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Brief Report

Delineating Terminal Change in Subjective Well-Being and Subjective Health

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The present study investigated whether several evaluative indicators of subjective well-being (SWB) and subjective health decline as death approaches and which of them shows a stronger decline. Using three-wave longitudinal data from deceased participants of the Cross-Sectional and Longitudinal Aging Study (*N* = 1,360; age range 75–94 at T1= Time 1), we found a stronger decline in most evaluative indicators when plotted by distance-to-death relative to distance from birth. After controlling for background characteristics and physical and cognitive functioning, death-related decline was still found for SWB but not for subjective health. Implications are discussed regarding the well-being paradox and the yet unclear mechanisms that link evaluative indicators to the dying process.

Key Words: CALAS—Self-rated health—Subjective well-being—Terminal change.

RECENT studies have attempted to disentangle the relative effects of the aging and the dying processes. The aging process may be defined as the natural course of development. If this process accounts for the changes prior to death, then deterioration should be associated with age rather than with distance to death (D-t-D). The dying process may be defined as an accelerated functional decline proximal to death. As both processes may result from the same underlying mechanisms, the dying process has been defined as tertiary aging (Birren & Cunningham, 1985). Still, it is important to delineate the relative effect that each of these processes has on functioning (Diehr, Williamson, Burke, & Psaty, 2002).

Studies of physical and cognitive change have documented pronounced late-life deterioration prior to death, termed as the "terminal change" (Bäckman & MacDonald, 2006; Lunney, Lynn, Foley, Lipson, & Guralnik, 2003). Moreover, it has been shown that the effects of the terminal change are stronger than those of aging, so that functional decline is more evident when plotted by D-t-D than by distance from birth (Diehr et al.).

In addition to terminal change in "informative" functional indicators that can be measured rather objectively by a person's performance or factual report (e.g., physical functioning and cognitive functioning), recent studies have found indication for terminal change in "evaluative" indicators that reflect the person's evaluation of his or her functioning. After controlling for age and/or informative indicators, terminal change was found in evaluative indicators, such as subjective well-being (SWB) and self-rated health (Diehr et al., 2002; Gerstorf, Ram, Estabrook, et al., 2008; Gerstorf, Ram, Röcke, Lindenberger, & Smith, 2008; Mroczek & Spiro, 2005). Previous studies have not compared different evaluative indicators, and this is the main goal of the present study. Accordingly, the current study attempts to disentangle the effects of aging and dying on SWB and subjective health and to examine which indicator shows a stronger decline prior to death.

Our first hypothesis is that the effects of dying are stronger than those of aging, so that the decline in SWB and subjective health would be more evident when plotted by D-t-D than when plotted by distance from birth. If this hypothesis is correct, it means that evaluative indicators are vulnerable to decline at the very end of life, even though the well-being paradox phenomenon shows that well-being characteristic levels are sustained into later life despite functioning decline (Kunzman, Little, & Smith, 2000) and even though there is a moderate association between subjective health and age (Benyamini & Idler, 1999). Our second hypothesis is that death-related decline in evaluative indicators will be found even after controlling for background characteristics and informative indicators. However, as subjective health is generally moderately related to demographic background and to informative indicators (Jylhä, 2009), whereas SWB is affected by a genetically determined set point and happiness-relevant activities and practices (Lyubomirsky, Sheldon, & Schkade, 2005), we hypothesize that when controlling for background characteristics and informative indicators, death-related decline would be more pronounced in SWB than in subjective health.

Method

Participants and Procedure

Analyses were performed on data from the Cross-Sectional and Longitudinal Aging Study (CALAS). This study conducted a multidimensional assessment of a random sample of the older Jewish population in Israel (aged 75–94), stratified by age groups, gender, and place of birth. The sample was drawn from the National Population Registry (NPR) in January 1989. Of 2,400 sampled individuals, 15.7% had died before the sampling day or were not located and 8.5% refused to participate. Of the remaining individuals, 451 participants were interviewed by proxy and were not included in the current analyses due to significant missing data. The final sample included 1,369 participants who were interviewed in person at T1 (= Time 1; 1989–1992), 697 of them were interviewed in person again at T2 (1993–1994), and 164 were interviewed in person at T3 (2001–2002). Attrition was mainly due to mortality or poor health. More details on the CALAS appeared elsewhere (e.g., Ben-Ezra & Shmotkin, 2006).

Date of death was drawn from NPR records up to May 2009. By that time, 1,310 participants had died and 50 were still alive. Mortality data were missing for nine participants. To avoid missing data on the D-t-D variable, we imputed the date of last update as the date of death for the 50 survivors (e.g., as in Thorvaldsson et al., 2008). Analyses included 1,360 participants in T1 (M = 83.53 years, SD = 5.42; 46.1% women), 677 participants in T2 (M = 85.65 years, SD = 5.09; 46.2% women), and 159 participants in T3 (M = 91.88 years, SD = 4.30; 56.6% women). D-t-D was calculated for each participant as the number of years from interview to date of death. The range of age and D-t-D was 30 and 20 years, respectively. Age and D-t-D correlated moderately ($r = -.37$, $p < .0001$).

The CALAS interviews were conducted in the participant's home after the participant had signed an informed consent. The CALAS was approved for ethical requirements by an institutional review board.

Measures

SWB measures.—Current life evaluation was measured by asking the respondent to rate her or his life today as 1 (*very difficult*), 2 (*difficult*), 3 (*pretty good*), or 4 (*good*).

Positive and negative effects (PA and NA) were measured by two subscales of the Center for Epidemiological Studies-Depression scale (Radloff, 1977). PA was measured by three of four items (e.g., "I felt happy") that comprised the well-being subscale. The fourth item ("I felt that I was just as good as other people") was omitted as it markedly decreased internal reliability. NA was measured by seven items (e.g., "I felt depressed") that comprised the depressed mood subscale. These scales have been previously used to assess affect (e.g., Ostir, Ottenbacher, & Markides, 2004). Respondents rated the frequency in which they experienced each affect within the last month on a scale of 0 (*not at all*) to 3 (*almost every day*). The score for each subscale was the respondent's mean rating on the relevant items. In the present study, Cronbach's alpha for PA was .71 in T1, .69 in T2, and .66 in T3. Cronbach's alpha for NA was .83 in T1, .84 in T2, and .77 in T3.

Subjective health measures.—Subjective health was measured by asking the respondent to rate her or his current health as 1 (*bad*), 2 (*fair*), 3 (*good*), or 4 (*excellent*).

Health comparison was measured by asking the respondent to rate her or his current health in comparison with last year as 1 (*worse*), 2 (*the same*), or 3 (*better*).

Health-related worry was measured by asking the respondent to rate how much during the last year she or he worried about her or his general health status: 1 (*not at all*), 2 (*a bit*), or 3 (*a lot*). To ensure a common metric across the six evaluative measures, they were standardized to a T metric.

Covariates.—Background characteristics included age (centered at 85), gender (0 = *women* and 1 = *men*), origin (0 = *born outside Israel* and 1 = *Israeli born*), years of education, marital status (0 = *unmarried* and 1 = *presently married*), and place of residence (0 = *home* and 1 = *institution*).

Informative measures included the number of diagnosed diseases marked by the respondent from a list of 26 diseases (such as high blood pressure, diabetes, or cancer), the number of hospitalizations in the past 5 years, and cognitive impairment as measured by the Orientation–Memory–Concentration test (OMC; Katzman et al., 1983). The OMC includes six items that test three cognitive functions of time orientation, memory, and concentration. Errors were multiplied by prefixed weights and summed up, and the raw score ranged from *no impairment* (0) to *full impairment* (28) (see Katzman et al.). Cronbach's alpha coefficients in T1, T2, and T3 were .73, .69, and .74, respectively.

Data Analysis

To test the first hypothesis, we fitted two separate growth curve models for each evaluative measure, once with chronological age as the time variable and once with D-t-D as the time variable. These models were parameterized as

$$\mathrm{sub}_{it} = L_i + S1_i(\mathrm{time}_{it}) + e_{it'}.$$

The score on the evaluative measure for person i at time t, sub_{it}, is a function of an individual-specific intercept parameter, L_i, an individual-specific slope parameter, $S1_i$, that captures change over the selected time dimension (age or D-t-D), and residual error $e_{it'}$. Interindividual differences in level (L_i) and slope ($S1_i$) are assumed to be normally distributed around group means, correlated with each other, and uncorrelated with the residual errors $\left(e_{it'}\right)$. To test the

second hypothesis, new models were run with background characteristics, diseases, hospitalizations, and cognitive impairment as predictors of interindividual differences in level (L_i) and in terminal change slope ($S1_i$).

The models were examined with SPSS 15. Incomplete data were treated as missing at random (Little & Rubin, 1987).

Results

Preliminary interclass correlations ranged between .58 and .88, suggesting that 58%–88% of the total variance in evaluative measures was between-persons variance and that the remainder (12%–42%) was within-person variation. Mixed linear models were run next.

Table 1 presents estimates and goodness-of-fit indices of all models. Model comparisons showed that the D-t-D models fitted the data better than did the age models for five of six evaluative measures. An exception was PA for which neither the slopes for D-t-D nor for age were significant. For the other five measures, we compared goodness of fit of D-t-D and age models by subtracting the −2 log likelihood (−2LL) of the age model from that of the D-t-D model. Δ −2LL ranged between 12 and 60 ($p < .0001$). As for the relative proportion of explained variance, the Δ pseudo-R^2 (Snijders & Bosker, 1999) for the D-t-D models ranged between 0.008 and 0.056 and was higher than the Δ pseudo-R^2 for the age models (which ranged 0.000–0.041). An exception was a higher Δ pseudo-R^2 for the age than the D-t-D model with regards to health comparison. Overall, D-t-D models fitted the data better and explained a greater proportion of the variance than did an intercept-only model. When the slope estimator was significant, the age-related decline in evaluative measures ranged between |0.10| and |0.16| T-score units per year, whereas the death-related decline ranged between |0.18| and |0.33| T-score units per year.

When background characteristics were added to the D-t-D models, the slope estimator was significant for all SWB measures but for none of the subjective health measures: 1.95 ($SE = 0.81$, $p < .05$) for current life evaluation, 1.94 ($SE = 0.90$, $p < .05$) for PA, and −1.46 ($SE = 0.76$, $p = .05$) for NA. When both background characteristics and informative measures were included, the slope estimate was still significant for all SWB measures: 2.08 ($SE = 0.83$, $p < .05$) for current life evaluation, 1.89 ($SE = 0.94$, $p < .05$) for PA, and −1.69 ($SE = 0.76$, $p < .05$) for NA.

Importantly, the results did not change when the analyses were conducted without the 50 living participants (N = 1,310).

Discussion

The aim of the current study was to examine terminal change in evaluative indicators of SWB and subjective health. Our results replicated previous studies (Diehr

Table 1. Growth Models for SWB and Subjective Health by Chronological Age and D-t-D

Effect	SWB indicators						Subjective health indicators					
	Life satisfaction		Positive affect		Negative affect		Subjective health		Health comparison		Health-related worry	
	Age	D-t-D	Age	D-t-D	Age	D-t-D	Age	D-t-D	Age	D-t-D	Age	D-t-D
Fixed-effect estimates												
Intercept	49.70 (0.24)***	47.89 (0.37)***	49.95 (0.24)***	49.99 (0.42)***	50.16 (0.25)***	51.45 (0.38)***	49.72 (0.24)***	47.71 (0.35)***	49.92 (0.22)***	48.43 (0.36)***	50.19 (0.23)***	51.38 (0.37)***
Slope	−0.16 (0.04)***	0.30 (0.04)***	0.08 (0.04)	−0.00 (0.04)	0.15 (0.04)***	−0.21 (0.04)***	−0.10 (0.04)**	0.33 (0.04)***	−0.07 (0.03)	0.23 (0.04)***	−0.02 (0.04)	−0.18 (0.04)***
Random-effect estimates												
Variance of intercept	36.08 (3.71)***	41.82 (7.80)***	13.67 (3.68)***	50.99 (10.67)***	40.38 (3.76)***	48.16 (5.73)***	42.06 (3.61)***	33.14 (7.61)***	15.13 (3.39)***	8.90 (5.49)	27.64 (3.48)***	25.97 (5.47)***
Variance of slope	0.05 (0.07)	0.05 (0.08)	0.37 (0.09)***	0.24 (0.08)**	0.00 (0.00)	0.01 (0.00)	0.00 (0.06)	0.02 (0.08)	0.00 (0.00)	0.00 (0.00)	0.03 (0.06)	0.00 (0.00)
Covariance intercept, slope	0.03 (0.27)	−0.60 (0.76)	0.75 (0.33)*	−3.30 (0.89)***	−0.03 (0.28)	−0.67 (0.28)	−0.44 (0.27)	0.44 (0.72)	−0.34 (0.23)	0.28 (0.28)	−0.10 (0.25)	0.08 (0.28)
Residual variance	62.06 (3.27)***	61.12 (3.36)***	76.15 (4.45)***	77.61 (4.77)***	59.80 (2.99)***	58.31 (2.89)***	57.20 (3.11)***	56.96 (3.32)***	83.69 (3.88)***	84.30 (4.00)***	71.41 (3.49)***	70.78 (3.58)***
Goodness-of-fit indices												
−2LL	16,060	16,032	14,365	14,378	15,396	15,384	15,985	15,935	16,183	16,159	15,970	15,954
AIC	16,072	16,044	14,377	14,390	15,408	15,396	15,997	15,947	16,195	16,171	15,982	15,966

Notes: N = 1,360 respondents who provided 2,441 observations. *SE*s are in parentheses. −2LL = −2 log likelihood; AIC = Akaike information criterion; D-t-D = distance-to-death; SWB = subjective well-being.
*$p < .05$; **$p < .01$; ***$p < .001$.

et al., 2002; Gerstorf, Ram, Estabrook, et al., 2008, Gerstorf, Ram, Röcke, et al., 2008; Mroczek & Spiro, 2005) in showing a stronger effect of dying than of age for various SWB and subjective health indicators. Moreover, after controlling for background characteristics and informative indicators, we found terminal change in all SWB indicators but not in subjective health indicators. Thus, beside the known terminal change in informative indicators, terminal change may be seen in the evaluative indicators of SWB.

The unique association between SWB and the dying process in old–old age may partially explain the phenomenon of the well-being paradox (Kunzman et al., 2000). It is possible that very late-in-life SWB is only weakly associated with chronological age and more affected by specific, yet unexplained mechanisms connected to the dying process. Gerstorf, Ram, Estabrook, et al. (2008) and Gerstorf, Ram, Röcke, et al. (2008) proposed that SWB might be linked to closeness to death through its relation to psychoneuroimmunological agents or to a motivational component, such as the will to live (Carmel, Baron-Epel, & Shemy, 2007). These propositions will need to be examined in the future.

The large longitudinal data set and the diversity of informative and evaluative indicators are the main strengths of our study. However, the large time gaps between waves prevented the collection of more longitudinal observations. Compared with previous studies, our D-t-D models explained less variance in evaluative indicators. It is possible that the relatively small number of waves and the use of single-item measures lowered the explained variance in our model.

In sum, this study presented evidence for a significant dying effect on SWB, but not on subjective health measures, which was documented when other background and informative indicators were accounted for. Future research on terminal change should focus on SWB and search for the mechanisms connecting SWB to the dying process.

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