Article

Isolation, Not Loneliness or Cynical Hostility, Predicts Cognitive Decline in Older Americans

Journal of Aging and Health
2020, Vol. 32(1-2) 52–60

DOI: 10.1177/0898264318800587
journals.sagepub.com/home/jah
SAGE

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Abstract

Objective: To jointly examine isolation, loneliness, and cynical hostility as risk factors for cognitive decline in older adults. **Method:** Data came from the 2006 to 2012 waves of the Health and Retirement Study (HRS), a longitudinal study of U.S. older adults (age ⩾ 65 years, $n = 6{,}654$). Measures included frequency of contact with social network (objective isolation), the Hughes Loneliness Scale (loneliness), a modified version of the Cook–Medley Hostility Inventory (cynical hostility), and a modified version of the Telephone Interview for Cognitive Status (cognitive function). Multilevel modeling (random slope + intercept) was used to examine the association between these factors and trajectories of cognitive function. **Results and Discussion:** After controlling for demographic characteristics, self-reported health, and functional limitations, loneliness ($\beta = -.34$, 95% confidence interval [CI] = [−0.56, −0.11), and cynical hostility ($\beta = -.14$, 95% CI = [−0.24, −0.04) correlated with lower cognitive function, but none predicted change in cognitive function. Objective social isolation was associated with lower cognitive function ($\beta = -.27$, 95% CI = [−0.41, −0.12]) and steeper decline in cognitive function ($\beta = -.09$, 95% CI = [−0.16, −0.01]).

Keywords

cynical hostility, loneliness, isolation, cognitive decline/function, aging

Introduction

Social isolation is an emerging risk factor for cognitive decline (Barnes, De Leon, Bienias, Wilson, Everson-Rose & Evans, 2009; Bassuk, Glass, & Berkman, 1999; Fratiglioni, Wang, Ericsson, Maytan, & Winblad, 2000; Håkansson et al., 2009; Helmer et al., 1999; James, Wilson, Barnes, & Bennett, 2011; Shankar, Hamer, McMunn, & Steptoe, 2013). Isolation refers to the objective aspects of isolation, such as living alone or spending little time with others, but it is possible that subjective isolation (i.e., the perceived separation from others) is of equal or greater importance.

One dimension of subjective isolation is loneliness. Loneliness refers to a state of emotional distress rooted in the feeling of being alone or unreciprocated desire for social connections (Cacioppo et al., 2002). Another potential dimension of subjective isolation is cynical hostility. Cynical hostility refers to an attitude of distrust and cynicism toward other people, whereby one assumes that others have hostile intentions and/or are just looking out for themselves (Everson-Rose, Clark, & Henderson, 2013). Although cynical hostility has typically been defined as a personality trait, it is also characterized by a subjective sense of being alone: If a person does not trust others, then he or she is on his or her own even when surrounded. Cynical hostility has been linked to other psychosocial factors (Hart & Hope, 2004; T. W. Smith, Pope, Sanders, Allred, & O'Keeffe, 1988), and it is important to account for cynical hostility when examining other social predictors (Chen, Gilligan, Coups, & Contrada, 2005). Loneliness and cynical hostility are similar, in that, both are characterized by a subjective sense of aloneness. However, they differ, in that, loneliness is a state of distress generated from feeling alone, whereas cynical hostility is an attitude that separates oneself from others through distrust.

Prior work has shown that loneliness is negatively correlated with cognitive function in older adults (Conroy, Golden, Jeffares, O'Neill, & McGee, 2010; O'Luanaigh et al., 2012) and predicts steeper cognitive decline (Donovan et al., 2017;

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Holwerda et al., 2012; Shankar et al., 2013; Tilvis et al., 2004; Wilson et al., 2007). However, this research is limited in two major ways. First, the majority of the longitudinal studies used a single-item question to assess loneliness, rather than a validated scale (e.g., Donovan et al., 2017; Holwerda et al., 2012; Tilvis et al., 2004). Moreover, with the exception of the Donovan et al. (2017) study, the samples used in these studies tended to be single-site samples, limiting their ability to speak to the diverse population of older adults in the United States.

Research on cynical hostility as a risk factor for cognitive decline is more limited and inconsistent. Neuvonen and colleagues (2014) identified cynical distrust as a predictor of incident dementia over 8 to 10 years in a sample of 1,449 older adults living in Finland after controlling for socioeconomic variables, lifestyle, health status, and APOE e4 carrier status. However, two longitudinal studies did not find cynical hostility to be a significant predictor of cognitive decline, although higher rates of cynical hostility correlated with lower cognitive function at baseline (Barnes et al., 2009; Mortensen, Barefoot, & Avlund, 2012). These studies differed substantially in their sampling frames, measures of cynical distrust/hostility (each study used a different subset of items from the Cook–Medley Hostility Inventory), and analytic approach, which may contribute to their disparate findings. To our knowledge, cynical hostility has not been examined as a predictor of cognitive decline in a U.S. sample.

Isolation, loneliness, and potentially cynical hostility appear to be risk factors for cognitive decline. However, much of this research is cross sectional or limited in terms of its sample or measures. The aim of this study was to jointly examine objective social isolation, loneliness, and cynical hostility as predictors of cognitive function and decline from 2006 to 2012 in a sample of U.S. older adults.

Method

Sample

This study analyzed data from the Health and Retirement Study (HRS), an ongoing nationally representative, longitudinal study of American adults aged 50 and above (Heeringa & Connor, 1995; Juster & Suzman, 1995). Participants are surveyed every 2 years on an array of health, socioeconomic, and health care characteristics. The outcome measure for this study—cognitive function—was reliably assessed for participants beginning at age 65; thus, this study is limited to participants aged 65 and above.

Interviews were conducted either by phone or in person (Sonnega et al., 2014). In 2006, the HRS began a mixed-mode follow-up, whereby 50% of the sample was randomly assigned to be interviewed in person, whereas the remaining 50% was assigned to be interviewed by phone. This assignment rotated every 2 years, so that both halves of the sample were interviewed in person every 4 years. The in-person follow-ups allowed for the implementation of physical measures (e.g., grip strength), biological measures (e.g., saliva sample), and the Leave-Behind Questionnaire (LBQ). The LBQ was a self-administered survey that was left behind after the face-to-face interview to be completed and mailed back (J. Smith et al., 2013). The LBQ included assessments of loneliness and cynical hostility (described below). This study used data from the 2006 (n = 10,376), 2008 (n = 9,143), 2010 (n = 7,626), and 2012 (n = 6,809) waves of the HRS, where n refers to the number of participants with cognitive function data.

Participants

The HRS interviewed approximately 20,000 respondents in each wave. Data from 6,654 participants were analyzed for this study. The HRS was approved by the institutional review board at the University of Michigan, and all participants provided informed consent. Table 1 describes the characteristics of the sample in 2006 stratified by cognitive impairment in 2006. There were differences in cognitive impairment according to age, gender, race, ethnicity, education, and socioeconomic status (SES). Those with cognitive impairment showed higher levels of loneliness (p = .0174), cynical hostility (p = .0030), and isolation (p = .0002). To assess for attrition bias, participants who completed a cognitive assessment in 2006 were divided into two groups according to whether they completed the cognitive assessment in 2012. These samples are described in Table 2.

Measures

Cognitive function (outcome measure). Total cognitive function was measured using a modified version of the Telephone Interview for Cognitive Status (TICS). The assessment consisted of seven tasks assessing recall (i.e., immediate and delayed word recall) and mental status (i.e., the serial 7s, backward counting from 20, and object, date, and president/vice president naming; Ofstedal, Fisher, & Herzog, 2005). The measure was administered for all participants at every wave. Scores range from 0 (*lowest possible performance*) to 35 (*highest possible performance*). There is evidence supporting the construct validity of this measure (Herzog & Wallace, 1997); for further discussion on psychometric properties, see Ofstedal et al. (2005). Cognitive impairment was defined as a score of ⩽8 on the overall measure of cognitive function (Herzog & Wallace, 1997).

Cynical hostility. Cynical hostility was quantified using five items from the Cook–Medley Hostility Inventory: (a) Most people dislike putting themselves out to help other people. (b) Most people will use somewhat unfair means to gain profit or an advantage rather than lose it. (c) No one cares much what happens to you. (d) I think most people would lie to get ahead. (e) I commonly wonder what hidden reasons

Table 1. Characteristics of the HRS Sample in 2006, Overall and Stratified by Cognitive Impairment Status in 2006.

	Overall (*N*, %)	No cognitive impairment (*N*, %)	Cognitive impairment (*N*, %)	*p*
M baseline age (*SE*)	74.90	74.36	82.64	<.0001[a]
Gender				.0020[b]
Male	4,350, 41.92%	4,272, 42.16%	78, 32.23%	
Female	6,026, 58.08%	5,862, 57.84%	164, 67.77%	
Race				
White/Caucasian	8,717, 84.01%	8,568, 84.55%	149, 61.89%	<.0001[b]
Black/African American	1,338, 12.90%	1,259, 12.42%	79, 32.64%	
Other	321, 3.09%	307, 3.03%	14, 5.79%	
Ethnicity				.0101
Not Hispanic	9,583, 92.36%	9,370, 92.46%	213, 88.02%	
Hispanic	793, 7.64%	764, 7.54%	29, 11.98%	
Education				<.0001[b]
No high school diploma	2,660, 25.64%	2,484, 24.51	176, 72.73	<.0001[b]
High school diploma	3,421, 32.97%	3,387, 33.43	34, 14.05	
GED	456, 4.40%	446, 4.40	10, 4.13	
Some college	1,978, 19.07%	1,968, 19.42	10, 4.13	
College and above	1,860, 17.93%	1,848, 18.24	12, 4.96	
Socioeconomic status				
Lower	1,921, 18.51%	1,799, 17.75%	122, 50.41%	<.0001[b]
Lower middle	2,070, 19.95%	2,013, 19.86%	57, 23.55%	
Middle	2,100, 20.24%	2,076, 20.49%	24, 9.92%	
Upper middle	2,134, 20.57%	2,114, 20.86%	20, 8.26%	
Upper	2,151, 20.73%	2,132, 21.04%	19, 7.85%	
Loneliness	−0.53	−0.53	−0.35	.0174[a]
Cynical hostility	2.92	2.91	3.32	.0030[a]
Isolation (social network)	3.41	3.40	3.82	.0002[a]

Note. HRS = Health and Retirement Study; GED = general educational development.
[a]*T* test.
[b]Chi-square test.

another person may have for doing something nice for me. Participants rated how much they agreed with each statement using a 5-point Likert-type scale. These values were then averaged to generate an index for cynical hostility, ranging from 1 to 6 (J. Smith et al., 2013). The scale was set to missing if there were more than three items missing. Psychometric assessment of these five items in 2006, 2008, and 2010 yielded an alpha of .79 to .80.

Loneliness. Loneliness was measured using the Hughes Scale, a three-item scale shortened from the University of California, Los Angeles (UCLA), Loneliness Scale. The three items were as follows: (a) How often do you feel that you lack companionship? (b) How often do you feel left out? (c) How often do you feel isolated from others? (J. Smith et al., 2013). Response options included *often, some of the time*, and *hardly ever or never*. Assessment of the psychometric properties of this scale yielded an alpha of .72 and showed a .48 ($p < .001$) correlation with depressive symptoms as measured by a short form of the Center for Epidemiologic Studies–Depression (CES-D) Scale validity (Hughes, Waite, Hawkley, & Cacioppo, 2004). The scale was set to missing if there was more than one missing item.

Objective social isolation (contact with social network). Participants rated how often they (a) meet up (include both arranged and chance meetings), (b) speak on the phone, (c) write or email their children, other family members, and friends respectively. Options included *three or more times a week, once or twice a week, once or twice a month, every few months, once or twice a year, less than once a year*, or *never* (J. Smith et al., 2013). The values for all three types of encounter (meet up, phone, and email) and relationship (children, other family members, friends) were combined into a single variable. The scale was set to missing if more than one item was missing. The scale was reverse coded so that higher values indicated higher levels of isolation from one's social network.

Partner status. Partner status was categorized as married/partnered, separated/divorced, widowed, and single. This variable was time varying, that is, partner status was assessed at each wave.

Table 2. Baseline Characteristics of the Sample With Cognitive Assessment in 2012 vs. No Cognitive Assessment in 2012, Excluding Participants Who Did Not Complete a Cognitive Assessment in 2006.

	Retained	Lost to follow-up
M baseline age (*SE*)	72.57	78.02
Gender		
Male	2,728, 41.00%	1,583, 44.33%
Female	3,926, 59.00%	1,988, 55.67%
Race		
White/Caucasian	5,632, 84.64%	2,691, 83.68%
Black/African American	806, 12.11%	436, 13.56%
Other	216, 3.25%	89, 2.77%
Ethnicity		
Not Hispanic	6,126, 92.06%	3,002, 93.35%
Hispanic	528, 7.94%	214, 6.65%
Education		
No high school diploma	1,415, 21.27%	1,046, 32.52%
High school diploma	2,249, 33.80%	1,017, 31.62%
GED	303, 4.55%	135, 4.20%
Some college	1,366, 20.53%	547, 17.01%
College and above	1,320, 19.84%	471, 14.65%
Socioeconomic status		
Lower	985, 14.80	795, 24.72%
Lower middle	1,216, 18.27	733, 22.79%
Middle	1,418, 21.31	594, 18.47%
Upper middle	1,475, 22.17	578, 17.97%
Upper	1,560, 23.44	516, 16.04%
Loneliness	−0.57	−0.45
Cynical hostility	3.35	3.06
Isolation (social network)	2.86	3.52

Note. GED = general educational development.

Covariates. Covariates included demographics (age, education, sex, SES, and race), health status, and functional limitations. Covariates were assessed by self-report. Self-reported health, difficulties with activities of daily living, age, and SES were time varying; education, sex, and race were assessed at baseline. In addition, baseline depression was use to exclude participants who were depressed at baseline.

Education was categorized as included less than high school, general educational development (GED), high school graduate, some college, and college or more (reference group: high school diploma). Sex was categorized as male and female (reference group: male). SES was indicated by net worth, an index that reflects all sources of wealth (i.e., salary, pension, home ownership) minus all sources of debt (i.e., mortgage, loans; Chien et al., 2014). Net worth was categorized into quintiles (lower, lower middle, middle, upper middle, upper; reference group: middle). Race was categorized as White/Caucasian, Black/African American, and Other (reference group: White). Self-reported health was determined by asking participants to rate their health as excellent, very good, good, fair, and poor. Functional limitations, or difficulties with activities of daily living, were quantified by summing endorsement of difficulty walking across a room, dressing, bathing, eating, getting in and out of bed, and using the toilet. This variable was transformed into a binary predictor (functional limitations present, no functional limitations present) due to most participants (77.73%) denying any limitations.

Baseline depressive symptoms were assessed using the eight-item modified version of the CES-D Scale, which asks about low mood and associated symptoms over the past week, each recorded dichotomously. The total score was calculated by subtracting Items 4 and 6 from the sum of the remaining items (Chien et al., 2014). A score of 4 or above was used to indicate significant depressive symptoms, consistent with prior work (Turvey, Wallace, & Herzog, 1999; Zivin et al., 2010).

Data Analyses

Prior to analysis, variables were assessed to determine whether they met assumptions of normality and were transformed if necessary. Multicollinearity was assessed for loneliness, cynical hostility, and contact with social network; all correlations were $<.5$. Continuous variables (e.g., age) were centered on the sample mean, and categorical variables (e.g., education, partner status) were dummy coded. For the longitudinal analysis, time was coded as 0, 1, 2, 3, so that the intercept would be baseline.

Baseline characteristics were assessed using measures of central tendency. Next, multilevel modeling (MLM) was used to estimate the relationships between change in loneliness and cynical hostility with cognitive function over time. First, we tested different covariance structures and selected the unstructured covariance matrix. Second, we fit an unconditional (i.e., no predictors) MLM to characterize change (e.g., linear, curvilinear) in cognitive function over the four-wave time period, where the unit of time was waves. Third, we estimated models with covariates nested within individuals. Model 1 included only loneliness and cynical hostility, plus their interactions with time, as predictors of the trajectory of cognitive function over time. Model 2 also added main effects of age, gender, race, education, and SES. Model 3 built on Model 2 by adding main effects of self-reported health and difficulties with activities of daily living. Model 4 added main effects of objective indicators of isolation (i.e., marriage status and contact with social network). Finally, Model 5 added an interaction effect for objective social isolation and time. MLM has several advantages over other approaches: to include the general linear model, to include the ability to account for variance both between and within an individual, to account for unevenly spaced time points across individuals, and to better account for missing data (for more information on this approach, see Goldstein, 2011).

Sensitivity analyses were conducted to determine (a) whether results changed after excluding participants who had elevated depressive symptoms at the analytic baseline (2006 wave), as indicated by a score of four or more on the modified CES-D (Zivin et al., 2010); (b) whether results changed after excluding participants who showed cognitive impairment at the analytic baseline (2006 wave), as indicated by a score below or equal to 8 on the cognitive function measure (Herzog & Wallace, 1997); and (c) whether results changed after weighting analyses using inverse probability weighting to control for potential bias due to selective attrition.

For the third set of sensitivity analyses, two inverse probability weights (stabilized) were calculated and applied to analyses according to the procedures outlined by Howe, Cole, Lau, Napravnik, and Eron (2016). In the first, weighting was applied to target demographic (age, race, ethnicity, gender, and education) differences in attrition; participants missing all four cognitive function assessments or demographic information were dropped from analyses. In the second, logistic regressions were run to identify which predictors predicted ($p < .25$) attrition (defined as missing the outcome variable, i.e., cognitive function, from that wave forward) at each wave, which identified the following predictors of attrition: loneliness, isolation, age, race, gender, education, SES, marital status, self-reported health, and functional limitations. If these variables were missing across all waves, these cases were dropped from the data set. To create the inverse probability weight, values were imputed according to response at the earlier wave for the 2008, 2010, and 2012 time points or either the minimum or average response for the 2006 time point (minimum: functional limitations and self-reported health, as these factors are likely to improve over time; average: SES, loneliness, and isolation). This weight was then applied to the original data set. These weights served to upweight data from participants similar to participants who were lost to follow-up, thereby accounting for potential changes in sample characteristics due to selective attrition. For more information on this approach, see Howe et al. (2016).

All analyses were conducted using SAS (Proc Mixed) with repeated measures nested in individuals. Analyses did not account for complex sampling; as such, certain groups (e.g., persons living in Florida, Black Americans) are overrepresented in the analyzed data set. Code for all procedures is included in Online Appendices 1 to 6.

Results

Relationship Between Loneliness, Cynical Hostility, and Contact With Social Network

Baseline loneliness, cynical hostility, and contact with social network (reverse coded) were all significantly correlated. There was a weak positive correlation between loneliness and cynical hostility ($r = .30$, $p < .0001$), cynical hostility and contact with social network ($r = .26$, $p < .0001$), and loneliness and contact with social network ($r = .20$, $p < .0001$).

Modeling Change in Cognitive Function Over Time

As expected, cognitive function declined over time ($\beta = -.49$, $SE(b) = 0.02$, $t(23E3) = -29.26$, $p < .0001$). Change in cognitive function over time was best captured by a linear trajectory model ($\chi^2(3) = 18{,}440.89$, $p < .0001$, Akaike information criterion [AIC] = 191,727.6, four parameters); the quadratic growth curve model was also tested, but the time × time term was not statistically significant ($p = .78$). The AIC provides an estimate of relative model fit, whereby smaller values indicate better fit. The intraclass correlation coefficient (ICC, an indicator of how much variance lies at each level) generated using the unconditional model was .7455, indicating that approximately 74.55% of the total variance in cognitive function is between individuals.

Table 3 provides the results of the nested multivariate models. Model 1 (unadjusted) shows that levels of loneliness ($\beta = -.87$, $SE(b) = 0.10$, $t(5{,}482) = -8.89$, $p < .0001$) and cynical hostility ($\beta = -.45$, $SE(b) = 0.05$, $t(5{,}482) = -9.86$, $p < .0001$) were both associated with lower cognitive function, but neither loneliness ($p = .9051$) nor cynical hostility ($p = .7022$) predicted change in cognitive function over time. These relationships were substantively unchanged after accounting for demographic characteristics (Model 2), self-reported health and functional limitations (Model 3), or objective indicators of isolation (Model 4). As shown by Model, 4, divorce or separation from a spouse, as compared with being married or partnered, $\beta = -.41$, $SE(b) = 0.16$, $t(60) = -2.47$, $p = .0163$, and less frequent contact with one's social network, $\beta = -.38$, $SE(b) = 0.05$, $t(3{,}520) = -6.99$, $p < .0001$, were associated with lower cognitive function. Finally, as shown by Model 5, less frequent contact with one's social network also predicted greater decline in cognitive function over time ($\beta = -.09$, $SE(b) = 0.04$, $t(3{,}519) = -2.18$, $p = .0292$). Coefficient estimates (β) for all predictors are included in Table 3. In the final model, the 95% confidence intervals (CIs) for the effects of the predictors of interest on cognitive function were as follows: loneliness [−0.56, −0.11], cynical hostility [−0.24, −0.04], isolation [−0.41, −0.12]; the 95% CIs for the effects of the predictors of interest on cognitive decline were as follows: loneliness [−0.11, 0.13], cynical hostility [−0.06, 0.06], isolation [−0.16, −0.01].

Sensitivity Analyses

Neither excluding participants with elevated depressive symptoms ($n = 2{,}633$) or cognitive impairment ($n = 242$) at

Table 3. Relationship Between Loneliness, Cynical Hostility, Isolation, and Cognitive Function Over Time: HRS 2006 to 2012.

	Model 0	Model 1	Model 2[a]	Model 3[a,b]	Model 4[a,b]	Model 5[a,b]
Fixed effects						
Intercept	−0.03	0.40****	−5.73****	−7.33****	−7.43****	−7.41****
Time	−0.49****	−0.24****	−0.12****	−0.10****	−0.07*	−0.07*
Loneliness		−0.87****	−0.52****	−0.40****	−0.31**	−0.34**
Cynical hostility		−0.45****	−0.16***	−0.15***	−0.12*	−0.14**
Isolation					−0.38****	−0.27***
Marital status (ref = married or partnered)						
Single					0.49	0.49
Divorced/separated					−0.41*	−0.40*
Widowed					−0.16	−0.16
Time × Loneliness		0.01	−0.05	−0.03	−0.00	0.01
Time × Cynical hostility		0.01	−0.01	−0.01	−0.01	0.00
Time × Isolation						−0.09*
Random effects						
Variability in intercept	21.77****	17.36****	10.02****	9.69****	9.30****	9.29****
Variability in slope	0.58****	0.53*	0.31*	0.31*	0.39*	0.38*
Covariance between intercept and slope	0.67***	0.04	−0.02	−0.04	−0.32	−0.31
Residual	7.43****	6.00****	6.45****	6.43****	6.20***	6.20****
Goodness of fit						
–2RLL	191,719.6	83,112.1	79,488.5	79,172.2	57,844.1	57,844.0
AIC	191,727.6	83,120.1	79,496.5	79,180.2	57,852.1	57,852.0
Parameters	4	4	4	4	4	4
LR test: χ^2 (degrees of freedom)	18,440.89 (3)****	3,111.96 (3)****	1,935.51 (3)****	1,865.82 (3)****	1,080.44 (3)****	1,080.10 (3)****
Participants (*n*)						
	11,400	9,164	9,164	9,157	7,212	7,212

Note. HRS = Health and Retirement Study; ref = reference group; RLL = residual log likelihood; AIC = Akaike information criterion; LR = likelihood ratio.

[a]Controlling for demographics.

[b]Controlling for self-reported health and functional limitations.

*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$.

baseline appreciably changed the findings for loneliness, cynical hostility, and contact with social network (see Table 4). The application of an inverse probability weight according to differences in demographics (age, race, ethnicity, gender, and education) between persons who were retained versus lost to follow-up also did not change conclusions regarding loneliness, cynical hostility, or contact with social network. Similarly, the application of an inverse probability weight according to differences in loneliness, isolation, age, race, gender, education, SES, marital status, self-reported health, and functional limitations did not appreciably change the findings on the psychosocial predictors of interest.

Discussion

The present study examined how loneliness and cynical hostility relate to trajectories of cognitive function in older Americans. Loneliness and cynical hostility were associated with lower cognitive function, but not with faster change in cognitive function over time. Objective social isolation, indexed by frequency of contact with one's social network, was associated lower cognitive function and faster decline of cognitive function over time.

The finding that loneliness and cynical hostility are correlates of lower cognitive function is consistent with prior literature (Barnes et al., 2009; Conroy et al., 2010; Mortensen et al., 2012; O'Luanaigh et al., 2012). This study builds on this body of research by using a validated scale that measures loneliness indirectly (i.e., does not use a variant of the word "lonely"; Hughes et al., 2004). An indirect measure of loneliness sidesteps the stigma that is associated with loneliness, thus reducing the risk of social desirability bias (Shiovitz-Ezra & Ayalon, 2012).

Loneliness was not associated with change in cognitive function over time, which contrasts with existing studies (Donovan et al., 2017; Holwerda et al., 2012; Shankar et al., 2013; Tilvis et al., 2004; Wilson et al., 2007). This finding is particularly surprising, as both this study and the Donovan and colleagues (2017) study, which did detect an effect, used

Table 4. Relationship Between Loneliness, Cynical Hostility, Isolation, and Cognitive Function Over Time (HRS 2006-2012) Controlling for Demographics, Self-Reported Health, and Functional Limitations.

	Model S1	Model S2	Model S3	Model S4
Fixed effects				
Loneliness	−0.49***	−0.29**	−0.34**	−0.34
Cynical hostility	−0.15**	−0.12*	−0.13*	−0.13
Isolation	−0.23**	−0.19**	−0.26***	−0.27
Marital status (ref = married or partnered)				
Single	0.43	0.45	0.47	0.48
Divorced/separated	−0.33	−0.26	−0.42*	−0.42
Widowed	−0.15	−0.08	−0.15	−0.15
Time × Loneliness	0.08	−0.02	0.01	0.01
Time × Cynical hostility	0.00	0.00	0.00	0.00
Time × Isolation	−0.10*	0.12**	−0.09*	−0.09

Note. Model S1: excluding participants with elevated depression at baseline, Model S2: excluding participants with cognitive impairment at baseline, Model S3: with inverse probability weighting to account for attrition differences in terms of age, race, ethnicity, gender, and education, Model S4: with inverse probability weighting to account for attrition differences in terms of age, race, gender, education, socioeconomic status, loneliness, isolation, marital status, self-reported health, and functional limitations. HRS = Health and Retirement Study; ref = reference group.
*$p < .05$. **$p < .01$. ***$p < .001$. ****$p < .0001$.

the same data set (the HRS). However, there were several key differences in the methodology of these studies. First, this study used the Hughes Loneliness Scale, rather than the CES-D single item of "I felt lonely." Second, this study followed participants over an 8-year, rather than 12-year, span to use the Hughes Loneliness Scale, which was added to the HRS in the mid-2000s. Finally, this study used MLM with repeated measures nested in individuals rather than the general linear model, and, thus, was better able to capture individual trajectories of cognitive function.

In this study, cynical hostility was not associated with change in cognitive function over time, consistent with research by Mortensen et al. (2012) and Barnes and colleagues (2009). However, this finding is not consistent with more recent research by Neuvonen and colleagues (2014), who found that cynical distrust was associated with higher risk of dementia when controlling for a large set of demographic and health characteristics (e.g., blood pressure, cholesterol, fasting glucose, body mass index, smoking, alcohol use, self-reported health, and APOE genotype). However, the Neuvonen and colleagues (2014) study also did not detect an effect of cynical hostility in models not controlling for these potential confounders. It is also possible that their use of a categorical variable for cynical hostility, rather than a continuous metric, and the use of dementia as an outcome, rather than cognitive function as a dimensional outcome, contributed to these discordant findings. However, the lack of a detectable effect of cynical hostility on cognitive decline using a large sample, multiple-item scale, and MLM suggests that the effect is likely too small to be of substantial clinical significance.

The finding that objective social isolation is a predictor of lower cognitive function and faster cognitive decline is consistent with prior literature (Barnes et al., 2009; Bassuk et al., 1999; Fratiglioni et al., 2000; Håkansson et al., 2009; Helmer et al., 1999; James et al., 2011; Shankar et al., 2013). This study also shows that the relationship between objective social integration and cognitive function is independent of subjective measures of isolation (i.e., loneliness and cynical hostility). This association may be due to the mental stimulation provided by company or a lack of instrumental social support related to health and well-being among other factors (National Research Council, 2006).

Findings should be interpreted in light of study strengths and limitations. The study possesses several strengths. First, the HRS is a cohort study, which allows for analyses examining the temporal relationship between the factors of interest and cognitive decline. Second, the HRS sample is sufficiently large to detect relatively small effects. Third, the HRS oversamples racial/ethnic minority groups who are at greater risk of cognitive decline (Alzheimer's Association, 2010). Fourth, the MLM approach used in this study accounts for within-person factors, and change in those factors, over time. Moreover, MLM is better equipped to deal with missing data than applications of the general linear model. Fifth, sensitivity analyses were conducted to address potential issues of confounding, inverse causality, and bias due to selective attrition. Finally, this study controlled for factors that might obscure the relationship between loneliness, cynical hostility, isolation, and cognitive decline.

The study also has limitations. First, the modified cynical hostility scale differs from those used in prior work, which muddles comparison across studies. Second, the MLM approach used in this study is not flexible enough to account for the complex sampling used by the HRS, and, as a result, our findings—although internally valid—are not representative of the U.S. population. Third, loneliness and cynical hostility occur in the context of demographic and other

health-related factors, which were treated as confounders in this study. Future research should examine whether these characteristics influence the relationships between psychosocial factors and cognitive function. Fourth, this study examined overall cognitive function, rather than looking at specific dimensions of cognitive function. It is possible that loneliness and cynical hostility differentially predict domains of cognitive functioning, and that the aggregation of these domains obscures such findings. Fifth, the loneliness scale used in this study is an abbreviated form of the Revised UCLA Loneliness Scale, which would have been better able to tap into the construct of loneliness. Finally, further research is necessary to examine the mechanisms through which objective social integration slows cognitive decline.

This study indicates that loneliness, cynical hostility, and objective social isolation are associated with lower cognitive function. However, only objective social isolation was a risk factor for accelerated cognitive decline. Further research is necessary to determine which aspect of contact with family and friends protects older Americans from cognitive decline. These findings build on the growing literature uncovering the importance of social relationships to healthy aging (Cornwell & Waite, 2009; Nicholson, 2012; Shankar, McMunn, Banks, & Steptoe, 2011). As the population grows older, it becomes increasingly important to work to integrate older Americans into society, not only to improve quality of life but also to protect against health issues, such as cognitive decline, that afflict this population.

Acknowledgments

First, thanks to Sage Hawn for her earlier feedback on this project. Second, thanks to Al Farrell, Liming Dong, Brian Keller, and Craig Enders for their assistance during the revision process.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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Supplemental Material

Supplemental Material for this article is available online.

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