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Review

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: $r = 0.13$, 95 %CI [0.08, 0.18], $p < .001$), and positive affect (cognitive state: $r = 0.25$, 95 %CI [0.14, 0.36], $p < .001$; memory: $r = 0.05$, 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.

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

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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 (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 (Fig. 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 ($n = 7$).

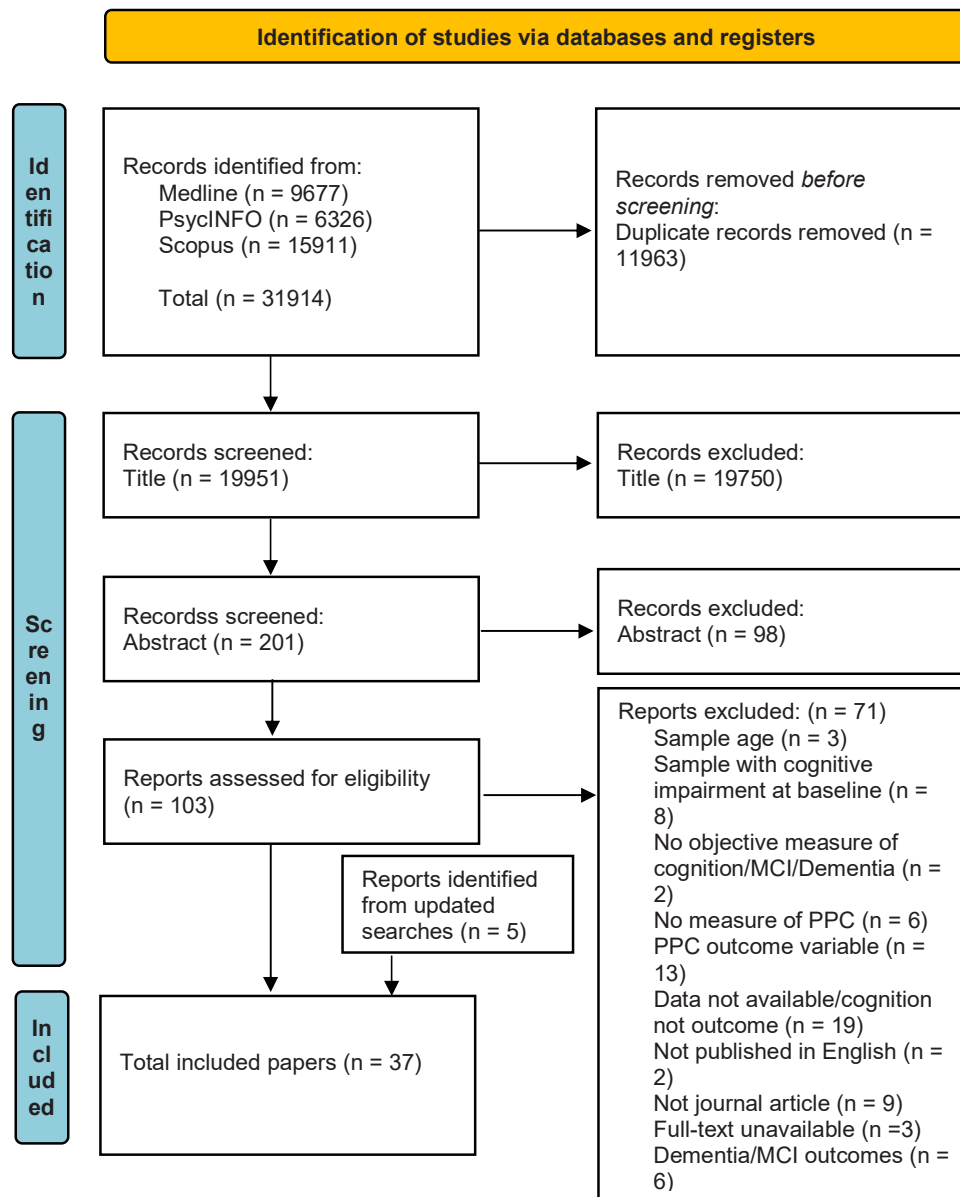


Fig. 1. PRISMA flow diagram (Page et al., 2021).

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 ($r = 0.17$, 95 % CI $[-0.05, 0.38]$, $p = .13$, $I^2 = 70.28\%$) (Fig. 2).

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, 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

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 et al. (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 et al. (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 and Lam (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 et al. (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 et al. (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 et al. (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 et al. (2017)	MIDUS	USA	3489	56.4 (32–84)	55 %	Purpose in life (Ryff's subscale)	Cognitive state, Episodic memory, Executive function (BTACT, SGST)	Significant association between purpose and all cognitive outcomes	Low
Requena et al. (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 et al. (2019)	N/A	Israel	151	79 (60 +)	63.6 %	Emotional intelligence (AVEI)	Cognitive state (MoCA)	Significant association between emotional intelligence and cognition	Low
Sharma and Babu (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 et al. (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 et al. (2021b)	HRS	USA	2516	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 et al. (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 cognition	Low
Waldman-Levi et al. (2020)	N/A	USA	39	74.9 (70 +)	48.7 %	Hope (IHS)	Cognitive state (MoCA)	Significant negative correlation between hope and cognition	Medium
West et al. (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

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Table 1 (continued)

Study	Data source	Country	Baseline sample size	Mean age (range)	Sex (%female)	Predictor (measure)	Outcome (measure)	Main findings	Risk of bias
Wettstein et al. (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 et al. (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 et al. (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
Berk et al. (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 et al. (2011)	GCS	USA	136	Not specified	Not specified	Positive affect (BABS)	Cognitive state (SPMSQ)	Non-significant association between positive affect and cognition	Medium
Boyle et al. (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 et al. (2019)	SALSA	USA	1789	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 et al. (2013)	Co-STAR	USA and Canada	1479	67.1 (65 +)	100 %	Positive affect (PANAS)	Cognitive state (3SME), Verbal knowledge (PMA vocabulary), Verbal fluency (letter and category fluency), Figural memory (BVRT), Verbal memory (CVLT, recall), Working memory (Digits forwards and backwards), Spatial ability (Card rotations), Fine motor speed (Finger tapping)	Significant association between positive affect and verbal fluency measures only	Medium
Dewitte et al. (2020)	MIDUS	USA	3633	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	Medium

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Table 1 (continued)

Study	Data source	Country	Baseline sample size	Mean age (range)	Sex (%female)	Predictor (measure)	Outcome (measure)	Main findings	Risk of bias
Gerstorff et al. (2007)	BASE	Germany	516	84.9 (70–103)	50 %	Psychological wellbeing (PGC)	Perceptual speed (Digit letter, identical pictures)	positive affect and memory for follow up cross-sectional only Significant longitudinal association between psychological wellbeing and perceptual speed, non-significant cross-sectional correlation	Medium
Hittner et al. (2020)	MIDUS	USA	991	55.5 (34–83)	54.5 %	Positive affect (PANAS, ABS-GWB)	Memory (BFACT)	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 et al. (2021)	VLV	Switzerland	1040	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 et al. (2019)	HRS	USA	11,525	72.6 (50 +)	57.3 %	Purpose in life (Ryff's subscale)	Cognitive state (recall, mental status tasks)	Significant association between purpose and cognition	Medium
Lewis and Hill (2021)	HRS	USA	4599	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 et al. (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 et al. (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 et al. (2020)	HRS	USA	4457	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 et al. (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 et al. (2020)	NHATS	USA	9411	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 change	Low
Wilson et al. (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 et al. (2015)	ALSA	Australia	1475	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

(continued on next page)

Table 1 (continued)

Study	Data source	Country	Baseline sample size	Mean age (range)	Sex (%female)	Predictor (measure)	Outcome (measure)	Main findings	Risk of bias
Zhang et al. (2021)	CLHLS	China	9487	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; WLSW = Wisconsin Longitudinal Study Graduate sample; WLSG = Wisconsin Longitudinal Study Sibling sample; NCDs = National Child Development Study; TILDA = The Irish Longitudinal Study; ELSI = Brazilian Longitudinal Study of Ageing; 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; MIQ = 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.

Life Satisfaction and Cognitive State

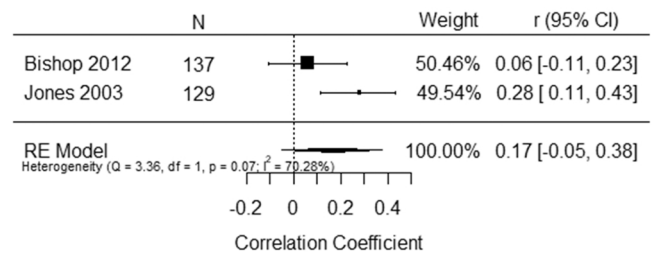
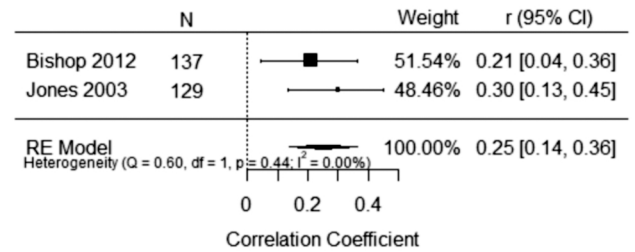
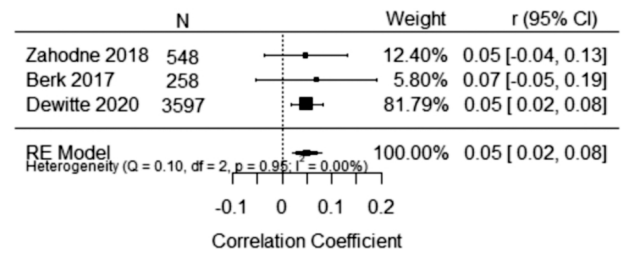


Fig. 2. Life satisfaction and cognitive state (cross-sectional).

a) Positive Affect and Cognitive State



b)* Positive Affect and Memory



c)* Positive Affect and Memory

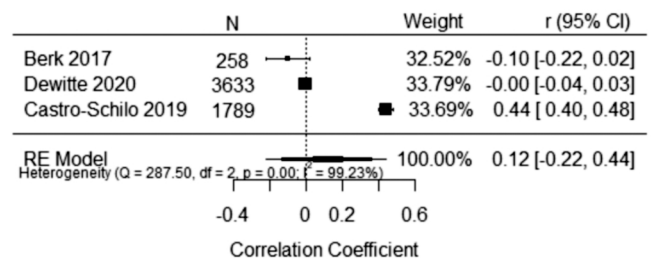


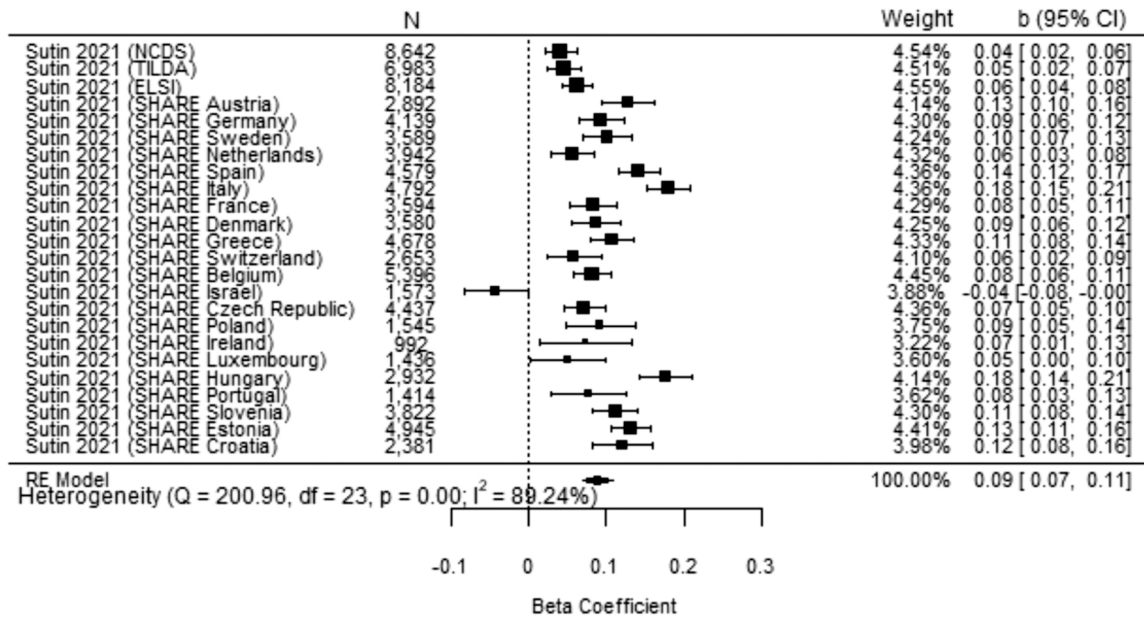
Fig. 3. Positive affect meta-analyses, *Due to repeated samples (MAAS and MIDUS), Hill et al. (2005) and Hittner et al. (2020) were excluded from the cross-sectional memory analysis and Hittner et al. (2020) was excluded from the longitudinal memory analysis.

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 ($r = 0.25$, 95 % CI [0.14, 0.36], $p < .0001$, $I^2 = 0.00$ %) (Fig. 3a) and memory ($r = 0.05$, 95 % CI [0.02, 0.08], $p = .0007$, $I^2 = 0.00$ %) (Fig. 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

a) Meaning and Verbal Fluency



b) Meaning and Memory

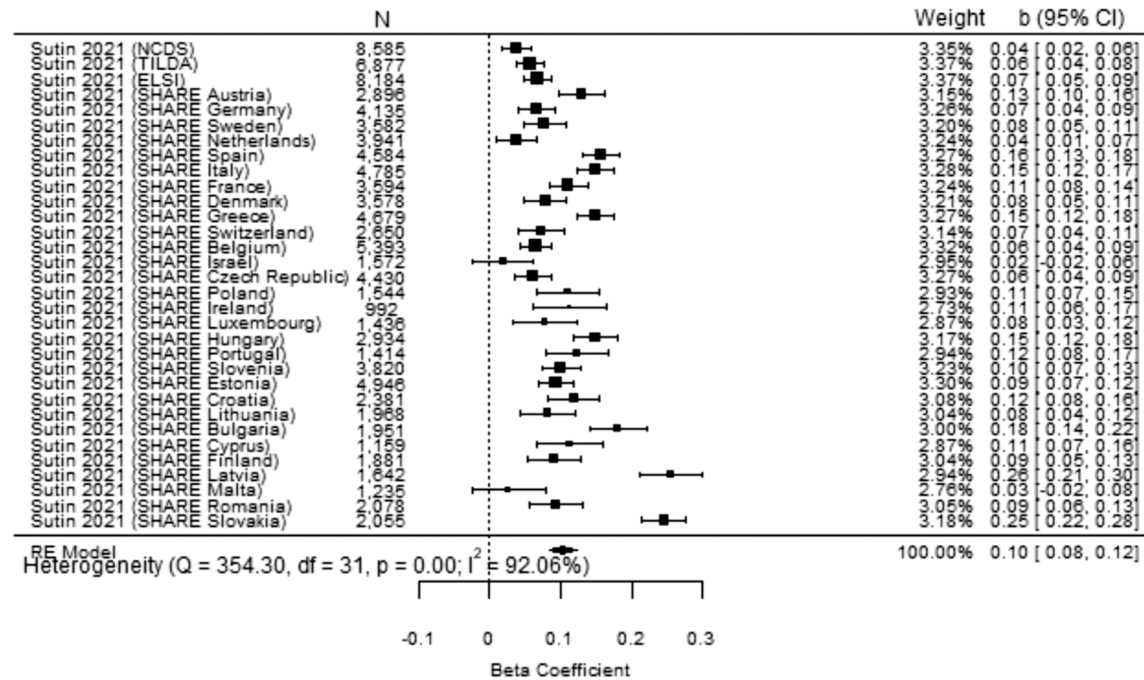


Fig. 4. Meaning in life meta-analyses (cross-sectional).

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 = 0.12, 95% CI

[- 0.22, 0.44], p = .48) (Fig. 3c). Substantial heterogeneity was observed in this model (I² = 99.23 %).

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

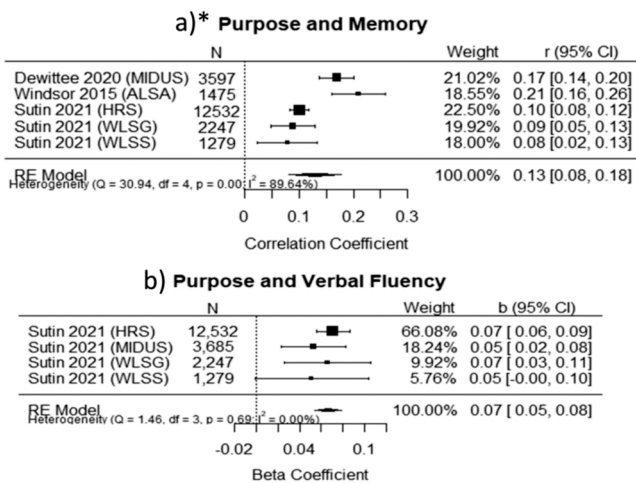


Fig. 5. Purpose in life meta-analyses (cross-sectional). *Due to repeated samples (MIDUS), Lewis et al. (2017) and Sutin et al. (2021a) were excluded from the memory analysis. This meta-analysis includes both correlational and beta effect sizes (Peterson and Brown, 2005).

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], $p < .0001$) (Fig. 4a) and memory ($b = 0.10$, 95 % CI [0.08, 0.12], $p < .0001$) (Fig. 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).

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 ($r = 0.13$, 95 % CI [0.08, 0.18], $p < .0001$) (Fig. 5a) and verbal fluency ($b = 0.07$, 95 % CI [0.05, 0.08], $p < .0001$, $I^2 = 0.00$ %) (Fig. 5b). Substantial heterogeneity was observed in the memory model ($I^2 = 89.64$ %).

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 's et al. (2020) study ($n = 3633$). 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 (Yemisciğil 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 multi-domain 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.

CRediT authorship contribution statement

Georgia Bell: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft. **Timothy Singham:** Methodology, Writing – review & editing. **Amber John:** Conceptualization, Formal analysis, Writing – review & editing, Supervision. **Joshua Stott:** Conceptualization, Formal analysis, Writing – review & editing,

Supervision. **Rob Saunders:** Formal analysis, Writing – review & editing. **Joshua Buckman:** Writing – review & editing. **Georgina Charlesworth:** Writing – review & editing. **Marcus Richards:** Writing – review & editing.

Role of funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

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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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.

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)
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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)
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12. "Mild Cognitive Impairment".tw. (11285)
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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)
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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 et al. (2010)	Castro-Schilo et al. (2019)	Wilson et al. (2013)	Zhang et al. (2021)	Danhauer et al. (2013)	Ihle et al. (2021)	Bishop et al. (2011)	Sol et al. (2020)	Windsor et al. (2015)	Oh et al. (2020)	Shin et al. (2021)	Nystrom et al. (2019)	Nakanishi et al. (2019)	Berk et al. (2017)	Dewitte et al. (2020)	Gerstorf et al. (2007)	Kim et al. (2019)	Hittner et al. (2020)	Lewis and Hill (2021)	Allerhand et al. (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	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	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	0
	No description																					
	Demonstration that outcome of interest was not present at start																					
	Yes *	1		1	1	1		1	1				1		1							1
	No		0				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	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	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	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	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	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	6	7

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

	Waldman-Levi et al. (2020)	Sharma and Babu (2017)	Lewis et al. (2017)	Koenig et al. (2004)	Hill et al. (2005)	Jones et al. (2003)	Bishop et al. (2012)	Saad et al. (2019)	Requena et al. (2009)	Fung and Lam (2013)	Aftab et al. (2019)	West et al. (1984)	Zahodne et al. (2018)	Wettstein et al. (2015)	Sutin et al. (2021a)	Sutin et al. (2021b)	Tani et al. (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., (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 for these factors. Sutin et al. (2021a) identified differences between SHARE and non-SHARE samples to be a potential source of heterogeneity in their models using the full samples. 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], $p = .08$).

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