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The Influence of Cognitive Decline on Well-Being in Old Age

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This study addressed the hypothesis that late life cognitive decline leads to loss of well-being. Participants are older persons from the Rush Memory and Aging Project. Beginning in 2001, they underwent annual clinical evaluations that included detailed cognitive performance testing and a 10-item self-report measure of purpose in life, an aspect of well-being. Initial analyses involved 1,049 individuals who were without dementia at baseline and followed a mean of 5.0 years. The intercepts and slopes of global cognition and purpose were positively correlated, and level of cognition at a given evaluation predicted level of purpose at the subsequent evaluation, consistent with the study hypothesis. Purpose also predicted subsequent cognition. These findings persisted in analyses that excluded mild cognitive impairment or controlled for time varying levels of depressive symptoms or disability. To see whether cognitive decline's correlation with purpose differed from its correlation with other aspects of well-being, we conducted additional analyses on a subgroup of 560 persons without dementia who completed a multidimensional measure of well-being once between 2008 and 2011. More rapid cognitive decline in the period preceding well-being assessment (M = 5.5 years, SD = 2.8) was associated with lower level of nearly all aspects of well-being (5 of 6 measures), but the extent of the association varied across well-being dimensions and was stronger for purpose than for self-acceptance and autonomy. The results support the hypothesis that cognitive aging leads to diminished well-being, particularly aspects such as purpose in life that involve behavioral regulation.

Keywords: well-being, purpose in life, cognitive decline, longitudinal study

Cognitive decline in old age is associated with a range of adverse health consequences, including disability (Nikolova, Demers, & Beland, 2009; Yaffe et al., 2006) and death (Laukka, MacDonald & Bäckman, 2006; MacDonald, Hultsch, & Dixon, 2011; Sliwinski, Stawski, Katz, Verghese, & Lipton, 2006; Thorvaldsson et al., 2008; Wilson, Beck, Bienias, & Bennett, 2007; Wilson, Beckett, Bienias, Evans, & Bennett, 2003; Wilson, Segawa, Hizel, Boyle, & Bennett, 2012). Little is known, however, about the effect of cognitive decline on a key domain in old age, well-being.

The association between cognitive function and well-being in old age has been hypothesized to be reciprocal (Lawton, 1983; Llewellyn, Lang, Langa, & Huppert, 2008). Consistent with half of the hypothesis, higher level of well-being has been associated with reduced cognitive decline (Boyle, Buchman, Barnes, & Bennett, 2010; Boyle et al., 2012; Gerstorf, Lövdén, Röcke, Smith, & Lindenberger, 2007). We are aware of only one longitudinal study that has directly addressed the second half of the hypothesis, however, and it found no evidence that cognitive decline predicted subsequent decline in well-being (Gerstorf et al., 2007). Studies of constructs related to well-being have yielded similar results. Thus, cognitive decline appears to be accompanied by little to no change in negative (Amieva et al., 2008; Wilson, Arnold, Beck, Bienias, & Bennett, 2008; Wilson et al., 2010) or positive (Wilson et al., 2010) affect. These studies suggest that cognitive decline may not strongly impact affective aspects of well-being in old age.

It is possible, however, that other aspects of well-being may be more cognitively demanding and thereby more sensitive to age-related cognitive decline. For example, purpose in life is defined as having a sense of direction and intentionality, aspirations and goals for the future, and the feeling that life's experiences are meaning-

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ful. Developing and maintaining purpose in life requires self-reflection, synthesis of diverse experiences into a coherent narrative, awareness of one's priorities and potential within the broader environment, thinking about the future, and emotion regulation (Pinquart, 2002; Seidlitz, Wyer, & Diener, 1997). Episodic memory plays an important role in remembering past experiences, as well as imagining future ones (Addis & Schacter, 2012; Schacter & Addis, 2007; Schacter & Addis, 2009), both of which are critical for integrating experiences and planning for the future. Furthermore, cognitive control strategies that depend in part on executive functions are needed for self-reflection, emotion regulation, and alignment of cognitive, motivational, and emotional goals (Kryla-Lighthall & Mather, 2008; Mather & Carstensen, 2005). Age-related changes in memory and executive functions and their neural architecture (i.e., prefrontal cortex and hippocampus) are well documented and may underlie declines in cognitively challenging aspects of well-being, such as maintaining a sense of purpose in life in old age.

In the present study, we test the hypothesis that cognitive decline in old age leads to a loss of well-being. Analyses are based on a cohort of more than 1,000 older persons who had annual assessments of cognitive function and purpose in life, an aspect of well-being. We investigated the hypothesis in a series of bivariate latent curve models with cross lagged components (Curran & Bollen, 2001). This approach, unlike an autoregressive approach, allowed us to determine whether individual differences in trajectories of change in cognition and purpose were associated (e.g., correlations between slopes), one component of the study hypothesis. In addition, with these across wave effects accounted for, examination of wave specific effects allowed us to test the directional component of the hypothesis: whether level of cognition in a specific wave predicted level of purpose in the subsequent wave, as hypothesized, and to compare this association with the more established correlation of purpose with subsequent cognition (Boyle et al., 2010; Boyle et al., 2012). We considered using an autoregressive latent trajectory model because it includes both autoregressive and latent growth curve components (Bollen & Curran, 2004; Curran & Bollen, 2001), but this approach has been shown to be prone to misspecification (Voelkle, 2008).

Although prior work suggests that some aspects of well-being require a cognitive infrastructure, it is also possible that the association of cognitive function with subsequent well-being might be because of their joint association with some other variables rather than to a direct effect of cognitive impairment on well-being. Depressive symptoms and disability are common in old age and associated with lower levels of well-being (Schleicher et al., 2005; Wood, Taylor, & Joseph, 2010) and cognitive function (Wilson et al., 2002; Yaffe et al., 2010). Therefore, we examined whether adding time varying versions of these covariates modified the association of cognitive function with subsequent well-being.

As previously noted, well-being is multidimensional, and dimensions such as purpose may be more sensitive to cognitive decline than more affective dimensions. We examined this possibility in a subset of Rush Memory and Aging Project participants who completed a standard well-being measure with brief subscales of purpose and other aspects of well-being. In a mixed-effect model, we estimated the association of prior rate of cognitive decline (during a mean of 5.5 years of observation) with current level of multiple well-being dimensions and tested whether cognitive decline's association with purpose was stronger than its association with other aspects of well-being.

Method

Participants

Study participants are from the Rush Memory and Aging Project, which involves annual clinical evaluations and brain autopsy at death (Bennett, Schneider, Buchman, et al., 2005; Bennett et al., 2012). Older persons were recruited from retirement communities, subsidized housing facilities, local churches, and social service agencies in the Chicago area. The aim was to recruit a group that was comparable to the 80-year-old population in the Chicago area at the time of the 1990 census in terms of education (approximately 33% with 12 years or less), gender (approximately 75% women), and racial or ethnic minorities (approximately 10%). After the study was fully described to individuals, written informed consent was obtained. The study began in 1997, the protocol and cohort were expanded in 2001, and data collection is continuing, including new recruitment as well as follow-up. The project was approved by the institutional review board of Rush University Medical Center.

At the time of these analyses, 1,259 persons aged 65 years or older had completed the baseline clinical evaluation and been found to be free of dementia. Of these, 38 died before the first annual follow-up, and 75 had been in the study less than 1 year. This left 1,146 eligible for follow-up, and 1,049 (91.5%) had longitudinal data on both cognition and purpose. Primary analyses are based on this group. They had a mean age at baseline of 80.3 years ($SD = 6.5$), a mean of 14.5 years of education ($SD = 3.2$), and a mean score of 27.9 on the Mini-Mental State Examination ($SD = 2.1$); 74.3% were women and 89.2% were white and non-Hispanic. They completed a mean of 6.0 annual evaluations ($SD = 2.7$; range = 2–14) during which 218 (20.8%) developed dementia.

Because the analysis with a time varying indicator of depression required a minimum of 5 valid depression scores, only 523 of the 1,049 original subjects were eligible. Compared with the 526 persons not included, the 523 persons included were similar in age (79.9 vs. 80.7), t (1,033.8) = 1.9, $p = .058$; and proportion of women (74.4% vs. 74.1%), $\chi^2(1) = 0.0$, $p = .931$; had higher levels of education (14.7 vs. 14.2), $t(1{,}038.1) = 2.7$, $p = .007$; global cognition (0.22 vs. −0.03), $t(1{,}008.3) = 7.8$, $p < .001$; and purpose (3.66 vs. 3.58), $t(909) = 2.8$, $p = .005$; and a lower level of depressive symptoms (0.96 vs. 1.45), $t(999.0) = 4.6$, $p < .001$. A nearly identical subset of 514 participants was included in the analysis with a time varying indicator of disability.

We conducted additional analyses on 560 persons who (a) completed Ryff's 18-item measure of well-being between 2008 and 2011 as part of a study of decision making (514 of whom were also included in primary analyses), and at the time of well-being assessment (b) did not meet dementia criteria and (c) had completed at least two waves of cognitive testing. Of 560 persons who met these criteria, 46 were not included in the initial group of 1,049 and 514 were. Compared with the 535 in the initial but not second group, the 514 in the second analytic group had a similar proportion of women (75.1% vs. 73.5%), $\chi^2(1) = 0.4$, $p = .544$, were younger (78.9 vs. 81.7), $t(1{,}047) = 7.2$, $p < .001$, and more educated (15.0 vs. 14.0), $t(1{,}047) = 5.6$, $p < .001$, and had a higher levels of global cognition (0.27 vs. −0.08), $t(1{,}030) = 11.5$, $p < .001$, and purpose (3.67 vs. 3.53), $t(909) = 5.5$, $p < .001$. At the time of well-being assessment, the 560 persons in this subgroup had completed a mean of 5.5 years of annual cognitive testing ($SD = 2.8$; range = 0.5–13). They had a mean age of 83.8 years ($SD = 7.4$), a mean of 15.0 years of education ($SD = 3.0$), and a mean score of 28.4 on the Mini-Mental State Examination ($SD = 1.7$); 75.7% were women, 90.7% were White and non-Hispanic, and 17.9% had mild cognitive impairment.

Assessment of Well-Being

Purpose in life (i.e., the tendency to derive meaning from life's experiences and possess a sense of goal-directedness and intentionality) was assessed annually beginning in 2001 with a 10-item scale from Ryff's Scales of Psychological Well Being (Ryff, 1989). Participants rated agreement with each item statement on 7-point Likert scale. Item scores were averaged to yield a total score ranging from a low of 1 to a high of 7. Cronbach's coefficient alpha was 0.74, indicating an adequate level of internal consistency. Low purpose in life has previously been associated with adverse health outcomes in this cohort (Boyle, Barnes, Buchman, & Bennett, 2009; Boyle, Buchman, & Bennett, 2010).

The 18-item version of Ryff's Scales of Psychological Well Being (Keyes, Shmotkin, & Ryff, 2002; Ryff & Keyes, 1995) was administered once to a subgroup of participants between 2008 and 2011. The scale includes 3 items for each of 6 aspects of well-being: purpose in life; personal growth (self-actualization); positive relations with others (high-quality satisfying relationships); self-acceptance (positive attitude toward oneself); autonomy (sense of self-determination and independence); and environmental mastery (ability to manage life). Item agreement scores ranged from 1 to 7. Item scores for each dimension were averaged to yield domain specific well-being scores.

Assessment of Cognitive Function

Cognitive function was assessed with a battery of 19 performance tests administered annually. The battery included 7 measures of episodic memory: Word List Memory, Word List Recall, Word List Recognition, and immediate and delayed recall of 2 brief stories. Semantic memory was assessed with verbal fluency, a 15-item form of the Boston Naming Test, and a 15-item word recognition test. Digit Span Forward, Digit Span Backward, and Digit Ordering were used to assess working memory. Perceptual speed was assessed with the oral version of the Symbol Digit Modalities Test, Number Comparison, and 2 measures from a modified version of the Stroop Neuropsychological Screening Test (number of color names correctly read and number of colors correctly identified). Visuospatial ability was assessed with a 15-item version of Judgment of Line Orientation and a 16-item version of Standard Progressive Matrices.

To minimize floor and ceiling artifacts, we used composites of 2 or more tests in analyses. To capitalize on all cognitive data, the primary measure was a composite index of global cognition based on all 19 tests. Raw scores on individual tests were converted to z scores, using the baseline mean and standard deviation of the entire cohort, and the z scores of each test were averaged to yield the composite score. With the 19 individual tests treated as items, Cronbach's coefficient alpha for the global cognitive measure was 0.92, indicating adequate internal consistency. In secondary analyses, we used previously established measures of specific cognitive functions constructed like the global cognitive measure. These included measures of episodic memory (based on 7 tests), semantic memory (3 tests), working memory (3 tests), and perceptual speed (4 tests). Further information on the individual tests and the derivation of the global and specific composite measures is contained in previous publications (Wilson, Barnes, & Bennett, 2003; Wilson et al., 2005).

Other Data Collection

Each annual clinical evaluation also included a structured medical history and neurological examination. Following the evaluation, an experienced clinician classified persons with respect to dementia and mild cognitive impairment, as previously described (Wilson et al., 2011; Wilson, Schneider, Arnold, Bienias, & Bennett, 2007). The diagnosis of dementia followed the guidelines of the joint working group of The National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's disease and Related Disorders Association (McKhann et al., 1984), which require a history of cognitive decline and impairment in at least two cognitive domains. Persons who did not meet dementia criteria but were impaired in at least one cognitive domain were classified as having mild cognitive impairment. These latter criteria have been associated with subsequent risk of cognitive decline, dementia, and death (Bennett et al., 2002; Boyle, Wilson, Aggarwal, Tang, & Bennett, 2006) and the neuropathologic hallmarks of dementia (Bennett, Schneider, Wilson, Bienias, & Arnold, 2005).

Two additional measures were collected at each annual evaluation. Depressive symptoms were assessed with a 10-item version (Kohout, Berkman, Evans, & Cornoni-Huntly, 1993) of the Center for Epidemiological Studies Depression scale (Radloff, 1977). Scores range from 0 to 10 and indicate the number of symptoms endorsed. Disability was assessed with the Katz scale (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963). The score was the number of six basic activities of daily living that the participant reported being unable to perform.

Statistical Analysis

Change in cognition and purpose. We used a series of bivariate latent curve models with cross lagged components (Curran & Bollen, 2001), shown schematically in Figure 1, to test for the hypothesized association of cognitive functioning with subsequent purpose in life. Each model included an across wave component that estimated rates of change in cognition and purpose across waves of data collection and a wave specific component that assessed relationships between outcomes collected in specific waves. The across wave components allowed us to estimate the correlation between trajectories of cognition and purpose, while the wave specific components allowed us to assess the possible direction of the correlation.

In the core model, presented below, y_{it} and x_{it} denote the cognitive score and purpose score, respectively, for participant i at time t ($t = 1, 2, 3, \ldots, T$).

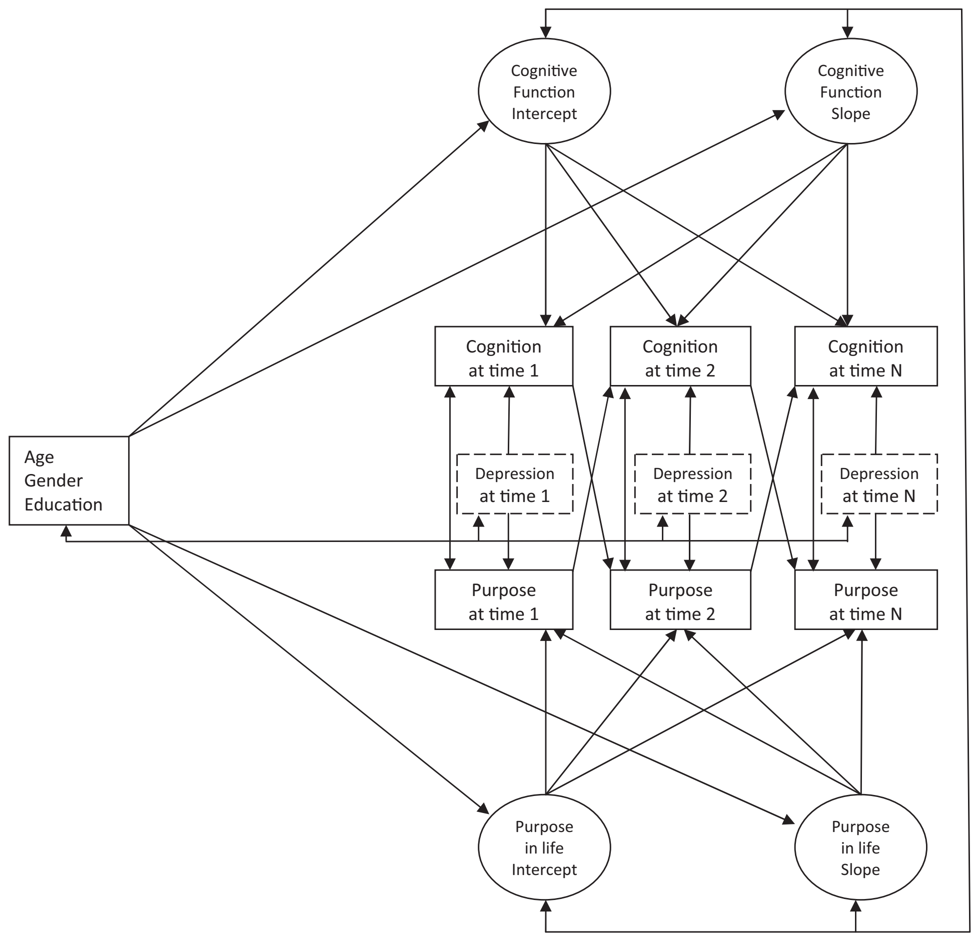

Figure 1. Schematic diagram of the bivariate cross lagged latent curve model. Age, gender, and education were placed together to simplify the diagram, and a dotted line rectangle was used for depression because not all models included a time varying covariate.

$$y_{it} = a_{yi} + \Lambda_{yt}\beta_{yi} + \rho_{y_t x_{t-1}}\, x_{i,t-1} + \varepsilon_{yit}$$

$$x_{it} = a_{xi} + \Lambda_{xt}\beta_{xi} + \rho_{x_t y_{t-1}}\, y_{i,t-1} + \varepsilon_{xit}$$

For cognition (the first equation above), α_{yi} is the random intercept and β_{yi} is the random slope for participant *i*. Λ_{yt} is the factor loading for the *t*-th cognitive score and is fixed at $t-1$ ($t = 1, 2, 3, \ldots, T$) for a linear curve. $\rho_{y_t x_{t-1}}$ represents the influence of purpose at previous time point, $x_{i,t-1}$, on current cognition (cross lagged coefficient). ε_{yit} is the residual of participant *i* at time *t*. Purpose is modeled the same way in the second equation. We allowed gender, age, and education to be associated with the random intercepts and slopes of both cognition and purpose. For cognition the association is,

$$\alpha_{yi} = \mu_{\alpha_y} + \gamma_{\alpha_y 1} z_{i1} + \gamma_{\alpha_y 2} z_{i2} + \gamma_{\alpha_y 3} z_{i3} + \zeta_{\alpha_y i}$$

$$\beta_{yi} = \mu_{\beta_y} + \gamma_{\beta_y 1} z_{i1} + \gamma_{\beta_y 2} z_{i2} + \gamma_{\beta_y 3} z_{i3} + \zeta_{\beta_y i}$$

Where z_{i1}, z_{i2}, and z_{i3} are the gender, age, and education of participant *i,* respectively. μ_{α_y} and μ_{β_y} are the intercepts of the random intercept and slope, respectively, the six gammas are regression coefficients, and $\zeta_{\alpha_y i}$ and $\zeta_{\beta_y i}$ are the error terms for the random intercept and slope, respectively. Purpose was modeled the same way.

Because change in each outcome was assumed to be linear, we repeated the core analysis using a free-loading model, a type of nonlinear spline that best fits the data between any two time points (Bollen & Curran, 2006). We repeated the core model using the actual time between evaluations to assess the assumption of equidistant time intervals. Subsequent analyses excluded persons with mild cognitive impairment at baseline, included terms for a time varying covariate, or used specific measures of cognition rather than the global cognitive measure.

Cognitive decline and dimensions of well-being. We examined the relation of prior rate of cognitive decline to current level of well-being (6 dimensions) in 2 steps. First, we estimated each person's annual rate of change (i.e., slope) in global cognition prior to well-being assessment in a linear mixed-effects model (Diggle, Liang, & Zeger, 2002; Laird & Ware, 1982), adjusted for age, gender, and education. Second, rather than constructing six separate regression models for individual dimensions, we examined the relation of cognitive slope with these dimensions in the context of repeated measures, such that it takes into consideration the correlations among dimensions. The model can be presented as $y_{ij} = \mu_i + \alpha_j + (\alpha\tau)_{ij} + e_{ij}$, where y_{ij} refers to the standardized measure of dimension j for subject i; μ_i refers to the overall mean of the measure, adjusted for age, gender and education; α_j differentiates the mean measure into dimensions; and $(\alpha\tau)_{ij}$ refers to the interaction of well-being dimensions with cognitive slope, which tested whether the association of cognitive slope with well-being varied among well-being dimensions. For each i, e_{ij} follows a multivariate normal distribution with means of 0 and an unstructured 6 by 6 variance covariance matrix.

Results

Change in Cognition and Purpose

At baseline, scores on the composite measure of global cognition ($M = 0.09$, $SD = 0.53$, range $= -1.83$ to 1.41, skewness $= -0.44$) and the purpose in life measure ($M = 3.62$, $SD = 0.46$, range $= 2.0$–5.0, skewness $= -0.15$) had approximately normal distributions. In each case, higher scores indicate a higher level of the characteristic. Global cognition and purpose were negatively related to age ($r = -0.28$, $p < .001$ for cognition; $r = -0.24$, $p < .001$ for purpose) and positively related to both education ($r = .27$, $p < .001$ for cognition; $r = .38$, $p < .001$ for purpose) and one another ($r = .29$, $p < .001$). There was no gender difference in global cognition, $t(1,047) = 1.72$, $p = .086$. Men reported a slightly higher level of purpose ($M = 3.70$, $SD = 0.47$) than did women ($M = 3.59$, $SD = 0.46$), $t(1,047) = 3.42$, $p < .001$.

Core model. Global cognition and purpose in life were annually assessed for a mean of 5 years. The crude paths of change, shown in Figure 2 for a random sample of 200 participants (thin lines), suggest substantial individual differences. We used a bivariate cross-lagged latent curve model to assess covariation between global cognition and purpose over time. Model fit indices were satisfactory (root mean square error of approximation = 0.028; standardized root mean square residual = 0.036; Tucker-Lewis index = 0.986; comparative fit index = 0.987).

In this analysis, there was a mean annual decline of 0.075-unit in the global cognitive measure (cognitive slope factor intercept in section A of Table 1; thick line in upper panel of Figure 2) and 0.25-unit in the purpose measure (purpose slope factor intercept in Section A of Table 1; thick line in lower panel of Figure 2). As shown by the covariances in section B of Table 1, the intercepts and slopes of global cognition and purpose were positively correlated, in agreement with the study hypothesis. The cognitive intercept was not related to the purpose slope, but the purpose intercept was related to the cognitive slope. The model also suggested wave specific covariation between cognition and purpose (section C of Table 1). Consistent with the study hypothesis, level of global cognition predicted level of purpose in the following year. In addition, level of purpose had an even more robust association with subsequent level of cognitive function.

Model assumptions. The core model assumed that rates of change in cognition and purpose were linear. To determine whether this assumption affected results, we repeated the analysis using a flexible nonlinear curve fitting approach (Bollen & Curran, 2006). Model fit measures and results (Model A in Table 2) were similar to the original analysis, suggesting that the linearity assumption did not bias findings.

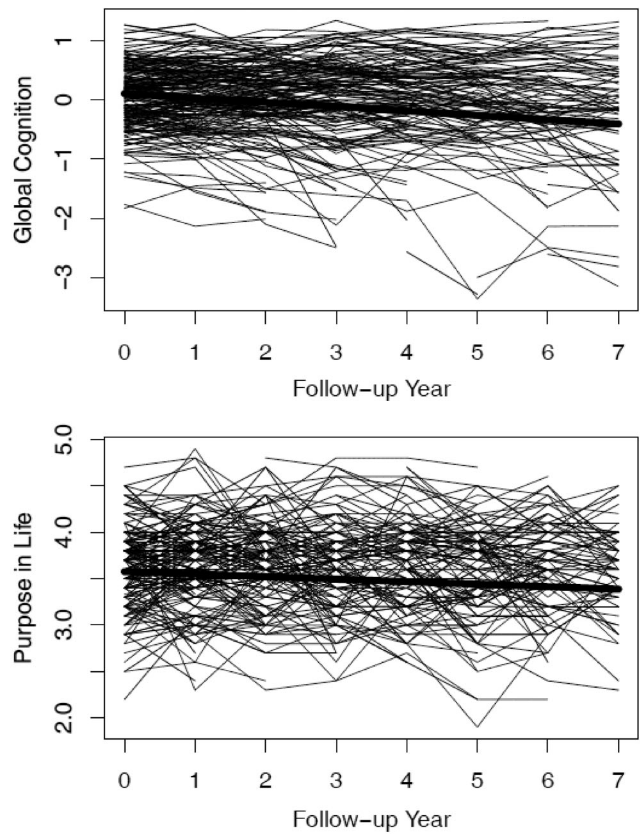

Figure 2. Crude paths of change in global cognition (top) and purpose in life (bottom) for a random sample of 200 participants (thin lines) and the predicted paths for a typical participant (thick line), adjusted for age, gender, and education.

The impact of another model assumption, that the temporal intervals between evaluations were equal, was assessed by repeating the analysis using the actual intervals. As shown in Model B of Table 2, the reciprocal cross lagged associations between global cognition and purpose were similar to the original analysis.

Potentially confounding factors. At the baseline evaluation, 290 individuals (27.6%) met criteria for mild cognitive impairment, widely viewed as a precursor to dementia. To evaluate the impact of this subgroup on results, we excluded them and repeated the model on the 759 individuals without cognitive impairment at baseline. In this analysis (Model C of Table 2), cognitive function continued to predict subsequent purpose and purpose continued to predict subsequent cognition.

Because of the previously noted association of depressive symptoms with cognition and well-being, we constructed a new model with a time varying term for number of symptoms on the Center for Epidemiological Studies Depression scale at each annual evaluation (dotted rectangles in Figure 1; baseline $M = 1.0$, $SD = 1.5$, range = 0–7, skewness = 1.9). As shown in Model D of Table 2, the results of this analysis were comparable to the original model.

Because disability is also related to cognition and well-being, we conducted a similar analysis with a time varying term for number of impaired activities of daily living on the Katz scale (baseline $M = 0.1$, $SD = 0.5$, range = 0–5, skewness = 5.7). As

Table 1
Core Analysis of Change in Global Cognition and Purpose in Life

	Estimate	*SE*	*P*
A. Regression of latent factors of covariates			
Cognition intercept factor			
Intercept	0.131	0.016	<.001
Age	−0.021	0.002	<.001
Gender	−0.147	0.033	<.001
Education	0.065	0.005	<.001
Cognition slope factor			
Intercept	−0.075	0.005	<.001
Age	−0.005	0.001	<.001
Gender	0.004	0.008	.636
Education	0.001	0.001	.217
Purpose intercept factor			
Intercept	3.611	0.015	<.001
Age	−0.017	0.002	<.001
Gender	0.062	0.030	.039
Education	0.037	0.004	<.001
Purpose slope factor			
Intercept	−0.025	0.003	<.001
Age	−0.002	<0.001	.001
Gender	0.002	0.006	.791
Education	−0.001	0.001	.197
B. Variances and covariances of latent factors			
Variances			
Cognition intercept	0.187	0.010	<.001
Cognition slope	0.010	0.001	<.001
Purpose intercept	0.119	0.009	<.001
Purpose slope	0.001	<0.001	<.001
Covariances			
Cognition intercept, cognition slope	0.017	0.002	<.001
Cognition intercept, purpose intercept	0.020	0.006	.001
Cognition intercept, purpose slope	0.001	0.001	.425
Cognition slope, purpose intercept	0.005	0.001	<.001
Cognition slope, purpose slope	0.001	<0.001	.012
Purpose intercept, purpose slope	−0.002	0.001	.069
C. Cross lagged associations			
Regression of purpose on cognition	0.071	0.019	<.001
Regression of cognition on purpose	0.019	0.002	<.001

Note. Data are from a bivariate latent curve model with cross logged components.

in the original model, global cognitive function predicted subsequent purpose and purpose predicted subsequent global cognition (Model E of Table 2).

Specific cognitive functions. To determine whether the relationship between purpose and cognition varied across cognitive domains, we repeated the analysis using measures of specific cognitive domains instead of the measure of global cognition. As shown in Table 3, model fits were satisfactory and there were both across wave and wave specific associations involving multiple cognitive domains. Rate of change in three cognitive measures was correlated with rate of change in purpose and the association was nearly significant for the remaining measure. Level of cognitive function predicted subsequent level of purpose but the association was not quite significant for episodic memory, whereas purpose was robustly related to subsequent function in all cognitive domains.

Cognitive Decline and Dimensions of Well-Being

To determine whether the association of cognitive decline with purpose differed from its association with other dimensions of well-being, we conducted additional analyses in a subgroup of 560 Rush Memory and Aging Project participants who had completed the 18-item short form of Ryff's scales of psychological well-being. As shown in Table 4, these brief scales had low to modest levels of internal consistency and were moderately intercorrelated.

At the time of well-being assessment, participants had completed annual cognitive testing for a mean of 5.5 years ($SD = 2.8$; range = 0.5–13.0). To make use of all available cognitive data, we used the composite measure of global cognitive function in analyses (baseline $M = 0.26$, $SD = 0.47$, range = −1.68 to 1.41). We constructed a mixed-effects model with a term for time (since baseline in years) to estimate each person's annual rate of global cognitive change (i.e., slope) prior to well-being assessment. The global cognitive measure declined a mean of 0.03-unit per year ($SD = 0.05$; range = −0.39 to 0.08), less than half the mean rate in the full group (i.e., 0.075), an indication of the cognitive health of the subgroup.

We constructed a mixed-effects model to assess the relation of prior rate of cognitive decline to current level of different well-being dimensions and to test whether cognitive decline was more strongly related to purpose than other well-being dimensions. In this analysis (Table 5), purpose in life was treated as the reference dimension of well-being. With the effects of age, gender, and education controlled, higher prior cognitive slope (indicating less cognitive decline) was associated with higher level of purpose, as shown by the term for cognitive slope in the table. On average, therefore, the purpose score was 0.53-point lower (55% of the *SD*) in those with rapid cognitive decline (prior cognitive slope = −0.090, 10th percentile) compared with those with minimal decline (prior cognitive slope = 0.024, 90th percentile). The interaction terms allowed computation of cognitive slope's correlation with the other well-being dimensions (personal growth estimate = 3.519 [i.e., 4.675 – 1.156], $SE = 0.802$, $p < .001$; self-acceptance estimate = 2.065, $SE = 0.807$, $p = .011$; autonomy estimate = 1.483, $SE = 0.834$, $p = .076$; environmental mastery estimate = 3.446, $SE = 0.812$, $p < .001$) and tested whether each correlation differed from the correlation with purpose. Cognitive decline was more strongly related to purpose than to self-acceptance and autonomy. Differences between purpose and the remaining well-being dimensions were in the same direction but not significant.

Discussion

We used data from a longitudinal cohort study of >1,000 community-dwelling older persons to examine the relation of cognitive aging to psychological well-being. Rates of change in cognition and well-being were correlated and cognitive level predicted subsequent level of purpose. The results support the hypothesis that cognitive decline in old age leads to decline in well-being.

Table 2
Secondary Analyses of Change in Global Cognition and Purpose

Model description	N	Cognition → Purpose			Purpose → Cognition			Model fit			
		Estimate	SE	p	Estimate	SE	p	RMSEA	SRMR	TLI	CFI
A. Linearity test	1,049	0.060	0.017	.001	0.014	0.003	<.001	0.027	0.039	0.989	0.987
B. Equidistant interval test	1,049	0.091	0.028	.001	0.020	0.003	<.001				
C. Exclude MCI	759	0.082	0.022	<.001	0.015	0.002	<.001	0.025	0.029	0.988	0.989
D. Time varying depression	523	0.095	0.029	<.001	0.015	0.003	<.001	0.044	0.083	0.971	0.974
E. Time varying disability	514	0.083	0.029	.004	0.015	0.003	<.001	0.040	0.078	0.975	0.978

Note. RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; TLI = Tucker-Lewis index; CFI = comparative fit index; MCI = mild cognitive impairment. Data are from separate bivariate latent curve models with cross lagged components adjusted for age, gender, and education. They indicate the result of a 1-unit shift in cognition (or purpose) on purpose (or cognition) 1 year later.

There has been little longitudinal research on the association of cognitive decline with well-being. The study most comparable to the present one used data from the Berlin Aging Study (Gerstorf et al., 2007). Older people were assessed at 2-year intervals for up to 13 years. As in the present study, well-being predicted subsequent rate of cognitive decline, but unlike the present results, cognitive function did not predict subsequent change in well-being. It is not clear what might account for these discrepant results. Cohort differences may be partly responsible. The Berlin Aging Study had substantially fewer participants with longitudinal data than the present study (361 vs. 1,049), and they were a mean of about 5 years older at baseline, likely resulting in greater mortality-related attrition (83% of cohort dead at last wave of data collection). The resulting limitation of statistical power may partly explain why the robust association of well-being with subsequent cognitive function was observed while the weaker association of cognitive function with subsequent well-being was not.

The association between cognitive decline and well-being varied across well-being dimensions. Cognitive decline had a stronger correlation with purpose in life than with self-acceptance and autonomy, dimensions that are primarily affective or attitudinal. In contrast, the correlations for purpose did not differ from the correlations for personal growth, positive relations, and environmental mastery. These latter dimensions, like purpose, involve not only intentions but also monitoring and regulating behavior in accordance with intentions. These considerations suggest that cognitive decline mostly impacts dimensions of well-being that require executive control skills. Consistent with this idea, the cross lagged association of cognition with well-being was robust for executive functions such as perceptual speed but not quite significant for episodic memory. Gerstorf et al. (2007) assessed well-being with the Philadelphia Geriatric Center Moral Scale (Lawton, 1975), and its association with the self-acceptance scale (Ryff, 1989) suggests that it may have been less sensitive to cognitive decline than the measure of purpose in life used in the present study.

These observations suggest that well-being requires a cognitive infrastructure involving executive control processes in particular. As that infrastructure deteriorates, so may the sense of purpose in life, quality of relationships, ability to manage affairs, and opportunities for growth. Three other observations are relevant. First, lower level of cognitive function and faster rate of cognitive decline predicted lower subsequent level of well-being, suggesting that the association is causal. Second, the association was observed in individuals without dementia, suggesting that diminished well-being is an early sign of cognitive decline and not simply the consequence of moderate to severe cognitive dysfunction. Third, controlling for indicators of affective and physical functioning did not influence the association, suggesting that loss of cognitive function has a specific association with decline in well-being.

Consistent with prior research (Boyle et al., 2010; Boyle et al., 2012), higher level of purpose predicted higher subsequent level of cognitive functioning, suggesting that well-being may contribute to cognitive resilience (Stern, 2002). That is, a high level of well-being may somehow help individuals compensate in the face of age related neurodegenerative changes and thereby delay the

Table 3
Longitudinal Relationship Between Specific Cognitive Functions and Purpose in Life

Cognitive function	Correlation between change in cognition and purpose			Cross-lagged effects: Cognition → Purpose			Cross-lagged effects: Purpose → Cognition			Model fit			
	Estimate	SE	p	Estimate	SE	p	Estimate	SE	p	RMSEA	SRMR	TLI	CFI
Episodic memory	0.291	0.107	.007	0.027	0.015	.065	0.023	0.004	<.001	0.026	0.034	0.987	0.988
Semantic memory	0.228	0.109	.037	0.038	0.016	.016	0.017	0.003	<.001	0.019	0.032	0.992	0.993
Working memory	0.197	0.108	.068	0.028	0.012	.016	0.014	0.004	.002	0.017	0.034	0.993	0.994
Perceptual speed	0.280	0.099	.005	0.043	0.013	.001	0.015	0.004	<.001	0.023	0.031	0.990	0.991

Note. RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; TLI = Tucker-Lewis index; CFI = comparative fit index. Estimated from separate bivariate latent curve models with cross-lagged components adjusted for age, gender, and education. The cross-lagged effects indicate the result of a 1-unit shift in cognition (or purpose) on purpose (or cognition) 1 year later. N = 1,049.

Table 4
Psychometric Information on Different Dimensions of Well Being

Well being dimension	*M*	*SD*	Alpha	Correlations: Growth	Relations	Acceptance	Autonomy	Mastery
Purpose in life	4.95	0.95	0.20	0.40	0.29	0.32	0.14	0.32
Personal growth	5.52	0.83	0.46		0.39	0.40	0.24	0.33
Positive relations	5.59	0.98	0.55			0.44	0.27	0.36
Self-acceptance	5.39	0.96	0.61				0.37	0.56
Autonomy	5.46	0.93	0.62					0.40
Environmental mastery	5.53	0.92	0.64					

Note. Alpha refers to Cronbach's coefficient alpha. For all correlations, $p < .001$. $N = 560$.

initial development of cognitive symptoms. Support for this idea comes from clinical and pathologic data from the Rush Memory and Aging Project showing that the associations of Alzheimer's disease pathologic burden with level of cognitive function and rate of cognitive decline proximate to death were reduced in those with higher levels of purpose in life compared to those with lower levels (Boyle et al., 2012).

The present study has several strengths. Individuals were evaluated at regular intervals for a mean of 5 to 6 years, with a high rate of follow-up participation among survivors. Multiple dimensions of well-being and cognition were assessed with previously established measures. These factors enhanced our ability to characterize person-specific paths of change in cognition and well-being and to evaluate covariation between paths.

The main study limitation is that participants were selected and mostly white, making it important to determine whether the findings can be replicated in other groups. In addition, use of brief scales of well-being dimensions probably increased measurement error and thereby hampered our ability to differentiate the association of cognitive slope with different dimensions of well-being. Our inferences about the within person coupling of cognition and well-being may have been constrained by several factors including a modeling approach heavily reliant on between persons differences and the 1-year interval between assessment (though the interval has been the same [Wilson et al., 2008; Wilson et al., 2010] or longer [Amieva et al., 2008; Gerstorf et al., 2007; Wilson et al., 2010] in previous studies). Further longitudinal research is needed on late-life changes in cognition and well-being, particularly studies of culturally and socioeconomically diverse cohorts with long observation periods and multidimensional measures of cognition and well-being.

In summary, decline in cognitive function, especially in executive control processes, was associated with loss of well-being, particularly aspects of well-being that involve the pursuit of long term behavioral objectives. Further longitudinal research is needed to clarify the dynamic association between cognitive function and well-being in old age and to develop strategies for limiting the deleterious impact of cognitive losses on well-being.

Table 5
Relation of Prior Rate of Cognitive Decline to Current Level of Different Well Being Dimensions

Model term	Estimate	*SE*	*p*
Intercept	0.142	0.048	.003
Age	−0.016	0.004	<.001
Male gender	−0.024	0.060	.690
Education	0.059	0.009	<.001
Cognitive slope	4.675	0.785	<.001
Dimension: purpose in life		Reference	
Dimension: personal growth	−0.035	0.054	.516
Dimension: positive relations	−0.043	0.058	.465
Dimension: self-acceptance	−0.079	0.057	.168
Dimension: autonomy	−0.096	0.064	.134
Dimension: environmental mastery	−0.037	0.057	.519
Slope × dimension: purpose in life		Reference	
Slope × dimension: personal growth	−1.156	0.909	.204
Slope × dimension: positive relations	−1.419	0.991	.153
Slope × dimension: self-acceptance	−2.609	0.966	.001
Slope × dimension: autonomy	−3.191	1.086	.003
Slope × dimension: environmental mastery	−1.229	0.973	.207

Note. Estimated from a mixed-effects model. $N = 560$.

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