Rumination in dementia and its relationship with depression, anxiety, and attentional biases

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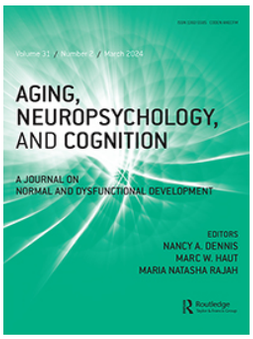

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Rumination in dementia and its relationship with depression, anxiety, and attentional biases

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ABSTRACT

Rumination (self-referential and repetitive thinking), attentional biases (AB), and impaired cognitive control are theorized as being integral factors in depression and anxiety. Yet, research examining the relationship between rumination, mood, and AB for populations with reduced cognitive control, e.g., people living with dementia (PwD), is lacking. To explore whether literature-based relationships are demonstrated in dementia, PwD ($n = 64$) and healthy controls (HC) ($n = 75$) completed an online self-report survey measuring rumination and mood (twice), and a telephone cognitive status interview (once). Rumination was measured as an emotion-regulation style, thinking style, and response to depression. We examined the test-retest reliability of PwD's ($n = 50$) ruminative-scale responses, ruminative-scale internal consistency, and correlations between rumination, age, cognitive ability, and mood scores. Also, nine participants (PwD = 6, HC = 3) completed an AB measure via eye-tracking. Participants fixated on a cross, naturally viewed pairs of facial images conveying sad, angry, happy, and neutral emotions, and then fixated on a dot. Exploratory analyses of emotional-face dwell-times versus rumination and mood scores were conducted. Except for the HC group's reflective response to depression measure, rumination measures were reliable, and correlation strengths between rumination and mood scores (.29 to .79) were in line with literature for both groups. For the AB measure subgroup, ruminative thinking style scores and angry-face metrics were negatively correlated. The results of this study show that literature-based relationships between rumination, depression, and anxiety are demonstrated in dementia, but the relationship between rumination and AB requires further investigation.

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Introduction

People living with dementia (PwD) are likely to experience one or more behavioral and psychological symptoms such as anxiety, depression, irritation, and aberrant motor

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behaviors during disease progression (Staedtler & Nunez, 2015). Of these, depression and anxiety are commonly experienced, often co-occur, have moderate persistence, and are associated with an increased rate of cognitive decline and reduced quality of life (Breitve et al., 2016; Gonfrier et al., 2012; Ryu et al., 2005; Seignourel et al., 2008; Spalletta et al., 2012; van der Linde et al., 2016). Although depression, anxiety, and dementia have a complex relationship in terms of their biological basis and symptoms, recent research suggests that repetitive negative thinking (RNT) may be a core process linking dementia with depression and anxiety (Goyal et al., 2019; Marchant et al., 2017, 2020; Seignourel et al., 2008). Repetitive thinking, an umbrella construct for discrete types of self-referential, repetitive, and/or frequent thoughts, is thought to be a transdiagnostic process contributing to the association between depression and anxiety symptoms (Segerstrom et al., 2010; Spinhoven, van Hemert, et al., 2018). Repetitive thinking can vary by valence (positivity/negativity), its volitional basis (intrusive vs. directed), focus and purpose amongst many other qualities which correlate with different physical and psychological outcomes (Ehring & Watkins, 2008; Segerstrom et al., 2010; Smith & Alloy, 2009; E. R. Watkins, 2008).

In terms of the relationship between repetitive thinking and dementia, the type of repetitive thinking and when it occurs may be important. Repetitive thinking in mid-life can be associated with a lower incidence of dementia, which is indicative of a protective factor (Ravona-Springer et al., 2009), whereas increased RNT has been associated with risk factors of Alzheimer's Disease (AD) dementia (greater declines in memory and elevated levels of protein deposits) (Marchant et al., 2017, 2020). However, there is limited research regarding the types of repetitive thinking used by people with a diagnosis of dementia, and their association with depression and anxiety. While PwD engage in repetitive thinking (e.g., pessimistic future-orientated thoughts (El Haj et al., 2021)), and reminiscence about past memories (Woods et al., 2018)), it is unclear whether distinct cognitive processes are involved in the different types of repetitive thinking (Mandell et al., 2014). Consequently, the capacity or tendency for one type of repetitive thinking may not reveal the capacity or tendency for other types, nor their distinct relationship with depression and anxiety in dementia.

Types of rumination

The current study focuses on a type of repetitive thinking called rumination (Martin & Tesser, 1996). While rumination is suggested to be more evident in depression than in anxiety (Olatunji et al., 2013; Spinhoven et al., 2015), it is assessed with the Ruminative Response Scale (RRS) (Nolen-Hoeksema, 1991) in the majority of studies (Olatunji et al., 2013). As the RRS measures rumination in response to a depressed or dysphoric mood, it is possible that the relationship between rumination and anxiety may be obscured within anxiety studies. Moreover, the RRS total score (combined depressive, brooding and reflection subscales scores) is most often used in studies which focus on, or include older adults (Chen et al., 2020; Fernández-Fernández et al., 2014; McLaughlin & Nolen-Hoeksema, 2011; Nolen-Hoeksema & Aldao, 2011; Opdebeeck et al., 2015; Ramirez-Ruiz et al., 2019; Romero-Moreno et al., 2016; Von Hippel et al., 2008). Yet, the contributions of the RRS subscales to depression and anxiety in older adults may be important to understand. For example, participants with higher global cognition scores (less cognitive

impairment) can use reflection to a greater extent than those with lower global cognition scores (more cognitive impairment) (Demnitz-King et al., 2021). Based on these findings, we could have hypothesized that a difference in the levels of reflective rumination could therefore be present between PwD and healthy older adults; PwD, having higher levels of cognitive impairment, may engage in less reflective rumination. Still, anxiety was not controlled for within these studies, and higher levels of reflective rumination are associated with higher levels of anxiety in older adults (D'Hudson & Saling, 2010). Consequently, an investigation of how different types of rumination, including brooding and reflective rumination, relate to depression and anxiety in older adults living with and without dementia is warranted.

Rumination and dementia

While rumination has been shown to be an important factor in late-life depression in people living without dementia (Tang et al., 2022), to our knowledge, the use of rumination as an emotion regulation style (RUM-EMO-REG), thinking style (RUM-THINK), and response to depression (RUM-RESP-DEP) by PwD has not been investigated to-date. Rumination is commonly associated with difficulties in inhibiting information and mental set switching (poor attentional control) (Koster et al., 2011). Depending upon the pathological process of AD, attentional control difficulties such as the disengagement and shifting of attention, can be the first non-memory deficits following the hallmark episodic memory deficits associated with AD (Amieva et al., 2004; Parasuraman & Haxby, 1993; Pekkala et al., 2008; Weintraub et al., 2012), and inhibitory control deficits may increase with disease severity (Kaiser et al., 2018). Poor attentional control is associated with higher levels of rumination and in turn, more severe symptoms of depression and anxiety in people living without dementia (Hsu et al., 2015; Von Hippel et al., 2008). An underlying impairment in attentional control may make it harder to reroute cognitive resources away from the ruminative thoughts toward task-relevant information (Levens et al., 2009). Being in a ruminative state can prolong depressed and anxious moods (Michl et al., 2013). Therefore, once a ruminative cycle is entered, disengaging from ruminative thinking may be more difficult for people living with AD (PwAD) leading to a longer depressed or anxious mood compared to people living without AD who ruminate. Although the question of whether the inhibitory control deficits associated with AD could modulate the capacity for rumination has been posed (Nash et al., 2007), an appropriate measure of rumination for PwAD to use is required. Investigating the reliability of rumination measures for PwAD in the current study is a step toward addressing this question.

Rumination and attentional biases

Cognitive inhibition impairment is central to both rumination and cognitive biases (i.e., attention, memory, and interpretation) (Joormann, 2010). While PwAD display biases in memory, emotion recognition/discrimination, and attentional biases (AB) (the tendency for a person to attend to, or avoid, a certain type or types of information) (Boller et al., 2002; Bourgin et al., 2020; Chau et al., 2016; Greenaway et al., 2024; LaBar et al., 2000; Maria & Juan, 2017; Werheid et al., 2011), research examining how these biases, and older adults' AB more generally, relate to mood or rumination is lacking (Cabrera et al., 2020;

Demeyer et al., 2017; Isaacowitz et al., 2008; Lee & Knight, 2009; Mohlman et al., 2013). The current study sought to examine the relationship between rumination and AB as a ruminative disposition is characterized by AB (Grafton et al., 2016; Koster et al., 2011; Mogg & Bradley, 2018). Depressed and anxious individuals can take longer to disengage (shift) their attention from negative stimuli, thus displaying negative AB (Donaldson et al., 2007; Georgiou et al., 2005; Grafton et al., 2016; Koster et al., 2011). AB are thought to have a bi-directional relationship with rumination (see Figure 1) in that negative AB may lead to rumination, which in turn increases negative AB (LeMoult & Gotlib, 2018). In older adults, reduced executive function, which includes inhibition and shifting ability, can predict higher levels of rumination (Ng et al., 2022), and negative AB can be more pronounced in habitual ruminators (albeit middle-aged adults) (Donaldson et al., 2007). Given that attentional control is required to disengage attention (Ng et al., 2022) and control deficits may increase with AD severity (Kaiser et al., 2018), it is possible that AB could be (1) pronounced for some PwAD (with and without high rumination levels), and (2) modulated by disease severity. As such, studies exploring the relationship between rumination and AB for PwAD are warranted.

In summary, while repetitive thinking such as rumination and AB are thought to be key processes in the development and maintenance of depression and anxiety, the consequences of repetitive thinking for PwD is rarely studied and the clinical significance of rumination and AB for older adults is also lacking (Mohlman et al., 2013; Schneider et al., 2023). Exploring the relationship between depression, anxiety, rumination, and AB within the current study is a step toward addressing the aforementioned research gaps.

Study aims

The current study had the following aims:

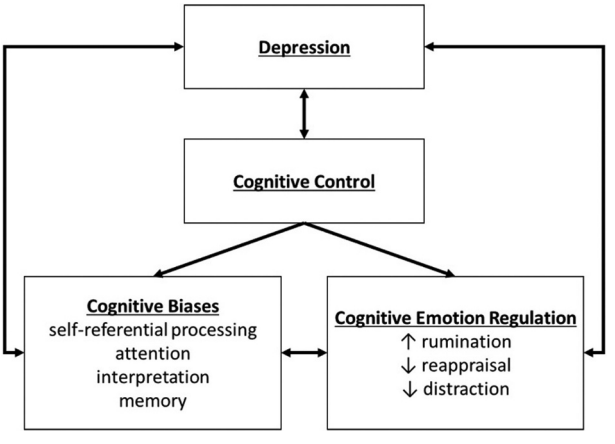

Figure 1. Cognitive perspective of the relationship between cognitive control, AB, and rumination (reprinted from Clinical Psychology Review, 69, LeMoult & gotlib, depression: a cognitive perspective, 51–66, copyright (2019), with permission from Elsevier).

(1) To investigate the reliability of the selected rumination measures for PwD
(2) To compare the level of rumination types used by PwD versus cognitively healthy controls (HC)
(3) To examine the relationships between rumination measures and age, cognitive ability, depression, anxiety, and AB scores

Materials and methods

Participants

The survey recipients ($N = 143$) were recruited via the Join Dementia Research platform (https://www.joindementiaresearch.nihr.ac.uk/) and from the community using newsletter advertisements, of which 139 participants aged between 60 and 96 years old completed the survey (64 with a diagnosis of dementia [PwD], 75 healthy controls [HC] without a diagnosis of dementia nor mild cognitive impairment). Diagnosis status (i.e., presence of dementia/dementia type) was self-/representative-reported. All PwD were recruited via Join Dementia Research which operates as a self, representative, or health professional research volunteer registration platform. Volunteer records must contain demographic details and specify if there is a diagnosis of dementia (diagnosis date is optional), the type of dementia diagnosed (option for unknown), the dementia medication type (if taken), any medical conditions/disabilities (specific options and other), and carer/representative support (yes or no). Volunteer records for potential PwD were screened and only those (1) specifying a diagnosis date and dementia type, (2) without a Mini Mental State Examination score of < 20 points (obtained from the most recent volunteer and/or unrelated study assessment data entries), and (3) with a spouse/partner/carer/representative, were considered for the study. Volunteer information was verified via the volunteer's representative during the enrollment process.

The PwD group comprised participants with different types of dementia (AD = 42, AD/Vascular = 6, AD/Lewy Bodies = 1, AD/Mixed = 1, Vascular = 9, Lewy Bodies = 3, and Mixed [of unknown types] = 2), 36 males and 28 females, aged 60 to 96 years old (see Error! Reference source not found. for demographic information). Approximately half (53%) of the PwD were classified as non-depressed/non-anxious, 25% as having comorbid depression and anxiety, 17% as having depression with no anxiety, and 5% as having anxiety with no depression (see Table 2. for group symptom status). Few PwD ($n = 7$, 11%) were taking anti-depressant medication, and 78% were taking cognitive medication (Donepezil = 42, Rivastigmine = 4, Memantine = 3, and Galantamine = 1). The HC group comprised 30 males and 45 females, aged 60 to 88 years old. The majority (81%) of the HC group were classified as non-depressed/non-anxious, 9% as having comorbid depression and anxiety, 7% as having depression with no anxiety, and 3% as having anxiety with no depression. No participants in the HC group were taking cognitive nor anti-depressant medication.

All participants with dementia were required to have a spouse/partner/carer/representative provide written or verbal confirmation of the participant's ability to provide informed consent. Each participant provided written or verbal consent before the telephone section of the study and consented via a checked tick box at the start of each online questionnaire.

Procedure

Participants completed the Telephone Interview for Cognitive Status (TICS) (Brandt et al., 1988) and received a personalized link to Online surveys (https://www.onlinesurveys.ac.uk/) via e-mail to complete a self-report questionnaire (timepoint 1 [T1]) which measured their level of rumination and screened for the presence of depression and anxiety. To examine test-retest reliability participants completed the online questionnaire a second time (timepoint 2 [T2]), two weeks after they submitted the first questionnaire. Participants were instructed to finish the questionnaire within 48 hours of receiving their links. The participants who consented to participate in the webcam-based AB assessment ($n = 11$), completed the TICS via a Microsoft Teams meeting and were emailed a link to access Gorilla (Anwyl-Irvine et al., 2020), a web-based eye-tracking platform to complete the AB task. These participants did not complete T2 questionnaires as AB measures may be associated with an interventional effect (Blackwell et al., 2017).

Participating, for any given participant, took no longer than 2 hours in total. The study was reviewed in accordance with the procedures of the University of Reading's Research Ethics Committee and received a favorable ethical opinion for conduct (UREC 18/27; UREC 19/71).

Measures

Cognitive status

Memory, orientation, attention, and language were assessed via the 11-item Telephone Interview for Cognitive Status (TICS). Scores range from 0 to 41 with scores ≤ 30 indicating cognitive impairment. The TICS has demonstrated a high correlation with the commonly used Mini Mental State Exam (MMSE) (Folstein et al., 1975) without the ceiling and floor effects associated with the MMSE (Brandt et al., 1988; Sheehan, 2012), and has a discriminative ability (those with and without dementia) comparable to the MMSE (Seo et al., 2011).

Rumination

Rumination as an emotion regulation style. Four items (3, 12, 21 and 30) from the 36-item Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001) measures the extent to which a ruminative coping strategy is used by an individual. Responses to statements such as "I dwell upon the feelings the situation has evoked in me" were given on a five-point scale from "almost never" (1), to "almost always" (5). The CERQ is standardized and suitable for use in populations that include older adults and psychiatric patients. The CERQ has good to very good factorial validity and reliabilities (Cronbach's αs between .75 and .87) (Garnefski & Kraaij, 2007). Convergent and criterion validity has generally been supported (Ireland et al., 2017; Jermann et al., 2006; Megreya et al., 2016).

Rumination as a thinking style. The Ruminative Thought Style Questionnaire (RTSQ) (Brinker & Dozois, 2009) was used to assess rumination as a style of thinking. The 20-item scale consists of statements of ruminative behaviors such as "I can't stop thinking about some things." Respondents rated the items in terms of the statements' self-descriptiveness on a 7-point scale ranging from 1 (not at all descriptive of me) to 7

(describes me very well). The RTSQ has shown good convergent validity with a global rumination measure (McIntosh et al., 1995) and the Response Style Questionnaire, adequate test-retest reliability and high internal consistency (Brinker & Dozois, 2009; Tanner et al., 2013).

Rumination as a response to depression. The 22-item Ruminative Response Scale (RRS) (Nolen-Hoeksema, 1991) was used to assess rumination in response to depression levels. Respondents indicated what they generally think or do in relation to items such as "Think 'What am I doing to deserve this?'" and "Go someplace alone to think about your feelings," using a four-point Likert scale ranging from "almost never" (1) to "almost always" (4). The score for each item was summed to obtain a total score ranging from 22 to 88. Higher scores indicate a higher level of ruminative response. Items reflect three sub-types of responses: depressive, brooding, and reflective rumination. The scale shows excellent internal consistency as well as adequate convergent and predictive validity (Nolen-Hoeksema et al., 1993, 1994).

Mood

Depression. The presence and severity of depression over the preceding fortnight were assessed using 8 items from the Patient Health Questionnaire 9 (PHQ-9) (Kroenke & Spitzer, 2002). A score of 0 (not at all) to 3 (nearly every day) is assigned for each item giving a total of between 0 and 24. A score of 5 represents the lower cutoff point for mild depression, 10 for moderate depression, 15 for moderately severe depression, and 20 for severe depression. The suicidal ideation item, removed for ethical concerns, did not affect the interpretation of final scores (Kroenke & Spitzer, 2002). A score of ≥ 10 has a specificity and sensitivity of 88% for major depression disorder (MDD) (Kroenke & Spitzer, 2002). The screen has been validated for people living with cognitive impairment, and is widely used in United Kingdom primary care psychological therapy services (Bell et al., 2022; Wong et al., 2022).

Anxiety. The presence and severity of anxiety over the preceding fortnight were assessed using the 7-item Generalized Anxiety Disorder Scale (GAD-7) (Spitzer et al., 2006). A score of 0 (not at all) to 3 (nearly every day) is assigned for each item giving a total of between 0 and 21. A score of 5 represents the lower cutoff point for mild anxiety, 10 for moderate anxiety, and 15 for severe anxiety. A score of ≥ 10 is suggestive of GAD and other anxiety disorders. It has high internal consistency ($\alpha = 0.89$), has been standardized with a community sample of 5030 participants aged 14 to ≥75 years (Löwe et al., 2008), validated for people living with cognitive impairment, and is widely used in United Kingdom primary care psychological therapy services (Bell et al., 2022; Wild et al., 2014).

Eye tracking

Positioning. Participants positioned themselves directly in front of their webcam and used their video feed (presented in the top left corner of their screen) to align themselves such that (1) their faces appeared in the middle of a black box outline overlaid in the center of the feed, and (2) the green face-mesh within the feed which detects users' faces, matched their features. Participants were told the box outline must turn green, and face-meshing must occur to enable a start button (see Greenaway et al. (2021) for a detailed face-meshing description).

Calibration and validation. Participants were instructed to remain still, blink as little as possible, and only move their eyes (rather than their head or body) to look at a 50 × 50-pixel red dot which appeared consecutively in each of 9 fixed locations (a 3 × 3 grid spanning the screen's height and width) in a random order (see Greenaway et al. (2021); Semmelmann and Weigelt (2018) for detailed descriptions). The participants were told to look at the dot as quickly as possible and fixate on it until it disappeared. The calibration and validation phases were identical, except that the validation phase displayed a green dot (instead of a red one).

Attentional bias measure

The AB measure involved a modified dot-probe task (MacLeod et al., 2002), in which each trial began with a blank screen for 500 ms. A fixation cross then appeared in the center of the screen for 500 ms. Two faces from the same actor were then presented in sad-neutral, angry-neutral, happy-neutral, sad-happy, angry-happy, and sad-angry expression pairings for 2000 ms. The faces were selected from the FACES database (Ebner et al., 2010). When the faces had disappeared, a black dot was displayed in the center of one of the face's previous location for 1000 ms. Participants were instructed to look at the cross and the dot as quickly as possible and fixate on them until they disappeared, and to view the facial stimuli naturally when they appeared. Trials ($N = 96$) were shown randomly, with each facial emotion type being presented 48 times by 24 actors. Each actor was displayed four times. Actor gender and the side of the screen the facial emotion type and dot appeared on were counter-balanced across the trials.

Data quality

Participants who wanted assistance ($n = 7$) from a representative to navigate the questionnaire stated that they were able to disclose their thoughts and feelings to their representatives. All participants were (1) informed that providing open and honest responses would help to improve data quality (Lu et al., 2022), (2) advised to start the survey when they were most alert and (at least) the suggested completion time could be accommodated, and (3) asked to take a break when required. All items in the survey were set to "required" (see supplementary material for detailed data quality improvement information).

Data analysis

Data quality

Straightlining (SL) (i.e., responses with little variation within a set of items), an indicator of low-attentiveness (Buchanan & Scofield, 2018; Silber et al., 2019), was examined in T1 surveys via graphs (Buchanan & Scofield, 2018). Each participant's relative frequency of SL across the rumination measures was computed (i.e., the number of measures with SL divided by the number of measures [three]) generating a score between 0 and 1 (Gummer et al., 2021). The percentage of participants scoring ≥ 0.33 was calculated and reported, and the T1 and T2 responses of these participants were then compared, where possible, as a consistency check.

Rumination

The median rumination score was computed to distinguish low (< median score) and high ruminators (> median score) (E. Watkins & Mason, 2002).

Attentional biases

A total dwell-time was computed for each emotional face and its corresponding neutral face in emotional-neutral pairings by summing the dwell-time in ms across each trial, and converting the resulting total to seconds (s). Bias scores were computed by subtracting the neutral total dwell-time from the corresponding emotional total dwell-time. Scores above zero were interpreted as a bias toward the emotional face, and scores below zero as a bias away from the emotional face (Duque & Vázquez, 2015).

Statistical analysis

Statistical analyses were performed with SPSS version 27 (IBM Corp, 2017). Non-parametric methods were mainly used to analyze the rumination questionnaires and mood data and a two-tailed critical alpha level of $p < .05$ was used for all significance tests. Mann-Whitney U (U) and t-tests (t) were used to compare the PwD and HC group in terms of age, cognitive ability (TICS), depression (PHQ-9), and anxiety (GAD-7) scores where appropriate. These tests were conducted using the full T1 dataset as this was the larger of the two ($N_{T1} = 139$ versus $N_{T2} = 117$). Wilcoxon signed-ranks tests (T), paired-sample t-test, and Spearman rho bivariate correlations (r_s) were used to assess the test-retest reliability of T1 versus T2 rumination measure (CERQ, RTSQ and RRS combined-types [combined depressive, brooding, and reflection subscale scores], brooding and reflection subscales) responses of the first 50 PwD participants who completed the questionnaires at both timepoints. Adequate Cronbach's alphas and correlation strengths in-line with those previously reported for these questionnaires (.60 to .80) were considered acceptable and permitted further data collection and analyses (Brinker & Dozois, 2009; Garnefski & Kraaij, 2007; McLaughlin & Nolen-Hoeksema, 2011). Cronbach's alpha calculations, rumination level comparisons (CERQ, RTSQ, RRS scales), and the following bivariate zero-order and partial correlation analyses were conducted using the full T1 dataset.

Zero-order r_s assessed the relationship between cognitive, rumination, and mood scores. Rank analysis of covariance (Quade, 1967) was used to investigate rumination levels (dependent variables) while controlling for depression using the following method:

(1) The dependent variables and covariates were ranked.
(2) A linear regression of the ranks of dependent variables on the ranks of the covariates was performed and the residuals (raw or unstandardized) were saved.
(3) Using the saved residuals as the dependent variable, a one-way analysis of variance (ANOVA) with group as the factor was conducted.

Ranked partial correlation coefficients (Conover, 1999) were performed to assess the strength of the relationship between rumination and one mood type while controlling for the other. Effect size (ES) (r) was calculated for significant U and T differences using the formula as seen in (1) (z = z-value; N = observation number).

$$r = \frac{Z}{\sqrt{N}} \quad (1)$$

ES (r^2) were calculated for significant bivariate correlations by squaring the correlation coefficient.

Results

Data quality

Survey response rates

A high survey response (139/143 = 97% of surveys were started; study drop-outs: PwD = 3, HC = 1) and completion (139/139 = 100%) rate was achieved for T1 surveys. T2 survey responses were not required from 11 PwD participants as they attempted or completed AB measures. Of the remaining T1 PwD participants ($n = 53$), a high survey response (50/53 = 98% of surveys were started; study drop-outs = 3) and completion (50/50 = 100%) rate was achieved.

Participants with dementia's data quality

No data were removed due to data quality concerns due to the consistency shown between T1 and T2 (see supplementary material for further details). While there was some evidence of SL in PwD T1 surveys (9/63 = 14%), the T1 versus T2 Cronbach alpha and/or correlations coefficients, as discussed later, are in line with the test-retest reliabilities of responses obtained via postal response (Garnefski & Kraaij, 2007), in the presence of a researcher and via telephone (Brinker & Dozois, 2009), and face-to-face interview (McLaughlin & Nolen-Hoeksema, 2011) with cognitively healthy adults.

There was a higher occurrence of SL in HC T1 surveys (21/75 = 28%). As an inattentiveness level of 25% may impact data quality (Silber et al., 2019), analyses were also conducted on the HC dataset after removing the SL participants (non-SL dataset, $n = 54$) as a matter of precaution (see supplementary material for descriptive, reliability, and zero-order correlation data). Higher SL in the full HC dataset was not associated with reduced data quality, and in general, demonstrated slightly higher reliability than the non-SL dataset.

Participant characteristics

There was no significant difference between the PwD and HC groups in terms of age, $U(N_{PwD} = 64, N_{HC} = 75) = 2{,}170.00$, $z = -.97$, $p = .33$) (see Table 1. for descriptive, mood, and rumination measures analyses). The PwD group had significantly higher levels of cognitive impairment, $U(N_{PwD} = 64, N_{HC} = 75) = 4{,}190.00$, $z = 7.59$, $p < .001$ (ES, $r = .64$), depression, $U(N_{PwD} = 64, N_{HC} = 75) = 1{,}731.00$, $z = -2.86$, $p = .004$ (ES, $r = -.24$), and anxiety, $U(N_{PwD} = 64, N_{HC} = 75) = 1{,}627.50$, $z = -3.37$, $p < .001$ (ES, $r = -.29$), than the HC group (see Table 2. for symptom status information).

The PwD group used RUM-EMO-REG style to the same extent as the HC group, $U(N_{PwD} = 64, N_{HC} = 75) = 2{,}256.50$, $z = -.61$, $p = .54$, but used a ruminative RUM-THINK significantly more than the HC group, $U(N_{PwD} = 64, N_{HC} = 75) = 1{,}908.50$, $z = -2.08$, $p = .04$

Table 1. Descriptive statistics and Cronbach's alpha for group demographic, cognitive ability, rumination, and mood measure scores.

	PwD ($n = 64$)				HC ($n = 75$)			
Measures	Median (mean)	*IQR* (*SD*)	Mean rank	α	Median (mean)	*IQR* (*SD*)	Mean rank	α
Age	73	9	74	N/A	71	9	67	N/A
TICS**	28	10	42	.72	35	4	94	.22
Rumination								
Emotion regulation style (CERQ)	7	4	72	.87	7	4	68	.73
Thinking style (RTSQ)*	(65)	(25)	78	.94	55	29	63	.93
Response to depression (RRS)								
*Combined-type***	35	13	82	.92	29	10	60	.89
*Brooding**	8	4	79	.72	7	3	62	.77
Reflection	6	3	73	.82	6	3	68	.59
Mood								
Depression (PHQ-9)**	3	7	80	.88	2	3	61	.78
Anxiety (GAD-7)**	2	5	82	.93	0	3	60	.89

PwD = people living with dementia; HC = healthy controls; α = Cronbach's alpha; TICS = Telephone interview for cognitive status; CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale; PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalized Anxiety Disorder scale.
RRS combined-type = combined depressive, brooding and reflection subscale scores.
*significant difference at the .05 level (2-tailed).
**significant difference at the .01 level (2-tailed).

Table 2. Group depression and anxiety symptom status.

	n	
Symptom status (scale points)	PwD	HC
Comorbid depression and anxiety (PHQ-9 ≥ 5 and GAD-7 ≥ 5)	15	7
Depression with no anxiety (PHQ-9 ≥ 5 and GAD-7 < 5)	11	5
Anxiety with no depression (GAD-7 ≥ 5 and PHQ-9 < 5)	3	2
Non-depressed/non-anxious (PHQ-9 < 5 and GAD-7 < 5)	34	59

PwD = people living with dementia; HC = healthy controls; PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalized Anxiety Disorder scale.

(ES, $r = -.18$) (see Error! Reference source not found. for descriptive analysis). In terms of ruminative responses to depression, the PwD group used combined-types, $U(N_{PwD} = 64, N_{HC} = 75) = 1{,}632.00$, $z = -3.25$, $p = .001$ (ES, $r = -.28$), and brooding, $U(N_{PwD} = 64, N_{HC} = 75) = 1{,}830.50$, $z = -2.44$, $p = .02$ (ES, $r = -.21$), significantly more than the HC group, but used reflection, $U(N_{PwD} = 64, N_{HC} = 75) = 2238.50$, $z = -.71$, $p = .48$), to the same extent as the HC group. (Tables 1 and 2).

Rumination measure reliability for participants living with dementia

Test-retest reliability

Significance tests were conducted for each rumination measure for the first 50 participants to have completed both T1 and T2 surveys (see Table 3. for descriptive analysis). No significant differences were found between T1 and T2 rumination scores (RUM-EMO-REG style, $T = 275.50$, $z = -1.39$, $p = .16$, RUM-THINK, $t(49) = 1.42$, $p = .16$, RUM-RESP-DEP

Table 3. Timepoint 1 (T1) and Timepoint 2 (T2) descriptive and correlational comparison data for 50 PwD's rumination measure scores.

	T1			T2			T1 vs T2	95% CI
Rumination measures	Median (mean)	*IQR (SD)*	α	Median (mean)	*IQR (SD)*	α	r_s (*r*)	Lower, upper (limit)
Emotion regulation style (CERQ)	8	4	.84	6	3	.82	.69**	.49, .83
Thinking style (RTSQ)	(64)	(24)	.94	(60)	(26)	.96	(.68**)	.49, .80
Response to depression (RRS)								
Combined-type	35	12	.92	33	11	.92	.77**	.60, .87
Brooding	8	4	.73	8	3	.79	.67**	.45, .81
Reflection	6	4	.83	6	3	.70	.71**	.52, .84

PwD = people living with dementia, CI = confidence interval; **α** = Cronbach's alpha; CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale.
RRS combined-type = combined depressive, brooding and reflection subscale scores.
**significant at the .01 level (2-tailed).

combined-types, $T = 378.50$, $z = -1.77$, $p = .08$; brooding, $T = 205.00$, $z = -1.82$, $p = .07$, and reflection, $T = 130.00$, $z = -1.68$, $p = .09$). Bivariate correlations between T1 and T2 scores were moderate to strong (see Table 3).

Cronbach's alpha

The internal consistency of the PwD group's T1 and T2 rumination measures was acceptable to high (Greco et al., 2018) (see Table 1. and Table 3).

Relationship between rumination, age, cognitive ability, depression, and anxiety

Age versus cognitive ability, rumination, and mood

Being older was associated with less use of RUM-EMO-REG ($r_s = -.29$, $p = .02$, 95% CI [−.51, −.05]), RUM-RESP-DEP reflection ($r_s = -.26$, $p = .04$, 95% CI [−.48, −.01]), and lower levels of anxiety ($r_s = -.28$, $p = .03$, 95% CI [−.50, −.03]) with small effects (ES, $r^2 = .07$ to .08) for the PwD group (see supplementary material for individual ES). Partial correlation analyses showed that these relationships were not independent of cognitive ability and/or mood (see supplementary material for partial correlational data).

Being older was associated with higher levels of cognitive impairment ($r_s = -.24$, $p = .04$, 95% CI [−.44, −.01]), less use of RUM-EMO-REG ($r_s = -.31$, $p = .01$, 95% CI [−.51, −.09]), and lower levels of depression ($r_s = -.27$, $p = .02$, 95% CI [−.47, −.04]) with small effects (ES, $r^2 = .06$ to.10) for the HC group (see supplementary material for individual ES). Partial correlation analyses showed that the relationship between age and (1) cognitive ability was independent of mood, (2) RUM-EMO-REG was independent of cognitive ability and mood, and (3) depression was not independent of anxiety (see supplementary material for partial correlational data).

Cognitive ability versus rumination and mood

Having less cognitive impairment (higher TICS scores) was associated with greater use of RUM-EMO-REG (95% CI [.08, .53]), RUM-THINK (95% CI [.02, .49]), RUM-RESP-DEP reflection (95% CI [.08, .54]), and higher levels of anxiety (95% CI [.04, .50]), with

Table 4. Spearman rho zero-order and partial correlations between cognitive ability, rumination, and mood measure scores.

	TICS							
	PwD ($n = 64$)				HC ($n = 75$)			
Measures	ZO	AgC	DC	AC	ZO	AgC	DC	AC
Rumination								
Emotion regulation style (CERQ)	.32**	.28*	.23	.19	.14	.07	.13	.18
Thinking style (RTSQ)	.27*	.24	.19	.08	.08	.05	.07	.18
Response to depression (RRS)								
Combined-type	.12	.09	−.01	−.08	.05	−.002	.02	.19
Brooding	.02	−.003	−.10	−.17	−.03	−.05	−.06	.06
Reflection	.33**	.29*	.26*	.22	.12	.08	.11	.18
Mood								
Depression (PHQ-9)	.24	.21	-	.09	.05	−.01	-	.16
Anxiety (GAD-7)	.28*	.24	.18	-	−.11	−.17	−.20	-

TICS = Telephone interview for cognitive status; PwD = people living with dementia; HC = healthy controls; ZO = zero-order correlation; AgC = age as a covariate (partial-correlation); DC = depression as a covariate (partial-correlation); AC = anxiety as a covariate (partial-correlation); CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale; PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalized Anxiety Disorder scale.
RRS combined-type = combined depressive, brooding and reflection subscale scores.
*significant at the .05 level (2-tailed).
**significant at the .01 level (2-tailed).

small effects (ES, $r^2 = .07$ to .10) for the PwD group (see Table 4). and supplementary material for individual ES). Partial correlation analyses showed that these relationship were not independent of age and/or mood (see Table 4). No significant correlations were found between cognitive ability and any type of rumination, nor mood for the HC group.

Table 5. Spearman rho zero-order and partial correlations between rumination and depression scores.

	Depression (PHQ-9)							
	PwD ($n = 64$)				HC ($n = 75$)			
Measures	ZO	CAC	AgC	AC	ZO	CAC	AgC	AC
Rumination								
Emotion regulation style (CERQ)	.56**	.52**	.53**	.29*	.33**	.32**	.27*	.18
Thinking style (RTSQ)	.46**	.42**	.43**	−.02*	.48**	.48**	.46**	.24*
Response to depression (RRS)								
Combined-types	.55**	.54**	.53**	.27*	.69**	.69**	.66**	.38**
Brooding	.42**	.43**	.41**	.14	.45**	.45**	.44**	.16
Reflection	.45**	.40**	.42**	.20	.51**	.51**	.49**	.27*
Mood								
Anxiety (GAD-7)	.59**	.56**	.57**	-	.70**	.70**	.67**	-

PHQ-9 = Patient Health Questionnaire 9; PwD = people living with dementia; HC = healthy controls; ZO = zero-order correlation; CAC = cognitive ability as a covariate (partial-correlation); AgC = age as a covariate (partial-correlation); AC = anxiety as a covariate (partial-correlation); CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale; GAD-7 = Generalized Anxiety Disorder scale.
RRS combined-types = combined depressive, brooding and reflection subscale scores.
*significant at the .05 level (2-tailed).
**significant at the .01 level (2-tailed).

Table 6. Spearman rho zero-order and partial correlations between rumination and anxiety scores.

	Anxiety (GAD-7)							
	PwD ($n = 64$)				HC ($n = 75$)			
Measures	ZO	CAC	AgC	DC	ZO	CAC	AgC	DC
Rumination								
Emotion regulation style (CERQ)	.64**	.60**	.60**	.46**	.29*	.32**	.25*	.10
Thinking style (RTSQ)	.79**	.77**	.77**	.72**	.47**	.48**	.45**	.21
Response to depression (RRS)								
Combined-types	.64**	.63**	.62**	.47**	.73**	.74**	.72**	.48**
Brooding	.55**	.57**	.55**	.41**	.50**	.50**	.48**	.30*
Reflection	.52**	.47**	.49**	.36**	.50**	.52**	.48**	.24*
Mood								
Depression (PHQ-9)	.59**	.56**	.57**	-	.70**	.70**	.67**	-

GAD-7 = Generalized Anxiety Disorder scale; PwD = people living with dementia; HC = healthy controls; ZO = zero-order correlation; CAC = cognitive ability as a covariate (partial-correlation); AgC = age as a covariate (partial-correlation); DC = depression as a covariate (partial-correlation); CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale; PHQ-9 = Patient Health Questionnaire 9.
RRS combined-types = combined depressive, brooding and reflection subscale scores.
*significant at the .05 level (2-tailed).
**significant at the .01 level (2-tailed).

Rumination and depression

Increased use of each type of rumination was associated with increased levels of depression with small to moderate effects for both the PwD (95% CI range = .18 to .71, ES, $r^2 = .18$ to .31) and HC group (95% CI range = .10 to .80, ES, $r^2 = .11$; to .48) (see Table 5). and supplementary material for individual CIs and ES). Partial correlation analyses showed that the relationship between depression and (1) RUM-THINK and, (2) RUM-RESP-DEP brooding and reflection were not independent of anxiety, but RUM-EMO-REG and RUM-RESP-DEP combined-types independently explained some of the variance in depression with small effects (RUM-EMO-REG style, $r^2 = .08$; combined-types, $r^2 = .07$) for the PwD group. For the HC group, the relationship between depression and (1) RUM-EMO-REG, and (2) RUM-RESP-DEP brooding were not independent of anxiety, but RUM-THINK, and RUM-RESP-DEP combined-types and reflection independently explained some of the variance in depression with small effects (RUM-THINK, $r^2 = .06$; combined-types, $r^2 = .14$; reflection, $r^2 = .07$).

Rumination and anxiety

Increased use of each type of rumination was associated with increased levels of anxiety with small to moderate effects for both the PwD (95% CI range = .30 to .88, ES, $r^2 = .27$ to .62) and HC group (95% CI range = .07 to .82, ES, $r^2 = .08$ to .53) (see Table 6). and see supplementary material for individual CIs and ES). Partial correlation analyses showed that each type of rumination independently explained some of the variance in anxiety with small and moderate effects (RUM-EMO-REG style, $r^2 = .21$; RUM-THINK, $r^2 = .52$; RUM-RESP-DEP combined-types, $r^2 = .22$, brooding, $r^2 = .17$, and reflection, $r^2 = .13$) for the PwD group. For the HC group, the relationship between anxiety and (1) RUM-EMO-REG style, and (2) RUM-THINK were not independent of depression, but all of the types of RUM-RESP-DEP independently explained some of the variance in anxiety with small effects (combined-types, $r^2 = .23$, brooding, $r^2 = .09$, and reflection, $r^2 = .06$).

Table 7. Descriptive analyses of the attentional bias subgroup's age, cognitive ability, rumination, mood, dwell-time, and attentional bias scores.

	N = 9	
Measures	Mean	*SD*
Age	67	5
Cognitive status (TICS)	32	5
Rumination		
Emotional regulation style (CERQ)	11	5
Thinking style (RTSQ)	87	22
Response to depression (RRS)		
Combined-type	45	11
Brooding	11	3
Reflection	6	2
Mood		
Depression (PHQ-9)	10	8
Anxiety (GAD-7)	9	6
Total dwell-time (s)		
Sad face	15	2
Neutral (versus sad faces)	16	2
Angry face	16	2
Neutral (versus angry faces)	15	2
Happy face	16	2
Neutral (versus happy faces)	15	2
Bias score (s)		
Sad face	−2	3
Angry face	1	3
Happy face	1	4

TICS = Telephone interview for cognitive status; CERQ = Cognitive Emotion Regulation Questionnaire; RTSQ = Ruminative Thought Style Questionnaire; RRS = Ruminative Response Scale; PHQ-9 = Patient Health Questionnaire 9; GAD-7 = Generalized Anxiety Disorder scale.

RRS combined-type = combined depressive, brooding and reflection subscale scores.

Bias scores (proportion of the total dwell-time on the emotional face relative to the total dwell-time on both the emotional face plus its corresponding neutral face). Scores of > 0 indicate longer dwelling on the emotional face, and < 0 indicate less dwelling on the emotional face.

Relationship between rumination and attentional biases

Full eye-tracking datasets were obtained from nine of the 11 participants within the AB subgroup. Exploratory analyses were conducted to provide estimate data for future larger-scale studies (see Table 7). Bivariate correlation analyses only yielded one significant correlation between RUM-THINK scores and angry-face dwell-times ($r_s = -.80$, $p = 0.01$, 95% CI [−.97, −.17], power = .64) with a moderate effect ($r^2 = .64$) (see Figure 2). Higher use of a ruminative thinking style was associated with less dwelling on angry faces. As we could have missed other relationships by not examining a relative bias metric, relative bias scores were then computed and explored. The only significant correlation yielded was between ruminative RUM-THINK and angry-face bias scores ($r_s = -.79$, $p = 0.01$, 95% CI [−.96, −.15], power = .62) with a moderate effect ($r^2 = .62$). Higher use of a ruminative thinking style (high ruminators) was associated with a bias away from angry faces, and lower use (low ruminators) with a bias toward angry faces (see Figure 3).

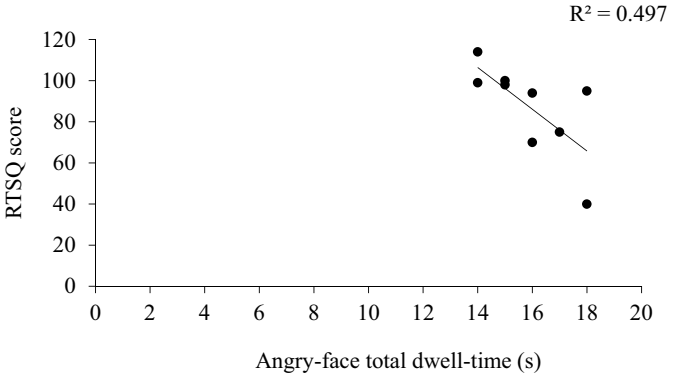

Figure 2. Participants' ($N = 9$) RTSQ (ruminative thought style questionnaire) scores against their angry-face dwell-time. R^2 = effect size.

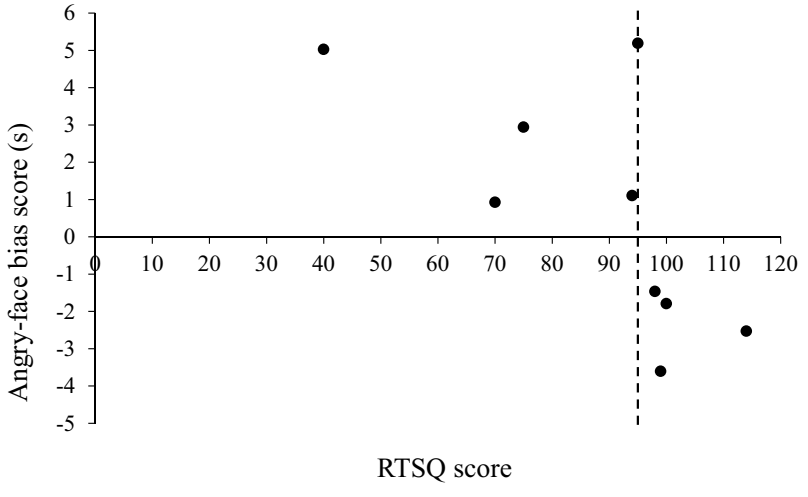

Figure 3. Participants' ($N = 9$) angry-face bias scores (proportion of the total dwell-time on the angry face relative to the total dwell-time on both the angry face plus its corresponding neutral face) against their RTSQ (ruminative thought style questionnaire) scores. Bias scores of > 0 indicate longer dwelling on angry faces, <0 indicate less dwelling on angry faces, and 0 indicates no bias. The dashed vertical line represents the median RTSQ score of 95. Scores below and above the median indicate low and high ruminators, respectively.

Discussion

This study investigated the reliability of the Cognitive Emotion Regulation Questionnaire (CERQ), Ruminative Thought Style Questionnaire (RTSQ), and the Ruminative Response Scale (RRS) as rumination measures for people living with dementia (PwD), the level of rumination observed in people living with and without dementia, and the relationships between rumination, age, cognitive ability, mood, and attentional biases (AB) in these populations. Our findings contribute to the sparse literature that focusses on old to very-old older adults (below and above 80 years old respectively) (Kunzmann et al., 2023), and to our knowledge, this is the first study to present a cross-sectional picture of these types

of ruminative processing in dementia. Our findings suggest that rumination as an emotion-regulation style (RUM-EMO-REG), thinking style (RUM-THINK), and response to depression (RUM-RESP-DEP) can be reliably assessed in dementia using the CERQ, RTSQ, and RRS respectively, and that PwD ruminate in these ways. The question of whether the inhibitory control deficits associated with AD would corresponded with higher or lower levels of rumination had been posed (Nash et al., 2007). While the PwD in the current study reported significantly higher levels of RUM-THINK and RUM-RESP-DEP (combined-type and brooding) than did healthy controls (HC) participants, this would be expected (based on cognitively healthy population literature) as they reported significantly higher levels of depression and anxiety. However, future studies should specifically investigate participants with AD, assess AD severity, include individuals with AD ranging from mild to severe, and assess cognitive inhibition and rumination levels concurrently to directly address this question.

In line with findings relating to participants living without dementia (Demnitz-King et al., 2021), we found that higher levels of reflective rumination were associated with better cognition after controlling for depression for the PwD group. However, this relationship diminished after controlling for anxiety. Based on previous findings (Marchant et al., 2017, 2020) of increased repetitive negative thinking (RNT) being independently associated with greater declines in memory, we could have expected the relationships between cognitive ability and rumination for the PwD group within the current study to be evident after controlling for anxiety (or depression) symptoms. However, our studies differ in terms of (1) study cohorts (e.g., PwD versus people living without dementia and sample sizes), (2) cognitive focus (memory versus a multi-domain score), and (3) the type/valence of repetitive thinking being assessed (CERQ, RTSQ, and RRS versus the Perseverative Thinking Questionnaire (Ehring et al., 2011)). The Perseverative Thinking Questionnaire was specifically designed to assess content-independent dysfunctional repetitive thinking and is more associated with the negative aspects of repetitive thinking. The RTSQ and RRS used in the current study contain neutral (i.e., RTSQ) and (relatively more) positive aspects of repetitive thinking which are considered (relatively) less dysfunctional (e.g., RRS reflective rumination). And while RRS brooding rumination is considered dysfunctional RNT, it is content specific (i.e., RNT focussed on depression). It may therefore be possible that different types of repetitive thinking may be associated with dementia (or cognitive ability) to differing degrees, with different consequences, at different stages of life (e.g., a protective factor in mid-life (Ravona-Springer et al., 2009), or associated with AD risk factors in later life (Marchant et al., 2020)).

Our finding that increased rumination is associated with increased levels of depression and anxiety for the PwD group corresponds with the literature involving older adults living without dementia (Chen et al., 2020; McLaughlin & Nolen-Hoeksema, 2011; Nolen-Hoeksema & Aldao, 2011; Opdebeeck et al., 2015; Philippot & Agrigoroaei, 2017; Ramirez-Ruiz et al., 2019; Ricarte et al., 2016; Romero-Moreno et al., 2016; Von Hippel et al., 2008), with the strongest relationship being seen between RUM-THINK and anxiety for the PwD group, and RUM-RESP-DEP and anxiety for the HC group. The RRS, used to measure RUM-RESP-DEP, is typically used in rumination studies involving both depression and anxiety (Chen et al., 2020; Olatunji et al., 2013; Opdebeeck et al., 2015). Our findings suggest that the use of the RRS may be appropriate in mood studies involving cognitively healthy older

adults given the higher amount of the variance accounted for by RUM-RESP-DEP in both depression and anxiety, compared to RUM-EMO-REG or RUM-THINK in this group. RUM-EMO-REG and RUM-RESP-DEP accounted for virtually the same amount of the variance in depression and anxiety as measured by the CERQ and RRS, respectively, for the PwD group. The CERQ contains 4 item and the RRS contains 22 items. If future studies have a large number of scales to administer, they may wish to consider using the CERQ as participant burden may be lessened, unless they were specifically interested in examining the types of rumination assessed within the RRS. Still, as RUM-THINK accounted for a higher amount of the variance in anxiety than any other type of rumination for PwD group, future anxiety studies involving PwD should consider including the RTSQ measure of rumination.

To the best of our knowledge, this is the first study to explore the relationship between rumination, depression, anxiety, and AB in a cohort that includes PwD. Although we found that a negative relationship between RTSQ scores and (1) angry-face dwell-time, and (2) angry-face bias scores (i.e., high ruminators dwelled less on angry faces/displayed an AB away from angry faces whereas low ruminators dwelled on angry faces more/displayed an AB toward angry faces), we acknowledge the preliminary nature of these findings, and that they should be interpreted with caution. While a negative relationship contrasts with theoretical accounts of rumination and findings showing a positive relationship between AB and rumination for participants with major depression or experiencing state anxiety (De Raedt & Koster, 2010; Donaldson et al., 2007; Vălenaş et al., 2017), these relationships need to be robustly explored in older adults living with and without cognitive impairment to examine whether existing theoretical accounts hold within these populations. Additionally, given the number of tests conducted in the analyses of the participant survey responses, there is the possibility of type one errors, so further investigation is warranted.

Clinical/Research relevance

Our finding show that it is prudent to use multiple rumination measures when examining the relationship between rumination and neuropsychiatric symptoms in populations where these relationships have not been previously examined. As we have established that there are moderate to strong relationships between rumination, depression, and anxiety for PwD, developing, or adapting interventions that target rumination for this population could potentially increase treatment options, particularly for anxiety. In general, rumination-based interventions should be further explored within older-adult populations (Tang et al., 2022). Moreover, measuring AB within these intervention studies, could evaluate the theoretical relationship between rumination, mood, and AB in older adults.

Study limitations

One limitation is that our cross-sectional and correlational study design is insufficient to establish causality. Other limitations include our sample size, use of self-/representative-reported diagnoses, and that a dementia severity assessment was not conducted. Our sample size did not allow for sub-group analysis (dementia

type, or symptom status). While 66% of our PwD group had a diagnosis of AD, it is possible our results were influenced by the combination of different types of dementia in this group (i.e., the varying types of cognitive impairment associated with each dementia). Further, our analysis was conducted on groups comprising individuals with varying symptomology (i.e., with and without depression and/or anxiety, and within score ranges indicative of subclinical and clinical depression [MDD] and anxiety [GAD]), and possibly different symptom histories (e.g., never, or formally experienced depressed and/or anxious episodes). This is likely to have affected our findings as rumination levels have been shown to differ between groups with subclinical and clinical levels of depression or anxiety, and those with comorbid depression and anxiety (Aldao et al., 2010; McEvoy et al., 2013), and symptom history can affect findings (Whitmer & Gotlib, 2011). In terms of dementia diagnosis and severity, our study sample might have been better characterized if the dementia diagnosis and severity were confirmed within the current study. While our findings provide preliminary data for future studies, the reliability of the examined rumination measures for participants with more clearly defined characteristics is required.

Lastly, a potential limitation could stem from the rumination types/measures that were investigated in our study. We were very conscious of participant overload so limited the number of rumination types/measures to be investigated. It would be worth investigating other types of ruminative or repetitive thinking not studied here, and their corresponding measures, to compare their suitability for examining the relationship between depression and anxiety in dementia.

Future studies

Future studies are needed to replicate these findings, with larger samples to enable sub-group analysis (e.g., dementia type and severity, symptom status [subclinical, clinical, or comorbid], and symptom history [i.e., no previous episode versus repeated episodes]). Further research (e.g., symptom criteria, cutoff scores, and validation in different settings and populations) is needed regarding the assessment of depression and anxiety in older adults (Balsamo, Cataldi, Carlucci, & Fairfield, 2018; Balsamo, Cataldi, Carlucci, Padulo, et al., 2018; Gerolimatos et al., 2015; Goodarzi et al., 2019). Moreover, future studies could incorporate a variety of measures (e.g., proxy and clinical interview) to examine the relationships between rumination, depression, anxiety, and AB. As RNT, depression and anxiety have been linked to AD risk, and we have established a relationship between rumination, depression, and anxiety for PwD, longitudinal studies are necessary to better examine these relationships, and assess their cognitive and biological impact (i.e., rate of cognitive decline and plaque formation). AB and rumination have already become intervention targets for depression and anxiety in cognitively healthy individuals (Spinhoven, Klein, et al., 2018; Yang et al., 2015). Experimental studies ought to be conducted to investigate whether a reduction in negative AB and rumination in dementia affects depression and anxiety symptoms, and perhaps the rate of cognitive decline and disease progression.

Conclusion

The Cognitive Emotion Regulation Questionnaire, Ruminative Thought Style Questionnaire, and Ruminative Response Scale are reliable measures of rumination in dementia. Our findings suggest that these types of rumination may be an important factor in anxiety in this population. They also highlight the need for further investigation of how different types of repetitive or ruminative thinking may affect individuals, pre- and post-diagnosis. The findings from this study support the idea that rumination could be a promising target for interventions intended to reduce depression and anxiety in PwD.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, AG, upon reasonable request.

References

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217–237. https://doi.org/10.1016/j.cpr.2009.11.004

Amieva, H., Phillips, L. H., Della Sala, S., & Henry, J. D. (2004). Inhibitory functioning in Alzheimer's disease. *Brain A Journal of Neurology*, *127*(5), 949–964. https://doi.org/10.1093/brain/awh045

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N, and Evershed, J K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behaviour Research*, *52*(1), 388–407. https://doi.org/10.3758/s13428-019-01237-x

Balsamo, M., Cataldi, F., Carlucci, L., & Fairfield, B. (2018). Assessment of anxiety in older adults: A review of self-report measures. *Clinical Interventions in Aging*, *13*, 573–593. https://doi.org/10.2147/CIA.S114100

Balsamo, M., Cataldi, F., Carlucci, L., Padulo, C., & Fairfield, B. (2018). Assessment of late-life depression via self-report measures: A review. *Clinical Interventions in Aging*, *13*, 573–593. https://doi.org/10.2147/CIA.S114100

Bell, G., Baou, C. E., Saunders, R., Buckman, J. E. J., Charlesworth, G., Richards, M., Brown, B., Nurock, S., Michael, S., Ware, P., Aguirre, E., Rio, M., Cooper, C., Pilling, S., John, A., & Stott, J. (2022). Effectiveness of primary care psychological therapy services for the treatment of depression and anxiety in people living with dementia: Evidence from national healthcare records in England. *EClinicalMedicine*, *52*, 101692. https://doi.org/10.1016/j.eclinm.2022.101692

Blackwell, S. E., Woud, M. L., & MacLeod, C. (2017). A question of control? Examining the role of control conditions in experimental psychopathology using the example of cognitive bias modification research. *The Spanish Journal of Psychology*, *20*, E54–E54. https://doi.org/10.1017/sjp.2017.41

Boller, F., El Massioui, F., Devouche, E., Traykov, L., Pomati, S., & Starkstein, S. E. (2002). Processing emotional information in Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, *14*(2), 104–112. https://doi.org/10.1159/000064932

Bourgin, J., Silvert, L., Borg, C., Morand, A., Sauvée, M., Moreaud, O., & Hot, P. (2020). Impact of emotionally negative information on attentional processes in normal aging and Alzheimer's disease. *Brain and Cognition*, *145*(April), 105624. https://doi.org/10.1016/j.bandc.2020.105624

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview for cognitive status. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, *1*(2), 111–117. https://doi.org/10.1037/t28542-000

Breitve, M. H., Hynninen, M. J., Brønnick, K., Chwiszczuk, L. J., Auestad, B. H., Aarsland, D., & Rongve, A. (2016). A longitudinal study of anxiety and cognitive decline in dementia with Lewy bodies and Alzheimer's disease. *Alzheimer's Research & Therapy*, *8*(1). https://doi.org/10.1186/s13195-016-0171-4

Brinker, J. K., & Dozois, D. J. A. (2009). Ruminative thought style and depressed mood. *Journal of Clinical Psychology*, *65*(1), 1–19. https://doi.org/10.1002/jclp.20542

Buchanan, E. M., & Scofield, J. E. (2018). Methods to detect low quality data and its implication for psychological research. *Behavior Research Methods*, *50*(6), 2586–2596. https://doi.org/10.3758/s13428-018-1035-6

Cabrera, I., Brugos, D., & Montorio, I. (2020). Attentional biases in older adults with generalized anxiety disorder. *Journal of Anxiety Disorders*, *71*, 102207. https://doi.org/10.1016/j.janxdis.2020.102207

Chau, S. A., Chung, J., Herrmann, N., Eizenman, M., & Lanctôt, K. L. (2016). Apathy and attentional biases in Alzheimer's disease. *Journal of Alzheimer's Disease*, *51*(3), 837–846. https://doi.org/10.3233/JAD-151026

Chen, X., Pu, J., Shi, W., & Zhou, Y. (2020). The impact of neuroticism on symptoms of anxiety and depression in elderly adults: The mediating role of rumination. *Current Psychology*, *39*(1), 42–50. https://doi.org/10.1007/s12144-017-9740-3

Conover, W. J. (1999). *Practical nonparametric statistics* (3rd ed.). John Wiley & Sons Inc.

Demeyer, I., Sanchez, A., & De Raedt, R. (2017). Older adults' attentional deployment: Differential gaze patterns for different negative mood states. *Journal of Behavior Therapy and Experimental Psychiatry*, *55*, 49–56. https://doi.org/10.1016/j.jbtep.2016.11.012

Demnitz-King, H., Chocat, A., Collette, F., Dautricourt, S., Gonneaud, J., Jessen, F., Klimecki, O. M., Salmon, P. K., Lutz, A., Molinuevo, J. L., Poisnel, G., Touron, E., Walker, Z., Chetelat, G., & Marchant, N. L. (2021). Self-reflection is associated with markers of Alzheimer's disease in cognitively unimpaired older adults. *Alzheimer's & Dementia*, *17*(S6), 1–2. https://doi.org/10.1002/alz.053678

De Raedt, R., & Koster, E. H. W. (2010). Understanding vulnerability for depression from a cognitive neuroscience perspective: A reappraisal of attentional factors and a new conceptual framework. *Cognitive, Affective, & Behavioral Neuroscience*, *10*(1), 50–70. https://doi.org/10.3758/CABN.10.1.50

D'Hudson, G., & Saling, L. L. (2010). Worry and rumination in older adults: Differentiating the processes. *Aging and Mental Health*, *14*(5), 524–534. https://doi.org/10.1080/13607861003713141

Donaldson, C., Lam, D., & Mathews, A. (2007). Rumination and attention in major depression. *Behaviour Research and Therapy*, *45*(11), 2664–2678. https://doi.org/10.1016/j.brat.2007.07.002

Duque, A., & Vázquez, C. (2015). Double attention bias for positive and negative emotional faces in clinical depression: Evidence from an eye-tracking study. *Journal of Behavior Therapy and Experimental Psychiatry*, *46*, 107–114. https://doi.org/10.1016/j.jbtep.2014.09.005

Ebner, N. C., Riediger, M., and Lindenberger, U. (2010). FACES—A database of facial expressions in young, middle-aged, and older women and men: Development and validation. *Behavior Research Methods*, *42*(1), 351–362. https://doi.org/10.3758/BRM.42.1.351

Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy*, *1*(3), 192–205. https://doi.org/10.1521/ijct.2008.1.3.192

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The perseverative thinking questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*(2), 225–232. https://doi.org/10.1016/j.jbtep.2010.12.003

El Haj, M., Boudoukha, A. H., & Moustafa, A. A. (2021). Future-oriented repetitive thought: Pessimistic view of future in patients with Alzheimer disease. *Journal of Geriatric Psychiatry and Neurology*, *34*(3), 216–221. https://doi.org/10.1177/0891988720924723

Fernández-Fernández, V., Márquez-González, M., Losada-Baltar, A., & Romero-Moreno, R. (2014). Frequency of leisure activities and depressive symptomatology in elderly people: The moderating role of rumination. *International Psychogeriatrics*, *26*(2), 297–305. https://doi.org/10.1017/S1041610213001877

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Garnefski, N., & Kraaij, V. (2007). The cognitive emotion regulation questionnaire: Psychometric features and prospective relationships with depression and anxiety in adults. *European Journal of Psychological Assessment*, *23*(3), 141–149. https://doi.org/10.1027/1015-5759.23.3.141

Garnefski, N., Kraaij, V., & Spinhoven, P. (2001). Negative life events, cognitive emotion regulation and emotional problems. *Personality and Individual Differences*, *30*(8), 1311–1327. https://doi.org/10.1016/S0191-8869(00)00113-6

Georgiou, G. A., Bleakley, C., Hayward, J., Russo, R., Dutton, K., Eltiti, S., & Fox, E. (2005). Focusing on fear: Attentional disengagement from emotional faces. *Visual Cognition*, *12*(1), 145–158. https://doi.org/10.1080/13506280444000076

Gerolimatos, L. A., Ciliberti, C. M., Gregg, J. J., Nazem, S., Bamonti, P. M., Cavanagh, C. E., & Edelstein, B. A. (2015). Development and preliminary evaluation of the anxiety in cognitive impairment and dementia (ACID) scales. *International Psychogeriatrics*, *27*(11), 1825–1838. https://doi.org/10.1017/S1041610215001027

Gonfrier, S., Andrieu, S., Renaud, D., Vellas, B., & Robert, P. (2012). Course of neuropsychiatric symptoms during a 4-year follow up in the REAL-FR cohort. *The Journal of Nutrition, Health and Aging*, *16*(2), 134–137. https://doi.org/10.1007/s12603-011-0147-9

Goodarzi, Z., Samii, L., Azeem, F., Sekhon, R., Crites, S., Pringsheim, T., Smith, E. E., Ismail, Z., & Holroyd-Leduc, J. (2019). Detection of anxiety symptoms in persons with dementia: A systematic review. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*, *11*(1), 340–347. https://doi.org/10.1016/j.dadm.2019.02.005

Goyal, A. R., Engedal, K., & Eriksen, S. (2019). Clinicians' experiences of anxiety in patients with dementia. *Dementia (London, England)*, *18*(1), 80–93. https://doi.org/10.1177/1471301216659770

Grafton, B., Southworth, F., Watkins, E., & MacLeod, C. (2016). Stuck in a sad place: Biased attentional disengagement in rumination. *Emotion*, *16*(1), 63–72. https://doi.org/10.1037/emo0000103

Greco, L. M., O'Boyle, E. H., Cockburn, B. S., & Yuan, Z. (2018). Meta-analysis of coefficient alpha: A reliability generalization study. *Journal of Management Studies*, *55*(4), 583–618. https://doi.org/10.1111/joms.12328

Greenaway, A.-M., Hwang, F., Nasuto, S., & Ho, A. (2024). Webcam-based eye-tracking of attentional biases in Alzheimer's disease: A proof-of-concept study. *Clinical Gerontologist*, *47*(1), 98–109. https://doi.org/10.1080/07317115.2023.2240783

Greenaway, A.-M., Nasuto, S., Ho, A., & Hwang, F. (2021). Is home-based webcam eye-tracking with older adults living with and without Alzheimer's disease feasible? *The 23rd International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '21)*, pp. 1–3. https://doi.org/10.1145/3441852.3476565

Gummer, T., Roßmann, J., & Silber, H. (2021). Using instructed response items as attention checks in web surveys: Properties and implementation. *Sociological Methods and Research*, *50*(1), 238–264. https://doi.org/10.1177/0049124118769083

Hsu, K. J., Beard, C., Rifkin, L., Dillon, D. G., Pizzagalli, D. A., & Björgvinsson, T. (2015). Transdiagnostic mechanisms in depression and anxiety: The role of rumination and attentional control. *Journal of Affective Disorders*, *188*, 22–27. https://doi.org/10.1016/j.jad.2015.08.008

IBM Corp. (2017). *IBM SPSS statistics software for windows (no. 25)*.

Ireland, M. J., Clough, B. A., & Day, J. J. (2017). The cognitive emotion regulation questionnaire: Factorial, convergent, and criterion validity analyses of the full and short versions. *Personality and Individual Differences*, *110*, 90–95. https://doi.org/10.1016/j.paid.2017.01.035

Isaacowitz, D. M., Toner, K., Goren, D., & Wilson, H. R. (2008). Looking while unhappy. *Psychological Science*, *19*(9), 848–853. https://doi.org/10.1111/j.1467-9280.2008.02167.x

Jermann, F., Van Der Linden, M., D'Acremont, M., & Zermatten, A. (2006). Cognitive Emotion Regulation Questionnaire (CERQ): Confirmatory factor analysis and psychometric properties of the French translation. *European Journal of Psychological Assessment*, *22*(2), 126–131. https://doi.org/10.1027/1015-5759.22.2.126

Joormann, J. (2010). Cognitive inhibition and emotion regulation in depression. *Current Directions in Psychological Science*, *19*(3), 161–166. https://doi.org/10.1177/0963721410370293

Kaiser, A., Kuhlmann, B. G., & Bosnjak, M. (2018). A meta-analysis of inhibitory-control deficits in patients diagnosed with Alzheimer's dementia. *Neuropsychology*, *32*(5), 615–633. https://doi.org/10.1037/neu0000460

Koster, E. H. W., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective: The impaired disengagement hypothesis. *Clinical Psychology Review*, *31*(1), 138–145. https://doi.org/10.1016/j.cpr.2010.08.005

Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals*, *32*(9), 509–515. https://doi.org/10.3928/0048-5713-20020901-06

Kunzmann, U., Nestler, S., Gerstorf, D., Schilling, O., Wahl, H., Hoppmann, C. A., Katzorreck, M., Lücke, A. J., Lücke, A. J., Katzorreck, M., Hoppmann, C. A., Wahl, H., Kunzmann, D., Gerstorf, U., & Nestler, S. (2023). Three facets of emotion regulation in old and very old age: Strategy use, effectiveness, and variability. *Emotion (Washington, DC)*, *24*(2), 316–328. https://doi.org/10.1037/emo0001269

LaBar, K. S., Mesulam, M. M., Gitelman, D. R., & Weintraub, S. (2000). Emotional curiosity: Modulation of visuospatial attention by arousal is preserved in aging and early-stage Alzheimer's disease. *Neuropsychologia*, *38*(13), 1734–1740. https://doi.org/10.1016/S0028-3932(00)00077-4

Lee, L. O., & Knight, B. G. (2009). Attentional bias for threat in older adults: Moderation of the positivity bias by trait anxiety and stimulus modality. *Psychology and Aging*, *24*(3), 741–747. https://doi.org/10.1037/a0016409

LeMoult, J., & Gotlib, I. H. (2018). Depression: A cognitive perspective. *Clinical Psychology Review*, *69*, 51–66. https://doi.org/10.1016/j.cpr.2018.06.008

Levens, S. M., Muhtadie, L., & Gotlib, I. H. (2009). Rumination and impaired resource allocation in depression. *Journal of Abnormal Psychology*, *118*(4), 757–766. https://doi.org/10.1037/a0017206

Löwe, B., Decker, O., Müller, S., Brähler, E., Schellberg, D., Herzog, W., & Herzberg, P. Y. (2008). Validation and standardization of the generalized anxiety disorder screener (GAD-7) in the general population. *Medical Care*, *46*(3), 266–274. https://doi.org/10.1097/MLR.0b013e318160d093

Lu, L., Neale, N., Line, N. D., & Bonn, M. (2022). Improving data quality using amazon mechanical Turk through platform setup. *Cornell Hospitality Quarterly*, *63*(2), 231–246. https://doi.org/10.1177/19389655211025475

MacLeod C., Rutherford E., Campbell L., Ebsworthy G., and Holker L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology*, *111*(1), 107–123. https://doi.org/10.1037/0021-843X.111.1.107

Mandell, D., Siegle, G. J., Shutt, L., Feldmiller, J., & Thase, M. E. (2014). Neural substrates of trait ruminations in depression. *Journal of Abnormal Psychology*, *123*(1), 35–48. https://doi.org/10.1037/a0035834

Marchant, N. L., Arenaza-Urquijo, E. M., & Chetelat, G. (2017). Repetitive negative thinking is associated with amyloid, tau, and cognitive decline. *Alzheimer's & Dementia*, *13*(7), P1152–P1152. https://doi.org/10.1016/j.jalz.2017.06.1685

Marchant, N. L., Lovland, L. R., Jones, R., Pichet Binette, A., Gonneaud, J., Arenaza-Urquijo, E. M., Chételat, G., & Villeneuve, S. (2020). Repetitive negative thinking is associated with amyloid, tau, and cognitive decline. *Alzheimer's & Dementia*, *16*(7), 1054–1064. https://doi.org/10.1002/alz.12116

Maria, G.-G., & Juan, G.-G. (2017). Negative bias in the perception and memory of emotional information in Alzheimer disease. *Journal of Geriatric Psychiatry and Neurology*, *30*(3), 131–139. https://doi.org/10.1177/0891988716686833

Martin, L. L., & Tesser, A. (1996). Some ruminative thoughts. In R. S. Wyer (Ed.), *Advances in social cognition* (pp. 1–47). Lawrence Erlbaum Associates, Inc.

McEvoy, P. M., Watson, H., Watkins, E. R., & Nathan, P. (2013). The relationship between worry, rumination, and comorbidity: Evidence for repetitive negative thinking as a transdiagnostic construct. *Journal of Affective Disorders*, *151*(1), 313–320. https://doi.org/10.1016/j.jad.2013.06.014

McIntosh, W. D., Harlow, T. F., & Martin, L. L. (1995). Linkers and nonlinkers: Goal beliefs as a moderator of the effects of everyday hassles on rumination, depression, and physical complaints 1. *Journal of Applied Social Psychology*, *25*(14), 1231–1244. https://doi.org/10.1111/j.1559-1816.1995.tb02616.x

McLaughlin, K. A., & Nolen-Hoeksema, S. (2011). Rumination as a transdiagnostic factor in depression and anxiety. *Behaviour Research and Therapy*, *49*(3), 186–193. https://doi.org/10.1016/j.brat.2010.12.006

Megreya, A. M., Latzman, R. D., Al-Attiyah, A. A., & Alrashidi, M. (2016). The robustness of the nine-factor structure of the cognitive emotion regulation questionnaire across four Arabic-Speaking Middle Eastern Countries. *Journal of Cross-Cultural Psychology*, *47*(6), 875–890. https://doi.org/10.1177/0022022116644785

Michl, L. C., McLaughlin, K. A., Shepherd, K., & Nolen-Hoeksema, S. (2013). Rumination as a mechanism linking stressful life events to symptoms of depression and anxiety: Longitudinal evidence in early adolescents and adults. *Journal of Abnormal Psychology*, *122*(2), 339–352. https://doi.org/10.1037/a0031994

Mogg, K., & Bradley, B. P. (2018). Anxiety and threat-related attention: Cognitive-motivational framework and treatment. *Trends in Cognitive Sciences*, *22*(3), 225–240. https://doi.org/10.1016/j.tics.2018.01.001

Mohlman, J., Price, R. B., & Vietri, J. (2013). Attentional bias in older adults: Effects of generalized anxiety disorder and cognitive behavior therapy. *Journal of Anxiety Disorders*, *27*(6), 585–591. https://doi.org/10.1016/j.janxdis.2013.06.005

Nash, S., Henrt, J. D., McDonald, S., Martin, I., Brodaty, H., & Peek O'Leary, M. A. (2007). Cognitive disinhibition and socioemotional functioning in Alzheimer's disease. *Journal of the International Neuropsychological Society*, *13*, 1060–1064. https://doi.org/10.1017/S1355617707071184 6

Ng, G., Ng, W. Q., & Yang, H. (2022). Executive functions predict the trajectories of rumination in middle-aged and older adults: A latent growth curve analysis. *Emotion*, *23*(3), 776–786. https://doi.org/10.1037/emo0001096

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, *100*(4), 569–582. https://doi.org/10.1037/0021-843X.100.4.569

Nolen-Hoeksema, S., & Aldao, A. (2011). Gender and age differences in emotion regulation strategies and their relationship to depressive symptoms. *Personality and Individual Differences*, *51*(6), 704–708. https://doi.org/10.1016/j.paid.2011.06.012

Nolen-Hoeksema, S., Morrow, J., & Fredrickson, B. L. (1993). Response styles and the duration of episodes of depressed mood. *Journal of Abnormal Psychology*, *102*(1), 20–28. https://doi.org/10.1037/0021-843X.102.1.20

Nolen-Hoeksema, S., Parker, L. E., & Larson, J. (1994). Ruminative coping with depressed mood following loss. *Journal of Personality and Social Psychology*, *67*(1), 92–104. https://doi.org/10.1037/0022-3514.67.1.92

Olatunji, B. O., Naragon-Gainey, K., & Wolitzky-Taylor, K. B. (2013). Specificity of rumination in anxiety and depression: A multimodal meta-analysis. *Clinical Psychology Science & Practice*, *20*(3), 225–257. https://doi.org/10.1037/h0101719

Opdebeeck, C., Nelis, S. M., Quinn, C., & Clare, L. (2015). How does cognitive reserve impact on the relationships between mood, rumination, and cognitive function in later life? *Aging and Mental Health*, *19*(8), 705–712. https://doi.org/10.1080/13607863.2014.962005

Parasuraman, R., & Haxby, J. V. (1993). Attention and brain function in Alzheimer's disease: A review. *Neuropsychology*, *7*(3), 242–272. https://doi.org/10.1037/0894-4105.7.3.242

Pekkala, S., Albert, M. L., Spiro, A., & Erkinjuntti, T. (2008). Perseveration in Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, *25*(2), 109–114. https://doi.org/10.1159/000112476

Philippot, P., & Agrigoroaei, S. (2017). Repetitive thinking, executive functioning, and depressive mood in the elderly. *Aging and Mental Health*, *21*(11), 1192–1196. https://doi.org/10.1080/13607863.2016.1211619

Quade, D. (1967). Rank analysis of covariance. *Journal of the American Statistical Association*, *62*(320), 1187–1200. https://doi.org/10.1080/01621459.1967.10500925

Ramirez-Ruiz, B., Quinn, K., & Ferreira, N. (2019). Emotion-regulation strategies in older people: A systematic review. *Working with Older People (Brighton, England)*, *24*(1), 1–18. https://doi.org/10.1108/WWOP-09-2019-0026

Ravona-Springer, R., Beeri, M. S., & Goldbourt, U. (2009). Repetitive thinking as a psychological cognitive style in midlife is associated with lower risk for dementia three decades later. *Dementia and Geriatric Cognitive Disorders*, *28*(6), 513–520. https://doi.org/10.1159/000257089

Ricarte, J., Ros, L., Serrano, J. P., Martínez-Lorca, M., & Latorre, J. M. (2016). Age differences in rumination and autobiographical retrieval. *Aging and Mental Health*, *20*(10), 1063–1069. https://doi.org/10.1080/13607863.2015.1060944

Romero-Moreno, R., Losada, A., Márquez-González, M., & Mausbach, B. T. (2016). Stressors and anxiety in dementia caregiving: Multiple mediation analysis of rumination, experiential avoidance, and leisure. *International Psychogeriatrics*, *28*(11), 1835–1844. https://doi.org/10.1017/S1041610216001009

Ryu, S.-H., Katona, C., Rive, B., & Livingston, G. (2005). Persistence of and changes in neuropsychiatric symptoms in Alzheimer disease over 6 months: The LASER-AD study. *The American Journal of Geriatric Psychiatry*, *13*(11), 976–983. https://doi.org/10.1097/00019442-200511000-00008

Schneider, B. C., Veckenstedt, R., Karamatskos, E., Pinho, L. G., Morgado, B., Fonseca, C., Moritz, S., & Jelinek, L. (2023). Negative cognitive beliefs, positive metacognitive beliefs, and rumination as mediators of metacognitive training for depression in older adults (MCT-Silver). *Frontiers in Psychology*, *14*, 153377–1153377. https://doi.org/10.3389/fpsyg.2023.1153377

Segerstrom, S. C., Roach, A. R., Evans, D. R., Schipper, L. J., & Darville, A. K. (2010). The structure and health correlates of trait repetitive thought in older adults. *Psychology and Aging*, *25*(3), 505–515. https://doi.org/10.1037/a0019456

Seignourel, P. J., Kunik, M. E., Snow, L., Wilson, N., & Stanley, M. (2008). Anxiety in dementia: A critical review. *Clinical Psychology Review*, *28*(7), 1071–1082. https://doi.org/10.1016/j.cpr.2008.02.008

Semmelmann, K., & Weigelt, S. (2018). Online webcam-based eye tracking in cognitive science: A first look. *Behavior Research Methods*, *50*(2), 451–465. https://doi.org/10.3758/s13428-017-0913-7

Seo, E. H., Lee, D. Y., Kim, S. G., Kim, K. W., Kim, D. H., Kim, B. J., Kim, M. D., Kim, S. Y., Kim, Y. H., Kim, J. L., Kim, J. W., Moon, S. W., Park, J. H., Ryu, S. H., Yoon, J. C., Lee, N. J., Lee, C. U., Jhoo, J. H., Choo, L. H., & Woo, J. I. (2011). Validity of the telephone interview for cognitive status (TICS) and

modified TICS (TICSm) for mild cognitive imparment (MCI) and dementia screening. *Archives of Gerontology and Geriatrics*, *52*(1), e26–e30. https://doi.org/10.1016/j.archger.2010.04.008

Sheehan, B. (2012). Assessment scales in dementia. *Therapeutic Advances in Neurological Disorders*, *5* (6), 349–358. https://doi.org/10.1177/1756285612455733

Silber, H., Danner, D., & Rammstedt, B. (2019). The impact of respondent attentiveness on reliability and validity. *International Journal of Social Research Methodology*, *22*(2), 153–164. https://doi.org/10.1080/13645579.2018.1507378

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review*, *29*(2), 116–128. https://doi.org/10.1016/j.cpr.2008.10.003

Spalletta, G., Caltagirone, C., Girardi, P., Gianni, W., Casini, A. R., & Palmer, K. (2012). The role of persistent and incident major depression on rate of cognitive deterioration in newly diagnosed Alzheimer's disease patients. *Psychiatry Research*, *198*(2), 263–268. https://doi.org/10.1016/j.psychres.2011.11.018

Spinhoven, P., Drost, J., van Hemert, B., & Penninx, B. W. (2015). Common rather than unique aspects of repetitive negative thinking are related to depressive and anxiety disorders and symptoms. *Journal of Anxiety Disorders*, *33*, 45–52. https://doi.org/10.1016/j.janxdis.2015.05.001

Spinhoven, P., Klein, N., Kennis, M., Cramer, A. O. J., Siegle, G., Cuijpers, P., Ormel, J., Hollon, S. D., & Bockting, C. L. (2018). The effects of cognitive-behavior therapy for depression on repetitive negative thinking: A meta-analysis. *Behaviour Research and Therapy*, *106*, 71–85. https://doi.org/10.1016/j.brat.2018.04.002

Spinhoven, P., van Hemert, A. M., & Penninx, B. W. (2018). Repetitive negative thinking as a predictor of depression and anxiety: A longitudinal cohort study. *Journal of Affective Disorders*, *241*, 216–225. https://doi.org/10.1016/j.jad.2018.08.037

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder. *Archives of Internal Medicine*, *166*(10), 1092. https://doi.org/10.1001/archinte.166.10.1092

Staedtler, A. V., & Nunez, D. (2015). Nonpharmacological therapy for the management of neuropsychiatric symptoms of Alzheimer's disease: Linking evidence to practice. *Worldviews on Evidence-Based Nursing / Sigma Theta Tau International, Honor Society of Nursing*, *12*(2), 108–115. https://doi.org/10.1111/wvn.12086

Tang, T., Jiang, J., & Tang, X. (2022). Psychological risk and protective factors associated with depression among older adults in mainland China: A systematic review and meta-analysis. *International Journal of Geriatric Psychiatry*, *37*(1). https://doi.org/10.1002/gps.5637

Tanner, A., Voon, D., Hasking, P., & Martin, G. (2013). Underlying structure of ruminative thinking: Factor analysis of the ruminative thought style questionnaire. *Cognitive Therapy and Research*, *37* (3), 633–646. https://doi.org/10.1007/s10608-012-9492-1

Vălenaş, S. P., Szentágotai-Tătar, A., Grafton, B., Notebaert, L., Miu, A. C., & MacLeod, C. (2017). Prediction of pre-exam state anxiety from ruminative disposition: The mediating role of impaired attentional disengagement from negative information. *Behaviour Research and Therapy*, *91*, 102–110. https://doi.org/10.1016/j.brat.2017.01.014

van der Linde, R. M., Dening, T., Stephan, B. C. M., Prina, A. M., Evans, E., & Brayne, C. (2016). Longitudinal course of behavioural and psychological symptoms of dementia: Systematic review. *British Journal of Psychiatry*, *209*(5), 366–377. https://doi.org/10.1192/bjp.bp.114.148403

Von Hippel, W., Vasey, M. W., Gonda, T., & Stern, T. (2008). Executive function deficits, rumination and late-onset depressive symptoms in older adults. *Cognitive Therapy and Research*, *32*(4), 474–487. https://doi.org/10.1007/s10608-006-9034-9

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin*, *134* (2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163

Watkins, E., & Mason, A. (2002). Mood as input and rumination. *Personality and Individual Differences*, *32*(4), 577–587. https://doi.org/10.1016/S0191-8869(01)00058-7

Weintraub, S., Wicklund, A. H., & Salmon, D. P. (2012). The neuropsychological profile of Alzheimer disease. *Cold Spring Harbor Perspectives in Medicine*, *2*(4), 006171. https://doi.org/10.1101/cshperspect.a006171

Werheid, K., McDonald, R. S., Simmons-Stern, N., Ally, B. A., & Budson, A. E. (2011). Familiar smiling faces in Alzheimer's disease: Understanding the positivity-related recognition bias. *Neuropsychologia*, *49*(10), 2935–2940. https://doi.org/10.1016/j.neuropsychologia.2011.06.022

Whitmer, A., & Gotlib, I. H. (2011). Brooding and reflection reconsidered: A factor analytic examination of rumination in currently depressed, formerly depressed, and never depressed individuals. *Cognitive Therapy and Research*, *35*(2), 99–107. https://doi.org/10.1007/s10608-011-9361-3

Wild, B., Eckl, A., Herzog, W., Niehoff, D., Lechner, S., Maatouk, I., Schellberg, D., Brenner, H., Müller, H., & Löwe, B. (2014). Assessing generalized anxiety disorder in elderly people using the GAD-7 and GAD-2 scales: Results of a validation study. *The American Journal of Geriatric Psychiatry*, *22*(10), 1029–1038. https://doi.org/10.1016/j.jagp.2013.01.076

Wong, B., Ismail, Z., & Goodarzi, Z. (2022). Detecting depression in persons living with mild cognitive impairment: A systematic review. *International Psychogeriatrics*, *34*(5), 453–465. https://doi.org/10.1017/S1041610222000175

Woods, B., O'Philbin, L., Farrell, E. M., Spector, A. E., & Orrell, M. (2018). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews*, *2018*(3), CD001120. https://doi.org/10.1002/14651858.CD001120.pub3

Yang, W., Ding, Z., Dai, T., Peng, F., & Zhang, J. X. (2015). Attention bias modification training in individuals with depressive symptoms: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, *49*(Pt A), 101–111. https://doi.org/10.1016/j.jbtep.2014.08.005