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Does widowhood affect memory performance of older persons?

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ABSTRACT

Background. The loss of a spouse has been found to have a negative effect on physical and mental health and leads to increased mortality. Whether conjugal bereavement also affects memory functioning has largely been unexamined. The present study investigates the effect of widowhood on memory functioning in older persons.

Method. The sample consisted of 474 married women and 690 married men aged 60–85 years in 1992, followed up in 1995 and 1998. During the study 135 (28%) of the women and 69 (10%) of the men lost their spouse. Linear regression analysis was used to examine whether widowed men and women differed from those who had not been widowed in rate of memory change over 6 years. Cross-domain latent-change models were subsequently used to evaluate the extent to which changes in memory are related to changes in other domains of functioning that may be affected by widowhood.

Results. Older adults who lost a spouse during follow-up showed a greater decline in memory over 6 years than those who remained married. A higher level of depressive symptoms at baseline was related to lower levels of memory functioning and a greater decline. Memory decline was unrelated to changes in depressive symptoms and physical health.

Conclusions. Loss of the spouse is related to a greater decline in memory in older adults. The absence of an association with physical functioning and the weak association with mental functioning suggest that losing a spouse has an independent effect on memory functioning.

INTRODUCTION

Loss of the spouse is often considered one of the most important negative life events, having far-reaching consequences. Studies on bereavement consistently show that losing a spouse is related to increased mortality (for an overview see Bowling, 1987), depression (Gallagher-Thompson *et al.* 1993; Byrne & Raphael, 1994; Bennett, 1998), and physical illness (Parkes, 1996). One factor potentially responsible for the direct negative effect of bereavement on physical and mental functioning is stress (Stroebe & Stroebe, 1983). As a consequence, one could also expect bereavement to have a negative effect on cognitive functioning. Surprisingly, studies on the relationship between cognitive functioning and bereavement are scarce, but a recent cross-sectional community-based study observed lower memory performance among older persons who had experienced grief, suggesting that bereavement had a negative effect on memory functioning (Xavier *et al.* 2002). However, because of the cross-sectional nature of this particular study, no conclusions could be made about a causal relationship between bereavement and memory functioning.

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Memory may be affected by bereavement via different pathways. High levels of stress negatively affect memory functioning (Newcomer *et al.* 1999; Sapolsky, 1999, 2000). Unfortunately, our study lacks measures of stress, but we do have measures of physical and mental health to evaluate an indirect effect of bereavement on memory. For example, reduced physical health due to bereavement may also lead to reduced levels of memory functioning. Furthermore, the loss of a loved one may lead to depressed mood (Gallagher-Thompson *et al.* 1993), which is found to be related to lower levels of memory functioning (McBride & Abeles, 2000).

The negative influence of bereavement on physical and mental health often fades over time. However, the length of time over which the negative consequences of widowhood seem to disappear differs greatly from person to person. While Shuchter & Zisook (1993) found that the majority of recently widowed persons no longer suffer from depressive symptoms after 25 months, Barrett & Schneweis (1980) suggest that the stresses of widowhood persist for many years after the spouse's death. This suggests that some widowed people recover after a period of severe stress, implying that the length of the bereavement period after the death of the spouse could be related to memory performance.

The central question in the present study is whether the loss of the spouse leads to a memory decline in older persons, greater than the general effect of ageing, and if so, to what extent is the decline in memory functioning the consequence of changes in other domains of functioning that are affected by spousal bereavement? More specifically, if there is an effect of bereavement on memory decline, we will investigate whether the greater memory decline is the consequence of lower levels of physical and mental health at baseline and whether changes in these domains are related to changes in memory. People who are in poor physical and mental health at baseline may be more susceptible to the effects of bereavement than people in better health. For example, Zisook *et al.* (1997) observed in a prospective study among widows and widowers that depression prior to the death of the spouse predicted an increased risk for major depression following bereavement. There are also indications that men suffer more from bereavement than women (e.g. Stroebe & Stroebe, 1983; Lee *et al.* 2001), therefore, we will also evaluate the interaction between gender and widowhood. The analyses will be controlled for age and level of education.

METHOD

Sample

Data are derived from the Longitudinal Ageing Study Amsterdam (LASA), which is an ongoing longitudinal, multidisciplinary research project focusing on autonomy and well-being in the ageing population (Deeg *et al.* 1993). The LASA sample is stratified by birth year and gender, and there is an over-sampling of older and male subjects. The sample is drawn from the population registries of 11 municipalities in three culturally distinct geographical areas in The Netherlands. The LASA sample was initially recruited for the study 'Living arrangements and Social Networks of older persons' (LSN) (Knipscheer *et al.* 1995). Of the LSN sample ($n = 3805$), 3107 persons aged 55–85 years took part in the first LASA cycle (T_1) (1992/1993). Of the 698 LSN respondents who did not participate in the LASA study, 126 (18%) had died and 134 (19%) were unable to participate in the study because of severe physical or mental health problems. In addition, 394 (56%) refused to be re-interviewed, and 44 (6%) could not be contacted. At T_2 (1995/1996), 2545 respondents (82% of the T_1 respondents) participated, and 2076 (67% of the T_1 respondents) were re-interviewed at T_3 (1998/1999).

For the present study, we selected respondents aged 60 years and over as the youngest birth cohort (55–60 years) was excluded for measures of memory performance at follow-up. We further selected only people who were married at baseline, resulting in a study sample of 1144. During follow-up, 135 women and 69 men (18% of the sample in total) lost their spouse. Attrition between T_1 and T_3 was not related to level of education or depressive symptoms, but to lower memory performance at baseline: 1·2 points lower on the 15 Words Test (Saan & Deelman, 1986). Being male, having greater age (4·5 years older), suffering from a number of chronic diseases (0·3 more diseases), or having a lower level of functional ability (1·0 lower on a 12-point scale) were also all significantly ($p < 0{\cdot}05$) related to attrition. Despite this

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selective attrition, at baseline there was still a fairly large proportion (33%) of respondents with two or more diseases, 9% had difficulty performing at least two functional tasks, and 14% remembered fewer than 4 out of 15 words after three learning trials. This indicate that the survivors are not extremely healthy.

At all observations (T_1, T_2 and T_3), data on the participants were collected by means of two face-to-face interviews and a self-administered questionnaire. With respect to the variables used in this study, the same instruments were used in each data-collection cycle.

MEASURES

Dependent variables

The 15 Words Test (Saan & Deelman, 1986), derived from the Auditory Verbal Learning Test (Rey, 1964), was chosen for the assessment of memory functioning. The test procedure started with a verbal presentation of 15 words by the interviewer. Immediately after the presentation, the respondent was asked to repeat as many words as possible. The same procedure took place another twice more, using the same 15 words. Subsequently, for a duration of approximately 20 minutes, the respondent performed a different non-verbal task. After this, to obtain an indication of the delayed-recall function, the respondent was asked to recall as many words as possible. The respondent was not prepared for this last trial. For subsequent cycles, parallel versions of the 15 listed words were used. The words of the parallel versions are comparable with respect to the frequency of daily occurrence, number of syllables, the stage at which they are acquired during life, and mental imagery. The scores on the 15 Words Test consisted of the number of words correctly remembered per trial, resulting in a score ranging between 0 and 15 for each attempt.

Explanatory variables

Age, gender, and level of education were included because of their association with cognitive functioning and because of the association of age and gender with widowhood. Level of education was measured by asking the respondents about the highest educational level attained, resulting in a nine-category variable ranging from 1 (elementary school, not completed) to 9 (university education). Length of widowhood was based on the date of death of the spouse and was converted to months of bereavement, counting from the last measurement (T_3).

Physical health was measured with two indices: functional ability and number of diseases. Functional ability was based on the ability to perform three activities: walking up and down a 15-step staircase without having to stop, using own or public transport, and cutting one's own toenails (Kriegsman *et al.* 1997). Response categories ranged from 1 (not able to carry out the activity) to 5 (no difficulty), with a sum score ranging from 3 to 15 and a higher score indicating a higher level of physical ability. Physical abilities are reliably measured (Cronbach's $\alpha > 0{\cdot}82$ at the three observations). The number of diseases was determined by asking the respondents whether they currently, or previously, had any of the following diseases: cardiac disease, peripheral atherosclerosis, stroke, diabetes mellitus, chronic non-specific lung disease (i.e. asthma, chronic bronchitis, or emphysema), cancer, osteoarthritis, or rheumatoid arthritis. Answers were coded 'yes' or 'no'.

Mental health was measured with the Dutch version of the Centre for Epidemiologic Studies Depression Scale (CES-D), which is a 20-item self-report scale designed to measure depressive symptoms in the general population (Radloff, 1977), with good psychometric properties (Beekman *et al.* 1994). Scores on the CES-D range from 0 to 60, with higher scores indicating higher levels of depressive symptoms (Cronbach's $\alpha > 0{\cdot}86$ at the three observations).

Procedure

The analyses included three steps. We started with a calculation of the proportions of respondents in each subgroup (men and women, widowed or not) who showed memory decline or not over 6 years. For this analysis we dichotomized memory change into decline and no decline by using the Edwards–Nunally difference score (Speer, 1992). This method takes into account the reliability of the test and regression to the mean. Decline was judged to be significant when p was smaller than 0·10. Next, with a hierarchical linear regression analysis, we estimated whether widowed men and women showed a greater decline in memory function

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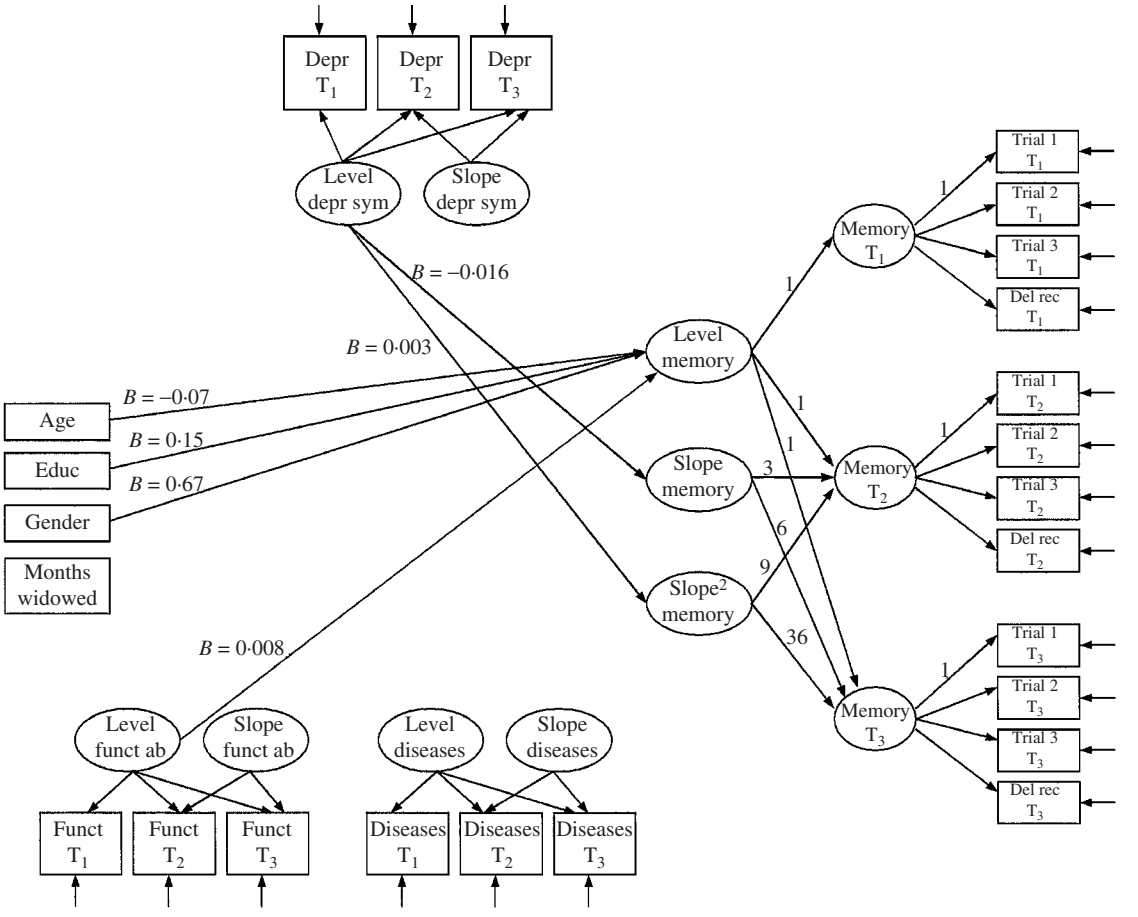


FIG. 1. Cross-domain latent-change model for adults who lost their spouse during follow-up. Note: latent variables are enclosed by ellipses; observed variables are enclosed by boxes. A one-headed arrow indicates a direct effect. To facilitate the readability of the figure, only the significant effects are presented. Funct ab, functional ability; Educ, level of education; Depr, level of depressive symptoms; Del rec, delayed recall. The numbers 1, 3, 6, 9 and 36 correspond to the value at which these factor loadings were fixed.

(continuous outcome) than men and women who were not widowed, and whether there was a difference in the rate of decline between widowed men and women. The regression analysis was done in a stepwise procedure by entering baseline memory performance, widowhood, and gender in the first step, and widowhood × gender in the second step. The level of memory used in the difference-score analysis and the linear regression analysis reflects the mean on the first three trials of the 15 Words Test and the delayed-recall score.

Analysis based on observed scores must be interpreted with caution, however, because the analyses summarize observed rather than true change. It is possible that observed change could be attributed to measurement error rather than to true change (Willett & Sayer, 1994). Furthermore, we are interested in associations in change across several domains of functioning. Such an analysis is complicated, if not impossible, with conventional regression techniques. Finally, change in memory performance is often not linear because of the learning effect. Therefore, we applied a structural equation model [cross-domain latent-change model (Willett & Sayer, 1996)] to estimate cross-domain relationships, taking into account the influence of measurement errors and the nonlinearity of change in memory performance (see Fig. 1). Cross-domain latent-change models make it possible to estimate an individual's initial level of

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memory functioning (intercept), rates of linear (slope) and nonlinear (e.g. quadratic slope) change, as well as the levels and rates of change of physical health (number of diseases and functional ability) and mental health (depressive symptoms).

Three models were estimated. Model 1 was the unconditional model, which is the model in which we controlled for age, and level of education. No further predictors of change were included. This model estimates the true level and true rate of change in memory performance. By estimating these parameters, the latent-change trajectories of memory for those widowed and not widowed can be calculated. Level and rate of change in memory performance was controlled for the effect of age, gender, and level of education. Model 2 was an extension of Model 1, including the explanatory variables physical and mental health at baseline, as well as the length of widowhood for those who had been widowed. With the third model, we estimated the correlation between changes in the three distinguished domains of functioning. As there might be interactions between widowhood and potential predictors of change, we estimated the latent-change models separately for those who had been and those who had not been widowed.

Fig. 1 is a graphical representation of the supposed relationships between the study variables. Observed variables are enclosed by boxes, not observed or latent variables are enclosed by ellipses. A straight arrow reflects a significant effect of a certain variable on another variable. In Fig. 1 only the significant effects are printed. The basic idea behind latent-growth models is that the observed scores are, according to the classical test theory, the result of a true underlying latent trait plus a measurement error. This true latent score may change over time, and if there are more than one measurement occasions, the true latent scores can be decomposed into 'level' of performance and 'slope' or rate of change in performance. The level and slope are also referred to as latent-growth parameters (Willett & Sayer, 1994) as with these parameters the level of functioning and the trajectory of change are given. If there are three or more measurement occasions, even the amount of nonlinear change (e.g. quadratic change) can be estimated. In order to decompose the latent variables into the latent-growth parameters, the factor loadings need to be fixed at a certain value (in our case 1, 3, 6, 9, 36). The factor loadings of the memory performance indicators were constrained to be equal across time (factorial invariance) to ensure that the same concept was measured over time.

We allowed the level and slope of memory to covary, which means that we estimated the covariation between initial level of memory and rate of change. A significant covariation between level and slope of memory indicates that the baseline level of memory functioning is predictive of the rate of decline. The models were estimated with Mplus2.1 (Muthén & Muthén, 2001). The fit of the model was evaluated as good when the comparative fit index (CFI) was $>0{\cdot}95$, root mean square error of approximation (RMSEA) was $<0{\cdot}06$, and the standardized root mean square residual (SRMR) was $<0{\cdot}08$. The latent-change models were estimated with Mplus2.1 (Muthén & Muthén, 2001).

Because attrition was related to most of the study variables, missing values in our study sample must be considered to be missing at random (MAR; Enders, 2001). If missing values were missing completely at random (MCAR), than ignoring cases containing missing values would not affect the estimates of the parameters. If observations are MAR which is the case when the probability of values being missing can be predicted by variables that are not missing (Muthén & Muthén, 2001), then a better approach is to use incomplete data and estimate all missing values based on observation of the variables that are not missing. The program Mplus2.1 copes with the missing data on the assumption that data are MAR.

RESULTS

We observed that the respondents who were not widowed during the study were, at baseline, in a more favourable condition on average than those who lost their spouse during the study (Table 1). Those who were not widowed were younger, had higher levels of education and functional ability, were less depressed, and had fewer diseases. However, within a multivariate logistic regression model only age and gender were predictive of being widowed at follow-up.

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Table 1. *Baseline and follow-up characteristics of the study sample by widowhood (observed data)*

	T_1						T_2						T_3					
	Not widowed at follow-up ($n=940$)		Widowed at follow-up ($n=204$)		Test statistics		Not widowed at follow-up ($n=920$)		Widowed at follow-up ($n=193$)		Test statistics		Not widowed at follow-up ($n=729$)		Widowed at follow-up ($n=178$)		Test statistics	
	Mean	S.D.	Mean	S.D.	t, χ^2	p	Mean	S.D.	Mean	S.D.	t, χ^2	p	Mean	S.D.	Mean	S.D.	t, χ^2	p
Age (years)	69·7	6·6	72·8	6·6	−6·1	0·00	72·7	6·6	75·8	6·6	−5·9		74·6	6·3	78·2	6·4	−6·9	0·00
Gender (% women)	36		66		62·6	0·00	36		66		62·5	0·00	38		70		61·9	0·00
Level of education (1–9)	3·7	1·9	3·0	1·8	4·5	0·00												
Memory (mean of four trials) (0–15)	6·1	2·1	5·9	2·1	0·9	0·37	6·2	2·4	5·7	2·5	2·0	0·04	6·0	2·3	5·4	2·3	3·0	0·00
Functional ability (3–15)	13·7	2·4	13·1	2·8	3·0	0·00	13·3	2·9	12·7	2·9	2·7	0·00	13·0	2·1	11·7	3·7	4·0	0·00
Number of diseases (0–8)	1·2	1·1	1·4	1·1	−2·7	0·01	1·4	1·2	1·5	1·0	−1·2	0·24	1·6	1·2	1·7	1·3	−1·6	0·12
Depressive symptoms (CES-D, 0–60)	5·9	6·4	8·1	7·4	−4·0	0·00	6·4	7·0	10·0	8·3	−5·4	0·00	7·4	7·0	11·6	8·2	−6·9	0·00

Odds ratios (95% CI) are 1·1 (1·08–1·15) for age and 5·1 (3·39–7·75) for gender.

Proportions of change in memory

According to the Edwards–Nunally difference score, it appeared that memory decline was most often observed among widowed men (33%), followed by widowed women (19%). Memory decline was also observed in people who had not been widowed, although the percentages were lower for both men (17%) and women (13%), being much lower for men. Differences in memory decline between widowed persons and those who had not been widowed were significant for men ($\chi^2_{(1)}=6{\cdot}4$, $p<0{\cdot}05$) but not for women ($\chi^2_{(1)}=2{\cdot}3$, $p=0{\cdot}13$). The change scores are based on complete cases.

Next, we conducted a stepwise hierarchical regression analysis to see whether these gender differences are sustained when continuous differences scores are used, and whether there is an interaction effect between gender and widowhood. Both gender and widowhood predicted the level of memory performance at T_3. Individuals who had lost their spouse during follow-up scored, on average, 0·66 lower on the memory test at T_3 than people who had remained married. Women outperformed men with respect to the level of memory (0·35 higher, on average). Because the interaction between gender and widowhood was not significant, and the reduction of unexplained variance was zero, we concluded that the differences between men and women in rate of memory decline after widowhood are not significant. Note that the estimates of the proportions of change (first analysis) and the linear regression models (second analysis) are based on complete data and on observed scores and may differ slightly from the estimates of the latent scores (which are presented below) in which measurement error and missing values were taken into account.

Predictors of change in memory with cross-domain latent-change models

The cross-domain latent-change models fitted the data adequately, as indicated by the five fit statistics (rows 20–24 in Table 2). The first three rows of Table 2 describe the latent intercept and rate of change in memory performance, controlling for age, level of education and

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Table 2. *Latent change in memory performance, unstandardized effects (B's) of functional ability, number of diseases and depressive symptoms on intercept and (nonlinear) change in memory by widowhood status*

		Model 1[a]						Model 2[a]						Model 3[a]					
		Not widowed			Widowed			Not widowed			Widowed			Not widowed			Widowed		
		Mean	S.E.	*t*	Mean	S.E.	*t*	Mean	S.E.	*t*	Mean	S.E.	*t*	Mean	S.E.	*t*	Mean	S.E.	*t*
Intercept memory (level)	1	4·57	0·05	86·04	4·29	0·11	39·55	4·56	0·05	86·04	4·30			4·56			4·30		
Linear change memory (slope)	2	0·06	0·02	2·71	0·03	0·04	0·63	0·08	0·02	2·71	–			0·08			–		
Quadratic change memory (slope²)	3	−0·02	0·03	−4·78	−0·02	0·01	−2·43	−0·02	0·03	−4·78	−0·02			−0·02			−0·02		
Covariance intercept memory and linear change memory	4	0·01	0·03	0·44	−0·03	0·05	−0·63	0·00	0·02	0·01	−0·05	0·04	−1·15	0·00	0·02	0·08	−0·04	0·04	−1·07
Months widowed on intercept memory	5										−0·01	0·00	−1·71						
Months widowed on linear change memory	6										0·00	0·00	1·33						
Months widowed on nonlinear change memory	7										0·00	0·00	−1·34						
Baseline depressive symptoms on intercept memory	8							−0·02	0·01	−1·72	0·00	0·01	−1·03						
Baseline depressive symptoms on linear change memory	9							−0·01	0·00	−1·42	−0·02	0·01	−2·83						
Baseline depressive symptoms on nonlinear change memory	10							0·00	0·00	0·89	0·003	0·00	2·73						
Baseline physical ability on intercept memory	11							0·07	0·02	3·43	0·08	0·04	2·22						
Baseline physical ability on linear change memory	12							0·00	0·01	0·20	0·01	0·02	0·74						
Baseline physical ability on nonlinear change memory	13							−0·00	0·00	−0·45	−0·00	0·00	−0·19						
Baseline no. of diseases on intercept memory	14							0·02	0·04	0·53	0·09	0·08	1·15						
Baseline no. of diseases on linear change memory	15							−0·03	0·02	−1·34	0·02	0·04	0·62						
Baseline no. of diseases on nonlinear change memory	16							0·00	0·00	0·93	−0·00	0·01	−0·34						
Correlation change depressive symptoms and change memory	17													0·00	0·01	0·26	0·01	0·02	0·27
Correlation change physical health and change memory	18													0·01	0·00	1·80	−0·01	0·01	−0·88
Correlation change no. diseases and change memory	19													−0·00	0·00	−0·94	0·00	0·00	0·05
Fit statistics																			
χ^2	20	408·06			58·89			509·30			135·37			647·43			232·96		
df	21	54			54			108			17			204			204		
CFI	22	0·95			1·00			0·95			0·99			0·96			0·99		
RMSEA	23	0·09			0·02			0·06			0·03			0·05			0·03		
SRMR	24	0·11			0·08			0·08			0·06			0·06			0·06		

df, degrees of freedom; CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual, –, fixed to zero.
[a] Controlling for age, gender, and level of education.

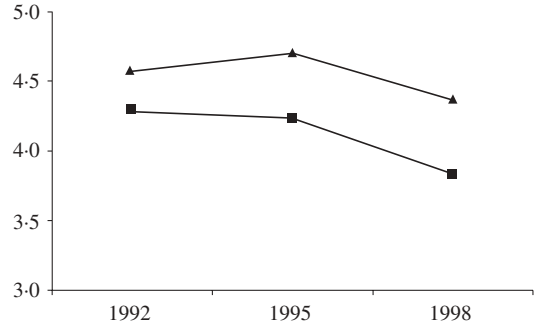


FIG. 2. Latent change in memory by widowhood status. –▲–, Not widowed; –■–, widowed.

gender. The estimated intercept (line 1) reflects the 'true' baseline level of memory performance. The estimated slope and quadratic slope reflect the 'true' yearly rate of change in memory performance. These estimates can be used to calculate the curves of change in memory performance as follows: T_1 level = intercept; T_2 level = intercept + 3 * slope + 9 * slope^2; and T_3 level = intercept + 6 * slope + 36 * slope^2 (Fig. 2).

The non-significant covariance in row 4 between intercept and change of memory indicates that level of memory is not related to the rate of decline. There is a significant linear and nonlinear decline in memory performance for people who had not been widowed. For people who had been widowed by the time of follow-up, only the nonlinear decline in memory performance was significant. As in many tests involving learning, practice effects lead to higher scores at a second measurement (T_2) (Lezak, 1995), causing a nonlinear pattern of change over 6 years. Practice effects could be due to the fact that respondents remembered the delayed-recall test, for which they were unprepared at the first measurement cycle. They may, therefore, have listened more carefully to the words at follow-up, resulting in a better overall score.

Rows 5–7 of Model 2 indicate that length of widowhood was unrelated to the level and rate of change in memory performance. The average length of widowhood was 37 months, and additional analysis revealed no gender difference (results not shown). Rows 8–16 reflect the unstandardized regression effects (*B*'s) of baseline physical and mental health on level and change of memory. Higher levels of depressive symptoms were related to greater changes in memory functioning among people who had been widowed. It can be derived that an increase from 5·9 (not widowed) to 8·1 (widowed) on the CES-D scale results, *ceterus paribus*, in a small decrease of 0·03 on the 15 Words Test. Rows 17–19 indicate that changes in physical and mental health were unrelated to changes in memory performance.

DISCUSSION

We focused on the effect of bereavement on memory functioning in a sample of 1144 older persons who were married at baseline. During the 6 years of follow-up, 219 respondents were widowed. Our central question was whether widowhood has a negative effect on memory. Analogous to the negative effect of bereavement on various aspects of somatic and mental functioning, a negative effect on cognitive functioning was expected. Secondary questions were how initial levels of and changes in memory were related to initial levels of and changes in physical and mental health, controlling for the effect of age, level of education, and gender. We also examined potential gender differences in rate of memory change after widowhood.

Our analysis indicated that, over 6 years, widowed people had a greater memory decline than people who remained married during follow-up. People who remain married showed a mean decline of 0·20 on a 15-point scale. For older adults who had lost their spouse, the mean decline in memory performance was 0·46. Gender differences in the effect of widowhood on memory performance did not reach the level of significance. The length of widowhood did not predict memory performance, suggesting that bereavement causes an irreversible decline in memory performance, at least during the average 37 months of bereavement.

The less favourable starting position of widowed people with respect to physical health and memory could not explain the greater memory decline. Nor was the lower level of memory functioning at baseline related to this decline. Only a higher level of depressive symptoms at baseline was related to greater memory decline, indicating that the loss of the spouse has a stronger impact on memory when people are already depressed prior to the death of the spouse. However, these effects were small: a

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2-point increase on the CES-D scale resulted in a decrease of 0·03 on the 15 Words Test.

The observed levels of depressive symptoms among both widowed people and those who were not widowed were below 16 on average, which is generally judged to indicate no clinically relevant depression (Beekman *et al*. 1994). Moreover, an increase in the level of depressive symptoms is most often a symptom of grief, which is a normal reaction to the loss of a loved one (Stroebe & Stroebe, 1983). Considering depression scores as an indirect measure of grief, we drew a preliminary conclusion that stronger feelings of grief are related to greater memory decline. However, as grief is a multifaceted concept (Shuchter & Zisook, 1993), further research into other aspects of grief and the rate of memory decline is needed.

We ruled out the effect of physical health as an alternative explanation for the negative effects of widowhood on memory performance, and there was a small effect of baseline depressive symptoms on the rate of memory change, both of which provide evidence for the role of stress on memory performance. High levels of stress have a negative effect on memory functioning (Newcomer *et al*. 1999; Sapolsky, 1999, 2000). This negative effect is caused by the production of the stress hormone cortisol. Cortisol affects the hippocampus, which plays a crucial role in learning and memory, especially the consolidation of short-term into long-term memory. However, as cortisol was not measured in our respondents, further research is needed to investigate the relationship of stress, cortisol, and memory.

Some comments on the design of the present study have to be made. First, we were not able to distinguish between a sudden and an anticipated death. Unless death was unexpected, the generation of stress could have started before the actual death of the spouse. Moreover, if the death of the spouse was a relief after a period of suffering, the actual death could mark a decrease in the level of stress. Those who had the greatest stress prior to the beginning of our study might already have had reduced levels of memory functioning that could not be detected in our analyses. However, the use of cross-domain latent-change models makes us feel comfortable about the study results. The replacement of missing values by estimated values based on all other study variables reduced the disadvantage of longitudinal studies where the most vulnerable people are most likely to drop out. Furthermore, the inclusion of measurement errors, which takes into account all sorts of disturbing influences on the measures, contributed to the reliability of the study results.

In sum, our study revealed that losing a spouse is detrimental for memory functioning for both men and women, which was not the result of either change in physical functioning, greater age, or lower levels of education. It appeared that adults who had higher levels of depressive symptoms prior to the death of the spouse were more vulnerable to the negative consequences of losing a spouse than those who had lower levels of depressive symptoms.

Our conclusions are of importance to those who are involved in bereavement counselling. It indicates that people who lose their spouse may benefit from programmes that help to ease the pain of losing a loved one, which possibly reduces the detrimental effects on memory performance. The study also adds to our understanding of the increasing differences in age-associated memory decline between older adults. The findings suggest that stressful live events are one of the factors causing accelerated decline in memory at older age.

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DECLARATION OF INTEREST

None.

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