

Positive psychological constructs and cognitive function: a systematic review and meta-analysis

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Abstract

Aim

To synthesise evidence regarding the association between positive psychological constructs (PPCs) and cognitive function in adults aged 50+.

Methods

Literature searches: Medline, PsycINFO, and Scopus (inception to February 2022). Studies were included if they reported on the association between at least one PPC and one objective measure of cognitive function in people aged 50+ without cognitive impairment at baseline. Where at least two studies reported on the same PPC and cognitive outcome, estimates were pooled through meta-analysis.

Findings

In total, 37 studies were included. There was evidence of cross-sectional associations for 'meaning in life' (verbal fluency: $b=0.09$, 95%CI[0.07,0.11], $p<.001$; memory: $b=0.10$, 95%CI[0.08,0.12], $p<.001$), 'purpose in life' (verbal fluency: $b=0.07$, 95%CI[0.05,0.08], $p<.001$; memory: $r=.13$, 95%CI[0.08,0.18], $p<.001$), and positive affect (cognitive state: $r=.25$, 95%CI[0.14,0.36], $p<.001$; memory: $r=.05$, 95%CI[0.02,0.08], $p<.001$) with various domains of cognitive function. However, no significant results were found for life satisfaction ($p=.13$) or longitudinal studies investigating positive affect and memory ($p=.48$). Other PPCs were included in narrative syntheses only.

Implications

Purpose and meaning in life may be sensible primary targets for interventions to promote healthy cognitive aging. More longitudinal and causal inference research is needed to better understand this association and its implications for clinical practice.

Keywords: Positive psychology; Cognitive function; Systematic review; Meta-analysis.

1. Introduction

Approximately 55 million people are living with dementia worldwide (World Health Organization, 2021), current treatments for dementia are not particularly effective, so prevention is of high importance. The Lancet Commission's report identified 12 potentially modifiable risk factors for dementia (Livingston et al., 2020), including depression in later life. Negative affective symptoms have also been associated with cognitive decline (John et al., 2019b), with effects detectable as early as age 50 (John et al., 2019a). Despite evidence for the association between depression and increased risk of dementia and cognitive decline, less is known about the possible association of cognition with positive psychological constructs (PPCs) that contribute to psychological wellbeing (PWB). This is important to examine independent of negative affect, because PWB is more than the absence of psychological distress (Huppert, 2009; Trudel-Fitzgerald et al., 2019), with several notable models of important PPCs contributing to PWB (Peterson and Seligman, 2004; Ryff, 1989; Seligman, 2011). We recently reviewed the literature investigating associations of PPCs suggested in these theoretical models and risk of both mild cognitive impairment and dementia. We found evidence that purpose/meaning in life but not positive affect is associated with these outcomes (Bell et al., 2022). To our knowledge, there have been no systematic reviews of the associations between PPCs and different aspects of cognition. Identifying which PPCs are associated with decline in different cognitive domains among adults aged 50+ could have important implications for the development and refinement of prevention and early intervention strategies prior to cognitive impairment reaching clinical levels of severity and in terms of understanding which PPCs might be important in enhancing which cognitive domain. The aim of this review was to synthesise evidence relating to the association between positive psychological constructs and different aspects of cognitive function within normal limits in adults aged 50+.

2. Methods

This systematic review and meta-analysis was registered on PROSPERO (https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020224669) and has been reported in accordance with PRISMA guidelines (Page et al., 2021).

2.1. Search strategy

Literature searches were conducted in Medline, PsycINFO, and Scopus (from inception until March 2021) using the same search strategy as our previous review (Bell et al., 2022). In short, search terms for PPCs were derived from positive psychological models of PWB (Peterson and Seligman, 2004;

Ryff, 1989; Seligman, 2011) and then developed through consultations with experts in the field. Search terms for cognitive function were based on those used in a recent systematic review (Desai et al., 2020), with additional terms for specific cognitive domains also added (e.g. memory, executive function). Additionally, age-related terms for Medline from ISSG Search Filter Resource (ISSG Search Filter Resource, 2006) were used and adapted for use in other databases. See Appendix A-C for full list of search terms for each database. Searches were re-run in all databases prior to final analyses (February 2022) to identify any additional papers for inclusion.

2.2. Inclusion / exclusion criteria

We included studies published in English in peer-reviewed journals. Given that this is an emerging area, an exploratory approach was used for identifying relevant papers. Studies were included if they had a measure of at least one positive psychological construct and at least one objective measure of cognitive function (cognitive state [a measure of overall cognitive function], memory, executive function). Both cross-sectional and longitudinal designs were included in which samples had a mean age of 50+ at the time of cognitive outcome collection. Studies were excluded if any identified cognitive impairment was present in the sample at baseline.

2.3. Screening procedure

After duplicate removal, studies were screened in accordance with the inclusion/exclusion criteria by the primary reviewer (GB) using a 3-stage process (title, abstract, full-text). A second independent reviewer (TS) screened 10% of studies at each stage. Disagreements were discussed and resolved between reviewers prior to commencing the next screening stage.

2.4. Data extraction

Summary data were extracted from published reports using a standardised form in Excel. This included: author name(s), publication year, sample size, mean age, demographic information (where provided), country, PPC type, measures used for predictor and outcome, covariates, and effect sizes. Effect sizes were extracted and where possible, cross-sectional results (both baseline and follow up) were also extracted from longitudinal studies.

2.5. Risk of bias (quality) assessment

Longitudinal studies were assessed using the Newcastle-Ottawa Quality Assessment Scale (Wells et al., 2014) (Appendix D) and cross-sectional studies were assessed using the Joanna Briggs Institute Checklist (Joanna Briggs Institute, 2017) (Appendix E). Longitudinal studies were scored out of 8 with scores representing low (7-8), medium (4-6), and high (< 4) risk of bias. Cross-sectional studies were

scored out of 7 with scores representing low (6-7), medium (3-5), and high (< 3) risk of bias (Singham et al., 2021).

2.6. *Statistical analysis and data synthesis*

Findings from all studies have been reported narratively. Where there were at least two studies reporting on the same PPC and cognitive outcome, data were pooled in the form of a meta-analysis. Random effects meta-analyses were conducted in R version 4.0.3 using the *metafor* package (Viechtbauer, 2010). Relevant effect sizes (correlation, standardised beta) were extracted from included studies. Analyses using standardised beta coefficients were conducted using adjusted effect sizes and standard error. Meta-analyses using correlation coefficients transformed r to fisher's z then back again. The proportion of variance in the pooled effects due to between study heterogeneity was assessed using the I^2 statistic and interpreted as either high (75%), moderate (50%), or low (25%) (Higgins et al., 2003). Meta-analytic data is presented in forest plots. Some studies were not pooled as the analytic models used were not comparable. Where data were subsamples drawn from the same cohort, the study with the largest sample was used in the analysis. Publication bias was not assessed due to the small number of studies (<10) in most analyses (Sterne et al., 2011). Meta-regressions of SHARE samples versus samples from other cohorts were conducted to explore heterogeneity in the meaning in life analyses (Appendix F).

3. Results

3.1. *Selection process*

Studies were screened against inclusion/exclusion criteria in a 3-step process, first, by title (reviewer agreement 97.3%), then abstract (agreement 90%), and finally by full-text (agreement 80%). Re-running updated searches prior to the final analysis identified another 5 eligible papers. Overall, 37 studies met inclusion criteria (Figure 1).

3.2. *Study characteristics*

Of the 37 included studies, 20 used longitudinal designs and 17 were cross-sectional (Table 1). Cross-sectional findings were also reported in eight of the longitudinal studies. All samples had a baseline mean age of 50+, although three studies included participants aged <50 years (Dewitte et al., 2020; Hittner et al., 2020; Lewis et al., 2017). The full age range across studies was 32-112. 20 studies specified that participants with dementia were excluded from their samples, 16 did not specify, and one study that examined multiple cohorts across different countries excluded participants with

dementia in some samples but were unable to specify in others (Sutin et al., 2021a). The majority of the studies were conducted in North America ($n = 21$), or Europe ($n = 10$), with several conducted in Asia ($n = 5$). PPCs explored in studies included positive affect ($n = 12$), purpose in life ($n = 11$), life satisfaction ($n = 8$), positive wellbeing ($n = 5$), meaning in life ($n = 2$), all others were included in one study only. Studies were at medium-low risk of bias (Table 1), so none were excluded from analyses based on quality assessment ratings. Primary cognitive outcomes explored included cognitive state ($n = 20$), memory ($n = 20$), executive function ($n = 6$), verbal fluency ($n = 4$), and processing speed ($n = 7$).

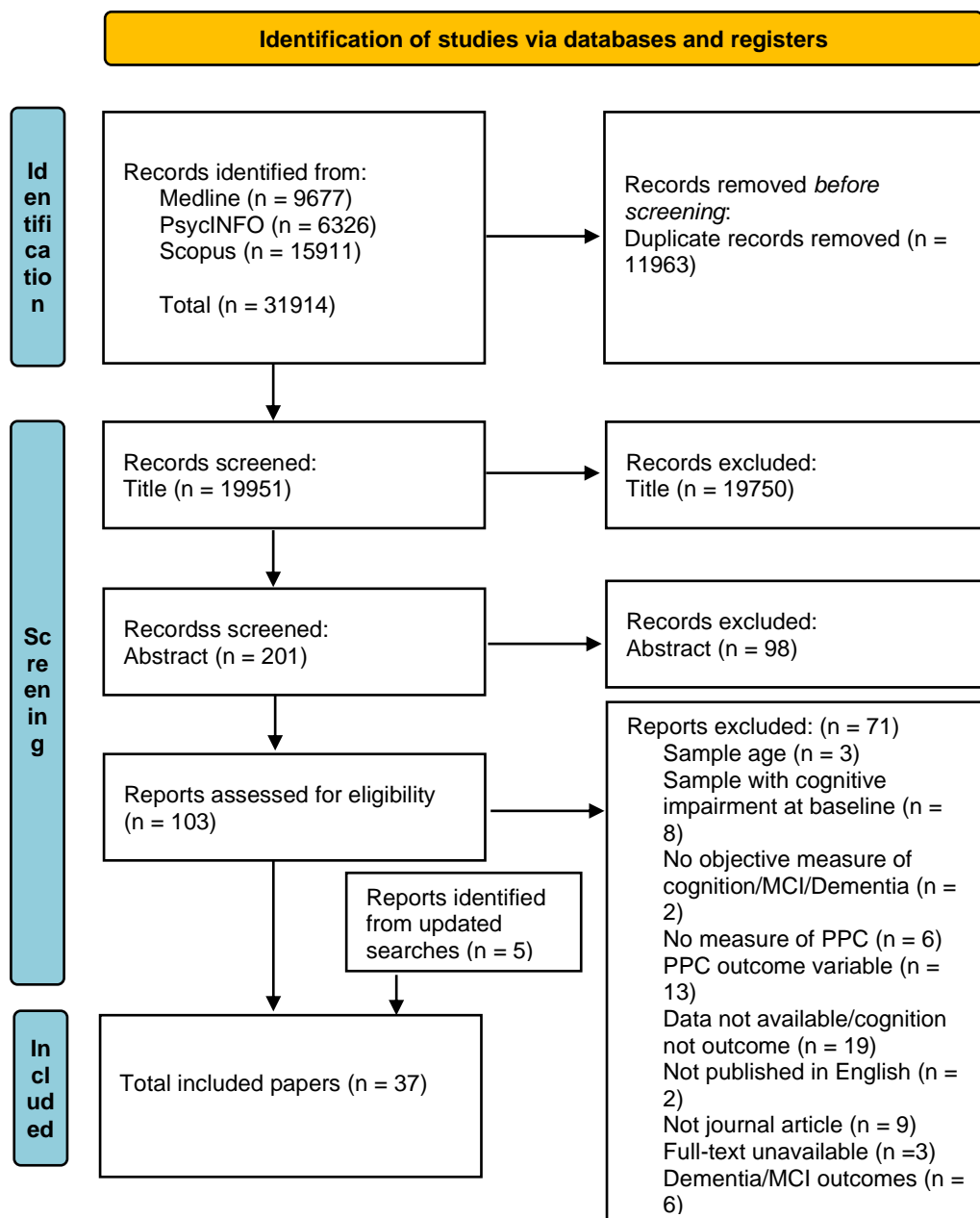


Figure 1: PRISMA flow diagram (Page et al., 2021)

Table 1: Characteristics of included studies

| Study | Data source | Country | Baseline sample size | Mean age (range) | Sex (%female) | Predictor (measure) | Outcome (measure) | Main findings | Risk of bias |
|------------------------|-------------|-------------|----------------------|------------------|---------------|--|--|---|--------------|
| Cross-sectional | | | | | | | | | |
| Aftab (2019) | SAGE | USA | 638 | 80.1 (61+) | 46.1% | Meaning in life (Presence and Search subscales from MLQ) | Cognitive state (TICS-m) | Significant positive correlation between presence and cognition and negative correlation between search and cognition | Medium |
| Bishop (2012) | GCS | USA | 137 | 99.7 (98+) | 78.83% | Positive affect (BABS), Life satisfaction (LSI-A) | Cognitive state (SPMSQ) | Significant correlation between positive affect and cognition, but not between life satisfaction and cognition | Medium |
| Fung (2013) | N/A | Hong Kong | 380 | 70.4 (60-97) | 50.3% | Purpose in life (Chinese version of Purpose in life scale) | Cognitive state (MMSE) | Significant association between purpose and cognition | Low |
| Hill (2005) | MAAS | Netherlands | 119 | 72.3 (65-82) | 49.6% | Positive affect (PANAS) | Memory (VVLT) | Significant association between positive affect and recall but not recognition | Low |
| Jones (2003) | N/A | USA | 129 | 75.4 (65-89) | 65.9% | Life satisfaction (PGC), Positive affect (PANAS) | Cognitive state (CERAD) | Significant correlation between both life satisfaction and positive affect with cognition | Medium |
| Koenig (2004) | N/A | USA | 838 | 64.3 (50+) | 53.1% | Religiosity (Hoge's 10-item scale) | Global cognitive function (MMSE) | Significant association between self-rated religiousness and cognition, non-significant association for intrinsic religiosity | Low |
| Lewis (2017) | MIDUS | USA | 3,489 | 56.4 (32-84) | 55% | Purpose in life (Ryff's subscale) | Cognitive state, Episodic memory, Executive function | Significant association between purpose and all | Low |

| | | | | | | | (BTACT, SGST) | cognitive outcomes | |
|----------------|--|--------------|----------------------------------|--|---|---|---|---|--------|
| Requena (2009) | N/A | Spain | 340 | 71.6 (60-85) | 91.2% | Life satisfaction (SWLS) | Memory (RBMT) | Significant negative correlation between life satisfaction and memory | Medium |
| Saad (2019) | N/A | Israel | 151 | 79 (60+) | 63.6% | Emotional intelligence (AVEI) | Cognitive state (MoCA) | Significant association between emotional intelligence and cognition | Low |
| Sharma (2017) | N/A | India | 58 | (50-64) | 56.9% | Creative thinking (TTCT) | Executive function (Stroop test), Memory (subtest of PGIMS) | Significant correlation between creativity and executive function, but not working memory | Medium |
| Sutin (2021a) | HRS, MIDUS, WLSG, WLSS, NCDS, TILDA, ELSI, SHARE | 32 countries | >140,000 (See paper for details) | See paper for details. Note, not reported for samples excluding dementia | See paper for details. Note, not available for samples excluding dementia | Purpose in life (Ryff's subscale), Meaning in life (single item from CASP-19) | Memory (word list recall), Verbal fluency (animal naming) | Significant association between meaning and verbal fluency in all cohorts except SHARE Israel and with episodic memory in all cohorts except SHARE Israel and SHARE Malta, significant association between purpose and episodic memory in all cohorts and with verbal fluency in all cohorts except Wisconsin Longitudinal Study sibling sample | Low |
| Sutin (2021b) | HRS | USA | 2,516 | 69.3 (65+) | 60% | Self-control (4 items), Industriousness (4 items) | Cognitive state (word learning and recall, logical memory, counting backwards, letter cancellation, SDMT, constructional praxis, animal fluency, Number series) | Significant association between industriousness and cognition, non-significant association between self-control and cognition | Low |
| Tani (2022) | NEIGE | Japan | 478 | (65-84) | 51.5% | Gratitude (2 items from GQ-6) | Cognitive state (Japanese version of MMSE) | Significant association between gratitude and | Low |

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|---------------------|--------|---------------|--------|--------------|-------|--|---|--|--------|
| | | | | | | | | cognition | |
| Waldman-Levi (2020) | N/A | USA | 39 | 74.9 (70+) | 48.7% | Hope (IHS) | Cognitive state (MoCA) | Significant negative correlation between hope and cognition | Medium |
| West (1984) | N/A | Not specified | 67 | 79.1 (65-90) | 100% | Life satisfaction (LSI-A) | Memory (Unrelated/related free recall, digit span, related numbers) | Significant correlation between life satisfaction and related numbers task only | Medium |
| Wettstein (2015) | N/A | Germany | 387 | 82.5 (75-94) | 49.9% | Life satisfaction (SWLS), Positive affect (PANAS) | Processing speed (counting backwards), working memory (digit span backwards), reasoning (number series), semantic fluency (animal naming), abstraction (similarities) | Results stratified by sensory impairment: no significant association between life satisfaction and any cognitive outcome. Significant association between positive affect and processing speed only in both visually-impaired and hearing-impaired groups, and positive affect and semantic fluency only in sensory unimpaired group | Medium |
| Zahodne (2018) | WHICAP | USA | 548 | 74.6 (65+) | 62.6% | Life satisfaction, Meaning/Purpose, Positive affect (Surveys from NIH toolbox) | Episodic memory, Working memory, Executive function, Verbal fluency, Processing speed (Neuropsychological battery) | Significant association between life satisfaction and episodic memory only, positive affect and processing speed only, and meaning/purpose with visuospatial and processing speed only | Low |
| Longitudinal | | | | | | | | | |
| Allerhand (2014) | ELSA | England | 10,985 | 65 (50-90) | 54.8% | Positive wellbeing (CASP-19) | Cognitive state, Executive function (animal naming), Memory (word list), Processing speed (letter cancellation) | Significant association between positive wellbeing and all cognitive outcomes | Low |

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|----------------------|---------|----------------|-------|---------------|---------------|---|--|--|--------|
| Berk (2017) | MAAS | Netherlands | 258 | 61 (40-82) | 54% | Positive affect (PANAS) | Memory (VVLT), Executive function (CST), Processing speed (LDST) | Non-significant associations between positive affect and all cognitive outcome | Low |
| Bishop (2011) | GCS | USA | 136 | Not specified | Not specified | Positive affect (BABS) | Cognitive state (SPMSQ) | Non-significant association between positive affect and cognition | Medium |
| Boyle (2010) | RMAP | USA | 698 | 80-4 | 74-9% | Purpose in life (Ryff's subscale) | Cognitive state (battery of 19 tests), Episodic memory (Logical memory story A, East Boston Story, Word list memory/recall/recognition), Semantic memory (BNT, Verbal fluency, Reading test), Working memory (Digit span forwards/backwards, Digit ordering), Perceptual speed (SDMT, Number comparison, Stroop test), Visuospatial ability (JLO, SPM) | Significant association between purpose and all cognitive outcomes except visuospatial ability | Medium |
| Castro-Schilo (2019) | SALSA | USA | 1,789 | 70-6 (60+) | 58-4% | Positive affect (4 positive items from CES-D) | Cognitive state (3MS), Verbal memory (SEVLT) | Significant association between baseline positive affect with cognition and memory but not rate of change, significant association between rate of change in positive affect with rate of change in cognition and memory | Medium |
| Danhauer (2013) | Co-STAR | USA and Canada | 1,479 | 67-1 (65+) | 100% | Positive affect (PANAS) | Cognitive state (3SME), Verbal knowledge (PMA vocabulary), Verbal fluency (letter and category fluency), Figural memory | Significant association between positive affect and verbal fluency measures only | Medium |

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| | | | | | | | (BVRT), Verbal memory (CVLT, recall), Working memory (Digits forwards and backwards), Spatial ability (Card rotations), Fine motor speed (Finger tapping) | | |
| Dewitte (2020) | MIDUS | USA | 3,633 | 56.4 (32-84) | 55.4% | Purpose in life (Ryff subscale), Positive affect (6 items) | Memory (word recall task from BTACT) | Significant cross-sectional and longitudinal correlations between purpose and memory, non-significant cross-lagged association. Significant correlation between positive affect and memory for follow up cross-sectional only | Medium |
| Gerstorf (2007) | BASE | Germany | 516 | 84.9 (70-103) | 50% | Psychological wellbeing (PGC) | Perceptual speed (Digit letter, identical pictures) | Significant longitudinal association between psychological wellbeing and perceptual speed, non-significant cross-sectional correlation | Medium |
| Hittner (2020) | MIDUS | USA | 991 | 55.5 (34-83) | 54.5% | Positive affect (PANAS, ABS-GWB) | Memory (BTACT) | Significant association between both measures of positive affect with follow up memory and change, significant cross-sectional correlation between PANAS and memory at follow up but not baseline | Medium |
| Ihle (2021) | VLV | Switzerland | 1,040 | 74.5 (64-96) | 49.2% | Life satisfaction (SWLS) | Executive function (TMT part A) | Non-significant association between life satisfaction and change in executive function | Medium |
| Kim | HRS | USA | 11,525 | 72.6 (50+) | 57.3% | Purpose in life | Cognitive state (recall, | Significant association | Medium |

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|------------------|-------|--------------------------|--------|---------------|-------|--|---|--|--------|
| (2019) | | | | | | (Ryff's subscale) | mental status tasks) | between purpose and cognition | |
| Lewis (2021) | HRS | USA | 4,599 | 74.3 (65-104) | 56.8% | Purpose in life (Ryff's subscale) | Word recall, Mental status (TICS) | Significant association between purpose and baseline word recall and mental status but not longitudinal change | Medium |
| Nakanishi (2019) | NSHD | England, Scotland, Wales | 703 | 52 | 100% | Autonomy, Environmental mastery, Personal growth, Purpose in life, Self-acceptance (42-item Ryff scales), Positive affect (WEMW), Life satisfaction (SWLS) | Cognitive state (ACE-III) | Significant associations only found for higher personal growth and lower self-acceptance | Medium |
| Nystrom (2019) | BPCS | Sweden | 586 | 70.2 (60-95) | 55.3% | Subjective wellbeing (3 items) | Memory (Sentence recall, Category-cued recall, Face recognition, Word recall, Activity recall) | Non-significant association between subjective wellbeing and objective memory | Medium |
| Oh (2020) | HRS | USA | 4,457 | 66.7 (50+) | 50% | Optimism (LOT-R) | Memory (word recall), Mental status (serial 7's, counting backwards, orientation) | Significant cross-sectional and longitudinal association between optimism and both memory and mental status | Medium |
| Shin (2021) | HRS | USA | 12,856 | 73.2 (50+) | 57.7% | Purpose in life (Ryff's subscale) | Cognitive state, Fluid intelligence (word recall, serial subtraction, counting backwards), Crystallised intelligence (object naming, orientation) | Significant association between purpose and all cognitive outcomes | Medium |
| Sol (2020) | NHATS | USA | 9,411 | 76.2 (65+) | 57.3% | Psychological wellbeing (5 items from Ryff's scale) | Memory (10-item list learning recall task) | Significant association between psychological wellbeing and baseline memory but not rate of | Low |

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|----------------|-------|-----------|-------|---------------|-------|-----------------------------------|---|--|--------|
| | | | | | | | | change | |
| Wilson (2013) | RMAP | USA | 759 | 80.3 (65+) | 74.3% | Purpose in life (Ryff's subscale) | Cognitive state (2 Story tasks, Word list memory/recall/recognition, BNT, Verbal fluency, Word recognition test, Digit span forwards/backwards, Digit ordering, SDMT, Number comparison, Stroop test, JLO, SPM) | Significant association between purpose and cognition | Medium |
| Windsor (2015) | ALSA | Australia | 1,475 | 77.1 (70+) | 50% | Purpose in life (Ryff's subscale) | Processing speed (DSS), Memory (immediate recall from BNT) | Significant association between purpose and memory intercept and processing speed intercept and slope but not memory slope | Medium |
| Zhang (2021) | CLHLS | China | 9,487 | 81.2 (61-112) | 48.1% | Psychological wellbeing (7 items) | Cognitive state (MMSE) | Significant association between psychological wellbeing and cognition | Medium |

GCS = Georgia Centenarian Study; WHICAP = Washington Heights-Inwood Columbia Aging Project; SLAS = Singapore Longitudinal Ageing Study; VLV = Vivre-Leben-Vivere survey; SAGE = Successful Aging Evaluation; MAAS = Maastricht Aging Study; MIDUS = Midlife Development in the United States; Co-STAR = Cognition in the Study of Tamoxifen and Raloxifene; BPCS = Betula Prospective Cohort Study; BASE = Berlin Aging Study; HRS = Health and Retirement Study; ELSA = English Longitudinal Study of Ageing; RMAP = Rush Memory and Aging Project; NSHD = National Survey of Health and Development 1946; ALSA = Australian Longitudinal Study of Ageing; NEIGE = Neuron to Environmental Impact across Generations study; NHATS = National Health and Aging Trends Study; SALSA = Sacramento Area Latino Study on Aging; WLSG = Wisconsin Longitudinal Study Graduate sample; WLSS = Wisconsin Longitudinal Study Sibling sample; NCDS = National Child Development Study; TILDA = The Irish Longitudinal study; ELSI = Brazilian Longitudinal Study of Aging; SHARE = Survey of Health, Ageing and Retirement in Europe; CLHLS = Chinese Longitudinal Health Longevity Survey; BABS = Bradburn Affect Balance Scale; LSI-A = Life Satisfaction Index-A; SWLS = Satisfaction with Life Scale; PANAS = Positive and Negative Affect Schedule; AVEI = Audio Visual test of Emotional Intelligence; MLQ = Meaning in Life Questionnaire; PGC = Philadelphia Geriatric Center's Morale Scale-revised; CASP-19 = Control, Autonomy, Self-realisation and Pleasure Scale; ABS-GWB = Affect Balance Scale-General Well-being Schedule; WEMW = Warwick-Edinburgh Mental Wellbeing; LOT-R = Revised Life Orientation Test; GQ-6 = Gratitude Questionnaire Six-item Form; CES-D = Center for Epidemiologic Studies Depression Scale; TTCT = Torrance Test of Creative Thinking; IHS = Integrative Hope Scale; SPMSQ = Short Portable Mental Status Questionnaire; NIH = National Institutes of Health; PGIMS = Post Graduate Institute Memory Scale; MoCA = Montreal Cognitive Assessment; TMT = Trail Making Test; TICS = Telephone Interview for Cognitive Status; CERAD = Consortium to Establish a Registry for Alzheimer's Disease; VVLT = Visual Verbal Learning Test; CST = Concept Shifting Test; LDST = Letter Digit Substitution Test; MMSE = Mini Mental State Examination; BTACT = Brief Test of Adult Cognition by Telephone; PMA = Primary Mental Abilities; BVRT = Benton Visual Retention Test; CVLT = Modified California Verbal Learning Test; RBMT = Rivermead Behavioural Memory Test; SGST = Stop and Go Switch Task; SDMT = Symbol Digit Modalities Test; JLO = Judgement of Line Orientation; SPM = Standard Progressive Matrices; ACE-III = Addenbrooke's Cognitive Examination; DSS = Digit Symbol Substitution subscale; BNT = Boston Naming Task; 3MS = Modified Mini-Mental State Examination; SEVLT = Spanish and English Verbal Learning Test.

3.3. Life satisfaction

In total, eight studies investigated life satisfaction (Bishop et al., 2012; Ihle et al., 2021; Jones et al., 2003; Nakanishi et al., 2019; Requena et al., 2009; West et al., 1984; Wettstein et al., 2015; Zahodne et al., 2018).

3.3.1. Cross-sectional

Results as to associations between life satisfaction and cognitive functioning were mixed. One study (Jones et al., 2003) but not another (Bishop et al., 2012) found a significant correlation between life satisfaction and cognitive state. Studies testing the association between life satisfaction and specific cognitive domains generally found non-significant results (Wettstein et al., 2015; Zahodne et al., 2018) with the exception of significant correlations with memory in two studies (Requena et al., 2009; Zahodne et al., 2018) and mixed findings for memory in another (West et al., 1984). There was no evidence of a significant association between life satisfaction and cognitive state in meta-analysis ($r = .17$, 95% CI [-0.05, 0.38], $p = .13$, $I^2 = 70.28\%$) (Figure 2).

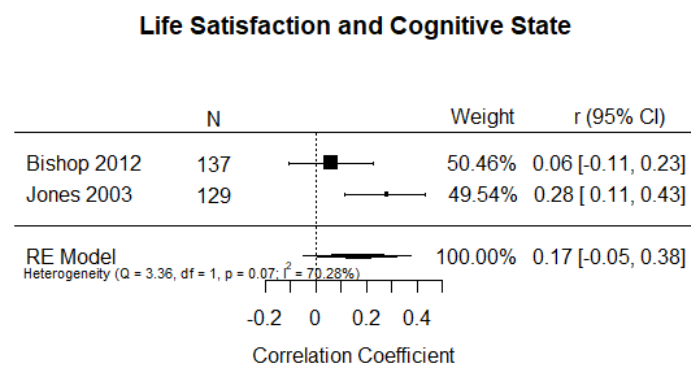


Figure 2: Life satisfaction and cognitive state (cross-sectional)

3.3.2. Longitudinal

There was also no evidence of an association between life satisfaction and later cognitive state (Nakanishi et al., 2019) or change in executive function (Ihle et al., 2021) from the longitudinal studies.

3.4. Positive affect

Twelve studies investigated positive affect (Berk et al., 2017; Bishop et al., 2011; Bishop et al., 2012; Castro-Schilo et al., 2019; Danhauer et al., 2013; Dewitte et al., 2020; Hill et al., 2005; Hittner et al., 2020; Jones et al., 2003; Nakanishi et al., 2019; Wettstein et al., 2015; Zahodne et al., 2018).

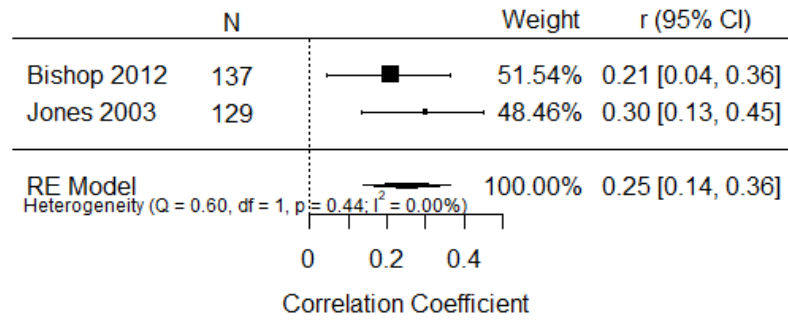
3.4.1. Cross-sectional

There was evidence of correlations between positive affect and cognitive state (Bishop et al., 2012; Jones et al., 2003). However, studies investigating specific cognitive domains generally reported non-significant correlations, with the exception of processing speed (Wettstein et al., 2015; Zahodne et al., 2018) and memory, where one study found a significant correlation with memory recall but not recognition (Hill et al., 2005) and two studies found a significant correlation between follow up positive affect and memory performance but not for baseline measures (Dewitte et al., 2020; Hittner et al., 2020). Meta-analyses of the cross-sectional studies supported this with positive affect associated with cognitive state ($r = .25$, 95% CI [0.14, 0.36], $p < .0001$, $I^2 = 0.00\%$) (Figure 3a) and memory ($r = .05$, 95% CI [0.02, 0.08], $p = .0007$, $I^2 = 0.00\%$) (Figure 3b).

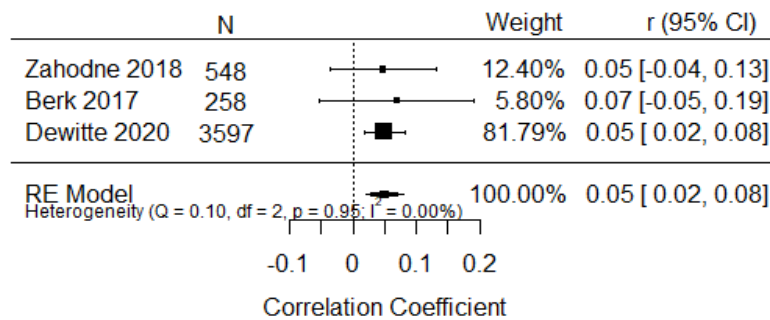
3.4.2. Longitudinal

Longitudinal studies generally found non-significant associations between positive affect and cognitive state (Bishop et al., 2011; Nakanishi et al., 2019). One study (Castro-Schilo et al., 2019) found that baseline positive affect was significantly associated with cognitive state and verbal memory three years later but not with rate of change. However, the rate of change in positive affect was significantly associated with rate of change in both cognitive outcomes. Studies exploring specific cognitive domains found little evidence for an association (Berk et al., 2017; Danhauer et al., 2013), with the exception of letter and category fluency (Danhauer et al., 2013) and mixed findings for memory, with one study finding significant associations for two measures of positive affect (Hittner et al., 2020) and three studies finding no significant association (Berk et al., 2017; Danhauer et al., 2013; Dewitte et al., 2020). Meta-analysis of longitudinal studies found no evidence of an association between positive affect and memory ($r = .12$, 95% CI [-0.22, 0.44], $p = .48$) (Figure 3c). Substantial heterogeneity was observed in this model ($I^2 = 99.23\%$).

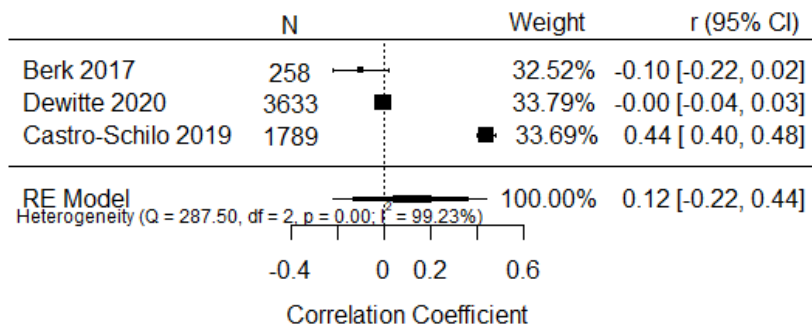
a) Positive Affect and Cognitive State



b)* Positive Affect and Memory



c)* Positive Affect and Memory



*Due to repeated samples (MAAS and MIDUS), Hill et al. (Hill et al., 2005) and Hittner et al. (Hittner et al., 2020) were excluded from the cross-sectional memory analysis and Hittner et al. (Hittner et al., 2020) was excluded from the longitudinal memory analysis.

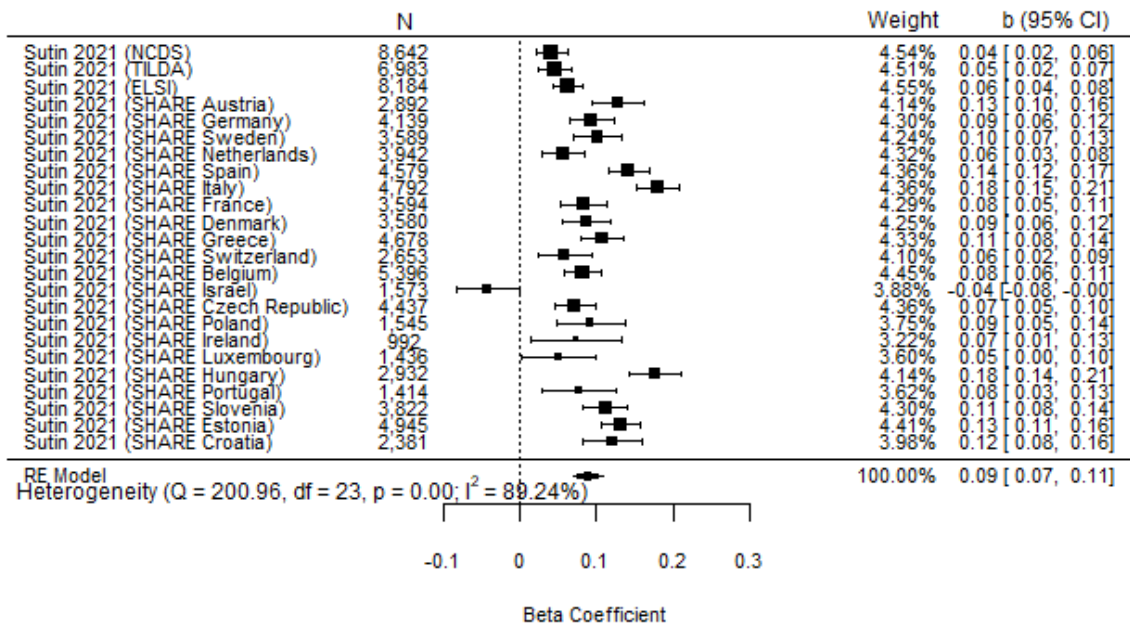
Figure 3: Positive affect meta-analyses

3.5. *Meaning in life*

3.5.1. Cross-sectional

In total, two papers (including analyses of 33 cohorts) investigated meaning in life (Aftab et al., 2019; Sutin et al., 2021a). Aftab et al. (2019) found positive correlation between cognitive state and 'presence of meaning in life', and negatively correlation with 'search for meaning in life'. Sutin et al. (2021a) found significant positive associations with verbal fluency in all cohorts (total $n = 24$) except SHARE Israel, and with episodic memory in all cohorts (total $n = 32$) except SHARE Israel and SHARE Malta. Meta-analytic results supported the evidence for associations between meaning in life and verbal fluency ($b = 0.09$, 95% CI [0.07, 0.11], $p < .0001$) (Figure 4a) and memory ($b = 0.10$, 95% CI [0.08, 0.12], $p < .0001$) (Figure 4b). Substantial heterogeneity was observed in the verbal fluency model ($I^2 = 89.24\%$) and the memory model ($I^2 = 92.06\%$). Results from meta-regressions exploring differences in findings between SHARE and non-SHARE samples were non-significant for both memory ($b = 0.05$, 95% CI [-0.01, 0.11], $p = .08$) and verbal fluency ($b = 0.05$, 95% CI [-0.01, 0.10], $p = .08$). Due to substantial heterogeneity funnel plots were not used to assess publication bias (Terrin et al., 2003).

a) Meaning and Verbal Fluency



b) Meaning and Memory

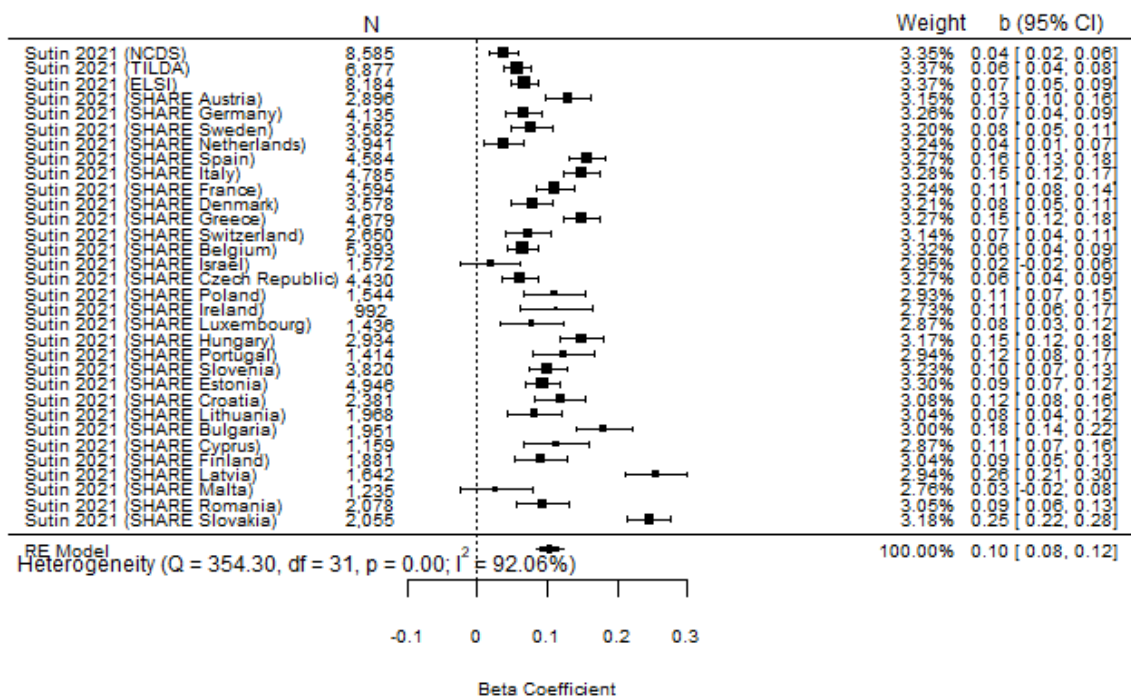


Figure 4: Meaning in life meta-analyses (cross-sectional)

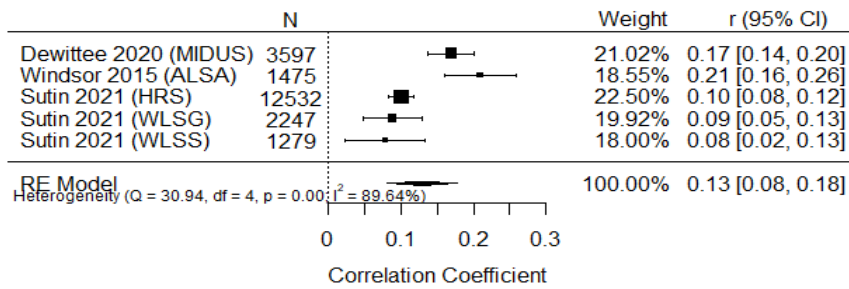
3.6. *Purpose in life*

Eleven studies investigated purpose in life (Boyle et al., 2010; Dewitte et al., 2020; Fung and Lam, 2013; Kim et al., 2019; Lewis and Hill, 2021; Lewis et al., 2017; Nakanishi et al., 2019; Shin et al., 2021; Sutin et al., 2021a; Wilson et al., 2013; Windsor et al., 2015).

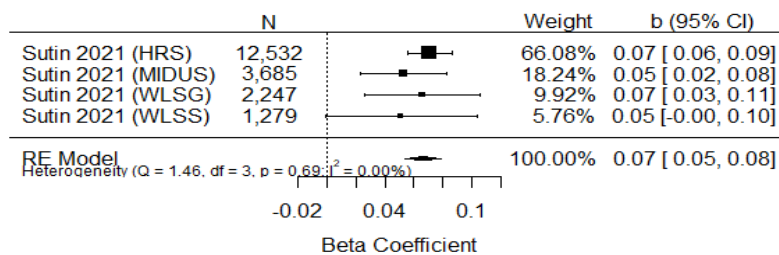
3.6.1. Cross-sectional

Seven studies reported cross-sectional findings and suggested that higher purpose in life was positively associated with cognitive state (Boyle et al., 2010; Fung and Lam, 2013; Lewis et al., 2017), memory (Boyle et al., 2010; Dewitte et al., 2020; Lewis and Hill, 2021; Lewis et al., 2017; Sutin et al., 2021a; Windsor et al., 2015), processing speed (Boyle et al., 2010; Windsor et al., 2015), and executive function (Lewis et al., 2017). Sutin et al. (2021a) also found significant positive associations between purpose and verbal fluency in all cohorts except the Wisconsin Longitudinal Study sibling sample. Meta-analyses found positive associations between purpose of life and both memory ($r = .13$, 95% CI [0.08, 0.18], $p < .0001$) (Figure 5a) and verbal fluency ($b = 0.07$, 95% CI [0.05, 0.08], $p < .0001$, $I^2 = 0.00\%$) (Figure 5b). Substantial heterogeneity was observed in the memory model ($I^2 = 89.64\%$).

a)* Purpose and Memory



b) Purpose and Verbal Fluency



*Due to repeated samples (MIDUS), Lewis et al. (Lewis et al., 2017) and Sutin et al. (Sutin et al., 2021a) were excluded from the memory analysis. This meta-analysis includes both correlational and beta effect sizes (Peterson and Brown, 2005).

Figure 5: Purpose in life meta-analyses(cross-sectional)

3.6.2. Longitudinal

Eight studies reported longitudinal findings. In general, they found significant positive associations between purpose in life and cognitive state (Boyle et al., 2010; Kim et al., 2019; Shin et al., 2021; Wilson et al., 2013). However, one study (Nakanishi et al., 2019) found that the association between midlife purpose in life and later cognitive function became non-significant after controlling for childhood cognitive ability. Studies investigating specific cognitive domains found evidence of positive associations between purpose in life and processing speed (Boyle et al., 2010; Windsor et al., 2015) and although one study reported significant associations with memory change (episodic, semantic, working) (Boyle et al., 2010) another two studies found no significant association (Lewis and Hill, 2021; Windsor et al., 2015). Further, one study (Dewitte et al., 2020) found significant positive correlations between purpose in life and memory; however cross-lagged results were only significant when positive affect, negative affect, and self-related health were removed as covariates.

3.7. *Wellbeing*

3.7.1. Longitudinal

Five longitudinal studies investigated various types of positive wellbeing (Allerhand et al., 2014; Gerstorf et al., 2007; Nystrom et al., 2019; Sol et al., 2020; Zhang et al., 2021). Due to differences in the measures and definitions of wellbeing used no pooled effects could be calculated. One study investigated multiple cognitive domains and found significant positive associations between wellbeing (control, autonomy, self-realisation, pleasure) and all cognitive outcomes (Allerhand et al., 2014). Another found that wellbeing (optimism, conscientiousness, neuroticism, loneliness, personal control, self-esteem, happiness) was significantly associated with slower decline in cognitive state (Zhang et al., 2021). One study found that wellbeing (nonagitation, aging satisfaction, life satisfaction) was significantly associated with change in perceptual speed, but not baseline level (Gerstorf et al., 2007). One study using items from Ryff's psychological wellbeing scale found a significant positive association with baseline memory but not rate of memory decline (Sol et al., 2020), whereas another found no significant associations between subjective wellbeing (life satisfaction, happiness, enjoyment of life) and memory (Nystrom et al., 2019).

3.8. *Other PPCs*

3.8.1. Cross-sectional

Six cross-sectional studies investigated other PPCs. One explored multiple cognitive domains and found significant positive correlations between a combined meaning and purpose measure with visuospatial function and working memory only (Zahodne et al., 2018). Another investigated facets of conscientiousness and found that industriousness was significantly positively associated with cognitive state independent of the other facets, whereas self-control was non-significant (Sutin et al., 2021b). Other individual studies found significant positive association for emotional intelligence (Saad et al., 2019), gratitude (Tani et al., 2022) and hope (Waldman-Levi et al., 2020) with cognitive state; however no significant association was found for intrinsic religiosity (Koenig et al., 2004). Finally, Sharma and Babu (2017) found creative thinking was significantly positively correlated with executive function but not working memory.

3.8.2. Longitudinal

Two longitudinal studies investigated other PPCs. One found that higher personal growth and lower self-acceptance in midlife were significantly positively associated with cognitive state at age 69, however no significant association was found for autonomy or environmental mastery (Nakanishi et

al., 2019). Another found a significant positive association between optimism and both memory and mental status (Oh et al., 2020).

4. Discussion

Meta-analyses found cross-sectional positive associations between positive affect with cognitive state and memory, as well as between meaning and purpose in life with episodic memory and verbal fluency. No significant cross-sectional association was found between life satisfaction and cognitive state. Only one meta-analysis of longitudinal effects was possible with no evidence of an association between positive affect and memory. In the narrative review we found some evidence for a longitudinal positive association between purpose in life and cognitive outcomes; however evidence for longitudinal associations with memory was mixed as were results for positive affect, and for wellbeing. There was little evidence for any associations between life satisfaction and any cognitive outcome, with the exception of some significant cross-sectional findings with memory. Finally, individual studies highlighted PPCs (emotional intelligence, hope, creative thinking, personal growth, gratitude, and optimism) for further investigation.

Despite some significant findings from the meta-analyses, these results should be interpreted with caution. In general, the effect sizes were small and, in some cases, had broad confidence intervals indicating uncertainty regarding the actual size of the effect. Moreover, through including the study with the largest sample in meta-analysis where samples were used more than once, we potentially inadvertently biased findings towards finding a 'significant' effect, since 'significance' becomes more likely the larger the sample size. Relatedly, it may be that in some analyses the inclusion of large samples may mean one or two studies drive the effect found. For example, it appears that the overall cross-sectional association between positive affect and memory may be being driven by Dewitte et al's (2020) study ($n = 3,633$). Overall, while individual studies were rated as low to medium risk of bias the fact that currently there are few studies reporting on the same PPC and cognitive outcome, means it is difficult to draw strong conclusions. Instead, this review is intended to provide a synthesised foundation for further investigation.

Consistent with our previous review (Bell et al., 2022), meta-analytic findings provide evidence for the positive association between meaning and purpose in life and cognitive outcomes. Whilst the non-significant longitudinal association between positive affect and memory is also consistent with our previous review, cross-sectional findings were significant. There are several possible explanations for this discrepancy. One may relate to within-person variations in positive affect.

Previous research has suggested that higher positive affect on the day of memory task administration is associated with better performance (Brose et al., 2014). Consequently, it may be that positive affect is associated with later memory performance if it is maintained. Alternatively, another explanation may be that differences in findings reflect reverse causality. As such, significant cross-sectional results may suggest that poor memory leads to poorer positive affect, whereas in the longitudinal studies as positive affect measurement precedes the memory measurement, this effect is not found. Next, similarly to our previous review, differences between eudemonic and hedonic approaches to wellbeing may lend some explanation to the different findings for individual PPCs. Broadly speaking, hedonic wellbeing (including experienced and evaluative) refers to experiencing pleasure and positive evaluations (e.g. positive affect, life satisfaction), and eudemonic wellbeing refers to the pursuit and experience of meaning, personal growth, and excellence (e.g. purpose/meaning in life) (Diener et al., 2018; Ryff et al., 2021). It may be that eudemonic wellbeing is more important in protecting against cognitive decline than hedonic wellbeing. One possible mechanism for this may be that individuals with higher eudemonic wellbeing (e.g., purpose in life) may have increased engagement in other protective behaviours which then reduce risk of cognitive decline. In support, previous research has found significant associations between meaning and purpose in life and other protective factors, such as social connectedness (Stavrova and Luhmann, 2016) and physical activity (Yemiscigil and Vlaev, 2021). More research is needed to better understand the mechanisms for these protective effects.

4.1. *Strengths and limitations*

To our knowledge, this is the first review synthesising evidence relating to associations between various PPCs and cognitive function. One strength is that by using a comprehensive list of PPCs this review provides a foundation for future research to build upon by identifying promising areas and those that have been under researched. Limitations of this review primarily relate to the emerging nature of this research area. At present, there are few studies reporting on the same individual PPC and often definitions differ across studies. Moreover, many longitudinal studies on the same PPC are either not directly comparable or use participants from the same population. As such, most analyses in this review are cross-sectional and thus longitudinal inferences are hard to make. More research is needed to understand longitudinal associations between different PPCs and later cognitive function. Causal inference methods (e.g., mendelian randomisation) may be particularly valuable. Another limitation is that we were unable to fully explore the substantial heterogeneity identified in the meaning in life analyses. All effect sizes for these analyses were drawn from Sutin et al. (2021a), and where possible taken from the supplementary analysis that excluded participants with a diagnosis of

dementia. As demographic information about the cohorts were provided for the full samples only, we were unable to obtain data needed to conduct meta-regression.

4.2. Implications and future directions

Understanding the possible protective effects of these and other PPCs on cognitive function could have important implications for informing early interventions for dementia prevention and promoting healthy cognitive ageing. Considering the evidence for purpose and meaning in life, it may be that these PPCs may be sensible first targets for interventions aimed at reducing the risk of cognitive decline in mid to later life. For example, interventions aiming to increase eudemonic PPCs, such as meaning-centred therapies (Vos and Vitali, 2018; Wong, 2010), may be beneficial for healthy cognitive ageing. Further, the WHO guidelines for risk reduction of cognitive decline and dementia (Stephen et al., 2021; World Health Organization, 2019) highlights that multidomain approaches to interventions are likely to be the most beneficial. Due to the potentially modifiable nature of PPCs, these could prove to be a useful target area to explore in the context of multidomain interventions. Findings from this review also have implications for informing future research. To better understand the possible protective effects of individual PPCs on later cognition, more high-quality longitudinal studies are needed, particularly around PPCs associated with eudemonic wellbeing. Future research could also explore the possible protective pathways for purpose and meaning in life.

5. Conclusions

Overall, we found that higher levels of eudaemonic but not hedonic PPCs are associated with better cognitive functioning. Most evidence was cross-sectional as existing longitudinal studies were not directly comparable. More high-quality longitudinal research is needed to better understand the role of PPCs on future cognitive function. As PPCs are modifiable, understanding which may be associated with better cognitive function could have important implications, informing healthy cognitive aging and highlighting targets for interventions to promote cognitive health and reduce dementia risk.

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Contributors

GB, JS, and AJ conceptualised and designed the study. GB conducted the literature searches. GB and TS screened papers. GB extracted data and completed the quality assessments. GB, AJ, JS, and RS contributed to the formal analysis. All authors contributed to manuscript writing, reviewing, and editing and approved the final version.

Declaration of Interest

We declare no competing interests.

Data availability

Data availability is not applicable to this article as no new data were created or analysed in this study.

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Appendices

A) List of search terms for Medline

- 1 Cognition/ (102155)
- 2 Executive Function/ (15674)
- 3 memory/ or memory, episodic/ or memory, long-term/ or memory, short-term/ or mental recall/ (120714)
- 4 cognition disorders/ or cognitive dysfunction/ (84548)
- 5 dementia/ or alzheimer disease/ or dementia, vascular/ or frontotemporal lobar degeneration/ (144963)
- 6 memory.tw. (258923)
- 7 dement*.tw. (118390)
- 8 alzheimer*.tw. (151915)
- 9 "cognition".tw. (71976)
- 10 "Mild Cognitive Impairment".tw. (17723)
- 11 "cognitive function*".tw. (64896)
- 12 "cognitive impairment*".tw. (68228)
- 13 "cognitive decline".tw. (23789)
- 14 "cognitive deficit*".tw. (22140)
- 15 "cognitive loss*".tw. (445)
- 16 "cognitive abilit*".tw. (14162)
- 17 "cognitive status".tw. (5352)
- 18 "cognitive change".tw. (1610)
- 19 "cognitive performance".tw. (19728)
- 20 "cognitive dysfunction*".tw. (15551)
- 21 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
(693276)
- 22 Optimism/ (712)
- 23 Psychology, Positive/ (51)
- 24 courage/ or forgiveness/ or happiness/ or hope/ or love/ (9810)
- 25 Creativity/ (7102)
- 26 spirituality/ (7799)
- 27 "positive psycholog*".tw. (1879)
- 28 "well-being".tw. (81834)
- 29 "self-acceptance".tw. (755)
- 30 "purpose in life".tw. (862)
- 31 courage.tw. (2120)
- 32 bravery.tw. (121)
- 33 valo?r.tw. (1315)
- 34 authenticity.tw. (4210)
- 35 honesty.tw. (1889)
- 36 love.tw. (8617)
- 37 kindness.tw. (1020)
- 38 generosity.tw. (831)
- 39 nurturance.tw. (524)
- 40 compassion.tw. (6160)
- 41 temperance.tw. (305)
- 42 forgiveness.tw. (1091)
- 43 mercy.tw. (1616)
- 44 humility.tw. (1168)
- 45 modesty.tw. (439)
- 46 prudence.tw. (910)
- 47 "self-regulation".tw. (8263)
- 48 "self-control".tw. (5874)
- 49 transcendence.tw. (1245)
- 50 gratitude.tw. (1628)
- 51 hope.tw. (52990)
- 52 optimism.tw. (9052)

53 "future-mindedness".tw. (3)
54 "future orientation".tw. (437)
55 humo?r.tw. (14629)
56 playfulness.tw. (262)
57 spirituality.tw. (6833)
58 religiousness.tw. (802)
59 faith.tw. (7186)
60 "positive emotion*".tw. (4931)
61 engagement.tw. (70190)
62 (meaning* adj3 life).tw. (2648)
63 accomplishment*.tw. (8674)
64 "positive affect".tw. (5988)
65 "life satisfaction".tw. (8168)
66 "personal growth".tw. (1578)
67 "environmental mastery".tw. (157)
68 perseverance.tw. (1559)
69 industriousness.tw. (57)
70 vitality.tw. (12694)
71 zest.tw. (288)
72 enthusiasm.tw. (7863)
73 vigo?r.tw. (5646)
74 justice.tw. (18858)
75 loyalty.tw. (1792)
76 fairness.tw. (3921)
77 humanity.tw. (3800)
78 "social intelligence".tw. (257)
79 "emotional intelligence".tw. (2226)
80 "personal intelligence".tw. (12)
81 "appreciation of beauty".tw. (22)
82 "appreciation of excellence".tw. (0)
83 awe.tw. (555)
84 wonder.tw. (2524)
85 wisdom.tw. (7900)
86 creativity.tw. (6628)
87 originality.tw. (4306)
88 ingenuity.tw. (4067)
89 curiosity.tw. (3792)
90 "novelty-seeking".tw. (1830)
91 "openness to experience".tw. (942)
92 "open-mindedness".tw. (188)
93 "critical thinking".tw. (3907)
94 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or
40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or
59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or
78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 (399695)
95 21 and 94 (22343)
96 aged.tw. (599003)
97 aging.tw. (187688)
98 ageing.tw. (43266)
99 elder*.tw. (265821)
100 ((old or retired) adj2 (people* or patient* or inpatient* or in-patient* or outpatient* or out-patient* or
client* or person* or individual* or wom?n or man or men or age)).tw. (401432)
101 older*.tw. (454179)
102 geriatr*.tw. (51135)
103 gerontolog*.tw. (7262)
104 senior*.tw. (42852)
105 senescen*.tw. (41674)

106 retiree*.tw. (1611)
107 sexagenarian*.tw. (97)
108 septuagenarian*.tw. (400)
109 octagenarian*.tw. (42)
110 nonagenarian*.tw. (1464)
111 centenarian*.tw. (2073)
112 supercentenarian*.tw. (105)
113 veteran*.tw. (37456)
114 aging/ (233106)
115 aged/ (3164510)
116 "aged, 80 and over"/ (947495)
117 "frail elderly"/ (12168)
118 "health services for the aged"/ (17926)
119 "homes for the aged"/ (14211)
120 geriatrics/ (30358)
121 midlife.tw. (5983)
122 "mid-life".tw. (1432)
123 (late* adj2 life).tw. (32164)
124 Middle Aged/ (4465061)
125 Retirement/ (9812)
126 retire*.tw. (21801)
127 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111
or 112 or 113 or 114 or 115 or 116 or 117 or 118 or 119 or 120 or 121 or 122 or 123 or 124 or 125 or 126
(6192412)
128 95 and 127 (9677)

B) List of search terms for PsychINFO

- 1 cognition/ (34613)
- 2 cognitive impairment/ (38445)
- 3 mild cognitive impairment/ (7376)
- 4 executive function/ (11109)
- 5 cognitive processing speed/ (2828)
- 6 memory/ or episodic memory/ or long term memory/ or short term memory/ (101178)
- 7 dementia/ or vascular dementia/ or alzheimer's disease/ (75694)
- 8 memory.tw. (218999)
- 9 dement*.tw. (70972)
- 10 alzheimer*.tw. (63828)
- 11 "cognition".tw. (97159)
- 12 "Mild Cognitive Impairment".tw. (11285)
- 13 "cognitive function*".tw. (43361)
- 14 "cognitive impairment*".tw. (40238)
- 15 "cognitive decline".tw. (12891)
- 16 "cognitive deficit*".tw. (15695)
- 17 "cognitive loss*".tw. (298)
- 18 "cognitive abilit*".tw. (21702)
- 19 "cognitive status".tw. (3267)
- 20 "cognitive change".tw. (1913)
- 21 "cognitive performance".tw. (15203)
- 22 "cognitive dysfunction*".tw. (7557)
- 23 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 (451100)
- 24 positive psychology/ (4900)
- 25 optimism/ (4391)
- 26 positive emotions/ (2764)
- 27 well being/ (46637)
- 28 hope/ (3573)
- 29 gratitude/ (1343)
- 30 life satisfaction/ (10551)
- 31 courage/ (759)
- 32 forgiveness/ (3050)
- 33 happiness/ (7783)
- 34 love/ (6699)
- 35 creativity/ (25383)
- 36 openness to experience/ (1347)
- 37 curiosity/ (1190)
- 38 spirituality/ (18442)
- 39 meaningfulness/ (3561)
- 40 kindness/ (481)
- 41 self-compassion/ (1216)
- 42 humility/ (889)
- 43 self-regulation/ (10355)
- 44 self-control/ (9652)
- 45 enthusiasm/ (471)
- 46 emotional intelligence/ (5916)
- 47 "positive psycholog*".tw. (7057)
- 48 "well-being".tw. (89638)
- 49 "self-acceptance".tw. (2575)
- 50 "purpose in life".tw. (1755)
- 51 courage.tw. (3864)
- 52 bravery.tw. (278)
- 53 valo?r.tw. (449)
- 54 authenticity.tw. (5439)

55 honesty.tw. (4144)
56 love.tw. (26909)
57 kindness.tw. (1995)
58 generosity.tw. (1592)
59 nurturance.tw. (2153)
60 compassion.tw. (9169)
61 temperance.tw. (445)
62 forgiveness.tw. (4656)
63 mercy.tw. (695)
64 humility.tw. (2639)
65 modesty.tw. (934)
66 prudence.tw. (655)
67 "self-regulation".tw. (17232)
68 "self-control".tw. (12606)
69 transcendence.tw. (3493)
70 gratitude.tw. (3450)
71 hope.tw. (37994)
72 optimism.tw. (10851)
73 "future-mindedness".tw. (11)
74 "future orientation".tw. (1052)
75 humo?r.tw. (8884)
76 playfulness.tw. (1071)
77 spirituality.tw. (18599)
78 religiousness.tw. (1984)
79 faith.tw. (14307)
80 "positive emotion*".tw. (9360)
81 engagement.tw. (73086)
82 (meaning* adj3 life).tw. (5839)
83 accomplishment*.tw. (10225)
84 "positive affect".tw. (10883)
85 "life satisfaction".tw. (15244)
86 "personal growth".tw. (4647)
87 "environmental mastery".tw. (365)
88 perseverance.tw. (2583)
89 industriousness.tw. (194)
90 vitality.tw. (4551)
91 zest.tw. (300)
92 enthusiasm.tw. (5063)
93 vigo?r.tw. (2579)
94 justice.tw. (47561)
95 loyalty.tw. (6765)
96 fairness.tw. (9142)
97 humanity.tw. (5766)
98 "social intelligence".tw. (1127)
99 "emotional intelligence".tw. (6741)
100 "personal intelligence".tw. (59)
101 "appreciation of beauty".tw. (95)
102 "appreciation of excellence".tw. (0)
103 awe.tw. (948)
104 wonder.tw. (3219)
105 wisdom.tw. (10829)
106 creativity.tw. (30183)
107 originality.tw. (23106)
108 ingenuity.tw. (837)
109 curiosity.tw. (5899)
110 "novelty-seeking".tw. (1852)
111 "openness to experience".tw. (2834)

112 "open-mindedness".tw. (625)
 113 "critical thinking".tw. (6651)
 114 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or
 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or
 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or
 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or
 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113 (526297)
 115 23 and 114 (31129)
 116 aged.tw. (269793)
 117 aging.tw. (64894)
 118 ageing.tw. (10386)
 119 elder*.tw. (73701)
 120 ((old or retired) adj2 (people* or patient* or inpatient* or in-patient* or outpatient* or out-patient* or
 client* or person* or individual* or wom?n or man or men or age)).tw. (63477)
 121 older*.tw. (165502)
 122 geriatr*.tw. (18235)
 123 gerontolog*.tw. (6357)
 124 senior*.tw. (29108)
 125 senescen*.tw. (1973)
 126 retiree*.tw. (1333)
 127 sexagenarian*.tw. (28)
 128 septuagenarian*.tw. (29)
 129 octagenarian*.tw. (1)
 130 nonagenarian*.tw. (155)
 131 centenarian*.tw. (458)
 132 supercentenarian*.tw. (19)
 133 veteran*.tw. (23392)
 134 aging/ (60870)
 135 older adulthood/ (6533)
 136 geriatrics/ (11725)
 137 middle adulthood/ (2910)
 138 midlife.tw. (5489)
 139 "mid-life".tw. (1473)
 140 (late* adj2 life).tw. (19031)
 141 retirement/ (4777)
 142 retire*.tw. (14624)
 143 116 or 117 or 118 or 119 or 120 or 121 or 122 or 123 or 124 or 125 or 126 or 127 or 128 or 129 or 130
 or 131 or 132 or 133 or 134 or 135 or 136 or 137 or 138 or 139 or 140 or 141 or 142 (565699)
 144 115 and 143 (6326)

C) List of search terms for Scopus

((TITLE-ABS-KEY (memory OR dement* OR alzheimer* OR "cognition" OR "mild cognitive impairment" OR "cognitive function*" OR "cognitive impairment" OR "cognitive decline" OR "cognitive deficit*" OR "cognitive loss*" OR "cognitive abilit*" OR "cognitive status" OR "cognitive change" OR "cognitive performance" OR "cognitive dysfunction")) AND (TITLE-ABS-KEY ("positive psycholog*" OR "well-being" OR "self-acceptance" OR "purpose in life" OR courage OR bravery OR valo?r OR authenticity OR honesty OR love OR kindness OR generosity OR nurturance OR compassion OR temperance OR forgiveness OR mercy OR humility OR modesty OR prudence OR "self-regulation" OR "self-control" OR transcendence OR gratitude OR hope OR optimism OR "future-mindedness" OR "future orientation" OR humo?r OR playfulness OR spirituality OR religiousness OR faith OR "positive emotion*" OR engagement OR (meaning* W/2 life) OR accomplishments OR "positive affect" OR "life satisfaction" OR "personal growth" OR "environmental mastery" OR perseverance OR industriousness OR vitality OR zest OR enthusiasm OR vigo?r OR justice OR loyalty OR fairness OR humanity OR "social intelligence" OR "emotional intelligence" OR "personal intelligence" OR "appreciation of beauty" OR "appreciation of excellence" OR awe OR wonder OR wisdom OR creativity OR originality OR ingenuity OR curiosity OR "novelty-seeking" OR "openness to experience" OR "open-mindedness" OR "critical thinking")) AND (TITLE-ABS-KEY (aged OR aging OR ageing OR elder* OR ((old OR retired) W/2 (people* OR patient* OR inpatient* OR "in-patient*" OR outpatient* OR "out-patient*" OR client* OR person* OR individual* OR wom?n OR man OR men OR age)) OR older* OR geriatr* OR gerontolog* OR senior* OR senescen* OR retiree* OR sexagenarian* OR septuagenarian* OR octagenarian* OR nonagenarian* OR centenarian* OR supercentenarian* OR veteran* OR midlife OR "mid-life" OR (late* W/2 life) OR retire*))

D) Newcastle-Ottawa Quality Assessment Scale (longitudinal studies n = 20)

| | | Boyle 2010 | Castro-Schilo 2019 | Wilson 2013 | Zhang 2021 | Danhauer 2013 | lhle 2021 | Bishop 2011 | Sol 2020 | Windsor 2015 | Oh 2020 | Shin 2021 | Nystrom 2019 | Nakanishi 2019 | Berk 2017 | Dewitte 2020 | Gerstorf 2007 | Kim 2019 | Hittner 2020 | Lewis 2021 | Allerhand 2014 |
|---|--|------------|--------------------|-------------|------------|---------------|-----------|-------------|------------|--------------|----------|-----------|--------------|----------------|------------|--------------|---------------|----------|--------------|------------|----------------|
| Selection | Representativeness of the exposed cohort | | | | | | | | | | | | | | | | | | | | |
| | Representative of the average in the community * | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Selected group of users | | | | | 0 | | | | | | | | | | | | | | | |
| | No description | | | | | | | | | | | | | | | | | | | | |
| | Selection of the non-exposed | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | Ascertainment of exposure | | | | | | | | | | | | | | | | | | | | |
| | Secure record OR structured interview * | | | | | | | | | | | | | | | | | | | | |
| | Written self-report | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | No description | | | | | | | | | | | | | | | | | | | | |
| | Demonstration that outcome of interest was not present at start | | | | | | | | | | | | | | | | | | | | |
| Yes * | 1 | | 1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | | | | | | | |
| No | | 0 | | | | 0 | | | | 0 | 0 | 0 | | 0 | | 0 | 0 | 0 | 0 | 0 | |
| Comparability | Comparability of cohorts on the basis of the design or analysis | | | | | | | | | | | | | | | | | | | | |
| | Study controls for age and gender * | 1 | NA | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ½ | 1 | 1 | 1 | 1 |
| | Study controls for education and depression * | ½ | NA | ½ | ½ | ½ | ½ | 0 | 1 | ½ | ½ | 1 | 0 | 1 | 1 | ½ | 0 | 1 | 1 | 1 | 1 |
| Outcome | Assessment of outcome | | | | | | | | | | | | | | | | | | | | |
| | Independent blind assessment OR record linkage * | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Self-report | | | | | | | | | | | | | | | | | | | | |
| | No description | | | | | | | | | | | | | | | | | | | | |
| | Was the follow up long enough for outcomes to occur? | | | | | | | | | | | | | | | | | | | | |
| | Yes * | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No | | | | | | | | | | | | | | | | | | | | | |
| Adequacy of follow up of cohorts | | | | | | | | | | | | | | | | | | | | | |
| Complete follow up OR subjects lost to follow up and description provided of those lost * | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| No description of those lost or No statement | | | | | 0 | | | | | 0 | 0 | | | | | | | | | | |
| Total | 6.5 | 4 | 6.5 | 6.5 | 4.5 | 5.5 | 5 | 7 | 5.5 | 4.5 | 5 | 6 | 6 | 7 | 5.5 | 4.5 | 6 | 6 | 6 | 7 | |

E) Joanna Briggs Institute Checklist (cross-sectional studies $n = 17$)

| | Waldman-Levi 2020 | Sharma 2017 | Lewis 2017 | Koenig 2004 | Hill 2005 | Jones 2003 | Bishop 2012 | Saad 2019 | Requena 2009 | Fung 2013 | Aftab 2019 | West 1984 | Zahodne 2018 | Wettstein 2015 | Sutin 2021a | Sutin 2021b | Tani 2022 |
|--|-------------------|-------------|------------|-------------|-----------|------------|-------------|-----------|--------------|-----------|------------|-----------|--------------|----------------|-------------|-------------|-----------|
| Were the criteria for inclusion in the sample clearly defined? | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |
| Were the study subjects and the setting described in detail? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Was the exposure measured in a valid and reliable way? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Were objective, standard criteria used for measurement of the condition? | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Were confounding factors identified? | NA | NA | 1 | 1 | NA | NA | NA | 1 | NA | 1 | NA | NA | 1 | NA | 1 | 1 | 1 |
| Were strategies to deal with confounding factors stated? | NA | NA | 1 | 1 | NA | NA | NA | 1 | NA | 1 | NA | NA | 1 | NA | 1 | 1 | 1 |
| Were the outcomes measured in a valid and reliable way? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Was appropriate statistical analysis used? | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total | 5 | 5 | 6 | 6 | 7 | 4 | 5 | 7 | 4 | 7 | 5 | 4 | 7 | 5 | 6 | 7 | 7 |

F) Meta-regressions

Substantial heterogeneity was observed in both meaning in life meta-analyses (verbal fluency $I^2 = 89.24\%$; memory $I^2 = 92.06\%$). All effect sizes for these analyses were drawn from Sutin et al., and where possible taken from the supplementary analysis that excluded participants with a diagnosis of dementia.²³ As demographic information about the cohorts were provided for the full samples only, we were unable to obtain data needed to conduct meta-regression for these factors. Sutin et al. identified differences between SHARE and non-SHARE samples to be a potential source of heterogeneity in their models using the full samples.²³ We conducted meta-regressions exploring differences in findings between SHARE samples versus samples from other cohorts (NCDS, TILDA, ELSI). Results from these meta-regressions were non-significant for both memory ($b = 0.05$, 95% CI [-0.01, 0.11], $p = .08$) and verbal fluency ($b = 0.05$, 95% CI [-0.01, 0.10], $p = .08$).