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## Episodic memory and executive functioning in informal dementia caregivers

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### ABSTRACT

**Objectives:** Informal dementia caregivers are thought to experience high levels of depression and burden, which can contribute to worse cognitive functioning. However, poorer cognitive functioning in caregivers is not always found. The current study explored whether caregivers perform better, worse, or similar to non-caregivers on tasks for executive functioning and memory. Whether sociodemographic and psychosocial characteristics are associated with caregivers' performance was also assessed.

**Methods:** One hundred forty-five caregivers completed the Letter Fluency and Category Fluency, the Logical Memory test from the WMS-III, and five questionnaires assessing psychological characteristics. Standardized z-scores (based on age, education, and sex) were calculated using data from a matched control group (187 non-caregivers). One sample z-tests were executed to examine if the caregivers' standardized mean z-score significantly deviated from the population mean of  $z = 0$ . The z-scores were used as dependent variables in multivariable regression analyses.

**Results:** The caregivers performed significantly better on Logical Memory - Immediate Recall than non-caregivers ( $z = 2.92, p = .004$ ). The obtained z-scores on the other tasks did not deviate significantly from 0. Male sex and social reliance predicted higher scores on Category Fluency, but the F-test was non-significant, and the explained variance was low (adjusted  $R^2 = .068$ ).

**Conclusions:** We found no evidence for poorer cognitive performance among informal caregivers compared to non-caregivers. Our results suggest that caregiving for a loved one with dementia does not impair the caregivers' episodic memory or executive functioning when measured cross-sectionally.

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### KEYWORDS

Caregivers; cognition; dementia; executive functioning; informal

### Introduction

Approximately 131.5 million people in the world will have some form of dementia by 2050 (Prince et al., 2015). Most of these people live at home and depend on informal caregivers, mostly unpaid spouses, children, or other relatives, for their daily care.

Informal caregivers can experience negative consequences, including increased depression and caregiver burden due to their caregiving responsibilities (Dang, Badiye, & Kelkar, 2008; Pinquart & Sörensen, 2003). In addition, previous research showed that caregivers performed significantly worse than non-caregivers on tasks assessing cognitive functioning (Caswell et al., 2003; Corrêa et al., 2015; De Vugt et al., 2006; Mackenzie, Wiprzycka, Hasher, & Goldstein, 2009; Mallya & Fiocco, 2018; Oken, Fonareva, & Wahbeh, 2011; Palma et al., 2011). A possible explanation for poorer cognitive functioning is that caregiving has been associated with high stress levels which has been assessed both subjectively (questionnaires) and objectively (elevated cortisol levels) (Allen et al., 2017). The stress hormone cortisol is able to cross the blood-brain barrier, and since the hippocampus and the prefrontal cortex are vulnerable to the impact of stress due to the dense concentration of cortisol receptors in these brain areas (Lupien, Maheu, Tu, Fiocco, & Schramek, 2007), this could subsequently lead to impaired memory and executive functioning. In fact, it has been found that

stress may mediate the relationship between caregiving and deficits in cognitive functioning (Caswell et al., 2003; Corrêa et al., 2015; Mackenzie et al., 2009; Pertl, Hannigan, Brennan, Robertson, & Lawlor, 2017). In addition, caregivers are thought to have elevated rates of depression (Vitaliano et al., 2009), and anxiety (Mahoney, Regan, Katona, & Livingston, 2005), which are possibly related to higher cortisol levels (Faravelli et al., 2012; Pariante & Lightman, 2008), and fewer social contacts (Vitaliano, 2010), all of which may contribute to poorer cognitive functioning (Vitaliano, Murphy, Young, Echeverria, & Borson, 2011).

Poorer caregiver cognitive functioning can have a detrimental impact on the lives of both the caregiver and the care receiver. Even mild problems with memory and executive functioning can affect the caregivers' ability to provide adequate care which can subsequently affect the quality of life of both members of the dyad (De Vugt et al., 2006; Vitaliano et al., 2009). In addition, when the caregiver can no longer provide care, the likelihood that the person with dementia will be institutionalized rises (Mausbach et al., 2004). Therefore, it is important to know whether or not caregivers have worse memory and/or executive functioning than expected for their age. If this, and the associated sociodemographic and psychosocial factors are known, policy around dementia care could be informed and targeted interventions to enhance the caregivers' cognitive functioning could be developed.

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However, cognitive impairment in caregivers is not always found. For example, Pertl, Lawlor, Robertson, Walsh, and Brennan (2015) found no differences between 179 spousal dementia caregivers and 179 non-caregivers on 11 cognitive tasks. O'Sullivan et al. (2018) found that the performance of 252 spousal dementia caregivers and non-caregivers did not differ on tests for immediate memory, delayed memory, and shifting attention, while the caregivers significantly outperformed non-caregivers on tests assessing reaction time, processing speed, and free recall. The healthy caregiver hypothesis suggests that factors related to caregiving, such as physical and cognitive caregiving demands, may serve to protect caregivers from stress and help to maintain their (cognitive) health as they age (Brown et al., 2009; Fredman, Cauley, Hochberg, Ensrud, & Doros, 2010; Fredman, Lyons, Cauley, Hochberg, & Applebaum, 2015; McCann, Hebert, Bienias, Morris, & Evans, 2004; O'Reilly, Connolly, Rosato, & Patterson, 2008). Proponents of this hypothesis claim that positive aspects associated with caregiving may explain better cognitive functioning among caregivers (Fredman et al., 2008). They argue that caregivers would be more motivated to preserve their health (O'Sullivan et al., 2018), and physical activities associated with caregiving could lead to better caregiver (cognitive) health (Fredman et al., 2008).

These contradictory findings can (partly) be explained by differences in sociodemographic characteristics between study samples (Pertl et al., 2015). For instance, Pertl et al. (2015) found that caregiving was only related to worse cognitive functioning in male (not female) caregivers. In addition, most studies assessed only spousal caregivers (excluding child-caregivers). Spousal caregivers are thought to be at risk for cognitive impairments due to their age, and because they share risk factors for dementia with the person with dementia, such as socio-economic status, and associated behaviors like diet (Hughes & Ganguli, 2009; Vitaliano et al., 2011). Estimations of impaired cognitive functioning might therefore not be generalizable to the entire caregiver population. O'Sullivan et al. (2018) and Roth, Fredman, & Haley, (2015) hypothesized that different findings may stem from different recruitment strategies: caregivers are generally recruited using dementia services and may therefore over-represent those reporting a higher burden (Pinquart & Sörensen, 2003; Pruchno et al., 2008). Non-caregivers on the other hand are typically recruited through (social) media, active retirement and social groups, and therefore tend to be socially active volunteers who are typically healthier than the general population (Okun, Yeung, & Brown, 2013). The disparity in performance between caregivers and non-caregivers can stem from these recruitment differences rather than from actual differences between the groups. Another explanation for the mixed findings of previous studies lies in methodological issues. Overall, studies which reported poorer cognitive functioning in caregivers were typically older and had small sample sizes (between 16 and 56), while the more recent studies of Pertl et al. (2015) and O'Sullivan (2018), did not find worse cognitive functioning and used larger samples (between 179 and 252). Also, the studies used different covariates in the analyses. Although neuropsychological tasks are known to be influenced by age, educational level, and (to a lesser extent) sex (Heaton, Grant, & Matthews,

1986), not all studies used standardized scores or controlled for these covariates. This hinders interpretation and comparison of findings.

This study examined whether informal dementia caregivers performed worse, better, or similar to non-caregivers on tests for executive functioning and memory. In addition, whether sociodemographic and/or psychosocial variables predicted the standardized scores on the cognitive tasks was also explored. We hypothesized that caregivers would perform more poorly on cognitive tests than non-caregivers, because most of the previous findings point to in that direction. In addition, we hypothesized that more depressive symptoms and burden would predict worse cognitive performance.

## Method

### Study design

The current study used the baseline data of a larger (intervention) study, complemented with a control group, and neuropsychological tests. The protocol for the larger study (Jütten et al., 2017), explains the method and procedure in greater detail.

### Participants

Participants were 145 adults (18+) (self-identified) informal caregivers, who spent at least eight hours per week on care for a relative, spouse, or friend with dementia who lived at home. Caregivers of institutionalized patients were excluded. In order to overcome the above-described methodological issues of previous research and to enhance generalizability, all caregivers were included instead of only spouses. Table 1 provides an overview of the demographic and psychosocial characteristics of the participants. Neither the people with dementia nor their caregivers were prohibited from usual care; all had access to a case manager, who usually assists with practical and personal difficulties, and all had the opportunity to join regular information and support groups. Caregivers were recruited via a variety of ways instead of only through dementia services in an attempt to obtain a more representative sample of the caregiver population; via (social) media, case managers, supervisors at day-time activity centers, and other health organizations and professionals like physiotherapists, and medical podiatrists. The control group was recruited from the same organizations, health professionals, and (social) media.

The caregivers' cognitive test-scores were standardized for age, sex, and educational level to enhance comparison of findings between studies. To standardize the neuropsychological test-scores employing regression-based norming, a matched control group (on age, sex, and educational level), of 187 adult non-caregivers, was recruited. Both group-matching and stratification by cluster (age, sex, and educational level) were applied to ensure comparability of the groups. Regression-based norming was applied instead of published norms, because the existing norms for the used cognitive tasks were collected over a decade ago and therefore may be outdated. Ageing of norms is an important threat to the usefulness of normative data

**Table 1.** Demographic and psychosocial characteristics of the informal caregiver and control participants.

	Informal caregivers (n = 145)	Control participants (n = 186)	Test-value	p-value
Demographic variables				
Age	59.6 ± 11.9	58.6 ± 13.4	0.658	.511
Male sex	30, 21%	55, 29%	3.362	.077
Level of education	Low	31, 17%	0.172	.917
	Middle	63, 33%		
	High	93, 50%		
Relationship with care receiver	Spouse	52, 36%		
	Child	67, 46%		
	Other	26, 18%		
Cohabiting with care receiver	46, 32%			
Hours spent on care, a week	47.2 ± 60.1			
Time since dementia diagnosis (in years)	3.4 ± 2.6			
Psychosocial and psychological variables				
HADS – anxiety	6.2 ± 3.8	5.0 ± 3.3	2.899	.004**
HADS – depression	4.8 ± 4.2	3.6 ± 2.8	3.011	.003**
CRA	57.6 ± 11.4			
RQI	31.6 ± 7.9			
ISR	30.7 ± 5.3	32.1 ± 5.1	–2.194	.029*
SSCQ	27.3 ± 5.0			

Note. Values presented as M ± SD, or n, %.

HADS = Hospital Anxiety and Depression Scale, CRA = Caregiver Reaction Assessment, RQI = Relationship Quality Index, ISR = Inventory for Social Reliance, SSCQ = Short Sense of Competence Questionnaire. The CRA, RQI, and SSCQ were relevant for caregivers only. Test-values were t-values for continuous variables and  $\chi^2$  for categorical variables.

\* $p < .05$ .

\*\* $p < .01$ .

(Evers, Sijtsma, Lucassen, & Meijer, 2010). In addition, the Dutch norms for letter fluency were based only on education, the norms for category fluency on age and education, and the norms for the WMS-III are based on data from American instead of Dutch persons (Wechsler, 1997). In addition, we hypothesize that the variance of the control group reflects the variance of the caregiver group. Because of these (potential) shortcomings, we used the data of the control group to standardize the scores.

### Power analysis

G\*Power was used to determine the needed sample size. Regarding the z-tests, 128 caregivers were needed to detect small to medium effects ( $d = 0.25$ ), based on an alpha of .05, a power of .80. For the regression analyses, 135 caregivers were needed to detect medium effects ( $f^2 = 0.15$ ), based on an alpha of 0.05, a power of 0.80 and 14 predictors. To standardize the scores, we aimed to recruit the same number of participants for the control group.

### Measures

#### Sociodemographic characteristics

The neuropsychological test-scores were standardized for age, sex, and educational level using regression based norms (see below). The highest completed educational level was determined using the classification system of Verhage (Verhage, 1964), self-reported by the participants during the semi-structured interviews. This system's seven categories were merged into three ordinal categories; low (1 - 4), middle (5) and high (6 - 7) educational level. Relationship with the care receiver (spouse, child, other), the number of hours spent on care a week, and the time since the dementia diagnosis of the care receiver in years were also examined. Information regarding these variables was self-reported by the caregivers during the semi-structured interviews.

#### Neuropsychological tests

*Wechsler Memory Scale III (WMS-III) logical memory; immediate recall and retention.* These tests were chosen to measure episodic memory. Trained interviewers read two separate stories out loud to each participant. The participant was then required, immediately after each story, and at a 20 minute delay for the second story, to verbally recall all they could remember. One immediate recall score was calculated for each participant as the total number of correct items given for both stories. The %retention (i.e. correct items on delayed recall), relative from their immediate recall score for that story, was calculated for the retention score. The test-retest reliability for both subtests is high; .70 and .77, for Immediate and Retention respectively (Lo, Humphreys, Byrne, & Pachana, 2012).

*Letter fluency and Category fluency.* These tests were chosen as measures of executive functioning, because these are sensitive indicators of brain dysfunction, and the administration of verbal fluency tasks is recognized as an important component in the comprehensive assessment of neuropsychological functioning (Lezak, Howieson, & Loring, 2012; Ross et al., 2007). For Letter fluency, the participants were instructed to verbally generate words beginning with the D, A, and T in three separate 60 second trials (Schmand, Groenink, & Van den Dungen, 2008). Names and numbers were considered incorrect. The number of correct responses was added up across the three trials, to one total score. For Category fluency, the participants were instructed to verbally generate words in two categories (animals and professions) in two separate, 60 seconds trials (Luteijn & Barelds, 2004). The numbers of correct responses were added up across the two trials, to one total score. The psychometric properties are comparable to those of the original (English) tests, with a high test-retest reliability of .80 (Ross et al., 2007; Schmand, Groenink, & den Dungen, 2008).

#### Questionnaires assessing psychological symptoms and psychosocial characteristics

Symptoms of depression and anxiety were measured using the Hospital Anxiety and Depression Scale (HADS) subscale

Depression and Anxiety respectively (Zigmond & Snaith, 1983). The HADS is a self-report questionnaire consisting of 14 items; 7 for each subscale (Cronbach's  $\alpha = .784$  for the subscale Depression and  $\alpha = .792$  for the subscale Anxiety in this study). The responses are based on the relative frequency of symptoms over the past week, using a 4-point Likert scale ranging from 0 (*not at all*) to 3 (*very often*). The maximum scores for both scales are 21; higher scores indicate more depression/anxiety symptoms. For both scales, the cut-off value indicating mild depression/anxiety symptoms is 8, and scores of 15 and higher indicate severe symptoms.

Social reliance was measured using the Dutch version of the Inventory for Social Reliance (ISR) - qualitative part (van Dam-Baggen & Kraaimaat, 1992). There are 11 items (Cronbach's  $\alpha = .863$ ), each rated according to a 4-point Likert scale (1 - 4). A total score (max. score = 44) was calculated by adding up all items; higher scores indicate more social support.

Caregiver burden was assessed using the Caregiver Reaction Assessment - Dutch (CRA-D) (Nijboer, Triemstra, Tempelaar, Sanderman, & Van Den Bos, 1999). The caregiver reports to what extent he or she agrees with the 24 statements on a 5-point scale (1 - 5). The scores were added up to one total score, ranging from 24 to 120. Scores were recoded so that higher scores indicate more burden, Cronbach's  $\alpha = .860$ .

Caregiver's sense of competence was assessed by the Short Sense of Competence Questionnaire (SSCQ), which consists of 7 items, rated according to a 5-point Likert scale (1 - 5). The items were summed, to a total score which ranges from 0 to 35 (Vernooij-Dassen et al., 1999), Cronbach's  $\alpha = .803$ .

The quality of the relationship between the caregiver and the person with dementia was assessed using the Relationship Quality Index (RQI) (Norton, 1983), consisting of 5 questions which can be answered on a 7-point Likert scale (1 - 7) (Cronbach's  $\alpha = .943$ ). The maximum score is 35. Higher scores indicate a higher relationship quality.

### Procedure

All participants completed a semi-structured interview, including the neuropsychological tests, and a questionnaire booklet. The CRA-D, SSCQ, and the RQI were only completed by the caregivers because the questions are not applicable to non-caregivers. Likewise, the interview contained additional dementia-related questions for the caregivers. The interviews took place either at Tilburg University or at the participants' home; depending on the participants' preference. Convenience sampling was used, where the participants could contact the researchers if they were interested in participating in the study. Written consent was obtained and the study protocol was approved by the local ethics committee.

### Statistical analyses

The statistical analyses were performed using R software (R Core Team, 2017) and SPSS Statistics 22 (SPSS Inc, 2013). Descriptive statistics and frequencies were used to describe the groups, t-tests and chi-square tests were used to

compare the groups on sociodemographic and psychosocial variables.

To obtain sociodemographically adjusted z-scores for age, sex, and educational level, regression-based norming based on the control groups' scores was applied. To ensure the groups were matched, both group matching and stratification by cluster were used (based on age (in clusters of 10 years), sex (two clusters), and educational level (three clusters)). These predictors were entered as a single block (forced entry), and the results of these regression models provided the formulae for computing the sociodemographically adjusted z-scores. All predictors were included in the normative formulae, irrespective of the significance of the effects. The results of these regression analyses and the resulting formulae are shown in Supplementary Table 1.

One sample z-tests, using the sociodemographically adjusted z-scores, were performed to examine if the caregivers' standardized mean z-score deviated from 0 (with a standard deviation of 1); the (expected) population mean.

To examine if the psychosocial characteristics or psychological symptoms described above predict cognitive functioning, the standardized z-scores were used as dependent variables in multivariable linear regression analyses. To examine the additive predictive value of age, sex, and educational level, these were added in the regression analyses as well.

P-values lower than .05 were considered statistically significant. However, to adjust for multiple significance testing, the Benjamini-Hochberg procedure (false discovery rate, FDR) was applied (Benjamini & Hochberg, 1995). This procedure is recommended for health-related studies (Glickman, Rao, & Schultz, 2014). The adjusted alpha levels were calculated and reported per analysis.

### Results

One hundred forty-five caregivers were included. On average they were 60 years old, 79% was female, 48% was highly educated, and most cared for their spouse (36%) or parent (46%), see Table 1. The control group consisted of 187 non-caregivers, who were on average 59 years old, 71% was female, and 50% was highly educated. The groups did not differ on these sociodemographic variables. While both groups scored below the cut-off of 8, the caregivers had significantly more anxiety symptoms ( $M = 6.2$ ,  $SD = 3.8$ , versus  $M = 5.0$ ,  $SD = 3.3$ ,  $p = .004$ ), and more depression symptoms ( $M = 4.8$ ,  $SD = 4.2$ , versus  $M = 3.6$ ,  $SD = 2.8$ ,  $p = .003$ ). The caregivers also had fewer social contacts ( $M = 30.7$ ,  $SD = 5.3$ , versus  $M = 32.1$ ,  $SD = 5.1$ ,  $p = .029$ ), than non-caregivers.

Table 2 shows the caregivers' raw scores, standardized z-scores, and results of the z-tests. Caregivers performed significantly better on the both subtests of the WMS logical memory than the population mean of  $z = 0$ : immediate recall ( $z = 2.92$ ,  $p = .004$ ) and retention ( $z = 2.12$ ,  $p = .033$ ). After adjusting for multiple comparisons, leading to an alpha level of .025, only the z-test for immediate recall remained significant. Caregiver's z-scores on both verbal fluency tests did not differ significantly from  $z = 0$ .

Table 3 shows the multivariable regression analyses predicting the z-scores for the logical memory immediate recall and retention. No significant predictors were



**Table 2.** Caregivers' z-scores and results of the z-tests for each neuropsychological test.

	Raw score (M ± SD)	Mean standardized z-score	p-value z-test
WMS - logical memory immediate	24.2 ± 6.9	2.92	.004**
WMS - logical memory retention	90.3 ± 26.0	2.14	.033*
Letter fluency	34.9 ± 11.0	-1.96	.050
Category fluency	41.1 ± 10.8	-0.08	.932

Note. WMS = Wechsler Memory Scale. Z-scores were adjusted for age, educational level, and sex based on the control group's scores.

The adjusted alpha was .0375, as calculated by the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995);  $(2/4 * 0.05 = .025)$ .

\* $p < .05$ .

\*\* $p < .025$ .

**Table 3.** Multiple regression analyses predicting the caregivers' z-scores on WMS-III logical memory.

	Logical memory immediate recall			Logical memory retention		
	B (SE)	$\beta$	$p$	B (SE)	$\beta$	$p$
Age	-0.01 (0.01)	-.07	.626	-0.01 (0.01)	-.06	.660
Sex (0 = female, 1 = male)	0.23 (0.24)	.09	.342	0.23 (0.25)	.09	.353
Level of education - Low <sup>a</sup>	0.32 (0.31)	.12	.306	0.28 (0.32)	.10	.373
Level of education - High <sup>a</sup>	0.23 (0.21)	.11	.279	-0.25 (0.21)	-.12	.229
Relationship with person with dementia - Spouse	0.43 (0.41)	.21	.306	0.12 (0.42)	.05	.785
Relationship with person with dementia - Child	0.18 (0.27)	.09	.519	0.18 (0.28)	.09	.519
Hours spent on care	-0.01 (0.01)	-.09	.564	-0.01 (0.01)	-.27	.068
Time since dementia diagnosis care receiver	0.04 (0.04)	.10	.307	-0.01 (0.04)	-.01	.982
HADS - anxiety	-0.03 (0.04)	-.12	.381	-0.05 (0.04)	-.19	.147
HADS - depression	0.03 (0.04)	.13	.400	0.10 (0.04)	.41	.009*
CRA	0.01 (0.01)	.12	.434	0.01 (0.01)	-.01	.992
RQI	-0.04 (0.02)	-.23	.053	0.01 (0.02)	.07	.592
ISR	0.01 (0.02)	.05	.639	0.01 (0.02)	.07	.536
SSCQ	0.01 (0.02)	.27	.075	-0.01 (0.03)	-.04	.792
R <sup>2</sup>	.087			.130		
Adjusted R <sup>2</sup>	<.001			.020		
F	.756			1.185		

Note. Z-scores were adjusted for age, educational level, and sex.

<sup>a</sup>Educational level, according to Verhage (Verhage, 1964), recoded into low (1–4); medium (5); and high (6–7); medium was the reference category.

HADS = Hospital Anxiety and Depression Scale, CRA = Caregiver Reaction Assessment, RQI = Relationship Quality Index, ISR = Inventory for Social Reliance, SSCQ = Short Sense of Competence Questionnaire.

For immediate recall, the alpha level did not need correction, because none of the predictors was significant. For retention, the adjusted alpha level was calculated by the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995), leading to an alpha level of  $(1/14 * 0.05 = .004)$ .

\* $p < .05$ .

\*\* $p < .004$ .

identified. The F-tests for neither immediate recall nor retention was significant, and the explained variance for both subtests was low;  $R^2 = .087$  (adjusted  $R^2 = <.001$ ), and  $R^2 = .130$  (adjusted  $R^2 = .020$ ) respectively.

Table 4 shows the multivariable regression analyses predicting the z-scores on the category- and letter fluency tasks. Male sex ( $\beta = .260$ ,  $p = .006$ ) and a higher score on the social reliance questionnaire ( $\beta = .338$ ,  $p = .002$ ) predicted higher scores on the category fluency task. For category fluency no significant predictors were identified. The F-tests for both category- and letter fluency were non-significant, and the explained variance for both tasks was low:  $R^2 = .172$  (adjusted  $R^2 = .068$ ), and  $R^2 = .151$  (adjusted  $R^2 = .043$ ) for category- and letter fluency respectively.

## Discussion

The primary aim of the current study was to examine if informal dementia caregivers performed similar to, worse than, or better on executive functioning and episodic memory tasks than non-caregivers. Which variables predicted the performance on these cognitive tasks was also examined.

The findings indicate that caregivers performed better on a test for immediate memory than non-caregivers despite their (slightly) higher levels of depression and anxiety. The caregivers performed similar to non-caregivers on tasks for memory retention and executive functioning. These results are in line with recent, and relatively large, studies on this topic (O'Sullivan et al., 2018; Pertl et al., 2015). A number of theories could explain these findings. Informal caregivers tend to experience more stress (both self-reported on questionnaires and higher cortisol levels) than non-caregivers (Allen et al., 2017; Dang et al., 2008; Pinquart & Sörensen, 2003), which are sometimes associated with poorer cognitive functioning. However, the emerging view is that while extreme stress can lead to cognitive problems, mild stress levels are associated with enhanced cognitive functioning, especially immediate memory functioning, when the cognitive load is not excessive (Sandi, 2013). While we did not measure stress or cortisol levels directly, we hypothesize that the caregivers in our study experienced mild stress levels: while they had slightly higher HADS scores than non-caregivers, 80% still scored under the cut-off, indicating zero to mild symptoms of both depression and anxiety, whereas only one caregiver scored in the range of 'severe' symptoms. These mild

**Table 4.** Multiple regression analyses predicting the caregivers' z-scores on category- and letter fluency.

	Category fluency			Letter fluency		
	B (SE)	$\beta$	p	B (SE)	$\beta$	p
Age	0.01 (0.01)	.01	.984	0.01 (0.01)	.09	.545
Sex (0 = female, 1 = male)	0.73 (0.26)	.26	.006**	0.37 (0.20)	.17	.073
Level of education - Low <sup>a</sup>	0.45 (0.34)	.15	.186	-0.37 (0.26)	-.16	.154
Level of education - High <sup>a</sup>	0.18 (0.22)	.08	.415	-0.35 (0.17)	-.21	.044*
Relationship with person with dementia - Spouse	0.14 (0.45)	.06	.752	-0.42 (0.35)	-.23	.231
Relationship with person with dementia - Child	0.10 (0.29)	.04	.744	-0.11 (0.23)	-.06	.626
Hours spent on care	-0.01 (0.01)	-.15	.303	0.01 (0.01)	.11	.435
Time since dementia diagnosis care receiver	-0.01 (0.04)	-.02	.817	-0.04 (0.03)	-.13	.189
HADS - anxiety	-0.07 (0.04)	-.22	.080	-0.04 (0.03)	-.17	.193
HADS - depression	0.09 (0.04)	.35	.023*	0.05 (0.03)	.23	.141
CRA - total score	-0.01 (0.01)	-.01	.928	0.01 (0.01)	.13	.374
RQI	-0.01 (0.01)	-.12	.335	-0.01 (0.02)	-.04	.755
ISR	0.06 (0.02)	.34	.002**	0.01 (0.02)	-.03	.815
SSCQ	-0.01 (0.03)	-.04	.764	0.03 (0.03)	.16	.277
R <sup>2</sup>	.172			.151		
Adjusted R <sup>2</sup>	.068			.043		
F	1.648			1.393		

Note. Z-scores were adjusted for age, educational level, and sex.

<sup>a</sup>Educational level, according to Verhage (Verhage, 1964), recoded into low (1–4); medium (5); and high (6–7); medium was the reference category.

HADS = Hospital Anxiety and Depression Scale, CRA = Caregiver Reaction Assessment, RQI = Relationship Quality Index, ISR = Inventory for Social Reliance, SSCQ = Short Sense of Competence Questionnaire.

For category fluency, the adjusted alpha level was calculated by the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995), leading to an alpha level of  $(3/14 \times 0.05) = .011$ . For letter fluency, the adjusted alpha level was  $(1/14 \times 0.05) = .004$ .

\* $p < .05$ .

\*\* $p < .011$ .

symptoms could explain why the caregivers actually performed better or similar to non-caregivers on the cognitive tests. This is also in line with the study by Comijs, van den Kommer, Minnaar, Penninx, & Deeg (2011), who argued that mild chronic stressors are associated with better cognitive performance in older adults, whereas no stress or too much stress is associated with worse cognitive functioning. These notions are supported by the healthy caregiver hypothesis, which proposes that caregiving demands may serve to protect the caregivers' health and this could also include their cognitive proficiency (Brown et al., 2009; Fredman et al., 2010; Fredman et al., 2015; McCann et al., 2004; O'Reilly et al., 2008). An important note however is that there are important individual differences in the cognitive impact of stress, with gender and age being associated factors (Sandi, 2013), so these results are not automatically generalizable to the individual caregiver. Another possible explanation for our finding lies in the fact that informal caregivers need to remember more than non-caregivers; they often think for two since they also need to remember things for the person with dementia. This could be seen as some sort of memory training, which is found to be beneficial in older adults due to plasticity of the brain (Buschkuhl et al., 2008). Finally, caregivers generally worry more about developing dementia themselves than non-caregivers, which is commonly called 'dementia anxiety' (Alberts, Hadjistavropoulos, Pugh, & Jones, 2011; Cantegreil-Kallen & Pin, 2012). Because of this fear, caregivers may be more driven or motivated to reduce their risk of dementia, by trying to live their lives in an enjoyable and meaningful way with positive attitudes, changing their negative lifestyle behaviors, and attempting to diminish passivity and negative attitudes. This may have in turn improved their cognitive functioning (Kim, Kim, & An, 2016). This hypothesis would however need to be comprehensively assessed in future studies.

Our results contradict our hypothesis and previous studies suggesting that caregiver's cognition is poorer compared to non-caregivers (Caswell et al., 2003; Corrêa et al., 2015; De Vugt et al., 2006; Fonareva & Oken, 2014; Mackenzie et al., 2009; Oken et al., 2011; Palma et al., 2011). However, these studies were based on small samples (between 16 and 54), and not all controlled for age, sex, and educational level. In addition, while the caregivers had more anxiety and depression symptoms than non-caregivers, they still scored well below the cut-offs, while other studies typically find higher prevalence of depression and anxiety among caregivers (Cooper, Balamurali, & Livingston, 2007; Mahoney et al., 2005; Omeranifard, Haghhighizadeh, & Akouchekian, 2018). It is possible that caregivers involved in previous studies had more depression, anxiety, and burden symptoms than the caregivers in the present study, which in turn may explain the differences in cognitive performance. The differences in depression, anxiety, and burden levels of the present study sample and other caregiver samples might be due to differences in recruitment strategies. The previous studies on caregiver cognition (except (De Vugt et al., 2006)) relied on convenience sampling using dementia service centers and support institutions. Caregivers recruited using these services are generally more burdened than caregivers recruited by other strategies, for example via (social) media, which was used in the present study (Pinquart & Sörensen, 2003; Pruchno et al., 2008). Our findings, and the findings of previous studies, may imply that caregiving does not necessarily lead to worse cognitive performance, but that differences exist between caregivers. We propose that the overburdened, depressed and/or anxious caregiver subgroup may be at risk for worse cognitive performance, while the not-overburdened caregiver has intact (or even better) cognitive performance.

Regarding the prediction models, our findings are in contradiction with our hypothesis and previous research

suggesting that more depression symptoms and more burden are associated with poorer cognitive functioning (Caswell et al., 2003; Corrêa et al., 2015; Mackenzie et al., 2009; Pertl et al., 2017; Vitaliano et al., 2009). A possible explanation for these differences is that, as outlined above, the caregivers did not have high levels of depression and burden. It is possible that only high levels of depression and burden are associated with worse cognition, which could not be examined due to the small range in scores: only one caregiver had a score indicating severe depression. After adjusting for multiple comparisons, we found that for each point increase on the ISR questionnaire for social reliance (range = 11 - 44), the score on the category fluency increased by 0.73 points and male caregivers score 0.06 higher than female caregivers on the category fluency task. However, while statistically significant, the effects were rather small and may not be clinically important. In addition, these factors only predicted category fluency scores; not the scores on the other cognitive tests, and were as such no 'systematic' predictors for cognitive functioning.

Several limitations should be noted. Only three neuropsychological tests were included in an attempt to keep the test time to a minimum, and it is unsure whether the same results would be obtained using other tests for the same cognitive functions. In addition, no conclusions can be drawn regarding other cognitive functions. However, while the fluency tasks arguably also measure verbal skills and semantic memory, performance on the fluency tasks has been successfully used as an index of executive functioning, as confirmed by neuropsychological and neuroimaging studies (Ricci et al., 1999; Thompson-Schill et al., 1998), and the logical memory test – remembering a story – is very comparable to everyday tasks. This enhances the translation of the results to daily life. The test-administrator was not blinded due to practical reasons: the semi-structured interview enclosed additional questions for the caregiver about caregiving-related topics; and the questionnaire booklet, about which the participants could ask questions, entailed specific questionnaires for caregivers. Depression, anxiety, burden, and the other psychological characteristics were measured using questionnaires which may be sensitive to social desirability. One should be hesitant in drawing conclusions about the psychological problems the caregivers actually experience. Another limitation is that the study used data from one measurement point only, making it impossible to relate the findings to specific caregiving- or dementia stages or talk about cause-effect relationships. In addition, the results may look different longitudinally. It is possible that an extended caregiving period may result in more stress, which may lead to greater decrements in cognitive functioning compared to their non-caregiving counterparts. Various recruitment strategies were used, leading to a more heterogeneous caregiver sample than typically found in the literature, more generalizable to the overall caregiver population. However, the caregivers were recruited for an intervention study, which may have led to selection bias. We may have included the more active caregivers with lower levels of stress and burden, excluding the overburdened caregivers. This might be reflected by the low average levels, and small range, of depression, anxiety, and burden. Since

convenience sampling was used, where caregivers could contact the researchers and not vice versa, the response rate could not be calculated and there is no information regarding reasons for non-participation. This study is novel in that a large, more generalizable sample was used, recruited via a variety of ways instead of only via dementia services. In addition, we standardized the scores for age, sex, and education, which is not often carried out by previous research.

The findings have important implications for both clinical practice and scientific research. Caregiving can be very stressful for some caregivers, and can lead to problems with cognitive health, and those caregivers should receive support such as respite care and other interventions. However, the present study, among all caregiver types, showed that caregivers can also have better cognitive performance than non-caregivers. We did not find systematic predictors for cognitive functioning: the caregivers' performance was independent of sociodemographic and psychosocial characteristics, and psychological symptoms.

We argue that studies should be careful with generalizing their findings to the whole caregiver population given the heterogeneity in psychosocial characteristics, psychological symptoms, and other characteristics. In addition, we deem it important to research (and report) both the negative and positive effects caregiving can have on caregivers. Policy reports should also present a more balanced and comprehensive view of the current state of caregiving research, instead of focusing only on the negative consequences such as burden.

In clinical (dementia) practice, we encourage the clinician to pay attention to the caregiver in a more personal way, because some caregivers should receive help, while others may not need interventions. We argue that it is important that the clinicians are aware that cognitive performance is likely to vary within individual caregivers; caregivers can have worse, but also better cognitive functioning than non-caregivers,

In conclusion, we found no evidence that informal dementia caregivers have poorer memory and executive functioning. Future, longitudinal, research is needed to study how their cognition develops over time, as the care receiver's dementia progresses.

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## Disclosure statement

The authors report no conflict of interest.

## Data sharing statement

The data will not be made public, assuring the study participants' privacy. Requests for data sharing will be considered on an individual basis, for appropriate research purposes only.

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