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LONELINESS, CYNICAL HOSTILITY, AND COGNITIVE DECLINE IN AMERICANS ABOVE AGE 50

Sarah C. Griffin
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LONELINESS, CYNICAL HOSTILITY, AND COGNITIVE DECLINE IN AMERICANS

ABOVE AGE 50

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science

at Virginia Commonwealth University

by

Sarah Clay Griffin

B.A.Sc., McGill University, 2011

Director: Bruce Rybarczyk, Ph.D.

Professor of Psychology

Virginia Commonwealth University

Richmond, Virginia

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Abstract

LONELINESS, CYNICAL HOSTILITY, AND COGNITIVE DECLINE IN AMERICANS ABOVE AGE 50

By Sarah Clay Griffin, B.A.Sc.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University

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Major Director: Bruce Rybarczyk, Ph.D, Professor of Psychology

Background. Research identifies isolation (being alone) as a risk factor for cognitive decline—yet it is possible that subjective dimensions of isolation are more critical. Potential risk factors are loneliness (the distress stemming from feeling alone) and cynical hostility (an attitude of distrust and cynicism). The present study examined the relationship between these factors and cognitive functioning and decline.

Methods. Data came from the Health and Retirement Study, a nationally representative longitudinal study of US adults over 50. Loneliness was measured using the Hughes Loneliness Scale; cynical hostility was measured using items from the Cook-Medley Hostility Inventory. Cognitive functioning was indexed by the Telephone Interview for Cognitive Status. Regressions were conducted to examine loneliness and cynical hostility as predictors of cognitive function at baseline as well as cognitive decline over four and six-year periods. Models were adjusted for demographic characteristics, health behaviors, and isolation.

Results. Loneliness, $[f^2=.003, t(52)=-3.75; p<.001]$ and cynical hostility, $[f^2=.002, t(52)=-2.98, p=.004]$ predicted cognitive function at baseline. Loneliness and cynical hostility each predicted cognitive decline over four $[f^2=.001, t(52)=-2.29; p=.026 \; f^2=.003, t(52)=-3.98; p<.001$ respectively] but not six years $[t(52)= -.78; p=.439; t(52)= -1.29; p=.203 \text{ respectively}].$

Discussion. Loneliness and cynical hostility are correlates of lower cognitive function and risk factors for cognitive decline over four years. The absence of significant effects of loneliness and cynical hostility over six years could be attributed to low statistical power in these analyses. The effect sizes in this study are small, yet meaningful in the context of the personal and social costs associated with cognitive decline.

Loneliness, Cynical Hostility, and Cognitive Decline in Americans above Age 50

Introduction

As the American population ages, the burden of diseases affecting older adults grows

heavier. One such family of diseases is dementia, which is characterized by cognitive decline.

Dementia already affects millions of Americans and is expected to proliferate in the coming

years (Center for Disease Control and Prevention, 2013). This growing prevalence is

disconcerting in light of the lack of treatment for most cases of dementia. As such, pinpointing

risk factors for dementia could be vital in mitigating the potential harm of this condition,

especially if these risk factors could be causal and malleable.

Research identifies social isolation as a risk factor for dementia (Barnes, De Leon,

Wilson, Bienias, & Evans, 2004; Bassuk, Glass, & Berkman, 1999; Fratiglioni, Wang, Ericsson,

Maytan, & Winblad, 2000; Håkansson et al., 2009; Helmer et al., 1999; James, Wilson, Barnes,

& Bennett, 2011). Isolation here refers to objective aspects of isolation, such as living alone or

spending little time with others. However, it is possible that the subjective dimensions of

isolation (i.e., perceived separation from others) are of equal or greater importance. Two

subjective dimensions of isolation are loneliness and cynical hostility. Loneliness refers to a state

of emotional distress rooting in the feeling of being alone (Cacioppo et al., 2002). Cynical

hostility refers to an attitude of distrust and cynicism towards other people, whereby one assumes

that others have hostile intentions and/or are just looking out for themselves (Everson-Rose,

Clark, & Henderson, 2013). Loneliness and cynical hostility are similar in that both are

characterized by a subjective sense of being alone. 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. The following two sections contain a brief

literature review on loneliness and cynical hostility respectively as predictors of cognitive decline.

Loneliness

To establish loneliness as a risk factor for cognitive decline it is necessary to (i) establish that there is a relationship between loneliness and cognitive function (i.e., the two are correlates) and (ii) to establish that the loneliness precedes the drop in cognitive function (i.e., loneliness is a risk factor for cognitive decline; Kazdin, 2003).

Research shows that loneliness is negatively correlated with cognitive function in older adults (Conroy et al., 2010; O'Luanaigh et al., 2012). However, these studies are inherently limited in that they are cross-sectional, which makes it difficult to infer directionality: it remains unclear whether lower cognitive function exacerbates loneliness or whether loneliness contributes to lower cognitive function.

Two studies led by Gow (2007; 2013) target the possibility that individuals with lower cognitive ability tend to lead more isolated lives. Both of these studies took advantage of a nation-wide intelligence test given to 11 year olds in Scotland to better gauge cognitive function over the lifespan. In the first study, individuals born in 1921 who had taken the test were examined at age 79 in terms of satisfaction with life, social network, household composition, loneliness, and present cognitive ability (2007). After controlling for sex, education, social class, and age-11 cognitive ability, loneliness significantly predicted performance on cognitive tasks at age 79. In the second study, individuals born in 1936 were examined at age 70 in terms of global cognitive ability, specific cognitive abilities, social network and support, social class, and depression (2013). Loneliness was significantly associated with cognitive function and processing speed (but not memory) after controlling for cognitive ability at age 11, age, sex, and

social class. However, controlling for cognitive ability at age 11 substantially lowered the association between loneliness and cognitive function at age 70, indicating that cross-sectional research is likely exaggerating the strength of the relationship between loneliness and cognitive decline. These studies add to the cross-sectional research through demonstrating that part of the later association between loneliness and cognitive function may be due to lower cognitive function over the lifespan. However, neither these studies nor the aforementioned cross-sectional research can speak to cognitive decline specifically.

Three longitudinal studies have demonstrated that loneliness is a risk factor for a decrease in cognitive function. The first study by Tilvis and colleagues followed adults aged 75 to show that those who reported being lonely were three times as likely (Relative Risk=3.0, 95% CI = 1.4 - 6.8) to show cognitive decline when controlling for age as compared to those who did not report loneliness (2004). A subsequent study by Wilson et al. (2007) showed that loneliness was associated with faster cognitive decline and higher chance of developing Alzheimer's over a four-year period even when controlling for baseline cognitive function, age, sex, education, and depression. In the third study, Holwerda et al. looked at loneliness as compared to social isolation as a risk factor for incident dementia over a three-year span in a large (n=2173) sample of older adults in the Netherlands (2012). The study indicated that loneliness predicted later dementia diagnosis (Odds Ratio 1.64, 95% Confidence Interval 1.05 to 2.56) after controlling for other risk factors such as depression.

The aforementioned research suggests that loneliness is a risk factor for cognitive decline. However, further research using comprehensive measures of loneliness is necessary to replicate these findings in other populations of interest using validated measures. Neither the Tilvis et al. (2004) study nor the Holwerda et al. (2012) study use a validated, comprehensive

measure of loneliness, but rather use a single-item question. Furthermore, both items contained a variant of the word "lonely" (i.e., "Do you suffer from loneliness?", "Do you feel lonely or do you feel very lonely?"). It has been theorized that the stigma associated with loneliness will affect scores on indirect (questions that pertain to feeling alone, but do not say the word lonely outright) as opposed to direct (questions that use the word lonely) measures of loneliness, which is supported by work showing that while indirect and direct measures of loneliness are positively correlated, they do differ (Shiovitz-Ezra & Ayalon, 2012). Thus studies using validated measures of loneliness that use indirect questioning and are thus less likely to be skewed by stigma are necessary for improving understanding of the relation between loneliness and cognitive decline.

Furthermore, the samples assessed in these three studies differ from other populations of interest, notably the United States of America. The samples in the Tilvis et al. (2004) and the Holwerda et al. (2012), although population-based, were based on the population of Helsinki, Finland and Amsterdam, the Netherlands respectively. The sample in the Wilson et al. (2007) study was a convenience sample of residents of senior citizen facilities in the Chicago, Illinois area. Characteristics that may be associated with living in a senior citizen facility, such as socioeconomic status and race (the study sample was 91% Caucasian) may have influenced the association between cognitive decline and loneliness in said study. As such, it is necessary to replicate these findings in a sample that is representative of the United States population. The failure of past research to look at the relationship between loneliness and cognition in minority samples is particularly disconcerting given that dementia in black Americans has been named a silent epidemic (Alzheimer's Association, 2003). While this condition in black Americans has commonly been overlooked in medical settings, studies in recent years indicate that black Americans are approximately two times more likely to develop dementia than white Americans

(Alzheimer's Association, 2010). Hispanic Americans also appear to be at greater risk (Alzheimer's Association, 2010).

To conclude, although past research indicates that loneliness relates to cognitive decline, there are holes in our understanding of this relationship. Cross-sectional studies cannot speak to the causal timeline of this relation. Moreover, two out of the three studies that can speak to the timeline of the relationship did not adequately measure loneliness, and thus far there is no study looking at this relationship using a sample that is generalizable to the United States population.

Cynical hostility

Cynical hostility is an attitude of distrust and hostility towards other people (Everson-Rose, Clark, & Henderson, 2013). This attitude has been studied extensively as a risk factor for cardiovascular disease—a 2009 meta-analysis indicated that hostility is associated with increased risk of cardiovascular disease in the normal population and worse outcomes in patients who already have cardiovascular disease (Chida & Steptoe). More broadly, cynical hostility has been identified as a risk factor for all-cause mortality (Klabbers, Bosma, van den Akker, Kempen, & van Eijk, 2012).

Two studies have examined cynical hostility as a risk factor for cognitive decline. In the first study, Barnes et al. followed over 4,800 individuals over approximately nine years (2009). Data came from the Chicago Health and Aging Project, a population-based longitudinal study of older adults in three neighborhoods of Chicago, Illinois. Though cynical hostility was associated with lower cognitive function, it was not associated with cognitive decline. The negative association between cognitive function and cynical hostility was higher in older participants. In the second study, Mortensen, Barefoot, and Avlund (2012) follow a cohort from Glostrup (Copenhagen) for over thirty years. The sample size began at 673 participants and dwindled to

184 by the time of the final follow-up. Consistent with Barnes et al. (2009), the study found that higher cynical hostility was associated with lower cognitive function, but not cognitive decline.

One study has looked into cynical distrust as a risk factor for dementia. Neuvonen and colleagues examined cynical distrust, as operationalized by eight items pertaining to distrust of others specifically from the larger Cook-Medley Hostility Scale, as a predictor of incident dementia over 8 to 10 years in a sample of 1,449 older adults living in Finland (2014). The authors found that, after controlling for cardiovascular risk factors, those with the highest level of cynical distrust were 2.54 more likely to be diagnosed with dementia than those with low cynical distrust. The association remained significant after controlling for socioeconomic variables, lifestyle, health status, and APOE e4 carrier status. This association remained even when accounting for depressive symptoms in those participants (N=555) for whom depression data was available, but the confidence interval included the null value.

Research thus far indicates that cynical hostility is a risk factor for dementia but not cognitive decline. This is inherently contradictory as dementia is a condition characterized by cognitive decline. There are a number of potential explanations for this discrepancy. First, samples differed across studies. Second, each study used a different subset of items from the Cook-Medley Hostility Inventory. Third, the sample size of the three studies differed. It is possible that the study by Mortensen, Barefoot, and Avlund (2012) did not find an effect of cynical hostility on cognitive decline due to statistical power; if the effect size of cynical hostility is small then the sample size used in the study (N=184 at the final time-point) would likely not be sufficient to detect an effect. However, the sample size in the study led by Barnes (2009) is large enough to detect a small effect. Fourth, the studies controlled for different factors, which could affect results. The study led by Neuvonen (2014) only found an effect of cynical hostility

on dementia incidence in a model that controlled for cardiovascular risk factors, which Barnes et al. (2009) did not control for. None of the three studies used a sample generalizable to the US population.

Mechanisms/model

Although not demonstrated consistently in the literature in the case of cynical hostility (Barnes et al., 2009; Mortensen, Barefoot, & Avlund), there is research identifying loneliness and cynical hostility as risk factors for cognitive decline (Tilvis et al., 2004; Wilson et al., 2007; Holwerda et al., 2012; Neuvonen et al., 2014). As highlighted earlier more research is necessary to solidify these findings. However, methodological weaknesses notwithstanding, in the longitudinal research that demonstrates an effect the loneliness and cynical hostility precede the drop in cognitive function. This does not negate the possibility that lower cognitive function increases loneliness and cynical hostility. Although there is not much work on this in terms of cynical hostility, the studies by Gow and colleagues (2007; 2013) indicate that higher cognitive function might protect against loneliness. However, it does run counter to the possibility that a potential relationship between subjective dimensions of isolation and cognitive function is purely because those with lower cognitive resources are less equipped to connect with others.

There are two possible explanations for why loneliness and cynical hostility might precede and predict subsequent cognitive decline. The first, posited by Holwerda and colleagues with regards to loneliness specifically, is that these states are indicators of prodromal dementia (2012). That is to say, loneliness and cynical hostility may be early indicators of cognitive decline that appear before the cognitive decline becomes overt or begins to affect functioning. The second is that loneliness and cynical hostility are agents in cognitive decline. In this theory, the states of loneliness and cynical hostility operate through some mechanism(s) to diminish

cognitive capacity.

There is some experimental research on social rejection to support the second possibility. Baumeister, Twegne and Nuss (2002) conducted a set of studies where they manipulated feelings of social rejection then assessed subsequent performance on cognitive tasks (for a review and commentary on these studies see Baumeister & DeWall, 2005). Social rejection was manipulated by giving participants a personality inventory then pretending to use the results from this inventory to generate predictions about the individual's future. Participants at random received the feedback that they were the type of person to have fulfilling relationships throughout his or her life (Future Belonging condition), the type of person to end up alone later in life (Future Alone condition), or the type of person to encounter accidents later in life (Misfortune control condition; for more information on the experimental paradigm see Twenge, Baumeister, Tice, & Stucke, 2001). The Future Alone group scored significantly lower than both other groups (Future Belonging and Misfortune control) when then tested on intelligence using the General Mental Abilities Test. This pattern remained for a second experiment where Baumeister, Twenge, and Nuss (2002) looked at the effects of social rejection on a memory recall task using a modified version of the Reading Comprehension section of the Graduate Record Examination (GRE); again the Future Alone group scored lower than both the Future Belonging and the Misfortune control groups, especially on more difficult questions. In a third experiment, Baumeister, Twenge, and Nuss looked at the effects of social rejection on two separate tasks: logic (problems from the GRE Analytical section) and rote memorization (memorization of a list of nonsense words). In this experiment, the Future Alone group performed significantly worse than the Future Belonging and the Misfortune control groups on the logic task but not on the rote memorization, suggesting that social rejection harms higher-level cognitive processes

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specifically.

These studies show that short-term social rejection can impair cognitive performance. Social rejection is different from both loneliness and cynical hostility. However, these studies show that social manipulations can have short-term effects on cognitive performance, or in other words that social factors can influence cognitive performance. As such, it is plausible that loneliness and cynical hostility have effects on cognitive performance over the life span.

However, the mechanisms by which this may occur remain unclear. Cacioppo and Hawkley present a model of the effects of loneliness on cognition in their 2009 paper. This model (see Figure 1) posits that loneliness increases vigilance towards social threats (Shintel, Nusbaum, & Cacioppo, 2006). This hypervigilance leads to biases in attention and memory, which lead a lonely individual to perceive greater social threat (Cacioppo & Hawkley, 2005), enter social encounters with negative expectations, and remember social encounters more negatively. These cognitions in turn affect how the individual interacts with others, leading to more negative encounters with others (Murray, Bellavia, Rose & Griffin, 2003; Romero-Canyas & Downey, 2005) that in turn strengthen the individual's conception that he or she has little social value. This loop activates the hypothalalmic pituitary adrenal (HPA) axis via neurological mechanisms (Cole, 2008; Adam, Hawkley, Kudielka, & Cacioppo, 2006; Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004; Cacioppo et al., 2000) and lowers sleep quality (Cacioppo, Hawkley, Burleson, et al., 2002; Cacioppo, Hawkley, Crawford, et al., 2002; Jacobs, Cohen, Hammerman-Rozenberg, & Stessman, 2006).

This model can easily be extended to cynical hostility. Distrust in others could lead to hypervigilance during social encounters, which lead to biases in attention and memory. These biases, in addition to the belief that other people are not to be trusted, could shape behavior to

then elicit hostile, selfish reactions from others, thus confirming the individual's conception that other people cannot be trusted. This loop could thus activate the hypothalamic pituitary adrenal (HPA) axis (Ranjit et al., 2009; Pope & Smith, 1991) and lower sleep quality (Taylor, Fireman, & Levin, 2013; Brissette & Cohen, 2002).

Figure 1.

Cacioppo & Hawkley (2009) Model of the effects of loneliness on cognition, modified to include cynical hostility.

Social Environment

Repulsion and isolation

Attraction and connection

More negative displays, social interactions, and affect

Loneliness / cynical hostility

Implicit hypervigilance for social threats

These dispositions, in turn, activate neurobiological mechanisms that increase HPA activation and diminish sleep quality

Attentional, confirmatory, and memory biases

Behavioral confirmation processes

Objectives

The present study aimed to investigate loneliness and cynical hostility as predictors of cognitive decline using data from the Health and Retirement Study (HRS), a nationally representative panel study of older Americans. The HRS administers surveys to look at factors such as physical health, mental health, insurance status, and health care expenditures as well as administers tasks to measure physical and cognitive function (to learn more on the HRS see Karp, 2007). The broad aims of the present study, which were to examine the relationships between loneliness and cynical hostility respectively and cognitive decline, are outlined here.

Aim 1. To investigate the relationship between loneliness, hostility, and cognitive function at baseline.

Hypothesis 1: Higher levels of loneliness and cynical hostility will be associated with lower levels of cognitive function at baseline.

Aim 2.1. To examine the relationship between loneliness at baseline and change in cognitive function over time.

Hypothesis 2.1: Higher levels of loneliness at baseline will predict higher rates of cognitive decline over time.

Aim 2.2. To examine the relationship between cynical hostility at baseline and change in cognitive function over time.

Hypothesis 2.2: Higher levels of cynical hostility at baseline will predict higher rates of cognitive decline over time.

Methods

This study analyzed data from the Health and Retirement Study, an ongoing cross-sequential study of American adults as they enter retirement age and their spouses. The full

sample size is around 20,000 individuals . Participants are eligible to be selected to take part in this study after their 50th birthday, and if selected are followed for the remainder of their lives. The study recruits new subjects as the population ages to examine multiple cohorts. Participants are surveyed every two years to assess income, employment, assets, pension plans, health insurance, physical health, mental health, physical functioning, cognitive functioning, and health care expenditures. Further detail on the participants, procedures, and measures of the Health and Retirement Study is included below.

This study used data from 2006, 2008, 2010, and 2012. Although the Health and Retirement study began in 1992, as explained under ***Procedures***, the Leave-Behind-Questionnaire was first piloted in 2004. Moreover, the administration of the Leave-Behind-Questionnaire was only fully implemented in 2006. The measures of cynical hostility and loneliness are both contained in the Leave-Behind-Questionnaire, therefore only data from 2006 onward was analyzed. The data collected in 2014 had not yet been compiled in the dataset that was analyzed in the present study.

More information on the administration of the Leave-Behind-Questionnaire is provided in the ***Procedures*** section. To briefly summarize here, only half the sample received the Leave-Behind-Questionnaire in 2006; the second half received the questionnaire in 2008. The data on loneliness and cynical hostility were collapsed from 2006 and 2008 to form a baseline for all participants and from 2010 to 2010 to form a four-year follow-up period for all participants. Only the participants who received the psychosocial questionnaire in 2006 were included in the analyses for the 6-year follow-up (i.e. from 2006 to 2012).

Participants

The population of interest in the Health and Retirement Study is community dwelling adults entering retirement age in the United States of America. The Health and Retirement Study follows a Longitudinal Cohort Sample Design, meaning the study follows multiple cohorts over time (Sonnega et al., 2014). There are currently six cohorts, which entered the study at different points. Since 1998, the Health and Retirement Study has used a steady state design whereby it adds a new cohort every six years (1998, 2004, 2010) as it enters retirement age (50+).

The initial response rates for the sample range from around 70% to 80%. This estimate is generated using the number of respondents versus the number deemed eligible using the screener. The follow-up response rates are higher and range from about 85% to 93%; this estimate does not include individuals who did not respond at baseline, who requested to be removed from the sample, or who died (Sonnega et al., 2014). For more detail on response rate for each cohort see Table 1.

Table 1.

Response rates by cohort 2004-2010, Mid Boomers not included (Sonnega et al., 2014)

Cohort		2004	2006	2008	2010
AHEAD	Eligible	3766	2979	2362	1708
	Interviewed	3365	2700	2142	1526
	%	89.4	90.6	90.7	89.3
CODA	Eligible	1973	1770	1608	1410
	Interviewed	1777	1618	1454	1255
	%	90.1	91.4	90.4	89
HRS	Eligible	10835	10026	9587	8919
	Interviewed	9362	8879	8493	7904

	%	86.4	88.6	88.6	88.6
War Babies	Eligible	2612	2539	2488	2445
	Interviewed	2295	2237	2165	2138
	%	87.9	88.1	87	87.4
Early Boomers	Eligible	4420	3461	3433	3405
	Interviewed	3330	3035	2963	2926
	%	75.3	87.7	86.3	85.9

The response rate for the Leave-Behind-Questionnaire is lower as it requires that participants complete and mail back the survey. According to the HRS Tracker File (http://hrsonline.isr.umich.edu/modules/meta/tracker/codebook/trk2014tr_ri.htm), in 2004 3,005 individuals who were selected to receive the Leave-Behind returned the questionnaire whereas 836 eligible individuals who were selected to receive the Leave-Behind and administered the Leave-Behind did not, yielding a response rate of approximately 78%. Response rates were approximately 90% in 2006 and 87.3% in 2008.

Sampling procedure

The sample for the Health and Retirement Study was selected using a multi-stage area probability sample design. In the first stage Metropolitan Statistical Areas and non-Metropolitan Statistical Areas were selected. In the second stage, area segments within these primary stage units were selected. In the third stage, housing units (taken from a comprehensive listing of all housing units within the second stage sampling area segment) were selected. In the fourth stage, an age-eligible person was selected from within the housing unit. The sample created using this multi-stage area probability sample was supplemented with oversamples of participants who are Black, Hispanic, or live in Florida.

A more comprehensive account of this sampling procedure can be found in Heeringa and Connor's report on the Health and Retirement Study survey sample design (1995).

Eligibility

The above procedure generates sampled housing units. To assess eligibility, a screening interview was then provided to each housing unit; adults in the household gave their age and coupleness status. A primary respondent was randomly selected from all household members who are eligible for the Health and Retirement Study (i.e. 50+). That individual's partner was also included in the sample.

Only community dwelling adults are recruited into the Health and Retirement Study. However, subjects are followed for the remainder of their lives, to include if they enter retirement homes. Only respondents (i.e. the individual selected to take part in the study, not his or her spouse) who were community-dwelling in 2006 were included in this project.

Weighting

To make the sample representative of the population of interest (i.e., community dwelling older adults in the United States), the Health and Retirement Study uses sample weights to align the data with that of the US population as determined by the Current Population Survey (until 2004) and the American Community Survey (2004 to present; Sonnega et al., 2014). Community dwelling and nursing home respondents are weighted separately to create a sample for each. The 2006 weighting for community-dwelling respondents was used for all analyses.

Procedures

Interviews are conducted every two years either by phone or face-to-face. The majority of baseline interviews have been conducted face-to-face (Sonnega et al., 2014). Initially, most follow-ups were conducted primarily by telephone, but in 2004 the Health and Retirement Study

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increased the number of face-to-face follow-ups. In 2006, the Health and Retirement study began

a mixed-mode follow-up whereby 50% of the sample was randomly assigned to be interviewed

face-to-face while the remaining 50% was assigned to be interviewed by phone. This assignment

rotates every two years so that both halves of the sample are interviewed face-to-face every four

years. The face-to-face follow-ups allowed for the implementation of physical measures (e.g,

grip strength), biological measures (e.g., saliva sample), and the Leave-Behind-Questionnaire.

The Leave-Behind-Questionnaire, also known as the Participant Lifestyle Questionnaire, is a

survey that is left behind with the participants after the face-to-face interview to be completed

and mailed back (Smith et al., 2013).

When an individual is unable or unwilling to answer interview questions the Health and

Retirement Study attempts to find a proxy respondent, typically a spouse or other family member

(Sonnega et al., 2014). The rate of proxies each wave is approximately 9% but rises to 18% for

individuals over the age of 80. For more on the importance of proxy interviews see Weir, Faul, &

Langa, 2011.

Measures

Each measure is described in detail in the below sections (see summary in Table 2).

Table 2.

Summary of measures

	Construct			Source
Predictors	Loneliness			Leave-behind questionnaire
	Cynical hostility			Leave-behind questionnaire
Criterion	Cognitive function	Recall	Immediate	Core interview
			Delayed	Core interview
		Mental status	Serial 7's	Core interview
			Backwards count	Core interview
			Date naming	Core interview

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		Object naming	Core interview
		President/vice president naming	Core interview
		Vocabulary	Core interview
Adjustments	Demographics	Age	Core interview
		Years of education	Core interview
		Race	Core interview
		Gender	Core interview
		Net worth	Core interview
	Health behaviors	History of smoking	Core interview
		Current smoking	Core interview
		Alcoholic beverages per week	Core interview
		Body mass index (BMI)	Core interview
	Objective isolation	Living arrangement	Core interview
		Contact with social network	Leave-behind questionnaire
Sensitivity analyses	Depression		Core interview

Loneliness

Loneliness was measured using the Hughes Scale, a scale shortened from the UCLA Loneliness items to consist of the following three items: (1) How often do you feel that you lack companionship? (2) How often do you feel left out? (3) How often do you feel isolated from others? (Smith, Fisher, Ryan, Clarke, House, & Weir, 2013). The Hughes scale demonstrates satisfactory reliability and concurrent and discriminant validity (Hughes, Waite, Hawkley, & Cacioppo, 2004).

Cynical hostility

Cynical hostility was quantified using five items from the Cook-Medley Hostility Inventory: (1) Most people dislike putting themselves out to help other people. (2) Most people will use somewhat unfair means to gain profit or an advantage rather than lose it. (3) No one cares much what happens to you. (4) I think most people would lie in order to get ahead. (5) I commonly wonder what hidden reasons another person may have for doing something nice for me. Participants rate how much they agree or disagree with each statement: strongly disagree

(corresponding to 1), somewhat disagree (2), slightly disagree (3), slightly agree (4), somewhat

agree (5), strongly agree (6). These values are then averaged to generate an index for cynical

hostility (Smith, Fisher, Ryan, Clarke, House, & Weir, 2013).

Cognitive function

Cognition was assessed with a battery of measures, including measures assessing recall

and mental status. Recall consisted of immediate recall and delayed recall. Mental status

consisted of the Serial 7's Test, backwards count, date naming, object naming, and president/vice

president naming. More on these measures can be found in the report "Documentation of

Cognitive Functioning Measures in the Health and Retirement Study" (Ofstedal, Fisher, &

Herzog, 2005). Each of these measures is described in detail below.

Immediate recall: Participants repeated as many nouns as possible from a list of 10 nouns. There

were four possible lists that did not overlap in word content and were randomly assigned to each

participant. The list the participant received varied with each wave and participants in the same

household (e.g., married couples) received different lists. The score comprised of the number of

words accurately recalled from the list.

Delayed word recall: Participants were asked to recall the nouns from the immediate recall task

once more after about five minutes of survey questions. The score comprised of the number of

words accurately recalled from the list.

Serial 7's Test: Participants were asked to start with 100 and subtract 7 five times. The score was

comprised of the number of correct subtractions (regardless of whether the starting point for the

subtraction was correct—this way one incorrect subtraction did not affect subsequent scores).

Backwards count: Participants were asked to count backwards as quickly as possible starting

with the number 20. A correct countdown on the first attempt received a score of 2, a correct

countdown on the second attempt received a score of 1, and an incorrect countdown on both attempts received a 0.

Date naming: Participants over the age of 65 reported the date, to include the month, day, year, and day of the week. Each of these items was scored a 0 (incorrect) or a 1 (correct).

Object naming: Participants over the age of 65 or new to the study answered the following questions: What do you usually use to cut paper? What do you call the kind of prickly plant that grows in the desert? Each of these items was scored a 0 (incorrect) or a 1 (correct).

President/vice president naming: Participants over the age of 65 or new to the study were asked to name the current President and Vice President of the United States. Each of these items was scored a 0 (incorrect) or a 1 (correct).

Demographics

Education: Education was quantified by asking participants the number of years of education they have obtained.

Race: Race categories included white/Caucasian, black/African American, and other.

Gender: Gender categories included male and female.

Net worth: The net worth, or total wealth, is the combined value of all wealth components (for example, salary, house, vehicle) minus all debt (Chien et al., 2015). This value was used to gauge socioeconomic status.

Health Behaviors:

Smoking: Participants were asked whether they had (1) ever smoked cigarettes or if they (2) smoked now (Chien et al., 2015).

Alcoholic beverages per week: Participants were asked how many days per week they consumed alcohol as well as how many drinks they consumed per day when drinking (Chien et al., 2015). The alcoholic beverages per week variable was calculated by multiplying the two together.

Body mass index (BMI): BMI was calculated by dividing weight (converted into kilograms) by the square of height (converted into meters; Chien et al., 2015).

Isolation:

Living arrangement: The number of persons in the household is assessed for each respondent. For the purposes of this study this variable was categorical—either the participant lived alone (i.e. 0 other residents in the household) or with others (i.e. 1 or more other residents in the household).

Contact with social network: Participants rated how often they (1) Meet up (include both arranged and chance meetings), (2) Speak on the phone, (3) 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 (Smith, Fisher, Ryan, Clarke, House, & Weir, 2013).

Depression

Depression was quantified using a modified version of the Center for Epidemiologic Studies Depression Scale (CES-D). Participants responded yes/no to whether they had experienced the following items: (1) I felt depressed (2) I felt that everything I did was an effort (3) My sleep was restless (4) I was happy (5) I felt lonely (6) I enjoyed life (7) I felt sad (8) I could not get going. The total score was calculated by subtracting items 4 and 6 from the sum of the remaining items (Chien et al., 2015). A score of 4 or above was considered the cut-off for showing significant depressive symptoms (Turvey, Wallace, Herzog, 1999; Zivin et al., 2010)

Analyses

Analyses were conducted using Statistical Package for the Social Sciences (SPSS; Version 23). The dataset was weighted to match the population of community-dwelling adults over the age of 50 in 2006. Because the sample was split so that half the sample received the Leave-Behind-Questionnaire (containing the psychosocial variables of loneliness and cynical hostility) in 2006 and half the sample received the Leave-Behind-Questionnaire in 2008, the data for the two halves of the sample were collapsed into a single baseline time point. Similarly, data were collapsed to create a 4-year follow-up time point for the two groups. Cognitive decline was quantified by subtracting cognitive function at baseline from cognitive function at follow-up.

Variables were assessed for skewness, kurtosis, and multicollinearity (cut-off .7). Net worth and number of alcoholic beverages per week were transformed using a reciprocal transformation as both were highly skewed and kurtotic.

To weight the sample to match the United States Population, the Complex Samples option in SPSS was used. The 2006 weight variable was used for all analyses (see Chien et al., 2015). To take into account the fact that the HRS sample is clustered and stratified (rather than a simple random sample), the clustering and stratum variables were used (see Chien et al., 2015 for details on the coding of the variables; see Leacock, 2006 for information on the weighting of the HRS RAND data). The General Linear Model option (see http://www-01.ibm.com/support/docview.wss?uid=swg21478454 for details) was used to conduct the regressions while taking into account the complex sample.

Regression analyses were conducted to look at baseline loneliness and cynical hostility as predictors of baseline cognitive function alone and while adjusting for demographics (age, years of education, gender, net worth), health behaviors (smoking history, current smoking, number of

alcoholic beverages consumed per week, BMI) and isolation (living alone, integration). Regression analyses were also conducted to look at baseline loneliness as a predictor of change in cognitive function alone and while adjusting for demographics, health behaviors, and isolation over a four-year span and six-year span. Finally, regression analyses were conducted to look at baseline cynical hostility as a predictor of change in cognitive function alone and while controlling for baseline cognitive function, demographics, health behaviors, and isolation over a four-year span and a six-year span. Correlations were run to look at the relationships between loneliness, cynical hostility, and contact with social network at baseline.

To look at the potential effect of depression on the relationship between these psychosocial variables and cognitive function, sensitivity analyses were conducted, whereby subjects who met a cut-off score of four on the modified CES-D (Zivin et al., 2010) at baseline were excluded from the sample.

The odds ration and population attributable risk of loneliness and cynical hostility on severe cognitive impairment at baseline was assessed. Exposure was defined as high loneliness (a score of 2 or above on the Hughes Loneliness Scale) and high cynical hostility (a score of 4 or above on the five selected items of the Cook-Medley Hostility Scale). Severe cognitive impairment was defined as a score of 8 or lower on the cognitive function measure as recommended by Herzog & Wallace (1997).

Results

Participants

Table 3 contains a description of the study sample.

Table 3.

Description of sample with and without weighting.

	Weighted		Unweighted	
	% (N)	Mean (SD)	% (N)	Mean (SD)
Age (baseline)		66.29 (9.78)		68.19 (10.53)
Gender				
Male	45.3 (31,603,887)		40.6[1] (6,698)	
Female	54.7 (38,175,980)		59.4[1] (9,795)	
Race				
White/Caucasian	85.8 (59,893,858)		81[1] (13,358)	
Black/African American	9.2 (6,435,251)		13.9[1] (2,291)	
Other	4.9 (3,442,891)		5.1[1] (843)	
Net worth (baseline)		543,489.67 (1,180,921.51)		509,789.82 (1,178,020.08)
Years of education		12.85 (3.10)		12.46 (3.26)

[1]This percentage is out of the total excluding missing cases.

Loneliness and cynical hostility as a predictor of cognitive function at baseline

First, a multiple linear regression (N=7305) was conducted to examine loneliness and cynical hostility as predictors of cognitive function at baseline. This crude model was significant [$F_{(2, 51)}$ = 99.458, p<.001] and accounted for 4.8% of the variation in cognitive function. Both loneliness [$t(52)$ = -6.570, p<.001] and cynical hostility [$t(52)$=-12.557, p<.001] were associated with lower cognitive function.

A multiple linear regression (N=5379) was conducted to examine loneliness and cynical hostility as predictors of cognitive function at baseline while adjusting for demographics (age, years of education, race, gender, net worth), health behaviors (current smoking, smoking history, alcoholic beverages per week, body mass index) and objective measures of isolation (living alone and contact with social network). See Table 4 for a summary of results. The overall model was significant [F (13, 40) = 67.04, p<.001] and accounted for 28.4% of the variation in cognitive function. Both loneliness, [f^2=.003 ,t(52)=-3.75; p<.001] and cynical hostility, [f^2=.002, t(52)=-2.98, p=.004] were significant predictors of cognitive function.

Table 4.

Loneliness and cynical hostility as predictors of cognitive function at baseline controlling for demographics, health behaviors, and objective isolation, F(13,40)=67.039, p<.001, R^2=.284.

	B	Beta	t (df)	Df	P
(Intercept)	29.735		24.77 (52)	52	.000
Loneliness	-.428	-.047	-3.75 (52)	52	.000
Cynical Hostility	-.179	-.042	-2.98 (52)	52	.004
Age	-.168	-.236	-14.82 (52)	52	.000
Education	.557	.353	20.59 (52)	52	.000
Race	-1.607	-.138	-8.84	52	.000
Gender	.874	.094	6.12	52	.000
Net worth	-5396667.472	-.055	-3.6	52	.001
Smoking, history	.130	.014	1.06	52	.296
Smoking, current	-.280	-.018	-1.16	52	.250
Alcoholic beverages per week	-.419	-.034	-2.44	52	.018
BMI	.021	.024	1.44	52	.156
Living alone	-.075	-.007	-.42	52	.678
Integration	.036	.053	4.09	52	.000

Loneliness as a predictor of cognitive decline

Baseline loneliness was examined as a predictor of cognitive decline over a four-year span for the entire sample and over a six-year span for approximately half of the sample.

A multiple linear regression (N=6050) was conducted to examine loneliness as a predictor of cognitive decline over four years. This crude model was not significant [F (1, 52)=2.703, p=.106]. A multiple linear regression (N=4522) was conducted to examine loneliness as a predictor of cognitive decline over four years while adjusting for demographics (age, years of education, race, gender, net worth), health behaviors factors at baseline (current smoking, smoking history, alcoholic beverages per week, body mass index) and objective measures of isolation (living alone and contact with social network) at baseline. The overall model was significant [F (13, 40) = 61.64, p<.001] and accounted for 16.9% of the variation in cognitive decline. Loneliness predicted cognitive decline, [f^2=.001, t(52)=-2.29; p=.026]. Table 5 contains a summary of results.

Table 5.

Loneliness as a predictor of cognitive decline over four years controlling for demographics, health behaviors, and objective isolation, F(13,40)= 61.637, p<.001, R^2=.169.

	B	Beta	t (df)	Df	P
(Intercept)	15.886		12.274	52	.000
Loneliness	-.288	-.038	-2.286	52	.026
Baseline cognitive function	-.381	-.432	-23.329	52	.000
Age	-.150	-.240	-14.935	52	.000
Education	.249	.189	12.525	52	.000
Race	-.483	-.050	-2.564	52	.013
Gender	.345	.046	2.721	52	.009
Net worth	-4134714.451	-.052	-2.616	52	.012
Smoking, history	.088	.012	.592	52	.557
Smoking, current	-.333	-.026	-1.415	52	.163
Alcoholic	-.413	-.042	-3.016	52	.004

beverages per week					
BMI	.020	.028	1.661	52	.103
Living alone	.092	.011	.811	52	.421
Integration	.015	.027	1.933	52	.059

A multiple linear regression (N=5283) was conducted to examine loneliness as a predictor of cognitive decline over six years. This crude model was not significant [F (1, 52)=.052, p=.820]. A multiple linear regression (N=2,228) was conducted to examine loneliness in 2006 as a predictor of cognitive decline from 2006 to 2012 while adjusting for demographics (age, years of education, race, gender, net worth), health behaviors in 2006 (current smoking, smoking history, alcoholic beverages per week, body mass index) and objective measures of isolation (living alone and contact with social network) in 2006. The overall model (see Table 6) was significant [F (13, 40) =18.25, p<.001] and accounted for 16.8% of the variation in cognitive decline. Loneliness did not predict cognitive decline, [t(52)= -.78; p=.439].

Table 6.

Loneliness as a predictor of cognitive decline over six years controlling for demographics, health behaviors, and objective isolation, F(13,40)= 18.248, p<.001, R^2=.168.

	B	Beta	t	Df	P
(Intercept)	17.953		8.466	52	.000
Loneliness	-.152	-.017	-.780	52	.439
Baseline cognitive function	-.415	-.407	-15.211	52	.000
Age	-.192	-.276	-10.412	52	.000
Education	.259	.178	8.334	52	.000
Race	-.200	-.019	-.886	52	.380
Gender	.511	.059	3.392	52	.001
Net worth	-5169389.362	-.058	-3.037	52	.004
Smoking, history	.193	.023	1.287	52	.204
Smoking,	-.930	-.058	-2.729	52	.009

current					
Alcoholic beverages per week	-.288	-.026	-1.224	52	.226
BMI	.009	.011	.540	52	.592
Living alone	.023	.002	.098	52	.922
Integration	.038	.060	2.518	52	.015

Cynical hostility as a predictor of cognitive decline

Baseline cynical hostility was examined as a predictor of cognitive decline over a four-year span for the entire sample and over a six-year span for approximately half of the sample.

A multiple linear regression (N=6060) was conducted to examine loneliness as a predictor of cognitive decline over four years. This crude model was significant [F (1, 52)=5.871, p<.02] and accounted for .1% of the variation in cognitive decline. Cynical hostility predicted cognitive decline [t(520=-2.423, p<.02].

A multiple linear regression was conducted to examine cynical hostility as a predictor of cognitive decline over four years while adjusting for demographics (age, years of education, race, gender, net worth), health behaviors at baseline (current smoking, smoking history, alcoholic beverages per week, body mass index) and objective measures of isolation (living alone and contact with social network) at baseline. Table 7 contains a summary of this model. The overall model (N=4549) was significant [F (13, 40) = 64.52, p<.001] and accounted for 16.9% of the variation in cognitive decline. Cynical hostility predicted cognitive decline, [f^2=.003, t(52)=-3.98; p<.001]. 00

Table 7.

Cynical hostility as a predictor of cognitive decline over four years controlling for demographics, health behaviors, and objective isolation, F(13,40)= 64.517, p<.001, R^2=.169.

	B	Beta	t (df)	Df	P
(Intercept)	16.336		12.633	52	.000
Cynical hostility	-.194	-.055	-3.980	52	.000
Baseline cognitive function	-.381	-.432	-23.504	52	.000
Age	-.152	-.243	-15.256	52	.000
Education	.242	.184	12.325	52	.000
Race	-.460	-.048	-2.506	52	.015
Gender	.247	.033	1.956	52	.056
Net worth	-3848654.677	-.048	-2.479	52	.016
Smoking, history	.075	.010	.507	52	.614
Smoking, current	-.370	-.028	-1.521	52	.134
Alcoholic beverages per week	-.424	-.043	-3.157	52	.003
BMI	.020	.028	1.729	52	.090
Living alone	.128	.015	1.097	52	.278
Integration	.013	.023	1.607	52	.114

A multiple linear regression (N=5288) was conducted to examine cynical hostility in 2006 as a predictor of cognitive decline from 2006 to 2012. This crude model was not significant [F (1,52) = .395, p=.532]. A multiple linear regression was conducted to examine cynical hostility in 2006 as a predictor of cognitive decline over six years (2006 to 2012) while adjusting for demographics (age, years of education, race, gender, net worth), health behaviors in 2006 (current smoking, smoking history, alcoholic beverages per week, body mass index) and objective measures of isolation (living alone and contact with social network) in 2006. The overall model (N=2,236) was significant [F (13, 40) =17.79, p<.001] and accounted for 16.6% of the variation in cognitive decline. Cynical hostility did not predict cognitive decline, [t(52)= -1.29; p=.203]. See Table 8 for a summary of these results.

Table 8.

Cynical hostility in 2006 as a predictor of cognitive decline over six years controlling for demographics, health behaviors, and objective isolation, $F(13,40)= 17.786, p<.001, R^2=.166$.

	B	Beta	t	Df	p
(Intercept)	17.985		8.782	52	.000
Cynical hostility	-.093	-.023	-1.288	52	.203
Baseline cognitive function	-.414	-.406	-15.029	52	.000
Age	-.192	-.276	-10.440	52	.000
Education	.254	.174	8.479	52	.000
Race	-.195	-.018	-.895	52	.375
Gender	.449	.052	2.733	52	.009
Net worth	-4988880.541	-.056	-2.822	52	.007
Smoking, history	.161	.019	1.086	52	.283
Smoking, current	-.913	-.057	-2.681	52	.010
Alcoholic beverages per week	-.300	-.027	-1.287	52	.204
BMI	.012	.014	.704	52	.485
Living alone	.047	.005	.193	52	.848
Integration	.039	.061	2.636	52	.011

Relationships between loneliness, cynical hostility, and contact with social network

Correlations were run to examine the relationships between loneliness, cynical hostility, and contact with social network (i.e. integration) at baseline. The correlations between these variables were below .3, indicating that these constructs are separate. Table 9 presents the correlation matrix.

Table 9.

Correlations between loneliness, cynical hostility, and contact with social network.

	Loneliness	Cynical hostility	Integration
Loneliness	1	.298	-.171
Cynical hostility	.298	1	-.245
Integration	-.171	-.245	1

Power analysis

To investigate why an effect for both loneliness and cynical hostility appeared in the four-year but not the six-year analyses, analyses were conducted to determine the achieved power in both six-year analyses using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009). The regression examining loneliness as a predictor of cognitive decline over six years, given the effect size of f^2=.001 (taken directly from the four-year analysis), α = .05, number of predictors = 13, sample size = 2,228 achieved a power of .320, or 32.0%. The regression examining cynical hostility as a predictor of cognitive decline over four years, given the effect size of f^2=.003, α = .05, number of predictors = 13, sample size = 2,236 achieved a power of .735, or 73.5%.

Sensitivity analyses

Sensitivity analyses were run whereby all analyses were repeated while excluding subjects who met the cut-off for probable depression on the modified CES-D. These analyses did not differ in their major conclusions with the exception of the regression looking at loneliness as a predictor of cognitive decline over four years while adjusting for demographics, health behaviors, and objective measures of isolation. In this model (N=4048), loneliness was not a significant predictor of cognitive decline [t(52)=-1.44, p = .156].

Population level analyses

The odds ratio and population attributable risk were determined for the exposures of high loneliness and high cynical hostility and the disease outcome of severe cognitive impairment. The odds ratio (OR) of loneliness was 2.127 and the OR of cynical hostility was 1.771. That is to

say, at baseline those with high levels of loneliness were 2.127 times more likely to show severe cognitive impairment; those with high levels of cynical hostility were 1.771 times more likely to show severe cognitive impairment. The population attributable risk, i.e., the percentage of the disease outcome in the population, was 21.7% for loneliness and 12.6% for cynical hostility.

Discussion

The present study examined loneliness and cynical hostility as predictors of cognitive function and cognitive decline over a four and 6-year period, after adjusting for demographics, health behaviors, and isolation in a nationally representative sample of community-dwelling adults over the age of 50. Loneliness and cynical hostility were associated with lower cognitive functioning at baseline. Higher baseline loneliness and cynical hostility were risk factors for cognitive decline over four years. Neither baseline loneliness nor cynical hostility predicted cognitive decline over six years. However, the sample for these analyses was approximately half that used in the four-year analyses and a post hoc power analysis indicated only a 32.0% and 73.5% chance of detecting an effect if present in the population in these analyses for loneliness and cynical hostility respectively. In sensitivity analyses that excluded participants whose modified CES-D scores suggested presence of depression loneliness was no longer a significant risk factor for cognitive decline over a four-year period. However, cynical hostility remained a significant predictor of cognitive decline over a four-year period after excluding individuals with depression. The study also examined the data through the lens of population attributable risk. High loneliness doubled the odds of showing cognitive impairment at baseline (OR: 2.13). Those high in cynical hostility were also approximately 77% more likely to show cognitive impairment (OR: 1.77). Assuming that these factors are causal, of Americans entering retirement age

approximately 22% of cognitive impairment is attributable to loneliness and approximately 13% is attributable to cynical hostility.

The finding that loneliness and cynical hostility are correlates of lower cognitive function is consistent with the literature (Conroy, Golden, Jeffares, O'Neill, & McGee, 2010; O'Luanaigh et al., 2012; Mortensen, Barefoot, & Avlund, 2012; Barnes, Bienias, Wilson, Everson-Rose, and Evans, 2009). However, the present study builds upon this literature through replicating this finding in a large sample that is representative of the U.S. population.

It seems unlikely that loneliness and cynical hostility would predict cognitive decline over four but not six years. The differences in the results between the four-year and six-year longitudinal analyses are instead likely a product of lack of statistical power in the six-year analyses. Halving the sample for the six-year analyses reduced the achieved power to 32.0% for loneliness and 73.5% for cynical hostility, which could be insufficient to detect an effect. Another possibility is that loneliness and cynical hostility are not stable over older adulthood. Loneliness in particular may be subject to change during these years; changes such as widowhood or moving in with family members could generate or ameliorate loneliness. However, due to the concerns about power, this discussion will primarily focus on the four-year analyses.

The finding that loneliness is a predictor of cognitive decline over a four-year period is consistent with the literature (Tilvis et al., 2004; Wilson et al., 2007; Holwerda et al., 2012). The present study replicates previous work using a sample that is representative of the United States population and a measure of loneliness that is indirect and has been assessed for psychometric properties (Hughes, Waite, Hawkley, & Cacioppo, 2004). As mentioned in the introduction,

assessing loneliness indirectly sidesteps the stigma associated with the phenomenon and has been shown to affect responses (Shiovitz-Ezra & Ayalon, 2012).

In sensitivity analyses that excluded participants with significant depressive symptoms, loneliness was no longer a significant predictor of cognitive decline. Previous studies indicate that controlling for depression can reduce or eliminate the association between cognition and loneliness (Wilson et al., 2007; Gow, Corley, Starr, & Deary, 2013) In the present study, the sensitivity analyses provide evidence that, independent of depression, loneliness is not a risk factor for cognitive decline. That said , it is difficult to neatly separate loneliness and depression. First, the measure of depression used in the study, the CES-D, contains an item asking participants directly about loneliness. Measures aside, the constructs of loneliness and depression are enmeshed. A study by Cacioppo, Hughes, Waite, Hawkley, and Thisted studied older adults using latent growth models to show reciprocal influences (i.e., each exacerbated the other) between loneliness and depressive symptoms over time (2006). As such, to conclude that the effect of loneliness on cognitive decline is a byproduct of depression would be an oversimplification, as loneliness maintains and exacerbates depression. Rather, loneliness is a risk factor for cognitive decline in the context of depression.

The literature on cynical hostility as a predictor of cognitive decline is contradictory. The present study indicates that there is an effect of cynical hostility on cognitive decline, though this effect is small. The size of the effect would explain why the study by Mortensen, Barefoot, and Avlund (2012) did not identify cynical hostility as a predictor of cognitive decline; the study was grossly underpowered to detect such a small effect. However, it remains unclear why this study uncovered an effect of cynical hostility on cognitive decline while the similarly powered study by Barnes and colleagues (2009) did not. One potential explanation for different results across

studies is that each used different items from the Cook-Medley Hostility Inventory, selected without a clear rationale. The Cook-Medley Hostility Inventory is 50 items, and thus not feasible for large-scale research looking at several predictors. Research is necessary to develop and assess an abbreviated version of this scale.

It is important to note that although this study unearthed statistically significant effects of loneliness and cynical hostility on both cognitive function and cognitive decline over four years, these effects were very small. It could be argued that the effects reported in this study are too trivial to be of real world importance. However, small effects can still be meaningful. As Kelly and Preacher assert, "the meaningfulness of an effect is inextricably tied to the particular area, research design, population of interest, and research goal, and it would be inappropriate to wed effect size to some necessary arbitrary suggestion of substantive significance" (2012). As mentioned in the introduction, research indicating who is at greater risk for dementia is vital given the sheer number of Americans who will be entering older adulthood, and thus at heightened risk, in coming years. Loneliness and cynical hostility, unlike other potential risk factors like the apolipoprotein E allele ε4 (Tilvis et al., 2004), could be particularly useful risk factors to investigate given that they may be malleable, and thus have the potential to become treatment targets.

Analyses of population attributable risk suggest that addressing high loneliness and cynical hostility in older Americans could greatly reduce the number of people suffering from cognitive impairment. However, it is important to note that these analyses do not take into account potential confounds. Furthermore, they assume causality, which in not tenable assumption at this point. However, these analyses give a population-level perspective on the relationships between loneliness, cynical hostility, and cognitive impairment. For example, it is

not just important to look at the effect of an exposure (i.e., loneliness and cynical hostility), but also how common this exposure is. A more rare exposure might have greater pernicious effects, yet by virtue of its rarity affect thousands fewer Americans and thus potentially be a lesser public health concern.

This study inherits a number of strengths and weaknesses from the Health and Retirement Study. The sample is a major strength of the study. This is the first study to examine these phenomena in a sample that is representative of the United States. This allows for better generalization to the United States population, to include minority samples who are at greater risk for dementia (Alzheimer's Association, 2010). Moreover, the sampling procedure avoids bias by randomly selecting participants as described in the Methods, Sampling Procedure. This approach is closer to the ideal of the random sample than the vast majority of psychological research. One potential source of bias is differences between individuals who chose to take part in the study and those who did not. The initial response rates were 70-80%, with higher follow-up response rates of 85-93%. There is evidence of systematic differences between those who do and do not partake in research (Kazdin, 2003). Furthermore, much of the data for this study comes from a subsample of the larger study that completed and mailed back the Participant Lifestyle Questionnaire, or the Leave-Behind-Questionnaire. The response rate was generally high (around 90%), but it is possible that those participants who filled out this questionnaire differ from those who did not.

The measures used in the present study are generally brief. This brevity is necessary given the number of outcomes assessed in the Health and Retirement Study. Although the loneliness scale demonstrated sound psychometric properties (Hughes, Waite, Hawkley, &

Cacioppo, 2004), this was not the case for the cynical hostility scale. The cynical hostility scale is also different from that used in other studies, muddling comparison across studies.

There are additional limitations specific to this project. One major limitation is the statistical approach to examining cognitive decline. The present study used linear regressions to predict change in cognitive function from baseline to follow-up, a technique that is common in the literature (Allison, 1990). However, the use of multilevel modeling with repeated measures nested in individuals would more accurately capture the individual trajectories of cognitive decline. Furthermore, this approach is better equipped to deal with missing data. Thus, it would be possible to analyze the four-year and the six-year cognitive decline in a single model without using imputation.

The analyses for this study looked at baseline loneliness and cynical hostility as predictors of cognitive decline. Temporal precedence is necessary to determine whether these variables are risk factors for cognitive decline. However, it is possible that these psychosocial variables change as people grow older. There is evidence that cynical hostility is a stable characteristic (Mortensen, Barefoot, & Avlund, 2012), but loneliness may fluctuate during late adulthood, especially given the possibility of major life changes such as widowhood (Golden et al., 2009). Future research could investigate how the course of loneliness in late life maps onto cognitive function.

The present study adjusted for variables known to affect cognitive decline, including demographics, health behaviors, and isolation. Accounting for these factors is necessary to speak to the relationship between loneliness and cynical hostility to cognitive decline specifically. However, loneliness and cynical hostility occur in the context of these factors. Rather than simply controlling for these variables, it would be useful to understand how they relate to the

relationship between loneliness, cynical hostility, and cognitive decline. Potential next steps would be to investigate the moderating and mediating effects of the aforementioned factors on the relation between loneliness/cynical hostility and cognitive decline.

To conclude, this study indicates that loneliness and cynical hostility are correlates of lower cognitive function and risk factors for cognitive decline over a four year period when adjusting for demographics, health behaviors, and objective aspects of isolation. Despite the small effect sizes, these findings are significant in the context of the growing prevalence of dementia and the personal and social costs involved in these conditions. This work represents a step towards a better understanding of factors involved in the cognitive decline, which corrodes the functioning and quality of life of millions of Americans. Further research is necessary to understand how subjective dimensions of social functioning change over time to affect cognition, how these variables interplay with contextual factors and behaviors, and whether and how they work to impair cognitive function.

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Vita

Sarah Clay Griffin was born on August 19th, 1988 in London, England. She graduated from Walt Whitman High School (Bethesda, Maryland) in 2007. She attained a Bachelor's of Arts and Science from McGill University (Montréal, Quebec) in 2011, graduating with first-class honors in Cognitive Science. She then worked for three years at Walter Reed National Military Medical Center (Bethesda, Maryland) as a research assistant then project coordinator on a number of studies pertaining to phantom limb pain, prosthetics, and traumatic brain injury. She began her graduate studies in the Clinical Psychology program at Virginia Commonwealth University (Richmond, Virginia) in the fall of 2014 under the mentorship of Bruce Rybarczyk, Ph.D.