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Does cognitive reserve moderate the association between mood and cognition? A systematic review

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Summary

The evidence regarding the association between mood and cognitive function is conflicting, suggesting the involvement of moderating factors. This systematic review aimed to assess whether cognitive reserve moderates the association between mood and cognition in older people. Cognitive reserve was considered in terms of the three key proxy measures – educational level, occupation, and engagement in cognitively stimulating leisure activities – individually and in combination. Sixteen studies representing 37,101 participants were included in the review. Of these, 13 used a measure of education, one used a measure of occupation, two used a measure of participation in cognitively stimulating activities, and one used a combination of these. In general, cognitive reserve moderated the association between mood and cognition, with a larger negative association between mood and cognition in those with low cognitive reserve than in those with high cognitive reserve. Further research utilizing multiple proxy measures of cognitive reserve is required to elucidate the associations.

Key words: depression, depressive symptoms, anxiety, cognitive decline

Introduction

Investigations of the associations between depression, anxiety and cognitive function have provided conflicting evidence regarding the direction and strength of these relationships. Most studies have found that greater levels of depression and/or anxiety are associated with poorer cognitive performance and a greater risk of cognitive decline, mild cognitive impairment and dementia.[1–6] However, other studies have found no association between depression or anxiety and cognitive function.[7,8] While differences in the methods of assessing mood and cognition may account for some of the variation, it is possible that other psychosocial factors may moderate the association between mood and cognition.

Several previous reviews have assessed the associations between cognition and either depression or anxiety in older people.[1, 9] While overall these reviews have reported that those with depression or anxiety have poorer cognitive performance than those without a mood disorder, the individual studies included in the reviews have shown mixed results. For instance, in the 40 studies included in the Kindermann and Brown[9] review, the effect of depression on cognition ranged from a strong negative effect to a moderate positive effect. Examination of potential moderators of the association indicated a significant difference by education; when the depressed and non-depressed groups were well-matched on education there was a weaker negative effect of depression on cognition. This may suggest that educational level, a commonly used proxy measure of cognitive reserve, plays a role in the association between depression and cognition.

Cognitive reserve is proposed to account for the incongruity between the levels of dementia pathology observed through autopsy or imaging and the individual's cognitive ability.[10] As cognitive reserve cannot be directly measured, it is frequently assessed in terms of the cognitive activities thought to increase it, most commonly educational level, complex occupational activity, and engagement in cognitive activities. These proxy measures of cognitive reserve are associated with better cognitive function and a reduced risk of cognitive decline and dementia.[11–13] Cognitive reserve has also been associated with cognitive function in people with Parkinson's disease, HIV, multiple sclerosis and traumatic brain injury.[14–17] In addition, greater educational level and participation in cognitively stimulating leisure activities in later life are associated with less risk of experiencing depression and lower

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scores on measures of depressive symptoms.[18–28] A number of studies have noted that mood disorders, most commonly depression, are associated with reduced brain volume and increased hippocampal atrophy,[29–31] both of which are associated with poorer cognitive performance in older people.[32] This evidence supports the proposition that depression and cognitive impairment share an underlying mechanism.[33–35] As cognitive reserve is thought to help maintain cognitive function through increased resistance to neuropathology, it may be reasonable to hypothesize that proxy measures of cognitive reserve may also account for some of the variance in findings regarding the associations between mood and cognition, playing a moderating role.

To date, however, evidence about the possible moderating role of cognitive reserve in the association between mood and cognition has been conflicting. In several studies, negative associations between mood and cognition have been found in those with lower but not higher levels of cognitive reserve,[36] while in others there was a negative mood–cognition association in those with higher but not lower levels of cognitive reserve,[37] and in yet other studies there was no moderating effect of cognitive reserve.[38] Given these apparent variations in the available evidence, we aimed to systematically review the existing studies to try to establish whether cognitive reserve, indicated by educational level, occupational complexity and/or engagement in cognitively stimulating leisure activities, acts as a moderator in the association between mood and cognition in older people. The review was limited to studies that investigated whether cognitive reserve, assessed by proxy measures, moderated the association between mood and cognitive function, impairment or decline in older people without dementia or other neurodegenerative conditions; including specific clinical groups, such as those with dementia, would have risked confounding the results.

Methods

Literature search strategy

In order to identify studies assessing whether cognitive reserve moderates the association between mood and cognition in later life, a search was conducted of the electronic databases ScienceDirect, PubMed, PsycInfo and CINAHL on 19 March 2015. Each database was searched for the terms (a) cognitive OR cognition AND (b) depress* OR mood OR anxiety AND (c) 'cognitive reserve' OR 'brain reserve' OR educat* OR occupation* OR activ* OR leisure AND (d) old* OR later life OR elder* OR aging OR ageing in the title, abstract or keywords. The reference sections of included studies were searched for additional papers not identified in the initial search.

Inclusion and exclusion criteria

Studies were included in this systematic review if (a) at least 80% of participants were aged over 60 or the information for those aged over 60 was reported separately, (b) at least 80% of participants were community-dwelling older people, (c) a proxy measure of cognitive reserve, specifically educational level, occupational status, cognitively stimulating leisure activities, or a combination of these was used, (d) a standardized measure of depression or level of self-reported depressive symptoms was used, and (e) a cross-sectional or longitudinal outcome measure of cognitive function was reported.

Studies were excluded if (a) more than 10% of the sample consisted of people with a neurological disorder or a disorder that may affect cognitive functioning (e.g. dementia, multiple sclerosis, Parkinson's disease, HIV, traumatic brain injury or stroke), (b) the study was an intervention or randomized controlled trial, and (c) the authors reported a biological or pathological proxy measure or outcome only.

Procedure

A summary of the procedure for selecting studies for inclusion can be seen in Figure 1. The searches identified 3877 unique titles that were evaluated in relation to the inclusion criteria, and those clearly unrelated to later life (e.g. child, animal or autism studies) were excluded. The remainder of the titles (n = 2625) were independently screened by two reviewers. The two reviewers achieved 98% agreement on inclusion/exclusion; where there was disagreement the title was retained for abstract screening. The primary reasons for exclusion after title screening were: the study focused solely on children, adolescents, animals or

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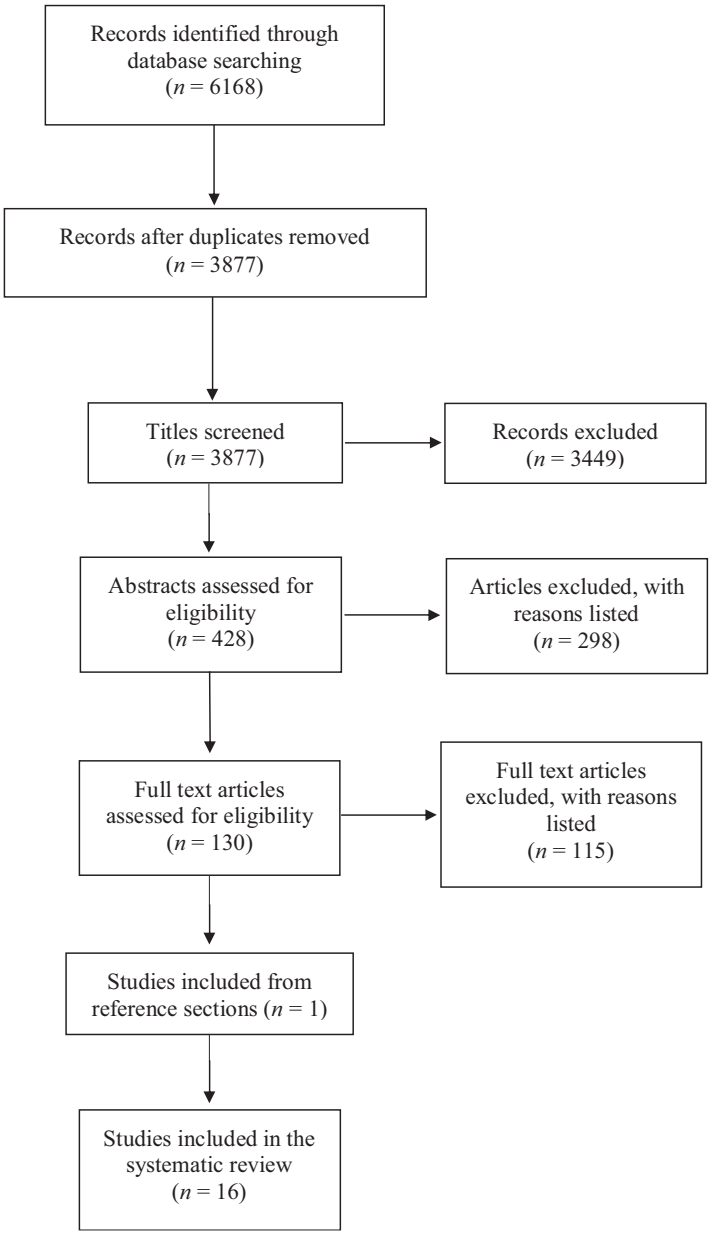


Figure 1. Study selection

clinical populations. The lead author and second reviewer independently screened the abstracts of the remaining articles. The reviewers achieved 92% agreement on the inclusion/exclusion of articles. Where agreement could not be reached, the full text was retrieved for screening. The primary reasons for exclusion after abstract screening were: the study did not utilize a measure of cognitive reserve, depression or anxiety, or cognition.

Full texts were retrieved for the remaining 130 articles and the methods and results sections were evaluated against the inclusion criteria. This

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resulted in 15 articles that satisfied the inclusion criteria. The articles rejected at this stage were primarily rejected because more than 20% of the population was from a clinical sample or aged under 60 ($n = 13$), there was no proxy measure of cognitive reserve or mood measure ($n = 10$), there was no cognition measure ($n = 19$), or the study did not consider whether a proxy measure of cognitive reserve moderated the association between mood and cognition ($n = 69$). In the majority of studies that did not assess any moderation effect analyses were adjusted for the cognitive reserve proxy measure or mood measure only. Searching the reference sections of the included studies resulted in the inclusion of one additional study.

Results

The search identified 16 studies with a total of 37,101 unique participants. The vast majority of the studies assessed whether educational level moderated the association between depression and cognitive function or decline ($n = 12$), with one study examining whether educational level moderated the association between anxiety and cognition.[39] Only one study considered whether occupation, using an occupation-based measure of social class, acted as a moderator of the depression–cognition association.[40] Two studies considered whether religious attendance, suggested by the authors of both studies to be a cognitive activity that contributes to cognitive reserve, moderated the depression–cognition association.[41,42] Only one study combined the three key indicators of cognitive reserve (education, occupation and cognitive activity), and assessed whether the association between depressive symptoms and anxiety and cognition differed in those with low and high cognitive reserve.[36] Table 1 provides details of the sample, proxy measure of cognitive reserve, mood and cognition measures, and outcome for each of the included studies. The majority of the studies considered only educational level as a potential moderator, and only two studies assessed whether the proxy measure of cognitive reserve moderated the association between anxiety and cognition. The following results are grouped by whether the proxy measures of cognitive reserve moderated the association between mood and cognition or not, with those studies that found no moderation effect discussed first.

Studies in which cognitive reserve was not a moderator of the mood–cognition association

Two studies reported that although there was a main effect of depression on cognitive performance, there was no difference in the associations between depression and cognition according to the educational level of participants across all the cognitive function measures employed.[38, 43] In the study of Bhalla and colleagues,[38] the level of education was relatively homogenous and there were few participants with lower levels of education; this lack of variability could account for why there was no moderation effect of educational level on the association between depression and cognition. However, Wilson and colleagues[43] included participants with a wide range of education and still noted no moderation effect; indeed, these two studies employed very different methodologies, as can be seen from Table 1. Bhalla and colleagues[38] suggested that a possible explanation for these results is that lowered mood might overwrite the protective effect of education on cognitive performance. However, this was not the case in the following set of studies.

Studies in which cognitive reserve was a moderator of the mood–cognition association

Nine studies found that proxy measures of cognitive reserve moderated the association between mood and cognition in older people across different cognitive function measures. In six of these nine studies, the negative association between mood and cognition was stronger in those with lower than higher levels of cognitive reserve. Of these six studies, four utilized educational level,[44–47] one considered religious attendance as a cognitively stimulating leisure activity,[42] and one combined educational level, occupational complexity and engagement in cognitive leisure activities to provide an overall indicator of cognitive reserve.[36] In all of these studies, having a higher level of cognitive reserve, indicated by one or a combination of the three key proxy measures, appeared to be somewhat protective against the observed negative main effect of clinical depression or depressive symptoms on cognitive function. In addition, in the one study that included a measure of anxiety, higher levels of anxiety were associated with poorer performance on memory tasks in those with lower levels but not higher levels of

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Table 1. *Studies included in the systematic review, with demographic, cognitive reserve proxy measure, mood measure, and cognitive outcome details, grouped by reported moderation effect found*

Author	Study aim	Participants and demographic details	Cognitive reserve, mood and cognition measures	Outcome
Studies in which cognitive reserve was not a moderator of the mood–cognition association				
Bhalla *et al.* (2005)	To assess whether educational level influences the association between cognition and depression	159 aged 59+ years 115 with depression 44 without	Education grouped as low and high Depression – none or clinically diagnosed Executive function memory, and language ability	There was no moderation effect of education on the depression–cognition association
Wilson *et al.* (2004)	To assess whether depressive symptoms predict cognitive decline (interaction secondary)	6158 at baseline aged 65–101 years CHAP	Education in years Depressive symptoms: 10-item CES-D General cognitive function	There was no moderation effect of education on the depression–cognition association
Studies in which cognitive reserve was a beneficial moderator of the mood–cognition association				
Fuhrer *et al.* (1992)	To assess factors associated with the co-occurrence of depression and cognitive impairment	2792 aged 65+ years PAQUID study	Education grouped as no school/primary without diploma to baccalaureate or university Depression: CES-D (cut-off = 17 for males and 23 for females) Cognitive impairment: scores of <24 on MMSE	Lower education was associated with a greater likelihood of experiencing cognitive impairment and depression than depression alone in women of all ages and men aged 75–84 but not in men aged 65–74 or 85+ years
Opdebeeck *et al.* (2015)	To assess whether cognitive reserve moderates the association between mood and cognition	236 aged 60+ (mean age 70.86 years)	Education, occupation and cognitive activity in combination (Lifetime of Experiences Questionnaire) Depressive symptoms and anxiety: HADS Memory and verbal fluency	Higher cognitive reserve positively moderated the association between depression and cognitive performance on all tasks and anxiety and cognitive performance on the memory tasks
Pálsson *et al.* (1999)	To assess the associations between depression, cognition and brain atrophy (interaction secondary)	268 aged 65+ years 59 with depression 209 without depression	Education dichotomized into 6 years or less and >6 years Depression: none, major or dysthymic disorder General cognitive function	Higher educational level positively moderated the association between depression and cognitive performance on the MMSE
Pálsson *et al.* (2001)	To assess the associations between depression, cognition and brain atrophy in women (interaction secondary)	421 women aged 70–74 years 206 without, 159 with previous depression, and 56 with current major depression or dysthymia	Education dichotomized into 6 years or less and >6 years Depression: none, major or dysthymic disorder General cognitive function	Higher educational level positively moderated the association between depression and cognitive performance on the MMSE

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Table 1. *Continued*

Author	Study aim	Participants and demographic details	Cognitive reserve, mood and cognition measures	Outcome
Reyes-Ortiz *et al.* (2008)	To assess whether the association between depressive symptoms and cognition is modified by church attendance	2759 Mexican Americans (mean age 72.7 years)	Church attendance dichotomized into frequent attenders and infrequent attenders Depression: CES-D (cut-off score = 16) General cognitive function	Frequent attendance positively moderated the negative association between mood and cognition
Wight *et al.* (2002)	To assess the association between educational attainment and training on cognition (interaction secondary)	1839 men aged 69–83 years	Education in years Depressive symptoms: CES-D General cognitive function	Education positively moderated the association between depressive symptoms and cognition
Studies in which cognitive reserve was a negative moderator of the mood–cognition association				
Geerlings *et al.* (2000)	To assess whether depression is associated with risk of cognitive decline and depression (interaction secondary)	3147 aged 65+ years AMSTEL 2399 aged 55+ years LASA	Education in years and dichotomised into lower and higher at 8 years in both samples AMSTEL: depression: GMS-AGECAT LASA: depression: CES-D AMSTEL: outcome of clinical Alzheimer's disease LASA: cognitive decline (MMSE decline of 3+)	In both samples educational level negatively moderated the depression–cognition association. Depression increased the risk of AD and cognitive decline in those with high but not low education
O'Shea *et al.* (2015)	To assess whether cognitive reserve moderates the association between depressive symptoms and cognition	3484 (mean age 76.07 years) WHICAP	Education in years Depressive symptoms: 10-item CES-D Memory, executive function, visuospatial ability and language	Higher educational level negatively moderated the depression–cognition association
Santos *et al.* (2014)	To assess the association between depressive symptoms and cognitive and the role of covariates	1051 aged 50+ years	Education grouped as <4 years, 4 years and >5 years Depressive symptoms: GDS Cognition categorised into general and executive function, processing speed and memory	Higher educational level negatively moderated the depression–cognition association in the general executive and memory domains and mixed moderation effects on processing speed
Studies with mixed moderation effects				
Avila *et al.* (2009)	To assess the influence of education and depression on cognition	110 aged 60+ years 59 with depression 51 without	Education dichotomized into low and high Depression: none, dysthymic or major General cognitive function, processing speed, executive function and memory	Higher education positively moderated the association between depression and cognitive performance on some but not all tasks

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Table 1. *Continued*

Author	Study aim	Participants and demographic details	Cognitive reserve, mood and cognition measures	Outcome
Corsentino *et al.* (2009)	To assess the effect of gender and depressive symptoms on the association between religious attendance and cognitive decline	2792 aged 65+ years from the PAQUID study	Religious attendance dichotomized into frequent and infrequent attenders Depression: modified version of the CES-D General cognitive function	Frequent attendance positively moderated the negative association between mood and cognition in females but not males
Gale *et al.* (2012)	To assess the association between depressive symptoms and cognition and the role of confounds	8611 aged 50+ years ELSA: those aged 60–80 and 80–90 were analysed separately	Age at which participants left education and occupation grouped from unskilled manual to professional Depression: 8-item CES-D (cut-off score of 4) General cognitive function	Occupation positively moderated the association between depression and cognitive performance in the 80–90 year old age group only There was no moderation effect of education on the depression cognition association
Moraes *et al.* (2010)	To assess the association between health and demographic variables and cognition by level of schooling	2712 grouped as those under 75 and those aged 75+	Education grouped as no formal education, 1–4 years, and 5+ years Depression: 10-item measure similar to the GDS General cognitive function	Depression entered alongside 15 other covariates. Depression was a significant predictor of cognition in those aged < 75 with no or 1–4 years of schooling only
Potvin *et al.* (2013)	To assess the relationship between state anxiety and performance on cognition (interaction secondary)	955 aged 65+	Education grouped as no diploma, primary diploma, or secondary/university Anxiety: state anxiety subscale of the French version of the State-Trait Anxiety Inventory Y-version General cognitive function, semantic verbal fluency, short-term visual memory, information processing, episodic memory, working memory	Short-term memory performance increased with moderate and high levels of anxiety in comparison with no anxiety in those with low education but not high education There were no significant moderation effect of education in the other domains

CHAP, Chicago Health and Aging Project; CES-D, Centre for Epidemiological Studies Depression Scale; PAQUID, Personnes Agées Quid; MMSE, Mini Mental State Exam; HADS, Hospital Anxiety and Depression Scale; AMSTEL, Amsterdam Study of the Elderly; LASA, Longitudinal Aging Study Amsterdam; GMS-AGECAT, Geriatric Mental State Automated Geriatric Examination for Computer Assisted Taxonomy; GDS, Geriatric Depression Scale; WHICAP, Washington Heights/Hamilton Heights Inwood Columbia Aging Project; ELSA, English Longitudinal Study of Aging.

cognitive reserve.[36] Three of these studies made some effort to match the cognitive reserve groups for levels of depression.[36,45,46] This could be an important factor in explaining differences in the observed associations given that previous research has suggested that higher levels of education, occupational complexity and engagement in cognitive activities are associated with reduced risk of experiencing clinical depression and lower scores on measures of depressive symptoms.

In contrast, the three other studies observing that a proxy measure of cognitive reserve acted as a moderator of the association between mood and cognition found the opposite effect.[37, 48,49] In these three studies, higher levels of depressive symptoms had a stronger association with poorer cognitive function or greater cognitive decline in those with higher educational level than in those with lower educational level. O'Shea and colleagues[37] suggested that these results could be due to the higher level of cognition seen in those with higher education, indicating that those individuals have more to lose whereas those with lower education were already performing at a lower level regardless of depressive symptoms. However, this explanation does not correspond with results from the six studies that noted a stronger negative association in those with lower levels of the proxy measures of cognitive reserve than those with higher levels. All of these studies varied considerably in their methodology (see Table 1), making it difficult to account for the opposing results.

Studies with mixed moderation effects

Five studies reported that proxy measures of cognitive reserve moderated the association between mood and cognition in some but not all of the groups or cognitive domains assessed.[39–41,50,51] In all but one of these studies, depressive symptoms had a stronger association with cognition in those with higher than lower levels of the proxy measure of cognitive reserve assessed in at least one age or gender group or for one of the cognitive measures assessed[40,41,50,51] (see Table 1). These studies varied considerably in their methodology. For instance, Avila and colleagues[50] assessed whether there was a significant interaction between education and depressive symptoms on 16 different cognitive measures across multiple domains while Corsentino and colleagues[41] focused on differences in the associations by age group. Moraes and colleagues[51] grouped participants by age and educational level and regressed depression alongside 15 other covariates on cognition, making it difficult to disentangle the results. One study reported mixed results when considering the associations with anxiety, with better performance on one of the seven cognitive measures employed in those with moderate and high levels of anxiety in comparison with those with no anxiety in the lower but not in the higher education group.[39] Avila and colleagues[50] suggest that the mixed moderation effects may be due to differences in the domains assessed and measures used. Those instruments wherein education moderated the association might be more sensitive to the effects of education; this could explain why there was an interaction on some measures and not others. However, this explanation does not account for the differences between groups of participants or why some studies report a main effect of education but not an interaction. The variation in the methodology of these studies makes it difficult to form a cohesive picture of the results; however, the majority of the significant findings indicated that depression has a stronger negative association with cognition in those with lower levels than in those with higher levels of education, occupation based social class, or attendance at religious activities.

Discussion

This study is the first to systematically review the evidence as to whether proxy measures of cognitive reserve moderate the association between depression or anxiety and cognitive function in older people. The 16 studies identified by this review were disparate in their methodology and findings. Of the 15 studies that assessed whether individual or combined proxy measures of cognitive reserve influence the association between clinical levels of depression or low levels of depressive symptoms and cognition, most suggested that cognitive reserve is beneficial. People with higher levels of cognitive reserve, indicated by educational level, more frequent religious attendance, or a combination of the three most common proxy measures, had better cognitive functioning regardless of depression level than those with lower cognitive reserve. In addition, in

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several of these studies, higher levels of depression were significantly associated with poorer cognition in those with lower but not higher levels of cognitive reserve. This evidence suggests that cognitive reserve may go at least some way towards moderating the negative association between depression and cognition. However, opposing findings were reported by five studies, ranging from no association to an association between depression and cognition in those with higher cognitive reserve only. Additionally, in four other studies, the proxy measures of cognitive reserve moderated the association between mood and cognition positively for some cognitive measures or some participant groups but not for all. The following sections will consider possible explanations for the disparate findings, discuss limitations of the review, and draw conclusions from the available evidence.

Methodological issues

There was significant variation across studies in the proxy measures of cognitive reserve, the measures of mood employed, and the methods of assessing cognitive function. We will address the variance in the methods employed to assess each of these complex and multi-faceted constructs in turn. The vast majority of studies considered only one commonly used proxy measure of cognitive reserve, with educational level the most frequent proxy measure employed. The average levels of education of participants in the individual studies ranged from very low levels[50] to very high levels[38] with no trend for similar education levels to show the same direction of moderation of the association between mood and cognition. Only one study considered a measure of occupational status as an independent moderator, and the only cognitive activity measure employed was religious attendance, utilized by two studies. These three studies all found that these measures were beneficial moderators of the association between depressive symptoms and cognitive function; however, the small number of studies makes it difficult to draw definitive conclusions about these specific proxy measures of cognitive reserve. Only one study considered cognitive reserve in terms of a proxy measure that combines educational level, occupational complexity, and engagement in cognitively stimulating activities across the lifespan. However, it has recently been suggested that cognitive reserve is not static but rather results from a lifetime of exposure to cognitively stimulating experiences.[52–58] To fully assess whether cognitive reserve moderates the association between mood and cognition it would seem prudent to include measures that evaluate a lifetime of experiences rather than assessing education, occupation or engagement in cognitive activities individually.

The measures of depression also varied considerably; most notably some measures considered the differences between those with clinically diagnosed major depression and those with no depression while others considered depressive symptoms on a continuous scale designed to assess the level of symptoms that does not provide a clinical diagnosis. Measures of depressive symptoms are very different from clinically diagnosed depression; clinical depression requiring intervention is likely to exert a much stronger influence on functioning than mild levels of depressive symptoms in community-dwelling older people. As such, we could reasonably have expected differences in the moderation effect of proxy measures of cognitive reserve on the association between clinical depression and cognition and depressive symptoms and cognition. However, there was no trend for proxy measures of cognitive reserve to show the same direction of moderation on the association between either type of depression measurement and cognition.

The methods of assessing cognition also varied considerably, from brief tests of general cognition such as the Mini-Mental State Examination[59] and more in depth neuropsychological assessment across multiple cognitive domains to measures of cognitive decline over time. Education has been differentially associated with different cognitive domains in several previous studies.[60–64] Additionally, in a recent meta-analysis, each of the three proxy measures of cognitive reserve varied in its associations with different domains of cognitive functioning.[11] However, this cannot explain the variations observed in this review, as there was no consistency in moderation effects according to cognitive domain assessed or in those studies that considered general cognitive function measures only. Without any consistency in the samples or methods of studies that showed a beneficial moderation effect of higher cognitive reserve levels on the negative association between

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mood and cognition, it is difficult to say why some studies report this finding while others found no moderation effect or indeed an opposing effect. However, as the majority of studies showed a beneficial moderation effect it seems reasonable to tentatively conclude that, in general, having higher levels of cognitive reserve may reduce the negative effects that depression exerts on cognition.

There may, however, be several possible confounding factors that result in the disparities between the moderation effects noted in the studies. The most notable of these may be cohort effects. There were significant cohort differences, including generational, geographical and racial differences. For instance, regarding geographical difference, four of the six studies that reported a beneficial moderation effect of cognitive reserve on the association between mood and cognition were conducted in Europe. In contrast, both studies in which there was no moderation effect were conducted in the USA. The aims of the studies also varied, with some setting out to specifically assess whether proxy measures of cognitive reserve moderate the association between mood and cognition whereas for others the moderation effect analysis was secondary to the main aim of the study (see Table 1). However, studies that considered the moderation effect as the main aim of the study are represented among those reporting each type of effect or no effect, as are studies in which assessing the moderation effect was secondary to the main aim. In sum, while there were a number of possible confounding factors, ranging from methodological differences to differences in study aims, none of these appears to relate to specific types of moderation effect.

Limitations

Due to the disparate methodology used in the studies included in this review it was not possible to carry out a meta-analysis that can avoid the bias associated with narrative reviews.[65] However, meta-analytic methods ignore differences across studies;[66] given the large variations seen in the relatively small number of studies available on this topic, a narrative systematic review was in any case deemed more appropriate. One of the major limitations of this review is our inability to address whether proxy measures of cognitive reserve moderate the association between anxiety and cognitive function. This was unavoidable as only two studies assessed whether the association between anxiety and cognition differed according to level of cognitive reserve, suggesting that this area has been under-researched to date. Given the heterogeneity of the methods employed and the results of these two studies, the question of whether proxy measures of cognitive reserve, individually or in combination, moderate the association between anxiety and cognition remains unanswered.

Conclusion

Cognitive reserve appears to moderate the negative effect that many neurological conditions and injuries have on cognition,[14–17] and perhaps further investigation may provide greater support for the supposition that it can also moderate the negative effect that mood disorders may have on cognition. If this is the case, it provides extra incentive to encourage people to engage in the activities that are associated with higher levels of cognitive reserve across the lifespan. It is not possible to give a definitive answer to the research question posed by this review until more studies, using consistent methods to assess cognitive reserve across varied samples of older people, have investigated whether cognitive reserve moderates the association between mood and cognition in later life. However, the current evidence assessed in this review suggests that we can tentatively conclude that cognitive reserve is a beneficial moderator of the negative associations between mood and cognition.

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Conflicts of interest

None

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*Indicates studies included in the systematic review

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