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Does loneliness mediate the relation between social support and cognitive functioning in later life?

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ABSTRACT

Research in gerontology has demonstrated mixed effects of social support on cognitive decline and dementia: Social support has been shown to be protective in some studies, but not in others. Moreover, little is known about the underlying mechanisms between social support and cognitive functioning. We investigate one of the possible mechanisms, and argue that subjective appraisals rather than received amounts of social support affect cognitive functioning. Loneliness is seen as an unpleasant experience that occurs when a person's network of relationships is felt to be deficient in some important way. As such, loneliness describes the extent to which someone's needs are not being met and thus provides a subjective assessment of support quality. We expect that receiving instrumental and emotional support reduces loneliness, which in turn preserves cognitive functioning. Data are from the Longitudinal Aging Study Amsterdam (LASA) and include 2255 Dutch participants aged 55–85 over a period of six years. Respondents were measured every three years. Cognitive functioning was assessed with the Mini-Mental State Examination (MMSE), the Coding Task, and the Raven's Coloured Progressive Matrices. The analytical approach comprised latent growth mediation models. Frequent emotional support related to reduced feelings of loneliness and better cognitive functioning. Increases in emotional support also directly enhanced cognitive performance. The protective effect of emotional support was strongest amongst adults aged 65 years and older. Increase in instrumental support did not buffer cognitive decline, instead there were indications for faster decline. After ruling out the possibility of reversed causation, we conclude that emotional support relationships are a more powerful protector of cognitive decline than instrumental support relationships.

Introduction

Population aging and increased life-expectancy have been challenging modern societies with age-related diseases such as dementia and Alzheimer's disease. In 2005, approximately 24 million people suffered from dementia worldwide, and this number is expected to exceed 80 million by 2040 (Ferri et al., 2005). The vast burden of dementia thus calls for identifying determinants of cognitive disabilities, so that policy and preventive programs can be further developed.

Along with biological, physiological and psychological markers, integration into supportive social networks is believed to be an important determinant of health and cognitive aging (Barnes, Mendes de Leon, Wilson, Bienias, & Evans, 2004; Bassuk, Glass, & Berkman, 1999; Berkman, Glass, Brissette, & Seeman, 2000; Ertel, Glymour, & Berkman, 2008; Wang, Karp, Winblad, & Fratiglioni, 2002). Individuals who are lonely have double the risk of developing Alzheimer's disease, and generally experience more rapid cognitive decline than individuals who are connected socially (Amieva et al., 2010; Wilson et al., 2007).

However, a considerable research body in gerontology has demonstrated mixed effects of social support on cognitive functioning. Empirical findings suggest that the quality rather than the quantity is protective of cognitive decline (Krueger et al., 2009), and that emotional support seems to have more beneficial effects than instrumental support (Amieva et al., 2010; Glymour, Weuve, Fay, Glass, & Berkman, 2008; Holtzman et al., 2004; Seeman, Lusignolo, Albert, & Berkman, 2001).

The underlying mechanisms between social support and cognitive functioning have hardly been unraveled both in

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theoretical and empirical terms. Because severe loneliness has consistently been found to be associated with impaired cognitive functioning (Cacioppo & Hawkley, 2009; Holmen, Ericsson, & Winblad, 2000; Wilson et al., 2007), it may be a stronger predictor than received amounts of social support. We expect that the mechanism is an indirect one, specifically that outcomes of cognitive functioning are explained by *perceived* rather than *received* quality of social support. A useful indicator of perceived support quality is loneliness (Bernardon, Babb, Hakim-Larson, & Gragg, 2011), broadly defined as the perception of the extent to which social needs are met by others. The objective of this study is to test whether a potential relation between received social support and cognitive functioning is mediated by loneliness.

We employ an advanced analytical approach and use data from the Longitudinal Aging Study Amsterdam (LASA), including 2255 subjects aged 55–85 over a period of six years. Using latent growth mediation models we are able to investigate cross-sectional associations of social support with initial levels of loneliness and cognition. Furthermore, we test longitudinal associations with changes in social support and changes in loneliness and cognition. We also address the possibility of reversed causality, because previous research indicated that change in support networks may follow from cognitive decline (Aartsen, Van Tilburg, Smits, & Knipscheer, 2004).

Theory and evidence

Social support

Research on the relation between cognitive functioning and support typically distinguishes between emotional and instrumental support (Berkman et al., 2000), with the first type referring to the amount of caring and understanding from others (e.g., talking about feelings), and the second type to receiving help, aid or assistance with tangible needs and daily activities (e.g., cooking meals, filling in forms, repairing things). Both types of support may be embedded in the same social relationship.

Scholars in gerontology widely agree that integration into support networks prevents from cognitive decline, postpones the onset of dementia, and buffers the progression of Alzheimer's disease (Bennett, Schneider, Tang, Arnold, & Wilson, 2006; Hultsch, Hertzog, Small, & Dixon, 1999; James, Wilson, Barnes, & Bennett, 2011; Wang et al., 2002; Zunzunegui, Alvarado, Del Ser, & Otero, 2003). Involvement in supportive relationships is argued to preserve cognitive capacities, such as episodic memory, working memory and perceptual speed. Preservation is facilitated directly through enhanced brain stimulation, and indirectly through lowered stress reactivity and vulnerability in older adults (Dickinson, Potter, Hybels, McQuoid, & Steffens, 2011; Fratiglioni, Paillard-Borg, & Winblad, 2004; Wilson, Begeny, Boyle, Schneider, & Bennett, 2011), and improved coping with critical life-events and healthy behaviors (Duncan & McAuley, 1993). These findings suggest that social support is one of the determinants of cognitive functioning, and that individuals with more social support experience slower rates of cognitive decline.

However, empirical evidence demonstrates a large variability in effects. Quite consistent positive associations with multiple indicators of cognitive functioning have been found for emotional support, both in cross-sectional and longitudinal studies (Glymour et al., 2008; Krueger et al., 2009; Seeman et al., 2001). In contrast, a mix of positive and negative associations has been shown for instrumental support (Dickinson et al., 2011; Seeman et al., 2001). In a study by Newsom, Rook, Nishishiba, Sorkin, and Mahan (2005), participants frequently receiving emotional support evaluated social exchanges more positively, whereas participants with frequent instrumental support reported greater distress. Note that these effects were shown independent of physical functioning, chronic diseases, and co-morbidity. Altogether evidence on the protective effects of support relationships against cognitive decline mainly rests on research using emotional support.

The above discussion emphasizes that when we want to explain cognitive functioning in older adults we should not rely on quantitative indicators (e.g. number of support relationships) but on type and quality of the support received (Uchino, 2009).

Loneliness

In their recent review, Uchino, Bowen, Carlisle, & Birmingham (2012) conclude that health does not directly improve through receipt of social support but indirectly through positive perceptions of support. Poor evaluations of support are assumed to have detrimental consequences for mental health and cognitive functioning. A crucial marker of unfavorably evaluated support and deficits in social relationships is loneliness (Heinrich & Gullone, 2006; O'Donovan & Hughes, 2007; Pinquart & Sörensen, 2001), defined as a "distressing feeling that accompanies the perception that one's social needs are not being met by the quantity or especially the quality of one's social relationships" (Hawkley & Cacioppo, 2010: 218). It implies that some people may lead relatively rich social lives but feel lonely nevertheless.

Yet, researchers often agree that amongst other factors receiving much support counteracts loneliness (Bernardon et al., 2011; Cacioppo, Hawkley, & Thisted, 2010; Newcomb & Bentler, 1986; Van Tilburg, 1990). Several intervention studies have shown that stimulating friendships (Pitkala, Routasalo, Kautiainen, Sintonen, & Tilvis, 2011; Stevens & Van Tilburg, 2000) and increasing support in social networks (Winningham & Pike, 2007) are successful means to reduce loneliness and eventually improve older people's cognitive functioning (Masi, Chen, Hawkley, & Cacioppo, 2011).

Once loneliness occurs it has serious consequences for emotion, behavior, morbidity and cognition. It has been associated with cognitive impairment, accelerated cognitive decline and elevated risks of Alzheimer's disease (Cacioppo & Hawkley, 2009; Holmen et al., 2000; Tilvis, Pitkala, Jolkkonen, & Strandberg, 2000; Wilson et al., 2007), even after controlling for amount of social support (Gow, Pattie, Whiteman, Whalley, & Deary, 2007) and ruling out the possibility of reverse causation.

Several mechanisms have been made responsible for these negative consequences. Biological theories state that mental disorders emerge from a chemical imbalance in the brain, caused by too much or too little activity of certain neurotransmitters and hormones. For instance, the monoamine hypothesis views depression as a result of underactivity of monoamine transmitters (Hirschfeld, 2000). Another example is the glucocorticoid cascade hypothesis, which claims that chronic stress affects aging brains more severely than younger brains. With advancing age, responses to stressful situations are characterized by cascaded release of stress hormones (glucocorticoids), which frequently cause loss in hippocampal neurons (Sapolsky, Krey, & McEwen, 1986). These proposed mechanisms, however, do not account for psychosocial pathways.

There is substantiated evidence that loneliness is often accompanied by social withdrawal and lessened regional brain activation (Baumeister, Twenge, & Nuss, 2002; Cacioppo, Norris, Decety, Monteleone, & Nusbaum, 2009), increased blood pressure and risk of cardiovascular diseases, elevated cortisol and stress levels (Hawkley, Burleson, Berntson, & Cacioppo, 2003), impaired sleep quality (which causes memory problems), heightened feelings of depression and anxiety, and increased vulnerability (Hawkley & Cacioppo, 2010). Lonely individuals are also less able to optimize positive emotional states and self-regulate their behavior. Social exclusion was shown to lead to impaired effortful attentional processes and limited physical activity (Hawkley et al., 2003), which in turn accelerates cognitive decline (Dik, Deeg, Visser, & Jonker, 2003). Detrimental effects of loneliness are exacerbated by the problem of hypervigilance (Hawkley & Cacioppo, 2010), with the consequence that lonely people avoid social interactions and thereby actively contribute to their isolation. Such disengagement from physical and social activities further adds to the risks of cognitive deficits.

Based on the above discussion, we assume that the previously found positive effect of social support on cognitive functioning is mediated by reduced loneliness: *We expect that the more social support individuals receive, the less likely they will feel lonely. Reduced feelings of loneliness will relate to higher baseline levels of cognitive functioning and slower rates of decline.*

Data and methods

Sample

Data are from the Longitudinal Aging Study Amsterdam (LASA), which is an ongoing longitudinal, multidisciplinary research project focusing on physical, emotional, cognitive and social functioning in later life. Its design and data collection are reported in detail elsewhere (Huisman et al., 2011). The research was subject to appropriate ethical review via the Committee on the Ethics of Research in Humans of the Faculty of Medicine of the Vrije Universiteit (VU) Amsterdam.

The LASA sample is a nationally representative sample of older adults aged 55–85 years at baseline. Participants were recruited from municipal registries within three geographic regions in The Netherlands, with an oversampling of older individuals and older men in particular. Since 1992, data have been collected every three years using the same face-to-face interviews and self-administered questionnaires. In 2002, an additional cohort of 1002 respondents aged between 55 and 64 was included. For the present analyses, data were used from wave 2001–2003 (T_1), 2005–2006 (T_2), and 2008–2009 (T_3), covering a total period of six years.

In longitudinal research on social support and cognitive functioning, individuals with poor cognitive functioning at baseline are commonly excluded (Amieva et al., 2010; Bennett et al., 2006; Holtzman et al., 2004; Krueger et al., 2009; Wang et al., 2002). Therefore we only included participants without signs of dementia at baseline (T_1), i.e. those who had a MMSE score of at least 24. We selected participants who had full information on all the control variables. The resulting sample consisted of 2255 individuals who on average were 63 years old at baseline ($SD = 6.65$). The sample included 54% females.

Measures

Dependent variable

Cognitive functioning is assessed with a combination of three measures. First, the Mini-Mental State Examination (MMSE) is a widely used 23-item screening instrument of cognitive functioning (Folstein, Folstein, & McHugh, 1975). It involves recall, orientation, registration, attention, language, and construction. Scale scores range from 0 to 30, with scores below 24 being considered critical. Second, an adapted version of the Coding Task assesses information processing speed (Savage, 1984). Participants are presented a sheet with rows of characters, and then asked to name the character that belonged underneath the printed characters as quickly and accurately as possible. The correct character combination is given at the top of the sheet. Every completed combination counts as one score point. There are three trials of one minute. A mean score of these three trials is computed. Cronbach's alpha is larger than 0.95 in all three waves. Third, the Raven Coloured Progressive Matrices (RCPM) is a non-verbal visual test, assessing the ability for non-verbal and abstract reasoning (Raven, 1995). There are two subsets with 12 drawings (matrices) each. In the pattern of every drawing a section is missing. At the bottom of the page, participants choose which one out of six patterns fits best into the missing section. Both drawings and subsets increase in difficulty. Correctly chosen patterns count one point, resulting in a total scale score ranging from 0 to 24. For every one of the three measures (MMSE, Coding Task, Raven Matrices), higher scores indicate better cognitive performance. We outline in the analytical approach how these measures are combined into an overall measure of cognitive functioning.

Independent variables

Emotional and instrumental support received from others is assessed with a number of questions on the personal network. The method used to identify the personal network is detailed elsewhere (Van Tilburg, 1998). Participants are first asked to name people with whom they have regular, socially active contacts. For the nine most frequently contacted people—other than the partner—it is asked how much support participants have received: for emotional support it is asked "How often in the past year did you talk to [name] about your personal experiences and feelings?". For instrumental support it is asked "How often in the past year did [name] help you with daily tasks in and around the house?". Response categories range from "never" (1) to "often" (4). Scores are summed across all answers and range from 0 to 36. If there is no support relationship other than the partner, a score of zero is assigned.

Mediating variable

Loneliness is measured with the De Jong Gierveld Loneliness Scale (De Jong Gierveld & Kamphuis, 1985). The scale includes eleven statements, for example "I experience a general sense of emptiness", and "there is always someone I can talk to about my day-to-day problems ". Possible answers are "yes", "more or less", and "no". Scores for positively formulated items are reversed. Answers are dichotomized, so that "yes" and "more or less" indicate loneliness (1) versus "no" loneliness (0). Scores are summed across all answers (range is 0–11), such that high scores represent severe loneliness.

Control variables

The analyses control for a number of potential confounders. Previous research found increased risks of cognitive decline for older adults who are very old (Brayne, Gill, Paykel, Huppert, & O'Connor, 1995), male, low educated, and physically unhealthy (Aartsen, Smits, Van Tilburg, Knipscheer, & Deeg, 2002). We therefore control for age, gender (1 = female, 0 = male), level of education (nine levels ranking from incomplete elementary education to university education), and physical functioning at baseline. Physical functioning is assessed by asking about the ability to perform three activities: walking up and down a 15-step staircase without having to stop, using own or public transportation, cutting one's own toenails. Participants indicate whether they can perform an activity without help (5), have some/much difficulty (4/3), need help (2), or are unable to perform it (1). We use a mean score, ranging from 1 to 5, with high scores representing good physical functioning.[1] Cronbach's alpha is 0.73.

[1] Note that the physical functioning scale can be seen as a proxy of autonomy. This scale correlated positively with the extent to that respondents reported limitations in their normal activities due to health problems (three possible answers: severe, slight and no limitations; $r = 0.52$, $p < 0.001$). The final results did not change when controlling for limitations instead of physical functioning.

Table 1 presents the descriptive statistics and the correlations between all variables used at baseline.

Analytical approach

To test our longitudinal mediation hypotheses we use latent growth mediation models. These models combine latent growth modeling with simultaneous equation modeling. First, latent growth parts estimate levels (intercepts) and change (slopes) of the time-varying variables. Second, simultaneous equations test for the direct and indirect effects (mediation) of level and change in social support on level and change in cognitive functioning.

Our analytical approach follows a stepwise procedure. First, separate latent growth models are estimated for each time-varying variable. Only models that are deemed to have a satisfactory model fit are used in higher-order models. Estimates of intercepts regard the initial level (intercept) of a variable, and estimates of the slope regard linear change (slope) of a variable. All intercepts were highly significant, and nearly all slopes were significant, suggesting that there was sufficient variation in the longitudinal data. Table 2 summarizes the fit statistics, intercepts and slopes of the latent growth models.

Second, the three outcome measures (MMSE, Coding Task, and Raven Matrices) all indicate level of fluid intelligence, which is the ability to deal with new information (Salthouse, 1996). We subsumed them into an overall construct of cognitive functioning in a factor-of-curves or second-order multivariate latent growth model (Duncan, Duncan, & Strycker, 2000). The resulting model estimating an overall intercept and an overall slope for the latent construct cognitive functioning had a good fit ($\chi^2(26) = 92.93$, RMSEA = 0.03, CFI = 0.99). Correlations between the first-order intercepts and slopes ranged from 0.29 to 0.89, and all their loadings on the second-order intercepts and slopes were large and highly significant. This confirms the feasibility of subsuming the three outcome measures.

Third, within the simultaneous equation part, cognitive functioning was regressed on social support and loneliness. This included two sets of equations, as suggested by MacKinnon (2008: 212). One set tested the path from the intercept of social support through the intercept of loneliness to the intercept of cognitive functioning. The other set tested the same path using slopes instead of intercepts. Both direct and indirect paths from social support to cognitive functioning were estimated. Intercept and slope of cognitive functioning were regressed on the control variables. The full model is illustrated in Fig. 1.

For the hypothesis test, two full latent growth mediation models were estimated, the first using emotional support and the second using instrumental support. All models employed maximum likelihood estimation with robust standard errors, which is relatively insensitive to variables that are typically non-normally distributed, such as MMSE and loneliness. Analyses were carried out with Stata 12.0 and Mplus 5.2 software.

Results

In the theory section, we argued that receiving social support would buffer cognitive decline. We hypothesized this relationship would be indirect and explained by reduced feelings of loneliness. Table 3 presents the results of the latent growth mediation models, with Model 1 reporting the effects of emotional support, and Model 2 reporting the effects of instrumental support. Both models had a good fit ($\chi^2(129) = 481.30$, RMSEA = 0.04, CFI = 0.97; $\chi^2(129) = 560.41$, RMSEA = 0.04, CFI = 0.96).

Emotional support

In line with our expectation, high levels of emotional support promoted greater cognitive performance indirectly through reduced feelings of loneliness. In Model 1, the intercept of emotional support did not show a direct ($\beta_{int} = 0.03$, *ns*) but a small indirect positive effect ($\beta_{int} = 0.02$, $p < 0.05$) on cognitive functioning. Frequent emotional support related to less loneliness ($\beta_{int} = -0.35$, $p < 0.001$), and less loneliness was associated with better cognitive functioning ($\beta_{int} = -0.05$, $p < 0.001$).

Parameter estimates on the slopes inform about relations between changes: An increase in received emotional support strongly related to an increase in cognitive functioning ($\beta_{slope} = 0.40$, $p = 0.06$), and a decrease in loneliness ($\beta_{slope} = -0.52$, $p < 0.001$). Note that there was no indirect effect through loneliness this time ($\beta_{slope} = 0.04$, *ns*). An intensification of emotional support had a larger and more direct effect on cognitive functioning than high level of emotional support.

Instrumental support

Similar to the findings on emotional support, high levels of instrumental support relates to reduced loneliness ($\beta_{int} = -0.24$, $p < 0.001$), and this in turn promotes greater cognitive performance ($\beta_{int} = -0.07$, $p < 0.01$). In Model 2, there is an indirect ($\beta_{int} = 0.02$, $p < 0.05$) but no direct effect ($\beta_{int} = -0.01$, *ns*) of the intercept of instrumental support on cognitive functioning.

Increases in instrumental support were unrelated to changes in loneliness and cognitive functioning, as neither of the relationships between the slopes were significant. Altogether the two support types differed in their impact on cognitive functioning: influences of emotional support were both direct and indirect, whereas influences of instrumental support were solely indirect. Emotionally supportive relationships were stronger protectors against cognitive decline than instrumentally supportive relationships.

Table 1
Means (*M*), standard deviations (*SD*) and correlations of the variables at baseline (T_1).

	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9
1	MMSE	27.93	1.60									
2	Coding task	26.88	6.88	0.42***								
3	Ravens Matrices	19.00	3.62	0.39***	0.53***							
4	Emotional support	22.21	7.76	0.11***	0.08***	0.07**						
5	Instrumental support	14.95	6.40	0.00	−0.06**	−0.02	0.49***					
6	Loneliness	1.95	2.49	−0.11***	−0.15***	−0.09***	−0.22***	−0.15***				
7	Age	63.45	6.65	−0.29***	−0.41***	−0.35***	−0.05*	0.07**	0.18***			
8	Gender (1 = female)	54.1%	–	−0.01	0.07**	−0.12***	0.26***	0.00	0.03	0.06**		
9	Education	4.01	2.04	0.27***	0.37***	0.39***	0.04	−0.05*	−0.06**	−0.14***	−0.22***	
10	Physical functioning	4.27	1.08	0.17***	0.31***	0.29***	0.05*	−0.07**	−0.20***	−0.49***	−0.20***	0.22***

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 2
Intercepts, slopes and fit statistics of the latent growth models (LGM).

	Intercept[a]		Slope[a]		Fit statistics[b]			
	M	*Var.*	*M*	*Var.*	χ^2 (*df*)	RMSEA	CFI	SRMR
First-order LGM								
MMSE	27.92***	1.83***	−0.28***	0.96***	18.62 (1)	0.09	0.96	0.03
Coding task	26.88***	43.02***	−1.03***	2.24**	2.19 (1)	0.02	1.00	0.01
Ravens Matrices	19.02***	8.76***	−0.31***	−0.01	5.65 (1)	0.05	1.00	0.02
Emotional support	22.26***	34.52***	0.03	4.58**	0.38 (1)	0.00	1.00	0.00
Instrumental support	15.03***	21.03***	0.25**	2.72*	3.01 (1)	0.03	1.00	0.01
Loneliness	1.95***	4.70***	0.07**	0.40**	0.20 (1)	0.00	1.00	0.00
Second-order LGM								
Cognitive functioning	n/a.	0.86***	n/a.	0.49***	92.93 (26)	0.03	0.99	0.11

Note. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
[a] Unstandardized coefficients.
[b] Because the models used MLR chi-square values cannot be used for chi-square difference tests; *df* = degrees of freedom, CFI = Confidence Fit Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual.

Supplemental analyses

Older age

Recall that the sample covered older adults aged 55–85 years at baseline. The risk of severe cognitive decline is expected to increase substantially with advancing age (Brayne et al., 1995), and also patterns of social support and loneliness likely undergo changes. Results from the latent growth models, which are presented in Table 2, demonstrate a decline (negative slope) in all three subdimensions of cognitive functioning, and an increase in instrumental support and loneliness (positive slopes) with aging. We therefore tested additional models for the group including only respondents aged 65 years and above.

In this group, neither emotional nor instrumental support exerted an indirect effect on cognitive functioning. Yet, high levels and increases in emotional support directly contributed to improved cognitive functioning ($\beta_{int} = 0.13$, $p < 0.05$; $\beta_{slope} = 0.42$, $p < 0.01$). None of these relationships was found for instrumental support. This implies that adults aged 65 years and older received direct benefits from emotional support, whereas the previously observed indirect mechanisms mainly pertained to comparatively young older adults (age 55–65 years).

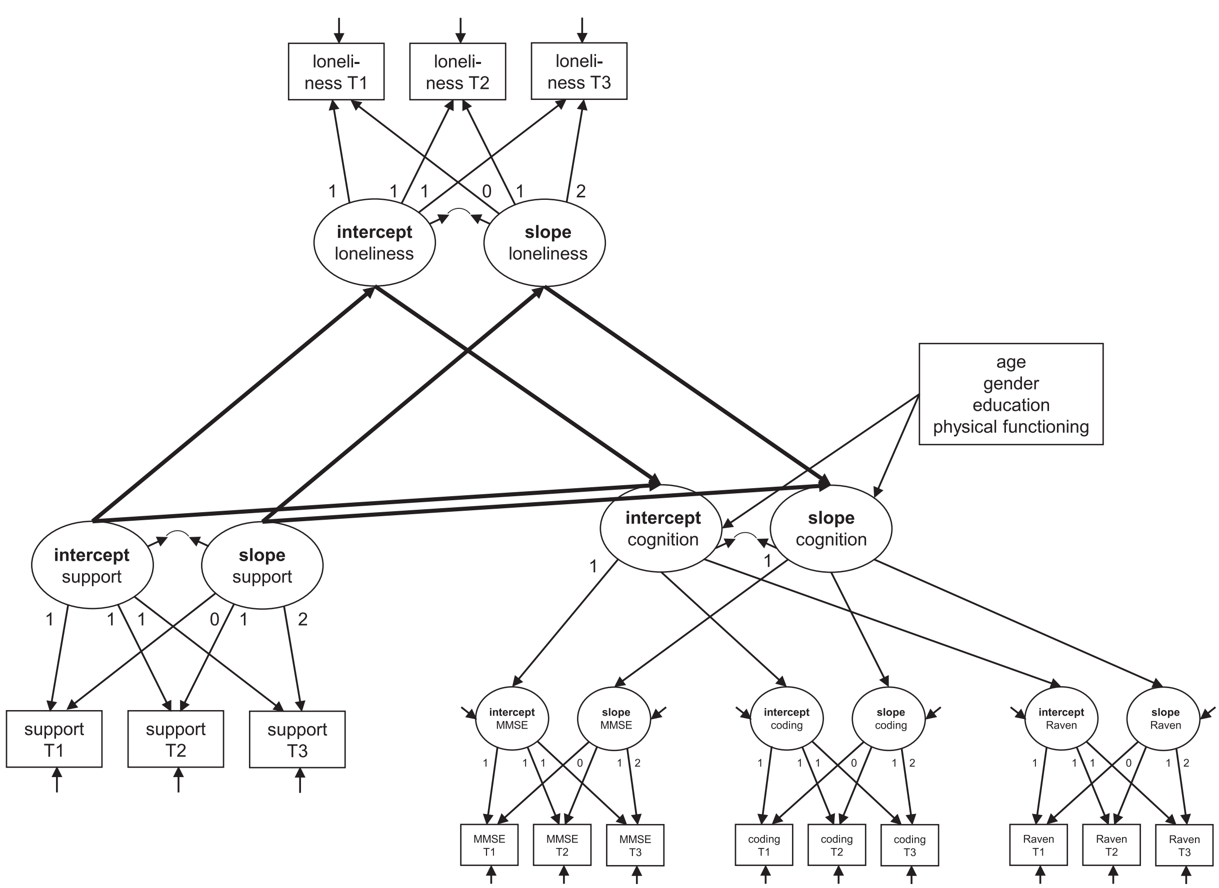

Fig. 1. Latent Growth Mediation Model. Bold arrows indicate the hypothesized mechanisms, a direct effect from support to cognition, and an indirect effect from support to cognition through loneliness.

Table 3
Results of latent growth mediation models on cognitive functioning.

	Model 1[a]				Model 2[b]			
	Direct effects[c]		Indirect effects[c]		Direct effects[c]		Indirect effects[c]	
	β	s.e.	β	s.e.	β	s.e.	β	s.e.
Control variables[d]								
Age	−0.38***	0.02			−0.38***	0.02		
Gender (1 = female)	0.11***	0.03			0.13***	0.02		
Education	0.43***	0.02			0.44***	0.02		
Physical functioning	0.22***	0.02			0.22***	0.02		
Effect of support on cognitive functioning								
Emotional support: intercepts	0.03	0.03	0.02*	0.01				
Emotional support: slopes	0.40+	0.22	−0.04	0.07				
Instrumental support: intercepts					−0.01	0.03	0.02*	0.01
Instrumental support: slopes					−0.02	0.09	0.00	0.01
Effect of loneliness on cognitive functioning								
Loneliness: intercepts	−0.05*	0.02			−0.07**	0.03		
Loneliness: slopes	−0.08	0.12			0.02	0.09		
Effect of support on loneliness[e]								
Em. support on loneliness: intercepts	−0.35***	0.03						
Em. support on loneliness: slopes	−0.52***	0.13						
Inst. support on loneliness: intercepts					−0.24***	0.04		
Inst. support on loneliness: slopes					−0.11	0.41		
Fit statistics								
χ^2 (*df*)	481.30 (129)				560.41 (129)			
RMSEA	0.04				0.04			
CFI	0.97				0.96			
SRMR	0.07				0.09			
N	2255				2255			

Note. $^{+}p < 0.07$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
[a] Model 1 uses emotional support.
[b] Model 2 uses instrumental support.
[c] Standardized coefficients.
[d] To accommodate a sufficient model fit, effects of control variables were estimated on both intercept and slope of cognitive functioning. Only effects on the intercept are reported.
[e] Em. = emotional, inst. = instrumental.

Reverse causality

Latent growth mediation models can merely test one causal direction per model, so that competing causal directionalities cannot be tested within a single mediation model (Kline, 2011: 166). Testing competing directionalities (but without a mediation test) is possible with cross-domain latent growth models (Willett & Sayer, 1996), as illustrated in Fig. 2. In total, there are six crossing relations between the three domains social support, loneliness, and cognitive functioning: The slope of cognitive functioning was regressed on the intercept of social support, and crossing back, the slope of social support was regressed on the intercept of cognitive functioning. The same cross-domain relations were modeled between social support and loneliness, and between loneliness and cognitive functioning. A causal effect is assumed to be present when the intercept of one domain affects the slope of another domain, and when this effect cannot be detected in reverse.

Based on the results in Table 4, reverse causality can be ruled out for both support types: The intercept of cognitive functioning is unrelated to the slopes of emotional ($\beta = 0.01$, *ns*) and instrumental support ($\beta = -0.07$, *ns*). As expected, the positive effect of emotional support on cognitive functioning continues to exist ($\beta = 0.13$, $p < 0.05$). But the analysis also unravels an intriguing finding. Enhanced instrumental support related to a decrease in cognitive functioning ($\beta = -0.19$, $p < 0.05$). This negative effect was net of impairments in physical functioning.

Discussion

In line with previous work, our findings overall showed that emotional support delays the onset of cognitive decline, while loneliness operates as a risk factor (Amieva et al., 2010; Seeman et al., 2001). These outcomes substantially varied for level and change in social support. Both high levels of emotional and instrumental support were related to lower levels of loneliness, which in turn related to better cognitive functioning. This underpins previous research where subjective appraisals mediated the link between social exchanges and psychological health (Cohen & Wills, 1985; Newsom et al., 2005).

Analyses of change in social support, however, delivered somewhat contrasting outcomes. In our study, prevention of cognitive decline was most likely through intensification of emotional support. Intensified support may occur in response to growing needs, for instance due to deteriorating health and stressful life-events. Yet, in tests of reverse causation, the positive association between emotional support and cognitive functioning was not explained by intensified emotional support exchanges after cognitive decline had progressed. Also re-analyzing our hypothesis including the previously excluded individuals with very low MMSE-scores ($N = 212$) did not lead to different conclusions.

Intensification of instrumental support had no such promoting effect on cognitive functioning, and the causation analyses even pointed towards opposite outcomes, i.e., accelerated cognitive decline. An explanation proposed by the literature is that instrumental support is a mixed blessing (Reinhardt, Boerner, & Horowitz, 2006). While this support type provides tangible assistance, it often also contributes to distress and feelings of low self-efficacy (Uchino, 2009). Instrumental support more than emotional support accentuates physical (and cognitive) impairments, vulnerability and inability to accomplish task of daily living.

Interestingly, we found differential pathways across age groups. The impact of emotional support on cognitive functioning was much more substantial in the older group (age > 65 years) than in the younger group (age 55–65 years) of aging adults. Loneliness played a less prominent role in the former group, perhaps because

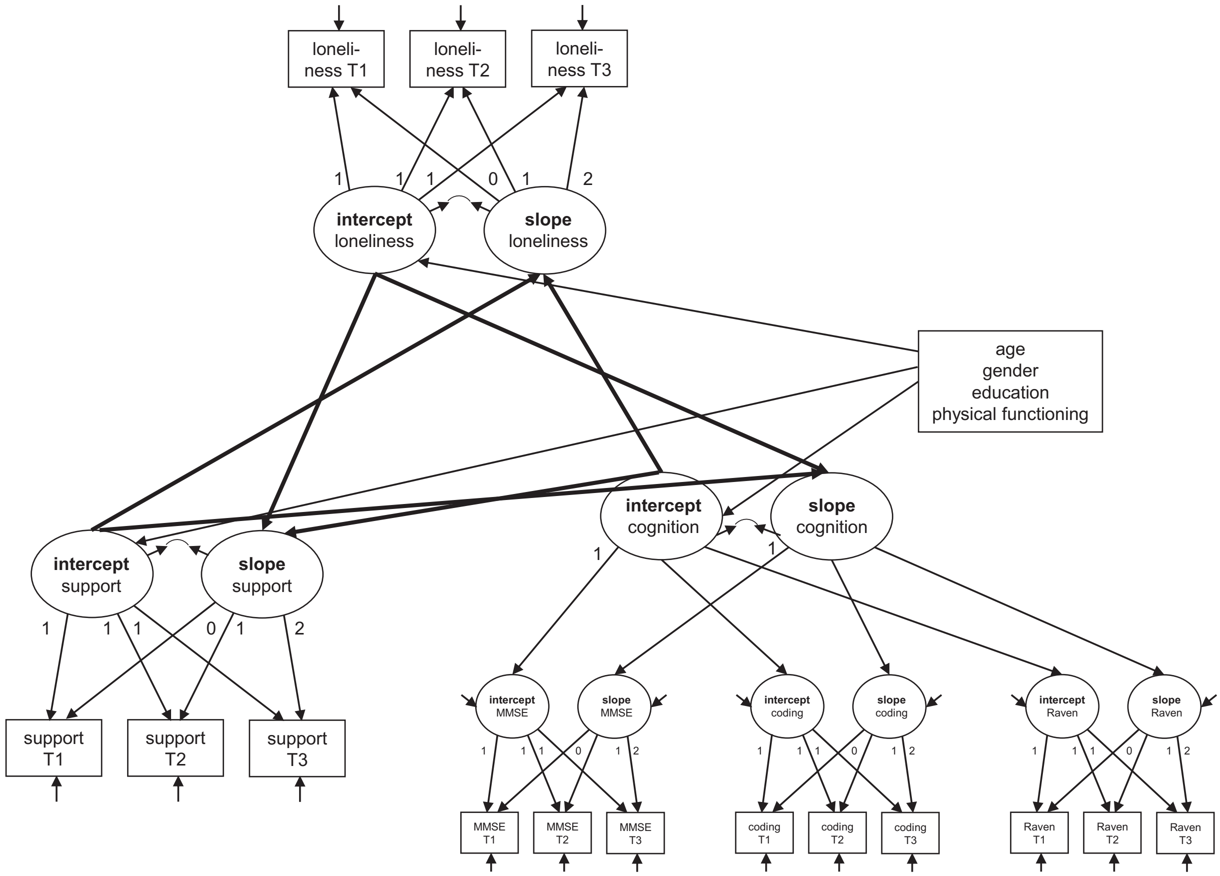

Fig. 2. Cross-domain Latent Growth Model. Bold arrows indicate the mechanisms of interest. For each pair of domains, two crossing relations between the intercepts and the slopes are modeled. For example, the slope of cognition is regressed on the intercept of support (hypothesized direction), and the slope of support is regressed on the intercept of cognition (reversed direction).

loneliness becomes more common with advanced age, and aging adults develop adaptive strategies to cope with feelings of loneliness. These insights emphasize that older adults are the main beneficiaries of intensified emotional support.

Receiving social support has the potential to stimulate a proactive lifestyle and improve coping with stressful situations when it is emotional in nature, evaluated as positive, and succeeds in inducing a sense of social connectedness, but can be ineffective otherwise. This confirms the notion that perceived support is a better predictor of mental health and well-being than received support (Helgeson, 1993). Similarly, Ashida and Heaney (2008) come to the conclusion in their study that perceived social connectedness is relatively more important for well-being in older adults than the availability of social support. Also Stephens and colleagues claim that “simply asking people about their perceptions of loneliness and isolation is a useful way to capture some of the effects of lack of social support” (Stephens, Alpass, Towers, & Stevenson, 2011: 906).

A number of practical implications follow from the present study. Interventions to reduce loneliness need not aim at increasing the mere quantity of support relationships in the personal network, but instead stimulate a select number of close and emotionally supportive relationships (e.g., based on shared interests that improve the perception of social support). Also socio-emotional selectivity theory argues that as adults grow older and their time horizon shortens, they prefer to engage in fewer but beneficial contacts (Carstensen, 1993). Additionally, studies based on social production function theory show that older adults who have various social needs fulfilled—not only emotional closeness—experience higher levels of life-satisfaction and positive affect (Steverink & Lindenberg, 2006). This asks for interventions aimed at promoting diversity in social contacts, and so lowering perceived isolation. Intervening strategies may be easily combined with free social networking technologies (e.g., Facebook), as they have been effective in reducing loneliness in university freshmen (Lou, Yan, Nickerson, & McMorris, 2012).

Besides the study’s contributions, there are some limitations and directions for future research. First, in our data there was relatively little change in emotional support, so that its effects on loneliness and cognitive decline may have been underestimated. Future research, for instance in the context of an intervention study, is needed to better understand the outcomes of increasing emotional support. Second, the population under study was characterized by an oversampling of older people and men, which may limit the generalizability of the results to the Dutch population. Third, we tested only one mediator. Especially in late life, e.g. after the age of 75 years, many other factors may mediate or influence the risk of cognitive decline. This includes deteriorating health, changes in the personal network (like losing the partner and thus an important source of social support), and experience of stressful live events. More mechanisms related to stress reduction and resource explanations need to be studied, such as self-efficacy and depression.

The present study showed that loneliness is a crucial marker of perceived deficits in social relations (Haber, Cohen, Lucas, & Baltes, 2007) and of cognitive decline (Cacioppo & Hawkley, 2009). This

Table 4
Results of cross-domain latent growth models.

	Model 1[a]		Model 2[b]	
	β[c]	s.e.	β[c]	s.e.
Control variables				
Effects on cognitive functioning				
Age	−0.41***	0.02	−0.41***	0.02
Gender (1 = female)	0.13***	0.02	0.13***	0.02
Education	0.43***	0.02	0.43***	0.02
Physical functioning	0.23***	0.02	0.23***	0.02
Effects on support				
Age	−0.08*	0.03	0.08	0.04
Gender (1 = female)	0.35***	0.02	−0.02	0.03
Education	0.12***	0.03	−0.05	0.03
Physical functioning	0.05	0.03	−0.12**	0.03
Effects on loneliness				
Age	0.15***	0.03	0.16***	0.03
Gender (1 = female)	0.03	0.02	−0.00	0.02
Education	0.00	0.02	0.00	0.02
Physical functioning	−0.18***	0.03	−0.18***	0.03
Support and cognitive functioning (CF)[d]				
Effect intercept em. support on slope CF	0.13*	0.06		
Effect intercept CF on slope em. support	0.01	0.06		
Effect intercept inst. support on slope CF			−0.19*	0.07
Effect intercept CF on slope inst. support			−0.07	0.07
Loneliness and cognitive functioning (CF)[d]				
Effect intercept loneliness on slope CF	−0.17*	0.06	−0.22***	0.06
Effect intercept CF on slope loneliness	−0.17*	0.07	−0.25**	0.08
Support and loneliness[d]				
Effect intercept em. support on slope loneliness	−0.29**	0.09		
Effect intercept loneliness on slope em. support	−0.31***	0.06		
Effect intercept inst. support on slope loneliness			−0.24**	0.09
Effect intercept loneliness on slope inst. support			−0.26**	0.08
Fit statistics				
χ^2 (*df*)	715.66 (130)		632.25 (130)	
RMSEA	0.05		0.04	
CFI	0.95		0.95	
SRMR	0.13		0.12	
N	2255		2255	

Note. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
[a] Model 1 uses emotional support.
[b] Model 2 uses instrumental support.
[c] Standardized coefficients.
[d] Em. = emotional, inst. = instrumental, CF = cognitive functioning.

can have alarming consequences for the aging population, as loneliness increases with age, especially in the old–old (Dykstra, Van Tilburg, & Gierveld, 2005; Pinquart & Sörensen, 2001), and 42% of adults over 65 years reported being lonely at least sometimes in our data. More research is needed to identify the antecedents and consequences of social networks, and to develop preventive policy advices against the growing problem of demented diseases in the future.

References

Aartsen, M., Smits, C., Van Tilburg, T., Knipscheer, K., & Deeg, D. (2002). Activity in older adults: cause or consequence of cognitive functioning? A longitudinal study on everyday activities and cognitive performance in older adults. *Journals of Gerontology Series B – Psychological Sciences and Social Sciences, 57*(2), P153–P162.

Aartsen, M., Van Tilburg, T., Smits, C., & Knipscheer, K. (2004). A longitudinal study of the impact of physical and cognitive decline on the personal network in old age. *Journal of Social and Personal Relationships, 21*(2), 249–266.

Amieva, H., Stoykova, R., Matharan, F., Helmer, C., Antonucci, T. C., & Dartigues, J. (2010). What aspects of social network are protective for dementia? Not the quantity but the quality of social interactions is protective up to 15 years later. *Psychosomatic Medicine, 72*(9), 905–911.

Ashida, S., & Heaney, C. A. (2008). Differential associations of social support and social connectedness with structural features of social networks and the health status of older adults. *Journal of Aging and Health, 20*(7), 872–893.

Barnes, L., Mendes de Leon, C., Wilson, R., Bienias, J., & Evans, D. (2004). Social resources and cognitive decline in a population of older African Americans and Whites. *Neurology, 63*(12), 2322–2326.

Bassuk, S., Glass, T., & Berkman, L. (1999). Social disengagement and incident cognitive decline in community-dwelling elderly persons. *Annals of Internal Medicine, 131*(3), 165–173.

Baumeister, R., Twenge, J., & Nuss, C. (2002). Effects of social exclusion on cognitive processes: anticipated aloneness reduces intelligent thought. *Journal of Personality and Social Psychology, 83*(4), 817–827.

Bennett, D., Schneider, J., Tang, Y., Arnold, S., & Wilson, R. (2006). The effect of social networks on the relation between Alzheimer's disease pathology and level of cognitive function in old people: a longitudinal cohort study. *Lancet Neurology, 5*(5), 406–412.

Berkman, L., Glass, T., Brissette, I., & Seeman, T. (2000). From social integration to health: Durkheim in the new millennium. *Social Science & Medicine, 51*(6), 843–857.

Bernardon, S., Babb, K. A., Hakim-Larson, J., & Gragg, M. (2011). Loneliness, attachment, and the perception and use of social support in university students. *Canadian Journal of Behavioural Science – Revue Canadienne Des Sciences Du Comportement, 43*(1), 40–51.

Brayne, C., Gill, C., Paykel, E. S., Huppert, F., & O'Connor, D. W. (1995). Cognitive decline in an elderly population – a two wave study of change. *Psychological Medicine, 25*, 673–683.

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences, 13*(10), 447–454.

Cacioppo, J. T., Hawkley, L. C., & Thisted, R. A. (2010). Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychology and Aging, 25*(2), 453–463.

Cacioppo, J. T., Norris, C. J., Decety, J., Monteleone, G., & Nusbaum, H. (2009). In the eye of the beholder: individual differences in perceived social isolation predict regional brain activation to social stimuli. *Journal of Cognitive Neuroscience, 21*(1), 83–92.

Carstensen, L. (1993). Motivation for social contact across the life-span – a theory of socioemotional selectivity. *Nebraska Symposium on Motivation, 40*, 209–254.

Cohen, S., & Wills, T. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98*(2), 310–357.

De Jong Gierveld, J., & Kamphuis, F. (1985). The development of a Rasch-type loneliness scale. *Applied Psychological Measurement, 9*(3), 289–299.

Dickinson, W. J., Potter, G. G., Hybels, C. F., McQuoid, D. R., & Steffens, D. C. (2011). Change in stress and social support as predictors of cognitive decline in older adults with and without depression. *International Journal of Geriatric Psychiatry, 26*(12), 1267–1274.

Dik, M., Deeg, D., Visser, M., & Jonker, C. (2003). Early life physical activity and cognition at old age. *Journal of Clinical and Experimental Neuropsychology, 25*(5), 643–653.

Duncan, S., Duncan, T., & Strycker, L. (2000). Risk and protective factors influencing adolescent problem behavior: a multivariate latent growth curve analysis. *Annals of Behavioral Medicine, 22*(2), 103–109.

Duncan, T., & McAuley, E. (1993). Social support and efficacy cognitions in exercise adherence – a latent growth curve analysis. *Journal of Behavioral Medicine, 16*(2), 199–218.

Dykstra, P., Van Tilburg, T., & Gierveld, J. (2005). Changes in older adult loneliness – results from a seven-year longitudinal study. *Research on Aging, 27*(6), 725–747.

Ertel, K. A., Glymour, M. M., & Berkman, L. (2008). Effects of social integration on preserving memory function in a nationally representative US elderly population. *American Journal of Public Health, 98*(7), 1215–1220.

Ferri, C., Prince, M., Brayne, C., Brodaty, H., Fratiglioni, L., Ganguli, M., & Alzheimer's Disease International. (2005). Global prevalence of dementia: a Delphi consensus study. *Lancet, 366*(9503), 2112–2117.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). Mini-mental state – practical method for grading cognitive state of patients for clinician. *Journal of Psychiatric Research, 12*(3), 189–198.

Fratiglioni, L., Paillard-Borg, S., & Winblad, B. (2004). An active and socially integrated lifestyle in late life might protect against dementia. *Lancet Neurology, 3*(6), 343–353.

Glymour, M. M., Weuve, J., Fay, M. E., Glass, T., & Berkman, L. (2008). Social ties and cognitive recovery after stroke: does social integration promote cognitive resilience? *Neuroepidemiology, 31*(1), 10–20.

Gow, A. J., Pattie, A., Whiteman, M. C., Whalley, L. J., & Deary, I. J. (2007). Social support and successful aging: investigating the relationships between lifetime cognitive change and life satisfaction. *Journal of Individual Differences, 28*, 103–115.

Haber, M. G., Cohen, J. L., Lucas, T., & Baltes, B. B. (2007). The relationship between self-reported received and perceived social support: a meta-analytic review. *American Journal of Community Psychology, 39*(1), 133–144.

Hawkley, L. C., Burleson, M. H., Berntson, G. G., & Cacioppo, J. T. (2003). Loneliness in everyday life: cardiovascular activity, psychosocial context, and health behaviors. *Journal of Personality and Social Psychology, 85*(1), 105–120.

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: a theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40*(2), 218–227.

Heinrich, L. M., & Gullone, E. (2006). The clinical significance of loneliness: a literature review. *Clinical Psychology Review, 26*(6), 695–718.

Helgeson, V. S. (1993). Two important distinctions in social support: kind of support and perceived versus received. *Journal of Applied Social Psychology, 23*(10), 825–845.

Hirschfeld, R. (2000). History and evolution of the monoamine hypothesis of depression. *Journal of Clinical Psychiatry, 61*, 4–6.

Holmen, K., Ericsson, K., & Winblad, B. (2000). Social and emotional loneliness among non-demented and demented elderly people. *Archives of Gerontology and Geriatrics, 31*(3), 177–192.

Holtzman, R., Rebok, G., Saczynski, J., Kouzis, A., Doyle, K., & Eaton, W. (2004). Social network characteristics and cognition in middle-aged and older adults. *Journals of Gerontology Series B – Psychological Sciences and Social Sciences, 59*(6), P278–P284.

Huisman, M., Poppelaars, J., Van der Horst, M., Beekman, A., Brug, J., Van Tilburg, T., et al. (2011). Cohort profile: the Longitudinal Aging Study Amsterdam. *International Journal of Epidemiology, 40*(4), 868–876.

Hultsch, D., Hertzog, C., Small, B., & Dixon, R. (1999). Use it or lose it: engaged lifestyle as a buffer of cognitive decline in aging? *Psychology and Aging, 14*(2), 245–263.

James, B. D., Wilson, R. S., Barnes, L. L., & Bennett, D. A. (2011). Late-life social activity and cognitive decline in old age. *Journal of the International Neuropsychological Society, 17*(6), 998–1005.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York, London: The Guilford Press.

Krueger, K. R., Wilson, R. S., Kamenetsky, J. M., Barnes, L. L., Bienias, J. L., & Bennett, D. A. (2009). Social engagement and cognitive function in old age. *Experimental Aging Research, 35*(1), 45–60.

Lou, L. L., Yan, Z., Nickerson, A., & McMorris, R. (2012). An examination of the reciprocal relationship of loneliness and Facebook use among first-year college students. *Journal of Educational Computing Research, 46*(1), 105–117.

MacKinnon, D. P. (2008). *Introduction to statistical mediation analysis*. New York: LEA.

Masi, C. M., Chen, H., Hawkley, L. C., & Cacioppo, J. T. (2011). A meta-analysis of interventions to reduce loneliness. *Personality and Social Psychology Review, 15*(3), 219–266.

Newcomb, M. D., & Bentler, P. M. (1986). Loneliness and social support – a confirmatory hierarchical analysis. *Personality and Social Psychology Bulletin, 12*(4), 520–535.

Newsom, J., Rook, K., Nishishiba, M., Sorkin, D., & Mahan, T. (2005). Understanding the relative importance of positive and negative social exchanges: examining specific domains and appraisals. *Journals of Gerontology Series B – Psychological Sciences and Social Sciences, 60*(6), P304–P312.

O'Donovan, A., & Hughes, B. (2007). Social support and loneliness in college students: effects on pulse pressure reactivity to acute stress. *International Journal of Adolescent Medicine and Health, 19*(4), 523–528.

Pinquart, M., & Sörensen, S. (2001). Influences on loneliness in older adults: a meta-analysis. *Basic & Applied Social Psychology, 23*(4), 245–266.

Pitkala, K. H., Routasalo, P., Kautiainen, H., Sintonen, H., & Tilvis, R. S. (2011). Effects of socially stimulating group intervention on lonely, older people's cognition: a randomized, controlled trial. *American Journal of Geriatric Psychiatry, 19*(7), 654–663.

Raven, J. C. (1995). *Manual for the coloured progressive matrices (revised)*. Windsor, UK: NFRE-Nelson.

Reinhardt, J. P., Boerner, K., & Horowitz, A. (2006). Good to have but not to use: differential impact of perceived and received support on well-being. *Journal of Social and Personal Relationships, 23*(1), 117–129.

Salthouse, T. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*(3), 403–428.

Sapolsky, R., Krey, L., & McEwen, B. (1986). The neuroendocrinology of stress and aging – the glucocorticoid cascade hypothesis. *Endocrine Reviews, 7*(3), 284–301.

Savage, D. (1984). *Alphabet coding task*. Western Australia: Murdoch University.

Seeman, T. E., Lusignolo, T. M., Albert, M., & Berkman, L. (2001). Social relationships, social support, and patterns of cognitive aging in healthy, high-functioning older adults: MacArthur Studies of Successful Aging. *Health Psychology, 20*(4), 243–255.

Stephens, C., Alpass, F., Towers, A., & Stevenson, B. (2011). The effects of types of social networks, perceived social support, and loneliness on the health of older people: accounting for the social context. *Journal of Aging and Health, 23*(6), 887–911.

Stevens, N., & Van Tilburg, T. (2000). Stimulating friendship in later life: a strategy for reducing loneliness among older women. *Educational Gerontology, 26*(1), 15–35.

Steverink, N., & Lindenberg, S. (2006). Which social needs are important for subjective well-being? What happens to them with aging? *Psychology and Aging, 21*(2), 281–290.

Tilvis, R., Pitkala, K., Jolkkonen, J., & Strandberg, T. (2000). Social networks and dementia. *Lancet, 356*(9223), 77–78.

Uchino, B. N. (2009). Understanding the links between social support and physical health: a life-span perspective with emphasis on the separability of perceived and received support. *Perspectives on Psychological Science, 4*(3), 236–255.

Uchino, B. N., Bowen, K., Carlisle, M., & Birmingham, W. (2012). Psychological pathways linking social support to health outcomes: a visit with the "ghosts" of research past, present, and future. *Social Science & Medicine, 74*(7), 949–957.

Van Tilburg, T. (1990). The size of the supportive network in association with the degree of loneliness. In C. Knipscheer, & T. Antonucci (Eds.), *Social network research: Substantive issues and methodological questions* (pp. 137–150). Lisse: Swets & Zeitlinger.

Van Tilburg, T. (1998). Losing and gaining in old age: changes in personal network size and social support in a four-year longitudinal study. *Journals of Gerontology Series B – Psychological Sciences and Social Sciences, 53*(6), S313–S323.

Wang, H., Karp, A., Winblad, B., & Fratiglioni, L. (2002). Late-life engagement in social and leisure activities is associated with a decreased risk of dementia: a longitudinal study from the Kungsholmen project. *American Journal of Epidemiology, 155*(12), 1081–1087.

Willett, J. B., & Sayer, A. G. (1996). Cross-domain analysis of change over time. Combining growth modeling and covariance structure analysis. In G. A. Marcoulides, & R. E. Schumacker (Eds.), *Advanced structural equation modeling: Issues and techniques* (pp. 125–157). Mahwah, New Jersey: Lawrence Erlbaum.

Wilson, R. S., Begeny, C. T., Boyle, P. A., Schneider, J. A., & Bennett, D. A. (2011). Vulnerability to stress, anxiety, and development of dementia in old age. *American Journal of Geriatric Psychiatry, 19*(4), 327–334.

Wilson, R. S., Krueger, K. R., Arnold, S. E., Schneider, J. A., Kelly, J. F., Barnes, L. L., et al. (2007). Loneliness and risk of Alzheimer disease. *Archives of General Psychiatry, 64*(2), 234–240.

Winningham, R. G., & Pike, N. L. (2007). A cognitive intervention to enhance institutionalized older adults' social support networks and decrease loneliness. *Aging & Mental Health, 11*(6), 716–721.

Zunzunegui, M., Alvarado, B., Del Ser, T., & Otero, A. (2003). Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. *Journals of Gerontology Series B – Psychological Sciences and Social Sciences, 58*(2), S93–S100.