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A Cross-Lagged Model of the Reciprocal Associations of Loneliness and Memory Functioning

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The study was designed to evaluate the reciprocal associations of loneliness and memory functioning using a cross-lagged model. The study was based on the psychosocial questionnaire of the Health and Retirement Study, which is a U.S. nationally representative survey of individuals over the age of 50 and their spouses of any age. A total of 1,225 respondents had complete data on the loneliness measure in 2004 and at least in 1 of the subsequent waves (e.g., 2008, 2012) and were maintained for analysis. A cross-lagged model was estimated to examine the reciprocal associations of loneliness and memory functioning, controlling for age, gender, education, depressive symptoms, number of medical conditions, and the number of close social relationships. The model had adequate fit indices: $\chi^2(860, N = 1{,}225) = 1{,}401.54$, $p < .001$, Tucker–Lewis index = .957, comparative fit index = .963, and root mean square error of approximation = .023 (90% confidence interval [.021, .025]). The lagged effect of loneliness on memory functioning was nonsignificant, $B(SE) = -.11(.08)$, $p = .15$, whereas the lagged effect of memory functioning on loneliness was significant, $B(SE) = -.06(.02)$, $p = .01$, indicating that lower levels of memory functioning precede higher levels of loneliness 4 years afterward. Further research is required to better understand the mechanisms responsible for the temporal association between reduced memory functioning and increased loneliness.

Keywords: longitudinal, loneliness, cognition, dementia, older adults

A substantial and growing body of literature has linked interpersonal relationships with health. Specifically, social ties and support have been associated with better mental and physical health (Cornwell & Waite, 2009), whereas socially isolated people were found to be at an increased risk for compromised health (Shankar, McMunn, Banks, & Steptoe, 2011) and all-cause mortality, even after adjustment for potential confounders such as sociodemographic variables and health indicators (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Shiovitz-Ezra & Ayalon, 2010; Steptoe, Shankar, Demakakos, & Wardle, 2013).

Loneliness is a subjective marker of the quality of one's social relationships (Andersson, 1998). It is a feeling of distress that is accompanied by the perception that the quantity, or especially the quality, of one's social interactions does not meet one's social needs (Gierveld, 1998). Ample studies have documented the detrimental effects of loneliness on both subjective and objective health (Kearns, Whitley, Tannahill, & Ellaway, 2015; Nummela, Seppänen, & Uutela, 2011). Moreover, a prospective association between loneliness and mortality has repeatedly been reported (Luo, Hawkley, Waite, & Cacioppo, 2012; Patterson & Veenstra, 2010; Perissinotto, Stijacic Cenzer, & Covinsky, 2012; Shiovitz-Ezra & Ayalon, 2010). In contrast, quantitative objective aspects of social relationships, such as number of friends, family ties, marital status, and frequency of contact, are not likely the best predictors of health outcomes (Berkman, Glass, Brissette, & Seeman, 2000; Fiori, Smith, & Antonucci, 2007).

Cognitive functioning is instrumental to older adults' quality of life and wellbeing (Abrahamson, Clark, Perkins, & Arling, 2012). Ample research has shown negative influences of reduced cognitive functioning on older adults' ability to carry out instrumental activities of daily living (Marshall et al., 2011; Rajan, Hebert, Scherr, de Leon, & Evans, 2013). Although age is a risk factor for both deteriorated cognitive functioning and loneliness, relatively little is known about the loneliness–cognitive-decline nexus. Similar to the relationship between engaged lifestyle and cognitive functioning (Lövdén, Ghisletta, & Lindenberger, 2005), the association between loneliness and cognitive functioning can be unidirectional (e.g., cognitive functioning affects loneliness or loneliness affects cognitive functioning) or bidirectional (cognitive functioning affects loneliness and loneliness affects cognitive

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functioning), or the relationship could be affected by a common third variable (e.g., both lower levels of loneliness and high levels of cognitive functioning are associated with high levels of education which serve as the antecedent condition).

Past research has suggested several potential pathways through which loneliness could contribute to a decrease in cognitive function (Cacioppo & Hawkley, 2009). People who are less socially engaged in satisfactory contacts have fewer opportunities to be engaged in more complex interpersonal exchanges and dynamic environments. This, in return, weakens their cognitive capacity. Being socially involved in close relationships also provides opportunities for the reciprocal provision of support not only from members of the social network to the older adults, but also from the older adult to his or her network members. This, in return, enhances functioning (Berkman et al., 2000). The stress hypothesis has also been suggested as a possible psychological mechanism. Being less involved in meaningful social interactions contributes to negative emotional states associated with increased stress. In support of this hypothesis, high concentrations of cortisol, a stress hormone, have been related to impaired cognitive function (Fratiglioni, Paillard-Borg, & Winblad, 2004). Loneliness was also found to increase inflammatory markers (Jaremka et al., 2013) that might lead to compromised cognitive function. The cognitive load produced by loneliness through the "regulatory loop" also restricts the availability of cognitive resources (Cacioppo & Hawkley, 2009).

Indeed, several studies have noted the negative association between loneliness and cognition in later life. In a cross-sectional community based study of 466 older adults (mean age of 75.45), loneliness was associated with impaired global cognition after adjusting for depression, social network and demographic characteristics (O'Luanaigh et al., 2012). In the Helsinki Aging Study, a longitudinal project conducted in Finland, loneliness at baseline predicted 10-year cognitive decline (Tilvis et al., 2004). Loneliness was also inversely associated with cognitive functioning among randomly selected noninstitutionalized Irish people, aged 65 and over (Conroy, Golden, Jeffares, O'Neill, & McGee, 2010). Increased loneliness at the age of 79 was significantly related to lower cognitive function indicated by lower age-79 IQ, even after controlling for background characteristics and age-11 IQ (Gow, Pattie, Whiteman, Whalley, & Deary, 2007). In accordance with these findings, in a prospective study of 823 older adults from Chicago, Illinois, and its suburbs, loneliness was found to be a robust risk factor for developing clinical Alzheimer's disease, net of the effect of potential confounders including social isolation. Loneliness at baseline was also associated with a more rapid decline in cognitive function in a 4-year follow-up study (Wilson et al., 2007). More recently, in the English Longitudinal Study of Ageing, loneliness at baseline was found to be associated with poorer cognitive functioning, measured by immediate and delayed recall over a 4-year follow-up (Shankar, Hamer, McMunn, & Steptoe, 2013).

A reverse causal direction between loneliness and cognitive functioning cannot be ruled out. This is because cognitive impairment has the potential to narrow one's social environment. This can result in social isolation and feelings of loneliness (Hawkley & Cacioppo, 2010). Memory decline, in particular, might lead to negative feelings such as shame and embarrassment that can eventually result in social withdrawal (Ballard, 2010). This is less likely to be the case for other cognitive functions such as perceptual speed, which is less likely to be subjectively noted as deteriorating (Lövdén et al., 2005). Presenting with signs and symptoms of cognitive impairment or dementia can also affect one's social circle. People may distance themselves from individuals who have a notable cognitive impairment either because they do not know how to act in their presence or because of the stigma associated with dementia and cognitive impairments (Werner, Goldstein, & Buchbinder, 2010).

Other studies, however, have not supported an effect of cognitive functioning on loneliness. Cognitive ability at baseline did not predict changes in loneliness in the 4-year follow-up study conducted by Wilson and colleagues (2007). A longitudinal study conducted in the Netherlands also found that change in cognitive function was not related to loneliness among men (Tijhuis, De Jong-Gierveld, Feskens, & Kromhout, 1999).

To date, there is only limited research on the cognitive-functioning–loneliness association. The few studies that have addressed this causal direction did not evaluate the potential for simultaneous associations of cognition on loneliness and vice versa, but rather evaluated each effect separately. Because of the limited number and limited representativeness of past studies, there is still an open question regarding the direction of the effect in the cognitive-functioning–loneliness association (Cacioppo & Hawkley, 2009).

Our study is specifically focused on memory functioning as an indicator of cognitive functioning for several reasons. First, memory impairment in older adults is often the first sign of dementia or mild cognitive impairment (Amariglio, Townsend, Grodstein, Sperling, & Rentz, 2011; Buckner, 2004; Gauthier et al., 2006). Hence, it has an important role as a sign of deteriorated cognitive functioning. Given its high prevalence and relatively early onset, the potential negative effects of loneliness on memory impairment are more likely to be observed compared with its effects on other less prevalent cognitive impairments. Second, memory impairment is highly visible and, therefore, a great source of concern for older adults. Unlike other cognitive difficulties, having a memory impairment is one of the greatest fears reported by older adults (Rowell, Green, Teachman, & Salthouse, 2015). Given its high visibility, it is likely that memory impairment would have an emotional impact on individuals, which could potentially manifest as heightened levels of loneliness, whereas other less noticeable cognitive impairments are less likely to have such an impact (Ballard, 2010). Therefore, the present study specifically focused on the association of memory functioning and loneliness in an attempt to identify its temporal order.

Method

The Sample

The present study relies on the 2004, 2008, and 2012 waves of the Health and Retirement Study (HRS). The HRS is a biannual longitudinal panel of U.S. nationally representative individuals over the age of 50 and their spouses of any age. The HRS is supported by the National Institute on Aging (NIA U01AG009740) and the Social Security Administration. In 2004, the HRS piloted a self-completed psychosocial questionnaire administered to a random sample of respondents (n = 3,262). As of 2006, the psychosocial questionnaire has been

administered to a rotating 50% of the core panel participants every 4 years. The present study is based on all respondents, 50 years of age and over, who completed the loneliness questionnaire and the memory functioning measure in 2004 and had at least one additional measurement point (2008, 2012; N = 1,225). For the years 2004–2012, response rate to the core HRS survey was around 90% and the overall response rate to the psychosocial questionnaire was around 70%.

Both loneliness and memory functioning were associated with participation level, with those individuals who reported higher levels of loneliness and scored lower on memory functioning, being less likely to complete the questionnaire. For instance, in 2004, those who responded to the loneliness questionnaire, had higher scores on the memory test, $M(SD)$ = 10.1(3.2), compared with those who were eligible but did not respond, $M(SD)$ = 8.5(3.3), $t(df) = -3.7(3,128)$, $p < .01$. A similar trend with regard to memory functioning was noted in 2008, $M(SD)$ = 9.8(3.3), $M(SD)$ = 8.7(3.7), $t(df) = -8.7(1,367.4)$, $p < .001$, and in 2012, $M(SD)$ = 9.7(3.3), $M(SD)$ = 9.1(3.5), $t(df) = -7.4(4,009.5)$, $p < .001$. In addition, those who completed the loneliness scale in 2008 reported lower levels of loneliness in 2004, $M(SD)$ = 1.4(.50) compared with those who did not complete the loneliness scale in 2008, $M(SD)$ = 1.6(.64), $t(df)$ = 2.4(112.3), p = .02. However, this trend was not maintained in 2012, $M(SD)$ = 1.4(.49), $M(SD)$ = 1.5(.55), $t(df)$ = 1.9(219.8), p = .06.

Measures

Loneliness. A short version of one of the most widely used scales of loneliness, the Revised University of California Los Angeles Loneliness Scale, was administered (Hughes, Waite, Hawkley, & Cacioppo, 2004; Russell, Peplau, & Cutrona, 1980). In its short form, the measure includes three questions with a simplified set of three response categories. Respondents were asked to rate, on a 3-point scale, how often they felt as if they (a) lacked companionship, (b) were left out, or (c) were isolated from others. A mean score was calculated, with a higher overall score representing greater loneliness (range 1–3). Cronbach's alpha in the present study was.80 in each wave. This scale is administered via the psychosocial questionnaire and, thus, is assessed through a self-administered questionnaire.

Memory functioning. Memory functioning was assessed either in a face-to-face interview or over the phone. The two modes are expected to result in comparable performance (Ofstedal, Fisher, & Herzog, 2005). A composite memory functioning score was constructed based on two memory tasks (range 0–20): (a) an immediate word recall task—respondents are presented with a list of 10 nouns, which they are asked to spontaneously repeat, and (b) a delayed verbal memory task—after 5 min of engaging in other tasks, respondents are asked to repeat the list of nouns previously presented to them. In the present study, we relied on the HRS imputed measures (Fisher, Hassan, Rodgers, & Weir, 2015). Cronbach's alpha was .84–.87 across waves.

Covariates. Age in 2004, gender, and years of education were gathered based on self-report. Number of medical conditions (e.g., hypertension, diabetes, cancer, lung disease, heart condition, arthritis and stroke; range 0–7) and depressive symptoms measured by seven items taken from the Center for Epidemiologic Studies Depression Scale (CES-D; excluding the loneliness item; range 0–7; Radloff, 1977; Wallace & Herzog, 1995) were used as covariates. In addition, the degree of closeness one feels toward spouse and the number of close ties with family members, friends, and children were summed to represent the number of close social relationships (range 1–111; Turner, Frankel, & Levin, 1983). This measure was severely skewed and, therefore, was log-transformed in the cross-lagged analysis. All the covariates were available for all three waves of data collection.

Statistical Analysis

We first calculated descriptive statistics and correlations between variables. Next, we used structural equation modeling with *Mplus* Version 7.3 (Muthén & Muthén, 1998-2012) to evaluate the cross-lagged autoregressive model outlined in Figure 1 (Finkel, 1995). The model allows for the simultaneous evaluation of the reciprocal associations of loneliness and memory functioning while controlling for measurement biases. Age in 2004, gender, years of education, number of medical conditions, depressive symptoms, and number of close social relationships were included as covariates because of their known associations with loneliness and with memory functioning (Prieto-Flores, Forjaz, Fernandez-Mayoralas, Rojo-Perez, & Martinez-Martin, 2011; Rajan et al., 2013). Loneliness, memory functioning, and depressive symptoms were modeled as latent constructs with their items serving as indicators. The log number of close social relationships and the number of medical conditions were modeled as single-indicator latent variables and their error terms were supplied in the model assuming reliability of .80. Age, gender, and years of education were modeled as observed variables.

Because there were missing values in the data (minimal covariance coverage = .72) and the data deviated from normality, we used the *Mplus* WLSMV estimator that allows for maximum likelihood estimation with robust standard errors and chi-square calculation in the presence of missing values. Weights and strata were specified in the model to account for the complex survey design. To estimate the models' goodness-of-fit, we followed the recommendations of Schreiber, Nora, Stage, Barlow, and King (2006) and report, in addition to the chi-square statistic, three approximate fit indices, the Tucker–Lewis index (TLI), the comparative fit index (CFI), and the root mean-square error of approximation (RMSEA). TLI and CFI close to or above .95 combined with RMSEA of 0.06 or lower indicate reasonably good fit (Hu & Bentler, 1999). The significance level criterion for all other statistical tests was set at .05.

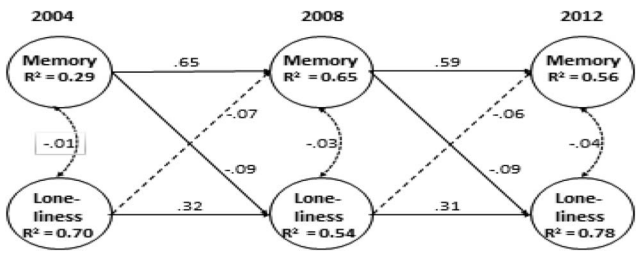

Figure 1. A structural equation model of cross-lagged memory functioning and loneliness effects with standardized parameters. The solid lines indicate paths statistically significant at $p < .05$. The dotted lines indicate nonsignificant paths. R^2 represents the proportion of explained variance.

Variance resulting from specific measurement occurrences in the cross-lagged panel model was accounted for by correlating the uniquenesses within waves (Marsh & Hau, 1996). Because factorial invariance across time points is a major requirement of a valid autoregressive model (Finkel, 1995), we first tested for and assured "weak factorial invariance" (in terms of Meredith, 1993) by setting the factor loadings of the main research latent variables, loneliness and memory functioning, as equal across waves. These constructs' disturbances were specified as correlated within each wave. Stationarity was tested for and specified by setting all path coefficients to be invariant across waves (except for the correlation between loneliness and memory functioning at Wave 1).

Results

Sample characteristics are presented in Table 1. Table 2 presents the associations between loneliness and memory functioning across the three waves of data collection. Significant negative associations between loneliness in 2004, 2008, and 2012 and memory functioning were evident across all three waves. Table 3 presents intercorrelations among baseline variables.

As the first step of our main analyses, we tested the measurement model of the three latent constructs measured over three time points, with cross-wave correlations between errors of the same measures and with factor loadings constrained for equality across waves. The model fitted well to the data, with $\chi^2(702, N = 1{,}225) = 1{,}068.48$, $p < .001$, TLI = .968, CFI = .974, RMSEA = .021 (90% confidence interval [CI] [.018, .023]).

Next, we fitted the hypothesized autoregressive cross-lagged model with covariates. Time-invariant age, gender, and education were specified to affect each one of the three occurrences of loneliness and memory functioning. Depressive symptoms, number of medical conditions, and log number of close social relationships, measured at each wave, were specified to affect loneliness and memory functioning measured in the same wave. Depressive symptoms at each wave were regressed on the other control variables. This model fitted the data well, $\chi^2(860, N = 1{,}225) = 1{,}401.54$, $p < .001$, TLI = .957, CFI = .963, RMSEA = .023 (90% CI [.021, .025]). Figure 1 presents the main elements of this model (standardized paths and proportions of explained variance), with relations between controls and main research variables omitted from the figure.

The autoregressive effects of loneliness, $B(SE) = .32(.07)$, $p = .004$, and memory functioning, $B(SE) = .66(.03)$, $p < .001$, were substantive and significant across the three waves, pointing to the stability of these constructs. A sensitivity analysis demonstrated that the stability of loneliness was significantly lower than the stability of memory: *dif* $\chi^2(1) = 20.21$, $p < .001$.

The lagged effect of loneliness on memory functioning was nonsignificant, $B(SE) = -.11(.08)$, $p = .15$, whereas the lagged effect of memory functioning on loneliness was significant, $B(SE) = -.06(.02)$, $p = .01$, indicating that lower levels of memory functioning precedes higher levels of loneliness 4 years afterward.

Table 1
Sample Characteristics at Baseline (N = 1,225)

Characteristic	*M*(*SE*)/Frequency (%)
Age	65.56 (9.02)
Women	732 (59.8%)
Education (0–17)	12.64 (2.85)
(Log) Number of close social relationships (1–4.90)	2.46 (.61)
Number of medical conditions (0–7)	1.82 (1.28)
Depressive symptoms (0–7)	1.17 (1.69)

Discussion

The uniqueness of the present study stems from the simultaneous evaluation of the reciprocal associations of loneliness with memory functioning and vice versa. This type of analysis provides a clearer answer regarding the temporal order of the relationships between loneliness and memory functioning. The fact that the study is based on three waves of data collection, stemming over a period of 8 years is another advantage of this study.

Our findings show that lower memory functioning is a potential risk for loneliness. Becoming more forgetful and disorganized likely impacts the state of the individual who undergoes these memory changes, especially during early stages of cognitive deterioration, when insight is still preserved (Balash et al., 2013). As noted by past research, memory problems are often the first signs of cognitive impairment or dementia (Geerlings, Jonker, Bouter, Adèr, & Schmand, 1999). Older adults tend to report great fears about losing their memory and are quite cautious about changes in their memory functioning (Geerlings et al., 1999). Under these circumstances, staying isolated and distant from others might play a protective role as this prevents the individual who experiences a memory decline from direct confrontation with the external social environment and with social demands. At the same time, individuals in the social environment might distance themselves from those who experiences evident signs of memory impairment due to stigma (Beard & Neary, 2013). Memory impairment is often a visible sign of old age and as such, serves as a constant reminder of inevitable future decline. Moreover, individuals might not know how to interact with older adults who experience a memory loss and might distance themselves in order not to face uncomfortable social situations. Given the well-documented negative effects of loneliness on a variety of health and mental health indicators (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Shankar et al., 2011), this finding is noteworthy.

Past research has largely emphasized the role of loneliness as a potential risk for reduced cognitive functioning or even Alzheimer's disease (Cacioppo & Hawkley, 2009; Wilson et al., 2007). The present study found no temporal effect from loneliness to cognitive functioning over time. This is somewhat consistent with Tilvis and colleagues (2004) who found such an effect only at the 10-year follow-up but not at earlier follow-ups of their study (Tilvis et al., 2004). Possibly, a longer follow-up is required to detect the effects of loneliness on cognitive functioning. Nonetheless, it is important to note that the sample analyzed by Tilvis and colleagues (2004) was substantially older than the present sample and that the loneliness measure used in that study consisted of a single direct question, which explicitly asked respondents about loneliness, instead of an indirect measure, as was the case in the present study. Hence, differences between the two studies could

Table 2
Means, Standard Errors, and Correlations Among Loneliness (Three-Item R-UCLA) and Memory Functioning Scores Across the Three Waves

Variable	*M*(*SE*)	1	2	3	4	5
1. Loneliness 2004 (1–3)	1.38 (.01)					
2. Loneliness 2008 (1–3)	1.43 (.02)	.52***				
3. Loneliness 2012 (1–3)	1.44 (.02)	.52***	.57***			
4. Memory functioning 2004 (0–20)	10.6 (.10)	–.15***	–.14***	–.16***		
5. Memory functioning 2008 (0–20)	10.4 (.10)	–.10**	–.11***	–.11***	.58***	
6. Memory functioning 2012 (0–20)	9.6 (.11)	–.04***	–.06*	–.10**	.55***	.57***

Note. Overall, 1,225 respondents over the age of 50 completed the loneliness scale in 2004 and in 2008 and/or 2012. R-UCLA = Revised University of California Los Angeles Loneliness Scale.
* $p < .05$. ** $p < .01$. *** $p < .001$.

also be accounted for by the use of direct versus indirect approach employed to assess loneliness (Shiovitz-Ezra & Ayalon, 2012).

The present findings potentially offer practical implications as they point to unmet and often neglected needs among older adults with deteriorated memory. Although a considerable amount of literature has addressed loneliness among family caregivers (Beeson, 2003; Wagner & Brandt, 2015), much less attention has been given to loneliness among older adults with deteriorated memory. Hence, the present study highlights potential unmet needs in a vulnerable population of older adults.

When interpreting this finding, in light of existing literature, it is important to also consider the statistical method used for the analysis. The present study relied on a statistical method that simultaneously examines reciprocal effects. Other studies, on the other hand, have largely relied on statistical methods that examined a single direction of influence at a time. Hence, the present study has the advantage of simultaneously assessing for the temporal order of the effects. It also is important to note the potential role of publication bias. Unlike deteriorated memory functioning, which is nonrepairable at the present time (Reijnders, van Heugten, & van Boxtel, 2013), loneliness is potentially amenable to interventions (Masi, Chen, Hawkley, & Cacioppo, 2011). Therefore, it is possible that researchers are more eager to identify and publish results that identify potentially amenable risk factors, such as loneliness, rather than unchangeable risk factors, such as memory impairment.

Finally, it is important to acknowledge the fact that although the lagged effect of memory functioning on loneliness was statistically significant, it was rather small. Hence, the clinical significance of the findings is unclear. Strength of the findings, however, lies in the fact that we controlled for depressive symptoms and closeness of social ties. Both covariates are correlated with loneliness, as can be clearly seen by the high explained variance of loneliness in 2004 as well as by the lower stability of loneliness compared with memory functioning. Hence, the results indicate that even after "cleaning" loneliness from related but different constructs, it is still associated with a lagged effect of memory functioning.

In interpreting the results, it is important to acknowledge several limitations. The HRS constitutes a U.S. representative sample of older adults over the age of 50. Although the 2004, 2008, and 2012 psychosocial waves are U.S. nationally representative samples, by design, not all respondents who participated in the 2004 wave were recruited to the 2008 wave and subsequently to the 2012 wave. Moreover, both memory functioning and loneliness (to a lower degree) were associated with nonresponse. It is possible that this response pattern is responsible for the present findings. To partially account for this, we relied on all available data from respondents who completed the 2004 and at least one additional wave of data collection (2008, 2012). Results were consistent with the more conservative analysis which relied on respondents who completed all three waves.

Second, the loneliness measure used in the present study is an abbreviated version, which consists of only three items. The negative wording employed by this measure likely enhances the correlation of this measure with other measures of negative affectivity, such as the depressive symptoms measure. Nonetheless, this measure has shown adequate reliability and validity in past research (Hughes et al., 2004) and had only moderate associations with depressive symptoms in the present study. Finally, the present study was limited to assessing the reciprocal associations between

Table 3
Intercorrelations Among Variables at Baseline (n = 1,225)

Variable	1	2	3	4	5	6	7
1. Loneliness (1–3)							
2. Memory functioning (0–20)	–.15***						
3. Age	–.06*	–.27***					
4. Woman	.07*	.13***	–.01				
5. Education	–.14***	.32***	–.10***	–.10***			
6. Number of close social relationships (1–111)	–.26***	.02	.12***	–.02	–.03		
7. Number of medical conditions (0–7)	.13***	–.17***	.25***	.07*	–.17***	.00	
8. Depressive symptoms (0–7)	.43***	–.15***	–.10***	.10***	–.22***	–.12***	.24***

* $p < .05$. *** $p < .001$.

memory functioning and loneliness. It is possible that other cognitive domains have different reciprocal associations with loneliness. Given the low reliability (Cronbach's alpha between .2 and .3) of the mental status construct (e.g., serial seven, naming, orientation) available in the HRS (McArdle, 2011), we refrained from examining this association in the present study.

Nonetheless, the study provides important insights concerning the reciprocal relationships between cognitive functioning and loneliness. Our findings show that even after controlling for the effects of number of medical conditions, number of close social relationships, depressive symptoms, age, gender and education, reduced memory functioning still has an effect on loneliness 4 years later. This effect appears to be stable across the three waves of data collection, which spanned over a period of 8 years. In contrast, the effect of loneliness on memory functioning was nonsignificant. Because the study can only allude to temporal order in these reciprocal relations, but not to cause and effect further research is required in order to identify, whether indeed, memory functioning impacts one's loneliness or whether the two are spuriously related through a third variable, not even addressed in this study.

References

Abrahamson, K., Clark, D., Perkins, A., & Arling, G. (2012). Does cognitive impairment influence quality of life among nursing home residents? *The Gerontologist, 52,* 632–640. http://dx.doi.org/10.1093/geront/gnr137

Amariglio, R. E., Townsend, M. K., Grodstein, F., Sperling, R. A., & Rentz, D. M. (2011). Specific subjective memory complaints in older persons may indicate poor cognitive function. *Journal of the American Geriatrics Society, 59,* 1612–1617. http://dx.doi.org/10.1111/j.1532-5415.2011.03543.x

Andersson, L. (1998). Loneliness research and interventions: A review of the literature. *Aging & Mental Health, 2,* 264–274. http://dx.doi.org/10.1080/13607869856506

Balash, Y., Mordechovich, M., Shabtai, H., Giladi, N., Gurevich, T., & Korczyn, A. D. (2013). Subjective memory complaints in elders: Depression, anxiety, or cognitive decline? *Acta Neurologica Scandinavica, 127,* 344–350. http://dx.doi.org/10.1111/ane.12038

Ballard, J. (2010). Forgetfulness and older adults: Concept analysis. *Journal of Advanced Nursing, 66,* 1409–1419. http://dx.doi.org/10.1111/j.1365-2648.2010.05279.x

Beard, R. L., & Neary, T. M. (2013). Making sense of nonsense: Experiences of mild cognitive impairment. *Sociology of Health & Illness, 35,* 130–146. http://dx.doi.org/10.1111/j.1467-9566.2012.01481.x

Beeson, R. A. (2003). Loneliness and depression in spousal caregivers of those with Alzheimer's disease versus non-caregiving spouses. *Archives of Psychiatric Nursing, 17,* 135–143. http://dx.doi.org/10.1016/S0883-9417(03)00057-8

Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine, 51,* 843–857. http://dx.doi.org/10.1016/S0277-9536(00)00065-4

Buckner, R. L. (2004). Memory and executive function in aging and AD: Multiple factors that cause decline and reserve factors that compensate. *Neuron, 44,* 195–208. http://dx.doi.org/10.1016/j.neuron.2004.09.006

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences, 13,* 447–454. http://dx.doi.org/10.1016/j.tics.2009.06.005

Cacioppo, J. T., Hughes, M. E., Waite, L. J., Hawkley, L. C., & Thisted, R. A. (2006). Loneliness as a specific risk factor for depressive symptoms: Cross-sectional and longitudinal analyses. *Psychology and Aging, 21,* 140–151. http://dx.doi.org/10.1037/0882-7974.21.1.140

Conroy, R. M., Golden, J., Jeffares, I., O'Neill, D., & McGee, H. (2010). Boredom-proneness, loneliness, social engagement and depression and their association with cognitive function in older people: A population study. *Psychology Health and Medicine, 15,* 463–473. http://dx.doi.org/10.1080/13548506.2010.487103

Cornwell, E. Y., & Waite, L. J. (2009). Social disconnectedness, perceived isolation, and health among older adults. *Journal of Health and Social Behavior, 50,* 31–48. http://dx.doi.org/10.1177/002214650905000103

Finkel, S. E. (1995). *Causal analysis with panel data*. Thousand Oaks, CA: Sage. http://dx.doi.org/10.4135/9781412983594

Fiori, K. L., Smith, J., & Antonucci, T. C. (2007). Social network types among older adults: A multidimensional approach. *The Journals of Gerontology Series B, Psychological Sciences and Social Sciences, 62,* 322–330. http://dx.doi.org/10.1093/geronb/62.6.P322

Fisher, G. G., Hassan, H., Rodgers, W. L., & Weir, D. R. (2015). *Health and retirement study imputation of cognitive functioning measures: 1992–2012* (final release version). Ann Arbor, MI: Survey Research Center.

Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *Lancet Neurology, 3,* 343–353. http://dx.doi.org/10.1016/S1474-4422(04)00767-7

Gauthier, S., Reisberg, B., Zaudig, M., Petersen, R. C., Ritchie, K., Broich, K., . . . the International Psychogeriatric Association Expert Conference on mild cognitive impairment. (2006). Mild cognitive impairment. *Lancet, 367,* 1262–1270. http://dx.doi.org/10.1016/S0140-6736(06)68542-5

Geerlings, M. I., Jonker, C., Bouter, L. M., Adèr, H. J., & Schmand, B. (1999). Association between memory complaints and incident Alzheimer's disease in elderly people with normal baseline cognition. *The American Journal of Psychiatry, 156,* 531–537.

Gierveld, J. J. (1998). A review of loneliness: Concept and definitions, determinants and consequences. *Reviews in Clinical Gerontology, 8,* 73–80http://dx.doi.org/10.1017/S0959259898008090

Gow, A. J., Pattie, A., Whiteman, M. C., Whalley, L. J., & Deary, I. J. (2007). Social support and successful aging. *Journal of Individual Differences, 28,* 103–115. http://dx.doi.org/10.1027/1614-0001.28.3.103

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40,* 218–227. http://dx.doi.org/10.1007/s12160-010-9210-8

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspectives on Psychological Science, 10,* 227–237. http://dx.doi.org/10.1177/1745691614568352

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6,* 1–55. http://dx.doi.org/10.1080/10705519909540118

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys results from two population-based studies. *Research on Aging, 26,* 655–672. http://dx.doi.org/10.1177/0164027504268574

Jaremka, L. M., Fagundes, C. P., Peng, J., Bennett, J. M., Glaser, R., Malarkey, W. B., & Kiecolt-Glaser, J. K. (2013). Loneliness promotes inflammation during acute stress. *Psychological Science, 24,* 1089–1097. http://dx.doi.org/10.1177/0956797612464059

Kearns, A., Whitley, E., Tannahill, C., & Ellaway, A. (2015). Loneliness, social relations and health and well-being in deprived communities. *Psychology Health and Medicine, 20,* 332–344.

Lövdén, M., Ghisletta, P., & Lindenberger, U. (2005). Social participation attenuates decline in perceptual speed in old and very old age. *Psychol-*

ogy and Aging, 20, 423–434. http://dx.doi.org/10.1037/0882-7974.20.3.423

Luo, Y., Hawkley, L. C., Waite, L. J., & Cacioppo, J. T. (2012). Loneliness, health, and mortality in old age: A national longitudinal study. *Social Science & Medicine, 74,* 907–914. http://dx.doi.org/10.1016/j.socscimed.2011.11.028

Marsh, H. W., & Hau, K.-T. (1996). Assessing goodness of fit: Is parsimony always desirable? *Journal of Experimental Education, 64,* 364–390. http://dx.doi.org/10.1080/00220973.1996.10806604

Marshall, G. A., Rentz, D. M., Frey, M. T., Locascio, J. J., Johnson, K. A., & Sperling, R. A., & the Alzheimer's Disease Neuroimaging Initiative. (2011). Executive function and instrumental activities of daily living in mild cognitive impairment and Alzheimer's disease. *Alzheimer's & Dementia, 7,* 300–308. http://dx.doi.org/10.1016/j.jalz.2010.04.005

Masi, C. M., Chen, H.-Y., Hawkley, L. C., & Cacioppo, J. T. (2011). A meta-analysis of interventions to reduce loneliness. *Personality and Social psychology Review, 15,* 219–266. http://dx.doi.org/10.1177/1088868310377394

McArdle, J. J. (2011). Longitudinal dynamic analyses of cognition in the health and retirement study panel. *AStA Advances in Statistical Analysis, 95,* 453–480. http://dx.doi.org/10.1007/s10182-011-0168-z

Meredith, W. (1993). Measurement invariance, factor analysis and factorial invariance. *Psychometrika, 58,* 525–543. http://dx.doi.org/10.1007/BF02294825

Muthén, L. K., & Muthén, B. O. (1998–2012). *Mplus user's guide* (7th ed.). Los Angeles, CA: Authors.

Nummela, O., Seppänen, M., & Uutela, A. (2011). The effect of loneliness and change in loneliness on self-rated health (SRH): A longitudinal study among aging people. *Archives of Gerontology and Geriatrics, 53,* 163–167. http://dx.doi.org/10.1016/j.archger.2010.10.023

Ofstedal, M. B., Fisher, G. G., & Herzog, A. R. (2005). *Documentation of cognitive functioning measures in the Health and Retirement Study*. Ann Arbor, MI: University of Michigan. http://dx.doi.org/10.7826/ISR-UM.06.585031.001.05.0010.2005

O'Luanaigh, C., O'Connell, H., Chin, A.-V., Hamilton, F., Coen, R., Walsh, C., . . . Lawlor, B. A. (2012). Loneliness and cognition in older people: The Dublin Healthy Ageing Study. *Aging & Mental Health, 16,* 347–352. http://dx.doi.org/10.1080/13607863.2011.628977

Patterson, A. C., & Veenstra, G. (2010). Loneliness and risk of mortality: A longitudinal investigation in Alameda County, CA. *Social Science & Medicine, 71,* 181–186. http://dx.doi.org/10.1016/j.socscimed.2010.03.024

Perissinotto, C. M., Stijacic Cenzer, I., & Covinsky, K. E. (2012). Loneliness in older persons: A predictor of functional decline and death. *Archives of Internal Medicine, 172,* 1078–1083. http://dx.doi.org/10.1001/archinternmed.2012.1993

Prieto-Flores, M-E., Forjaz, M. J., Fernandez-Mayoralas, G., Rojo-Perez, F., & Martinez-Martin, P. (2011). Factors associated with loneliness of noninstitutionalized and institutionalized older adults. *Journal of Aging and Health, 23,* 177–194. http://dx.doi.org/10.1177/0898264310382658

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385–401. http://dx.doi.org/10.1177/014662167700100306

Rajan, K. B., Hebert, L. E., Scherr, P. A., de Leon, C. F. M., & Evans, D. A. (2013). Disability in basic and instrumental activities of daily living is associated with faster rate of decline in cognitive function of older adults. *The Journals of Gerontology*. Series A, Biological Sciences and Medical Sciences, *68,* 624–630.

Reijnders, J., van Heugten, C., & van Boxtel, M. (2013). Cognitive interventions in healthy older adults and people with mild cognitive impairment: A systematic review. *Ageing Research Reviews, 12,* 263–275. http://dx.doi.org/10.1016/j.arr.2012.07.003

Rowell, S. F., Green, J. S., Teachman, B. A., & Salthouse, T. A. (2015). Age does not matter: Memory complaints are related to negative affect throughout adulthood. *Aging & Mental Health*. Advance online publication.

Russell, D., Peplau, L. A., & Cutrona, C. E. (1980). The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *Journal of Personality and Social Psychology, 39,* 472–480. http://dx.doi.org/10.1037/0022-3514.39.3.472

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research, 99,* 323–338. http://dx.doi.org/10.3200/JOER.99.6.323-338

Shankar, A., Hamer, M., McMunn, A., & Steptoe, A. (2013). Social isolation and loneliness: Relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. *Psychosomatic Medicine, 75,* 161–170. http://dx.doi.org/10.1097/PSY.0b013e31827f09cd

Shankar, A., McMunn, A., Banks, J., & Steptoe, A. (2011). Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychology, 30,* 377–385. http://dx.doi.org/10.1037/a0022826

Shiovitz-Ezra, S., & Ayalon, L. (2010). Situational versus chronic loneliness as risk factors for all-cause mortality. *International Psychogeriatrics, 22,* 455–462. http://dx.doi.org/10.1017/S1041610209991426

Shiovitz-Ezra, S., & Ayalon, L. (2012). Use of direct versus indirect approaches to measure loneliness in later life. *Research on Aging, 34,* 572–591.

Steptoe, A., Shankar, A., Demakakos, P., & Wardle, J. (2013). Social isolation, loneliness, and all-cause mortality in older men and women. *Proceedings of the National Academy of Sciences of the United States of America, 110,* 5797–5801. http://dx.doi.org/10.1073/pnas.1219686110

Tijhuis, M. A., De Jong-Gierveld, J., Feskens, E. J., & Kromhout, D. (1999). Changes in and factors related to loneliness in older men. The Zutphen Elderly Study. *Age and Ageing, 28,* 491–495. http://dx.doi.org/10.1093/ageing/28.5.491

Tilvis, R. S., Kähönen-Väre, M. H., Jolkkonen, J., Valvanne, J., Pitkala, K. H., & Strandberg, T. E. (2004). Predictors of cognitive decline and mortality of aged people over a 10-year period. *The Journals of Gerontology Series A, Biological Sciences and Medical Sciences, 59,* 268–274. http://dx.doi.org/10.1093/gerona/59.3.M268

Turner, R. J., Frankel, B. G., & Levin, D. M. (1983). Social support: Conceptualization, measurement, and implications for mental health. *Research in Community and Mental Health, 3,* 67–111.

Wagner, M., & Brandt, M. (2015). Loneliness among informal caregivers aged 50+ in Europe. In A. Borsch-Supan, T. Kneip, H. Litwin, M. Myck, & G. Weber (Eds.), *Ageing in Europe: Supporting policies for an inclusive society* (pp. 179–188). Berlin, Germany: De Gruyter.

Wallace, R. B., & Herzog, A. R. (1995). Overview of the health measures in the Health and Retirement Study. *The Journal of Human Resources, 30,* S84–S107. http://dx.doi.org/10.2307/146279

Werner, P., Goldstein, D., & Buchbinder, E. (2010). Subjective experience of family stigma as reported by children of Alzheimer's disease patients. *Qualitative Health Research, 20,* 159–169. http://dx.doi.org/10.1177/1049732309358330

Wilson, R. S., Krueger, K. R., Arnold, S. E., Schneider, J. A., Kelly, J. F., Barnes, L. L., . . . Bennett, D. A. (2007). Loneliness and risk of Alzheimer disease. *Archives of General Psychiatry, 64,* 234–240. http://dx.doi.org/10.1001/archpsyc.64.2.234

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