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Longitudinal Associations between Loneliness-Related Experiences and Changes in Naming Ability among US Older Adults: Evidence from the Bivariate Latent Change Score Models

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Abstract

Background

Naming ability is a key indicator of language-related cognitive function in older adults, but its longitudinal relationship with different loneliness-related dimensions remains unclear. This study investigated the longitudinal dynamic relationships between naming ability and two loneliness-related dimensions, Feeling isolated and Lack of social connection, among older adults in the US.

Methods

The main analyses used baseline and 12-year follow-up data from the 2008 and 2020 waves of the Health and Retirement Study. The analytic sample included 2,960 adults aged 65 years and older at baseline. Naming ability was measured using TICS-based naming-related items. Feeling isolated and Lack of social connection were derived from the 11-item UCLA Loneliness Scale. Two bivariate latent change score models were estimated to examine self-feedback effects and cross-domain coupling effects between naming ability and each loneliness-related dimension. The models adjusted for demographic characteristics, socioeconomic status, physical health, depressive symptoms, and family structure.

Results

From 2008 to 2020, naming ability was lower at follow-up, whereas Feeling isolated and Lack of social connection were higher. In the model of naming ability and Feeling isolated, baseline naming ability significantly and positively predicted subsequent change in Feeling isolated, while baseline Feeling isolated significantly and negatively predicted subsequent change in naming ability. In the model of naming ability and Lack of social connection, baseline Lack of social connection significantly and negatively predicted subsequent change in naming ability, whereas baseline naming ability did not significantly predict change in Lack of social connection. Both models showed significant self-feedback effects, but the associations between change in naming ability and change in loneliness-related dimensions were not significant.

Conclusion

Loneliness-related experiences may serve as prospective risk factors for unfavorable changes in naming ability among older adults. Feeling isolated and Lack of social connection were both linked to later changes in naming ability, but their longitudinal patterns differed. These findings highlight the importance of understanding language-related cognitive aging within the broader context of social interaction and social connection. Public health interventions should support daily communication, social participation, and stable social relationships to help maintain language-related cognitive function in later life.

Introduction

Naming ability in older adults is an important indicator of language-related cognitive function [1]. It reflects the ability to retrieve words from the semantic system and use them in oral expression. It is not only a key measure in research on cognitive aging, but also an important social tool for maintaining daily communication, social participation, and independent living [2]. However, changes in naming ability during aging show clear individual differences. Previous studies have often understood decline in naming ability as a result of age-related neurocognitive deterioration, with less attention to the social interaction context in which this ability is embedded [3]. In fact, language ability is not an isolated cognitive function, but a social practice embedded in everyday communication [4, 5]. Therefore, loneliness-related experiences in older adults may further shape long-term changes in naming ability by influencing social participation, communicative opportunities, and cognitive stimulation [6]. Although previous studies have examined the associations of loneliness and its related dimensions with cognitive function, the longitudinal dynamic relationships between naming ability and different dimensions of loneliness remain unclear [7]. In particular, although prior longitudinal studies have examined reciprocal associations between loneliness and general cognitive function [8, 9], and psychometric work based on the HRS has supported the distinction between Feeling isolated and available social connections [10], it remains unclear whether naming ability and distinct loneliness-related dimensions are linked through shared developmental trends or through more specific cross-domain predictive relationships. To address this issue, the present study used bivariate latent change score models (LCSM) to examine whether the

initial levels of naming ability and two loneliness-related dimensions, Feeling isolated and Lack of social connection, predicted subsequent changes in the other construct over a 12-year period. This approach allowed us to clarify whether loneliness-related psychosocial experiences were dynamically associated with changes in language-related cognitive aging among older adults.

Loneliness-Related Dimensions and Naming Ability in Cognitive Aging

Existing research often treats loneliness as a single construct and mainly examines its overall association with cognitive decline. For example, one study used data from Waves 5 to 8 of SHARE, including 55,662 adults aged 50 and older from 15 countries, and found that among adults aged 65 and older, the association between loneliness and cognitive function was mainly reflected in the finding that higher loneliness predicted lower cognitive function in the next wave [9]. This was shown by poorer subsequent performance in semantic fluency, numeracy, and immediate recall. At the same time, semantic fluency also predicted loneliness in the opposite direction, such that lower semantic fluency predicted higher loneliness in the next wave. These findings suggest a bidirectional relationship between the two constructs [9]. Although this approach is useful for capturing the overall risk associated with loneliness, it may overlook the mechanisms linked to its different internal dimensions. Based on Lee and Cagle's validation of the HRS 11-item R-UCLA Loneliness Scale[10], loneliness-related experiences can be divided into two relatively independent but related dimensions, namely Feeling isolated and Available social connections. When interpreted from a risk-oriented perspective, the latter can also be described as Lack of social connection. Feeling isolated refers to the subjective experience of feeling psychologically separated, excluded, or disconnected from others. In contrast, Lack of social connection is closer to a structural and resource-based form of social disconnection, reflecting perceived insufficiency in dependable relationships, people to talk to, and sources of social support [10].

Examining these two dimensions separately can help clarify the different theoretical pathways through which loneliness may influence language-related cognitive aging. Specifically, Lack of social connection is more consistent with the use-it-or-lose-it principle of cognitive aging [11]. This view suggests that the maintenance of cognitive abilities depends on continued use and environmental stimulation. When individuals use a certain ability less often, that ability may become more vulnerable to age-related decline. The findings of Hanushek et al. [11] also support this view, showing that declines in literacy and numeracy skills mainly occurred among adults who used these skills less frequently. Ma et al. [12] found that both social support and cognitive activity were associated with a lower risk of cognitive impairment in older adults, and that cognitive activity partly mediated the association between social support and cognitive impairment. Similarly, a meta-analysis by Siette et al. [13] found that social behavioral interventions significantly improved global cognitive function in older adults. Taken together, these studies suggest that sustained cognitive activity, social interaction, and opportunities for language communication may delay cognitive aging by providing cognitive stimulation.

Therefore, when older adults lack stable social ties and available interaction partners, their daily communication opportunities, frequency of oral expression, and environment for semantic activation may all be weakened. Naming ability depends on the continued use of lexical retrieval and semantic access. Thus, insufficient social connection may reduce daily language practice and cognitive stimulation, forming a pathway through which deficits in the social environment are transmitted to decline in language-related cognitive function. In contrast, Feeling isolated may be more likely to reflect a feedback process shaped by subjective social threat and difficulties in language interaction. Subjective feelings of isolation may lead to vigilance and avoidance in social situations, thereby reducing active communication. At the same time, decline in naming ability may increase communication frustration and weaken social confidence. A recent study based on 12 years of HRS longitudinal data found that, compared with Feeling isolated, Lack of social connection was a more stable predictor of decline in naming ability among older adults [7]. After controlling for covariates, the predictive effect of Feeling isolated on decline in naming ability was no longer significant. The cross-lagged model in that study further showed a stage-specific bidirectional reinforcing relationship between naming ability and social connection. At some stages, lower naming ability predicted subsequent reductions in social connection, whereas at other stages, insufficient social connection predicted subsequent decline in naming ability [7].

A Latent Change Score Approach to Naming Ability and Loneliness-Related Dimensions

To clarify the longitudinal relationships among subjective isolation, lack of social connection, and aging-related changes in naming ability, the present study adopted a bivariate latent change score model (LCSM). The latent change score models are useful for

examining longitudinal coupling because they estimate change as a latent construct while accounting for initial levels [14, 15]. To be more specific,

This method could examine whether the baseline level of one construct predicts subsequent change in another construct over the study period [16]. This focus is appropriate for our research questions because the current study aims to explore whether loneliness-related experiences are merely associated with naming ability at baseline or whether they are linked to later changes in language-related cognitive functioning.

In the present study, this method was used to model change in naming ability and change in each loneliness-related dimension from 2008 to 2020. By including self-feedback paths, the model can examine whether the initial level of a construct predicts its own subsequent change. By including cross-domain coupling paths, the model can further test whether the initial level of one construct predicts later change in the other construct.

The Current Study

Previous studies have shown a significant association between loneliness and cognitive decline, but one key issue remains unclear. It is still uncertain whether different dimensions of loneliness predict subsequent changes in naming ability, and whether naming ability also predicts later changes in loneliness-related experiences in the opposite direction. In other words, Feeling isolated and Lack of social connection may not simply co-occur with lower naming ability. Instead, they may be prospectively associated with language-related cognitive aging through different pathways. Based on this gap, the present study aimed to examine the longitudinal coupling relationships between naming ability and two loneliness-related dimensions in older adults.

The present study used the 2008 baseline wave and the 2020 follow-up wave of the HRS for the main bivariate latent change score analyses, with adults aged 65 years or older included in the analytic sample. Bivariate latent change score models were used to examine whether baseline loneliness-related dimensions predicted subsequent change in naming ability, and whether baseline naming ability predicted subsequent change in loneliness-related dimensions in the opposite direction. Separate models were estimated for Feeling isolated and Lack of social connection. This design allowed us to compare whether the two loneliness-related dimensions showed different patterns of longitudinal coupling with naming ability over the 12-year study period.

The present study proposed two main hypotheses.

H1: Baseline naming ability was expected to predict subsequent changes in loneliness-related dimensions.

H2: Baseline Feeling isolated and Lack of social connection were expected to predict subsequent changes in naming ability, such that higher levels of loneliness-related experiences at baseline would be associated with lower subsequent change scores in naming ability.

Method

Sample and data

Data were drawn from the Health and Retirement Study (HRS), an ongoing population based panel study designed to examine aging trajectories among adults in the United States. Since its inception in 1992, the HRS has collected repeated measurements of health, cognition, psychological well being, family resources, and financial status among adults aged 50 and older, with support from the National Institute on Aging and the Social Security Administration [17].

For the main LCSM analyses, we used baseline measures from 2008 and endpoint measures from 2020. Measures from the 2012 and 2016 waves were retained only for descriptive summaries of observed variables across the 12-year observation period. These four waves were considered because they contained the psychosocial items required to derive the two loneliness-related dimensions examined in this study. Measures from the Psychosocial and Lifestyle Questionnaire, also known as the Leave Behind Questionnaire, were combined with the RAND HRS longitudinal file, which provides harmonized longitudinal variables and imputed measures for major economic, health, family, and cognitive domains [18].

Sample eligibility was defined before model estimation. Participants had to be at least 65 years old at the 2008 baseline wave. We further excluded respondents with nonzero indicators for memory related disease, Alzheimer's disease, or dementia during the observed period, because these conditions could substantially affect both naming performance and self reported psychosocial functioning. Cases with incomplete information on baseline demographic characteristics, including gender, race, age, or educational years, were also removed. After these restrictions, the working sample was prepared for longitudinal analysis.

Missing values in the study variables were handled using multiple imputation by chained equations. Predictive mean matching was used as the imputation method, with five imputed datasets and 20 iterations. The imputation procedure included demographic characteristics, household wealth, physical health, depressive symptoms, household size, number of children, number of living siblings, UCLA loneliness items, and HRS naming items.

The final sample consisted of 2,960 respondents. At the 2008 baseline, participants ranged in age from 65 to 91 years (M = 70.76, SD = 4.47) and had a mean educational attainment of 12.94 years (SD = 3.04). Women accounted for 61.79% of the sample, and men accounted for 38.21%. In terms of race, 83.92% were White, 12.87% were African American, and 3.21% were classified as Others. Table 1 reports the wave specific descriptive statistics for wealth, physical health, depressive symptoms, family structure variables, naming ability, Feeling isolated, and Lack of social connection.

Table 1
Descriptive statistics of demographic and covariate variables across waves (HRS 2008–2020; N = 2,960)

Variable	2008		2012		2016		2020	
	N	%	N	%	N	%	N	%
Gender								
Male (0)	1131.00	38.21						
Female (1)	1829.00	61.79						
Race								
White	2484.00	83.92						
African American	381.00	12.87						
Others	95.00	3.21						
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	70.76	4.47						
Educational Years	12.94	3.04						
Total wealth	675688.10	1361961.44	579121.81	1001071.59	646721.75	1176784.35	652148.38	1196499.99
Physical health	1.88	1.19	2.24	1.25	2.60	1.31	2.92	1.37
Depression	0.94	1.55	0.96	1.56	1.06	1.59	1.37	1.83
Number of people living in the household	2.04	0.92	2.00	0.96	1.93	0.97	1.86	0.94
Number of children	3.42	2.08	3.40	2.07	3.33	2.03	3.18	1.94
Number of living sibling	2.63	2.36	2.63	2.36	2.62	2.36	2.61	2.37
Naming ability	7.59	0.70	7.43	0.80	7.39	0.86	7.16	1.14
Feeling isolated	5.70	1.71	5.68	1.66	5.81	1.70	6.20	1.81
Lack of social connection	10.36	2.50	10.12	2.40	10.80	2.39	10.82	2.39

Note. Age was coded in years, and total wealth was defined as household net worth in U.S. dollars. Physical health reflected the number of self-reported chronic conditions previously diagnosed by a physician, whereas depressive symptoms were assessed using the CES-D scale. Naming ability was measured with the HRS naming test. Feeling isolated and Lack of social connection were both derived from the UCLA 11-item Loneliness Scale.

<Insert Table 1>

Measure

Name ability

Naming ability was operationalized with the TICS based composite used in the present study. The score was derived from three types of items: date naming, object naming, and president or vice president naming. For date naming, respondents were first asked to state the current date. If their initial answer was incomplete, the interviewer prompted them for specific components, including the month, day, year, and day of the week. Object naming was evaluated through two common knowledge items, one referring to the tool typically used to cut paper and the other referring to the thorny plant that grows in the desert. Respondents were also asked to identify the current U.S. president and vice president.

Correct answers were added together to form an overall naming ability score, with possible values ranging from 0 to 8. A higher score represented stronger performance on this naming related measure. This composite score has also been used in prior HRS research as an indicator of naming ability [7]. It is important to clarify, however, that this index combines orientation based items with object and person naming items. Therefore, the score reflects a general language and mental status measure rather than a pure lexical naming task.

Feeling isolated

The Feeling isolated measure was based on the 11 item Revised UCLA Loneliness Scale administered in the HRS Psychosocial and Lifestyle Questionnaire [19]. The HRS contains both the 3 item short form proposed by Hughes et al. [20] and the extended 11 item version. In this study, the extended version was used because it provides a more differentiated assessment of loneliness among older adults. Instead of treating loneliness as a unidimensional construct, we followed Lee and Cagle [10] and distinguished between Feeling isolated and Lack of social connection.

Feeling isolated refers to the subjective and affective side of loneliness. It was represented by four items that capture feelings of being isolated from others, including the perceived lack of companionship. For each wave, item responses were coded so that higher scores reflected stronger perceived isolation. The four items were then summed to obtain the wave specific Feeling isolated score. In the current sample, Cronbach's α values for this dimension were 0.65 in 2008, 0.64 in 2012, 0.63 in 2016, and 0.60 in 2020. These estimates indicate modest internal consistency across waves.

Lack of social connection

Lack of social connection was computed from the remaining seven items of the 11 item Revised UCLA Loneliness Scale. Conceptually, this dimension focuses on the social relational component of loneliness. It reflects the extent to which respondents perceive insufficient interpersonal availability, communication, and support in their social lives.

For each assessment wave, responses to the seven items were scored in the direction of greater connection deficit and summed to form the Lack of social connection score. Thus, higher scores indicated a more pronounced lack of perceived social connection. In the current sample, Cronbach's α values were 0.66 in 2008, 0.66 in 2012, 0.62 in 2016, and 0.57 in 2020. These reliability estimates were modest, which should be considered when interpreting findings based on this brief subdimension.

Covariates

To control for individual differences that may influence both naming ability and social relationship measures, the longitudinal models included a set of covariates related to demographic background, socioeconomic status, health status, and family structure. These covariates were grouped into time invariant and time varying covariates according to whether they changed across waves [7].

Time invariant covariates included gender, race, and years of education. Gender was coded as a binary variable, with female coded as 1 and male coded as 0. Race was based on respondents' self-reports and was recoded into three categories, including White, African American, and Others. In the models, these categories were coded as 0, 1, and 2, respectively. Educational attainment was measured by years of education and was standardized before model estimation.

Time-varying covariates were measured at baseline in 2008 and at the endpoint in 2020 for the main LCSM analyses. These variables included total household wealth, physical health, depressive symptoms, number of people living in the household, number of children, and number of living siblings. Total household wealth was used to indicate economic resources and was calculated as total assets minus total liabilities. Physical health was measured by the number of doctor diagnosed chronic conditions available in the HRS.

Depressive symptoms were assessed using the CES-D score, with higher scores indicating more severe depressive symptoms. Family structure and potential kinship resources were controlled by including the number of people living in the household, the number of children, and the number of living siblings. All continuous covariates were standardized before model fitting to improve comparability across predictors.

In the latent change score models, 2008 covariates were used to adjust for baseline levels of naming ability and loneliness-related variables, whereas 2020 covariates were used to account for endpoint differences when estimating latent change scores.

Data analysis

The longitudinal analyses aimed to examine cross-domain change associations between naming ability and two loneliness-related dimensions. Two bivariate latent change score models were estimated. One model examined Naming ability and Feeling isolated, and the other examined Naming ability and Lack of social connection. Each model included a latent change factor for naming ability from 2008 to 2020 and a latent change factor for the corresponding loneliness-related dimension. Self-feedback paths were specified to test whether the initial level of each construct predicted its own subsequent change. Cross-domain coupling paths were specified to test whether baseline naming ability predicted subsequent change in loneliness-related variables and whether baseline loneliness-related variables predicted subsequent change in naming ability. We initially attempted to estimate four-wave bivariate latent change score models using data from 2008, 2012, 2016, and 2020. However, these models did not achieve acceptable fit based on conventional fit indices. Given the limited descriptive change in naming ability across adjacent waves, as shown in Table 1, and prior evidence that longitudinal changes in cognitive and language-related skills can be modest and use-dependent in non-clinical adult samples [11], the final analyses focused on two-wave latent change from baseline in 2008 to the end point in 2020.

All continuous variables were standardized before analysis, including naming ability, Feeling isolated, Lack of social connection, and continuous covariates. All models were estimated in R using the “lavaan” package and Maximum likelihood estimation was used. To obtain more robust statistical inference, standard errors and confidence intervals were calculated based on 5,000 bootstrap samples. Model fit was evaluated using the chi-square test, Comparative Fit Index, Tucker-Lewis Index, RMSEA, and SRMR.

Results

Sample Characteristics

The descriptive profile of the analytic sample is reported in Table 1. A total of 2,960 older adults from the HRS were included in the analysis. In 2008, the average age of participants was 70.76 years (SD = 4.47), and the mean level of education was 12.94 years (SD = 3.04). Women accounted for 61.79% of the sample, whereas men accounted for 38.21%. The racial composition was primarily White, with 2,484 participants identifying as White (83.92%), 381 as African American (12.87%), and 95 as belonging to other racial or ethnic groups (3.21%).

Across the 12-year observation period, several covariates displayed clear longitudinal patterns. The average number of chronic conditions increased consistently, rising from 1.88 (SD = 1.19) in 2008 to 2.92 (SD = 1.37) in 2020. This pattern indicates that participants experienced a growing chronic disease burden as they aged. Household net worth showed a different descriptive pattern. Mean Total wealth was $675,688.10 (SD = 1,361,961.44) at baseline, dropped to $579,121.81 (SD = 1,001,071.59) in 2012, and then partially recovered in later waves, reaching $646,721.75 (SD = 1,176,784.35) in 2016 and $652,148.38 (SD = 1,196,499.99) in 2020. Depression increased more gradually, with mean CES-D scores changing from 0.94 (SD = 1.55) in 2008 to 1.37 (SD = 1.83) in 2020.

The family-structure variables suggested a mild reduction in household and kinship resources over time. The average number of people living in the household decreased from 2.04 (SD = 0.92) to 1.86 (SD = 0.94) between 2008 and 2020. The number of children also declined slightly, from 3.42 (SD = 2.08) at baseline to 3.18 (SD = 1.94) in the final wave. In contrast, the number of living siblings changed very little across the study period, with means of 2.63 (SD = 2.36) in both 2008 and 2012, 2.62 (SD = 2.36) in 2016, and 2.61 (SD = 2.37) in 2020.

The primary study variables also varied across waves. Naming ability was lower in 2020 than in 2008, decreasing from 7.59 (SD = 0.70) in 2008 to 7.16 (SD = 1.14) in 2020. For the two loneliness-related dimensions, Feeling isolated increased over time, particularly by the final wave, from 5.70 (SD = 1.71) in 2008 to 6.20 (SD = 1.81) in 2020. Lack of social connection showed a small decrease

between 2008 and 2012, from 10.36 (SD = 2.50) to 10.12 (SD = 2.40), followed by an increase to 10.80 (SD = 2.39) in 2016 and 10.82 (SD = 2.39) in 2020.

<Insert Table 1 here>

Bivariate Latent Change Score Model l Results

The bivariate latent change score model of Naming ability and Feeling isolated

The LCSM of Naming ability and Feeling isolated showed an acceptable fit, $\chi^2(24) = 160.61$, $p < .001$, AIC = 30,126.95, BIC = 30,474.54, CFI = .96, TLI = .88, RMSEA = .04, 90% CI [.04, .05], SRMR = .01. The self-feedback effects showed that Naming ability at T1 significantly and negatively predicted its subsequent change score, b = -0.59, SE = 0.04, $p < .001$. Similarly, Feeling isolated at T1 significantly and negatively predicted its subsequent change score, b = -0.83, SE = 0.02, $p < .001$. These findings indicate significant self-feedback effects for both constructs, suggesting that higher initial levels were associated with lower subsequent change scores.

The cross-domain coupling effects showed that Feeling isolated at T1 significantly and negatively predicted subsequent change in Naming ability, b = -0.05, SE = 0.02, p = .023. This suggests that individuals with higher Feeling isolated at T1 showed lower subsequent change scores in Naming ability. At the same time, Naming ability at T1 significantly and positively predicted subsequent change in Feeling isolated, b = 0.06, SE = 0.02, p = .010, indicating that individuals with higher Naming ability at T1 showed higher change scores in Feeling isolated over the following 12 years. In addition, Naming ability at T1 was significantly and negatively associated with Feeling isolated at T1, b = -0.03, SE = 0.01, p = .007. This suggests that individuals with higher Naming ability at T1 tended to report lower levels of Feeling isolated. However, the association between change in Naming ability and change in Feeling isolated was not significant, b = -0.03, SE = 0.02, p = .074, indicating that the two constructs did not show a significant pattern of coupled change from 2008 to 2020.

<Insert Fig. 1 here>

The bivariate latent change score model of Naming ability and Lack of social connection

The LCSM of Naming ability and Lack of social connection showed a good fit, $\chi^2(24) = 57.37$, $p < .001$, AIC = 31,331.95, BIC = 31,679.54, CFI = .98, TLI = .95, RMSEA = .02, 90% CI [.02, .03], SRMR = .007. The self-feedback effects showed that Naming ability at T1 significantly and negatively predicted its subsequent change score, b = -0.59, SE = 0.04, $p < .001$. Lack of social connection at T1 also significantly and negatively predicted its subsequent change score, b = -0.72, SE = 0.02, $p < .001$. These findings indicate significant self-feedback effects for both constructs, suggesting that higher initial levels were associated with lower subsequent change scores.

The cross-domain coupling effects showed that Lack of social connection at T1 significantly and negatively predicted subsequent change in Naming ability, b = -0.06, SE = 0.02, p = .007. This indicates that individuals with higher Lack of social connection at T1 showed lower subsequent change scores in Naming ability. In contrast, Naming ability at T1 did not significantly predict subsequent change in Lack of social connection, b = -0.05, SE = 0.03, p = .068. Thus, this model showed a relatively clear one-way coupling pattern, in which the initial level of Lack of social connection predicted change in Naming ability, whereas the reverse path did not reach the conventional level of statistical significance. In addition, Naming ability at T1 was significantly and negatively associated with Lack of social connection at T1, b = -0.06, SE = 0.01, $p < .001$. This suggests that individuals with higher Naming ability at T1 tended to report lower levels of Lack of social connection. The association between change in Naming ability and change in Lack of social connection was not significant, b = -0.04, SE = 0.02, p = .066, indicating that the two constructs did not show a significant pattern of coupled change.

Table 2 summarizes the effects of covariates on T1 levels and latent change scores in the two bivariate LCSM models. Overall, Educational years significantly and positively predicted Naming ability at T1 and change in Naming ability, and significantly and negatively predicted the T1 levels of both loneliness-related dimensions. Age significantly and negatively predicted change in Naming ability, indicating that older individuals showed lower change scores in Naming ability over the following 12 years. Depression significantly and negatively predicted Naming ability at T1 and change in Naming ability, while also significantly and positively

predicting the T1 levels and change scores of both loneliness-related dimensions. Physical health significantly and positively predicted the T1 levels and change scores of both loneliness-related dimensions. Taken together, the covariate results indicate that Educational years, Age, Depression, and Physical health were relatively stable covariates of change in Naming ability and loneliness-related dimensions.

Table 2
Covariate effects on T1 levels and latent change scores in the two bivariate latent change score models

Variable	Naming ability T1	Δ Naming ability	Feeling isolated T1	Δ Feeling isolated	Lack of social connection T1	Δ Lack of social connection
	b **(SE)**	***b*** **(SE)**	***b*** **(SE)**	***b*** **(SE)**	***b*** **(SE)**	***b*** **(SE)**
Gender: Female	0.07 (0.03)**	0.09 (0.04)*	0.08 (0.03)*	0.07 (0.03)*	-0.18 (0.04)***	-0.06 (0.04)
Race: African American	-0.35 (0.05)***	-0.30 (0.07)***	0.02 (0.05)	-0.01 (0.05)	0.03 (0.05)	0.07 (0.05)
Race: Others	-0.25 (0.09)**	-0.24 (0.16)	0.07 (0.10)	-0.07 (0.08)	0.16 (0.12)	0.05 (0.09)
Age	0.003 (0.01)	-0.21 (0.03)***	0.02 (0.02)	0.03 (0.02)	0.02 (0.02)	0.01 (0.02)
Educational years	0.23 (0.02)***	0.17 (0.03)***	-0.09 (0.02)***	0.008 (0.02)	-0.09 (0.02)***	-0.02 (0.02)
Total wealth	0.003 (0.008)	0.05 (0.02)**	-0.03 (0.02)	-0.003 (0.02)	-0.001 (0.02)	-0.03 (0.02)
Physical health	0.02 (0.02)	0.02 (0.02)	0.04 (0.02)*	0.11 (0.02)***	0.06 (0.02)*	0.08 (0.02)***
Depression	-0.04 (0.02)**	-0.05 (0.02)*	0.49 (0.02)***	0.41 (0.02)***	0.27 (0.02)***	0.16 (0.02)***
Number of people living in the household	-0.01 (0.01)	-0.02 (0.02)	-0.07 (0.02)***	-0.16 (0.02)***	-0.01 (0.02)	0.02 (0.02)
Number of children	-0.02 (0.01)	-0.009 (0.02)	-0.03 (0.02)	0.003 (0.02)	-0.03 (0.02)	0.02 (0.02)
Number of living sibling	-0.03 (0.02)	-0.02 (0.02)	0.02 (0.02)	-0.003 (0.02)	0.03 (0.02)	-0.02 (0.02)

Note. T1 represents baseline in 2008. Δ represents latent change from 2008 to 2020. Unstandardized estimates are reported with bootstrap standard errors in parentheses. Naming ability was included in both bivariate latent change score models. To avoid duplicate columns, the table reports one set of estimates for Naming ability at T1 and Δ Naming ability indicates latent change score for Naming ability. The corresponding estimates for Naming ability were highly similar across the two models. For time-varying covariates, T1 covariates were used to predict baseline variables, whereas 2020 endpoint covariates were used to predict latent change scores. Gender was dummy-coded as female = 1 and male = 0. Race was dummy-coded using White as the reference group. Age and educational years were standardized before analysis. * $p < .05$. ** $p < .01$. *** $p < .001$.

<Insert Table 2 here>

Discussion

Using a bivariate latent change score model, this study examined the longitudinal predictive relationships between baseline naming ability and changes in loneliness-related dimensions over a 12-year period. Overall, the results provided partial support for H1. Baseline naming ability significantly predicted subsequent change in Feeling isolated, but it did not significantly predict change in Lack of social connection. This suggests that the role of naming ability in loneliness-related changes may be dimension-specific. In contrast, H2 received more consistent support. Both baseline Feeling isolated and Lack of social connection significantly and negatively predicted subsequent change scores in naming ability. This indicates that older adults who felt more isolated and reported a greater lack of social connection at baseline showed more unfavorable changes in naming ability over the following 12 years. Taken together, the findings provide more stable evidence for the prospective role of loneliness-related dimensions in predicting later changes in naming ability.

With respect to H1, the findings of this study provided partial support. Baseline naming ability significantly and positively predicted subsequent change in Feeling isolated, but it did not significantly predict change in Lack of social connection. This finding suggests that naming ability may be more closely related to the subjective emotional dimension of loneliness, rather than predicting later changes in structural or resource-based social disconnection [10]. The predictive effect of baseline naming ability on change in Feeling isolated was positive. This indicates that, after controlling for baseline Feeling isolated and its self-feedback effect, older adults with higher baseline naming ability showed higher change scores in Feeling isolated over the following 12 years. One possible explanation is that naming ability, as a language-related cognitive resource, may help individuals maintain better social communication at baseline[21, 22]. Therefore, these individuals may often report lower levels of subjective isolation at the initial stage. However, according to the use-it-or-lose-it principle in cognitive aging, the protective role of cognitive and language abilities does not depend only on their initial level [23], but also on whether these abilities continue to be used and activated in later life. As people age, older adults may experience a narrowing of social roles, fewer opportunities for interaction, declining health, and changes in family or community environments [24]. When opportunities for daily communication and social participation decrease, even individuals with better naming ability at baseline may not be able to maintain this initial advantage as a lasting protection against subjective isolation [25]. Thus, the higher change scores in Feeling isolated among those with higher baseline naming ability may reflect that they started from a lower level of isolation but were still affected by reduced social interaction and a weakened language-use environment during the long-term aging process. In other words, higher baseline naming ability may be associated with a better initial state of social communication, but it cannot fully offset the influence of changes in the social environment on feelings of isolation in later life.

With respect to H2, the findings of this study received relatively consistent support. Both baseline Feeling isolated and Lack of social connection significantly and negatively predicted subsequent change scores in naming ability. This indicates that stronger loneliness-related experiences at baseline were associated with more unfavorable changes in naming ability among older adults over the following 12 years. The use-it-or-lose-it principle suggests that the maintenance of cognitive and language abilities depends on continued use and environmental stimulation. When individuals use a certain ability less often, that ability may be more likely to decline during aging. Naming ability depends on lexical retrieval, semantic access, and everyday language production. Loneliness-related experiences may affect the long-term maintenance of naming ability by reducing social interaction, lowering communication frequency, and weakening opportunities for language use and semantic activation. Therefore, both feeling subjectively isolated and lacking social connection in terms of relational resources may lead to more unfavorable changes in naming ability by reducing language practice and cognitive stimulation. Existing empirical evidence also supports this explanation. For example, Hanushek et al. [11] found that declines in literacy and numeracy skills mainly occurred among adults who used these skills less often, suggesting that the maintenance of cognitive abilities is closely related to the frequency of everyday use. This suggests that social relationships may help protect cognitive function by maintaining cognitive activity. In addition, following the distinction proposed by Lee and Cagle [10] between two loneliness-related dimensions, Feeling Isolated and Lack of Social Connection may influence naming ability through different pathways. Feeling isolated is more closely related to subjective emotional experience, reflecting psychological distance, perceived exclusion, or a lack of companionship. This dimension may indirectly reduce older adults' active language use by increasing perceived social threat, promoting social avoidance, lowering willingness to communicate, and weakening social confidence. In contrast, Lack of social connection is closer to structural and resource-based social disconnection, reflecting a lack of stable relationships, conversational partners, and available social support. This dimension may more directly limit actual opportunities for communication, leaving individuals with fewer everyday contexts for lexical retrieval, naming, and semantic processing. Thus, although both loneliness-related experiences negatively predicted changes in naming ability, their mechanisms may not be exactly the same. The former may operate more through subjective psychological and interactional motivation pathways, whereas the latter may operate more through social resources and the language-use environment.

By using a bivariate latent change score model, this study found that Feeling isolated and Lack of social connection were both related to changes in naming ability, but they may operate through different pathways. This suggests that examining loneliness by dimension can help provide a more accurate understanding of its relationship with language and cognitive aging. In addition, this study shows that language and cognitive aging in older adults is not an isolated individual cognitive process. Rather, it is embedded in everyday social interaction, opportunities for communication, and the broader environment of social connection. Therefore, future interventions should not focus only on individual-level cognitive training. They should also place greater emphasis on increasing older adults' opportunities for daily communication, social participation, and stable social connections, so as to provide continued environmental stimulation for language use and semantic activation. This study also has several limitations. First, the naming measure in the HRS is not a pure lexical naming task. Instead, it combines items involving date naming, object naming, and naming the president and vice

president. As a result, it may be closer to a general indicator of language ability and mental status. Future research could use more fine-grained picture naming, lexical retrieval, or semantic fluency tasks to further examine the relationships between loneliness-related dimensions and changes in specific language abilities.

Conclusion

Using a bivariate latent change score model, this study revealed the longitudinal dynamic relationships between naming ability and loneliness-related dimensions. The results showed that baseline naming ability had a limited and dimension-specific predictive effect on subsequent changes in loneliness-related dimensions. In contrast, both baseline Feeling isolated and Lack of social connection significantly predicted more unfavorable subsequent changes in naming ability. These findings suggest that loneliness-related experiences are not only concurrent correlates of lower language and cognitive functioning in older adults, but may also serve as important prospective risk factors for later changes in naming ability. This study situates language and cognitive aging in later life within the context of social interaction and social connection. It shows that long-term changes in naming ability are influenced not only by individual cognitive and health-related factors, but also by the social relationship environment in which older adults live. By revealing the distinct roles of different loneliness dimensions in language and cognitive aging, the present findings provide empirical evidence for future efforts to maintain older adults' language function by increasing social participation, opportunities for daily communication, and social support.

Declarations

Ethics approval and consent to participate

The original Health and Retirement Study protocol was approved by the University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board (Protocol No. HUM00061128). All participants included in the present study provided informed consent to participate in the HRS in accordance with its approved procedures. The present study involved a secondary analysis of de-identified public-use HRS data and did not involve any new participant recruitment or data collection.

Clinical trial number

Not applicable.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Availability of data and materials

The Health and Retirement Study is a publicly available data set available through the University of Michigan at http://hrsonline.isr.umich.edu/

Authors' contribution

YBH and XYZ designed the study, analyzed the data and drafted the manuscript

CW and CGD help revise the manuscript

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Not applicable

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Figures

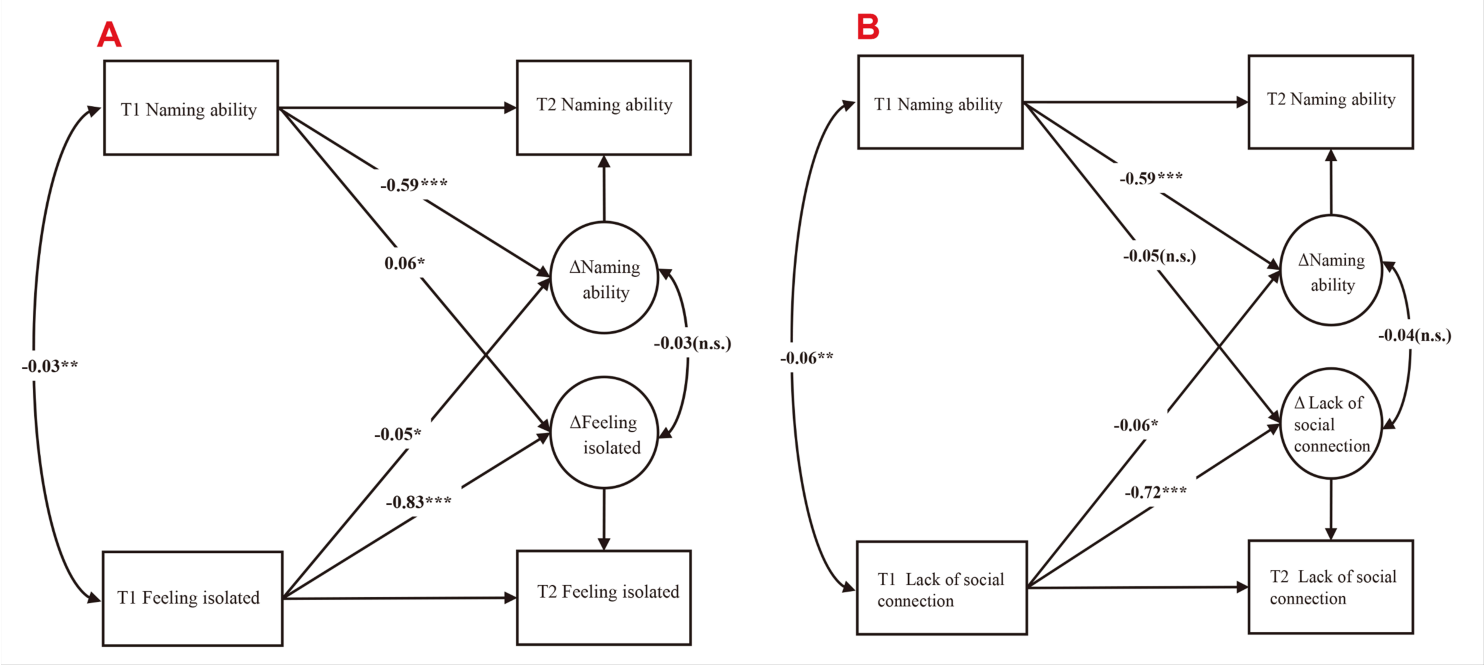


Figure 1

Two-wave bivariate latent change score models of naming ability and loneliness-related dimensions from 2008 to 2020. Panel A shows the model for naming ability and Feeling isolated, and Panel B shows the model for naming ability and Lack of social connection. Rectangles represent the observed scores at T1, corresponding to 2008, and at T2, corresponding to 2020. Circles represent the latent change scores from 2008 to 2020. Straight arrows indicate self-feedback and cross-domain coupling paths. Curved arrows indicate correlations between baseline levels and between latent change scores. Only standardized path coefficients are shown. Covariates are omitted for clarity. $p < .05$, $\boldsymbol{p} < .01$, $\boldsymbol{p} < .001$; n.s. = not significant.