-20
-15
-10
-5
-1
Time-to-Death
male
female

(c)


Affect balance (T score)
60
55
50
45
40
35
30
-20
-15
-10
-5
-1
Time-to-Death
low contact children (-1 SD)
high contact children (+1 SD)

(d)