Measuring psychological mechanisms in meditation practice: Using a phenomenologically grounded classification system to develop theory-based composite scores

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Abstract

Objectives: Deepening our understanding of the mechanisms by which meditation practices impact well-being and human flourishing is essential for advancing the science of meditation. A recent phenomenologically grounded classification system distinguishes attentional, constructive, and deconstructive forms of meditation based on the psychological mechanisms these practices primarily target or necessitate. Our main aim was to understand whether this theory-based taxonomy could be used as a guiding principle for combining established psychological self-report measures of meditation-related mechanisms into psychometrically adequate composite scores.

Methods: We used cross-sectional data to compute meditation composite scores in three independent samples, namely meditation-naïve healthy older adults from the Age-Well trial (n = 135), meditation-naïve older adults with subjective cognitive decline from the SCD-Well trial (n = 147), and healthy long-term meditators (≥10,000 hours of practice including one three-year meditation retreat) from the Brain & Mindfulness project (n=29). The psychometric properties of the composite scores were assessed via floor and ceiling effects, composite intercorrelations, interpretability, and convergent validity in relation to well-being, anxiety, and depression.

Results: Three theoretically derived meditation composite scores, reflecting mechanisms involved in attentional, constructive, and deconstructive practices, displayed adequate psychometric properties. Separate secondary confirmatory factor analyses empirically corroborated the theoretically predicted three-factor structure of this classification system.

Conclusions: Complementing data-driven approaches, this study offers preliminary support for using a theoretical model of meditation-related mechanisms to create empirically meaningful and psychometrically sound composite scores. We conclude by suggesting conceptual and methodological considerations for future research in this area.

Keywords: expert meditators; meta-awareness; mindfulness; compassion; well-being; mental health

Meditation is a multidimensional construct whose conceptual and phenomenological fields are deep and wide (Burbea, 2014; Dahl et al., 2020; Lutz et al., 2007). Its depth encompasses spectra of increasing meditative skill, subtlety, and refinement. Its width describes a vast range of distinct practices and mechanisms. As the science of meditation is moving beyond its mindfulness-centric focus (Van Dam et al., 2018), classification systems for meditation practices become increasingly important as they can help differentiate practice-specific psychological mechanisms (Trautwein et al., 2020). This differentiation can have pertinent implications for the development, optimisation, and efficacy of tailored meditation training and its effects on well-being and human flourishing.

Several ways of classifying traditional and contemporary meditation practices and their purported mechanisms have been proposed. Methodologically, it can be beneficial to tentatively distinguish theory-based, top-down approaches to categorising meditation practices and mechanisms (e.g., Hölzel et al., 2011; Lutz et al., 2008; Lutz et al., 2015; Vago & David, 2012) from primarily data-driven, bottom-up approaches (e.g., Farb et al., 2018; Matko et al., 2021). Both approaches aim to effectively measure the underlying constructs of interest and employ data reduction techniques that can range from theory-guided classification by experts to data-driven exploratory factor analysis.

Here, we used a theory-based approach because (i) it is less reliant on specific measures and factor analysis and thus less psychometrically volatile, (ii) it can flexibly respond to the introduction of new measures by assessing their conceptual fit to the model, (iii) it can be used as a guiding principle to parsimoniously compare studies that administer similar, yet distinct measures of the same latent constructs (e.g., compassion) in different populations (e.g., clinical, non-clinical), and because (iv) there is a paucity of attempts to empirically evaluate theoretical models of meditation practice.

We utilised the theoretical model introduced by Dahl, Lutz, and Davidson (2015), which is grounded in phenomenology and informed by a synthesis of the relevant literature in clinical psychology, cognitive neuroscience, and contemplative studies. This model categorises the complex web of meditation practices into attentional, constructive, and deconstructive families based on the psychological mechanisms that are necessitated, trained, and primarily targeted by different forms of meditation. Attentional, constructive, and deconstructive families can be conceptualised as theory-based psychological mechanisms by which the practice of meditation is purported to exert its impact on well-being (Dahl et al., 2020). Other theory-based approaches have proposed twofold taxonomies of meditation practices. For example, the model introduced by Lutz et al. (2008) distinguishes between focused attention and open monitoring practices. In many contemplative traditions, prevailing models often contrast concentration and calming practices (e.g., samadhi, samatha) to insight practices (e.g., vipassana; see Lutz et al., 2007). A particular advantage of Dahl et al.'s (2015) model is its ability to include and transcend many twofold classification systems by capturing concentration, mindfulness, and insight practices while also including constructive forms of meditation (e.g., loving-kindness, compassion).

In Dahl et al.'s (2015) framework, the attentional family comprises practices that cultivate the capacity to initiate, direct, and sustain meta-awareness, which is the primary psychological mechanism of this type of meditation. Meta-awareness can be defined as a form of attention regulation that allows a heightened awareness of thinking, feeling, and perceiving (Dahl et al., 2020; Schooler et al., 2011). It involves monitoring the contents of experience without becoming unintentionally absorbed by them. The attentional family includes forms of concentration and mindfulness-based practices.

The constructive meditation family comprises practices that train skilful psychological habits aimed at nurturing prosocial qualities, healthy interpersonal dynamics, a

commitment to embodying ethical values, and weakening maladaptive self-schemata. Perspective taking and cognitive reappraisal have been proposed as the primary psychological mechanisms of this type of meditation. Perspective taking is the capacity to consider the thoughts, feelings, and perceptions one would have in a specific situation or context. Cognitive reappraisal is the capacity to change one's way of relating to contexts and situations in such a way that it affects one's perception of and response to them. The constructive family includes forms of loving-kindness and compassion practices.

The deconstructive meditation family comprises practices that primarily intend to understand and weaken unhelpful modes of thinking, feeling, and conceiving that are causing psychological and existential stress. Self-inquiry, the primary psychological mechanism of this type of meditation, is the capacity to actively investigate the complex dynamics of lived experience in order to transform patterns of cognitive and perceptual reification. Reification can be defined as a way of perceiving that is imbued with the implicit belief in the inherent and independent existence of perceptions (e.g., sensations, thoughts, the sense of self) and of consciousness itself (Lutz et al., 2015). In this context, cultivating insight through self-inquiry can be conceptualised as strengthening, to whatever degree, the understanding that the unskilful reification of phenomena causes suffering and prevents well-being and human flourishing. The deconstructive family includes forms of insight practices and meditations on emptiness and dependent origination.

Importantly, Dahl et al. (2015) acknowledge that a psychological capacity primarily cultivated by one family can also be trained by, or necessary for, practices in other families, albeit in a more indirect manner. For instance, as detailed above, the delineation between attentional and deconstructive capacities is based primarily on a distinction between meta-awareness and dereification. Meta-awareness and dereification, despite being regularly conflated in the literature, can be conceptualised as locally orthogonal constructs (see Lutz et

al., 2015). That is, a meditator could be aware of having anxious thoughts without being able to weaken the reification of these thoughts. However, some degree of meta-awareness is required for the process of dereification. Empirically, we would thus predict the attentional, constructive, and deconstructive families to be highly correlated in individuals who have undergone long-term meditation training, but not so highly as to indicate a simpler underlying structure (e.g., a unidimensional general meditation capacity). In contrast, in individuals without prior meditation training, we would not expect the composite scores of conceptually distinct meditation-related families to be highly correlated because the measures comprising each meditation composite were developed to capture specific constructs in a discriminant manner.

Preliminary empirical evidence offers tentative support for the predictive value of this threefold classification system for meditation research. For instance, a recent longitudinal magnetic resonance imaging study (Valk et al., 2017) assessed the effects of three mental training modules: attentional skills including mindfulness-based practices, socio-affective skills including loving-kindness and prosocial motivation, and socio-cognitive skills including perspective-taking and metacognition. These training modules share some of the phenomenological features and mechanisms that characterises Dahl et al.'s (2015) typology. Attention training, socio-affective training, and sociocognitive training induced changes in cortical morphology in prefrontal regions, frontoinsular regions, and inferior frontal and lateral temporal cortices, respectively (Valk et al., 2017).

Our aim was to offer a methodological blueprint for creating theoretically meaningful meditation composite scores using established self-report measures commonly employed in meditation research. To that end, we tested whether the classification system introduced by Dahl et al. (2015) could be used as a guiding principle for combining psychological self-report measures into attentional, constructive, and deconstructive composite scores with

satisfactory psychometric properties. We tested whether these composite scores would show adequate intercorrelations, no floor and ceiling effects, adequate interpretability, and convergent validity (in relation to well-being, anxiety, and depression). In line with previous research indicating sex differences in levels of compassion (Pommier et al., 2020; Schlosser et al., 2021), empathy (Eisenberg & Lennon, 1983), and prosocial behaviour (Caprara et al., 2005) in healthy samples, female participants were expected to display higher constructive composite scores. We hypothesised that these sex differences in constructive composite scores would be attenuated by intensive meditation practice and thus be less pronounced in the sample of long-term meditators. We did not predict sex differences in attentional and deconstructive scores. Further, age and education were not expected to be associated with meditation composite scores. We investigated these properties in three independent samples that comprised meditation-naïve healthy older adults, meditation-naïve older adults with subjective cognitive decline, and healthy long-term meditators (≥10,000 hours of practice including one three-year meditation retreat). When identical self-report measures were administered across studies, we expected that long-term meditators would report higher raw scores than meditation-naïve participants on the scales comprising the meditation composites. As a secondary statistical verification, we used confirmatory factor analysis to compare the theoretically predicted latent variable structure (i.e., an intercorrelated three-factor model) to a structure reflecting a general meditation capacity (i.e., a one-factor model).

Methods

Participants

We utilised cross-sectional data from three different studies, namely the Age-Well randomised controlled trial (Poisnel et al., 2018) and the SCD-Well randomised controlled trial (Marchant et al., 2021) of the European Union's Horizon 2020-funded Medit-Ageing

project (public name: Silver Santé Study), and the European Research Council-funded Brain & Mindfulness project (Abdoun et al., 2018).

The Age-Well randomised controlled trial (Poisnel et al., 2018) compares an 18-month meditation training aimed at promoting mental health and well-being in the ageing population to a structurally matched English language training and a passive control condition. A total of 157 community-dwelling older adults were assessed and 137 participants were subsequently randomised in the Age-Well trial. Two participants were excluded from the Age-Well trial after randomisation: one participant presented with amyotrophic lateral sclerosis and one participant experienced a head trauma with loss of consciousness for more than one hour. The present study thus included baseline data from 135 cognitively unimpaired, older adults (≥ 65 years) who had no major neurological or psychiatric disorder, no present or past regular or intensive practice of meditation, were native French speakers, were retired for at least one year, and had completed at least seven years of formal education.

The SCD-Well randomised controlled trial (Marchant et al., 2021) compares the effects of a mindfulness-based intervention versus a health education programme on mental health in participants with subjective cognitive decline (SCD), which is associated with a heightened risk of developing dementia. The present study included baseline data from 147 older adults (aged ≥60 years) with no major neurological or psychiatric disorder, and no present or past regular or intensive practice of meditation, recruited from memory clinics at four European sites, and meeting the research criteria for SCD proposed by the SCD-I working group (Jessen et al., 2014).

The Brain & Mindfulness project (Abdoun et al., 2018) is a cross-sectional study that investigates the relationship between meditation expertise and affective, cognitive, and phenomenological processes. The present study included data from 29 long-term meditators

(aged between 35 and 65 years) with no neurological or psychiatric disorder, no psychotropic drug use, a minimum of 10,000 hours of formal meditation practice in the Kagyu or Nyingma school of Tibetan Buddhism (including one traditional three-year meditation retreat), and a daily practice during the 12 months preceding inclusion.

Procedure

Details of the recruitment procedure, settings, and design of the three studies and a comprehensive list of the measures and domains sampled can be found in the trial protocols and manual (Age-Well: Poisnel et al., 2018; SCD-Well: Marchant et al., 2018; Brain & Mindfulness: Abdoun et al., 2018).

Measures

The present study drew from the self-report measures employed in the Age-Well trial, the SCD-Well trial, and the Brain & Mindfulness project (Table 1). The following scales were considered for inclusion in the meditation composites: the *Compassionate Love Scale* (CLS; stranger-humanity version; Sprecher & Fehr, 2005), the *Compassion for Others Scale* (COS-7; Schlosser et al., 2021), the *Compassion Scale* (Pommier, 2010), the *Drexel Defusion Scale* (DDS; Forman et al., 2012), the *39-item Five Facet Mindfulness Questionnaire* (FFMQ-39; Baer et al., 2006), the *15-item Five Facet Mindfulness Questionnaire* (FFMQ-15; Baer et al., 2008), the *Interpersonal Reactivity Index* (IRI; Davis, 1983), the *Multidimensional Assessment of Interoceptive Awareness* questionnaire (MAIA; Mehling et al., 2012), the *Prosocialness Scale* (Caprara et al., 2005), and the reappraisal subscale of the *Emotion Regulation Questionnaire* (ERQ; Gross & John, 2003). Detailed descriptions of the scales are included in the supplementary material.

To assess the convergent validity of the meditation composite scores, we used established self-report measures of anxiety, depression, and well-being, namely the trait scale of the State-Trait Anxiety Inventory (Spielberger et al., 1983), the Geriatric Depression Scale

(Sheikh & Yesavage, 1986), the Beck Depression Inventory (Beck et al., 1961), and the 42-item Psychological Well-being Scale (PWBS-42; Ryff et al., 1995) and 18-item Psychological Well-being Scale (PWBS-18; Ryff, 1989).

Meditation composite scores were developed based on the psychological capacities that Dahl et al. (2015) described as the primary mechanisms of attentional, constructive, and deconstructive types of meditation. Using this threefold taxonomy of meditation practices, five researchers (MS, AL, TB, OK, YIDA) assessed which psychological self-report measures could potentially capture the relevant psychological capacities. Given the absence of self-report measures of meta-awareness and dereification whose development and validation have been informed by contemplative perspectives, we aimed to select meaningful proxy measures of attentional and deconstructive capacities. Next, four researchers (MS, AL, TB, OK) independently evaluated the items from each of the selected scales and assigned them to the attentional, constructive, or deconstructive practice family. Any disagreements were resolved via group discussions. Scales and subscales were retained if most of their items were judged to clearly measure one of the meditation types' mechanisms. In other words, we did not remove individual items from the scales and subscales that we assigned to the meditation composites. We reasoned that the benefits of this approach outweigh the level of noise introduced by the few items that we judged to not clearly reflect one of the psychological capacities of interest. Furthermore, deriving the composite scores from a combination of scale and subscale scores rather than individual item scores maintains each measures' psychometric integrity, eases the conceptual comparison between studies using similar yet slightly distinct measures of the same construct (e.g., different mindfulness measures), and allows more parsimonious and replicable factor analytic modelling (i.e., factor structures with fewer indicators).

Before computing the meditation composite scores, we reverse-scored scale scores if lower total scores reflected better functioning so that higher composite scores would indicate higher meditation-related psychological capacities. Scale scores were then standardised using their baseline mean and standard deviation. Each meditation composite score was computed by averaging the standardised scores of the scales that were assigned to the respective composite, yielding composite scores with a baseline mean of 0 and a standard deviation smaller than one. Lastly, we re-standardised each composite score so that estimates from regression analyses can be directly interpreted in standard deviation units. Participants with missing scale scores were not included in the composite score to which this scale was assigned. No participant data were excluded based on very high or low scale scores.

Data Analyses

Distribution and floor/ceiling effects of the meditation composite scores were assessed using skewness and kurtosis estimates and visual inspection of the histograms. In an initial step, interpretability was assessed by comparing meditation composite scores based on age, sex, and education. A mixed effects regression model was fit that included the re-standardised composite scores as the outcome and age, sex, education, type of composite, and three interaction terms (i.e., sex/age/education by type of composite) as the predictors.

Convergent validity was assessed using Pearson's correlation coefficients. We expected higher meditation composite scores to be correlated with greater well-being and lower levels of anxiety and depression. Based on the theoretical model, we expected the attentional, constructive, and deconstructive composite scores to be correlated – but not so highly (>0.8) as to suggest conceptual redundancy (i.e., lack of differentiation between meditation-related mechanisms) – and that these intercorrelations would be higher in the sample of long-term meditators. To test this hypothesis, we used the R package *cocor* (Diedenhofen & Musch, 2015) to compare two correlations based on two independent

samples with different sample sizes. For the equality tests, we used the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995) to control the false discovery rate in multiple testing.

We utilised confirmatory factor analysis with maximum likelihood estimation as a secondary statistical verification to the primary theory-driven scale evaluation. In other words, the confirmatory factor analysis did not influence the development and computation of the meditation composite scores. We compared a one-factor model to a three-factor model in which factors were allowed to covary. The one-factor solution modelled a general meditation capacity as a single latent variable and scale scores as indicators. The three-factor solution modelled the psychological mechanisms characterising the attentional, constructive, and deconstructive meditation types as latent variables and their respective scale scores as indicators. Two comparative measures of model fit were used to compare the one- and three-factor solutions, namely the Akaike's Information Criterion (AIC; Akaike, 1998) and Bayesian Information Criterion (BIC; Schwarz, 1978). Lower AIC and BIC values indicate a better fit. In addition, three global measures of model fit were reported (Kenny, 2015): the Comparative Fit Index (CFI), the Tucker Lewis Index (TLI), and the Standardised Root Mean Square Residual (SRMR). Because confirmatory factor analysis was only used as a secondary verification of our theory-based approach, we assessed global measures of fit using liberal criteria: values above 0.80 for the CFI, above 0.90 for TLI, and below 0.10 for the SRMR were deemed as indicating an acceptable fit (Bentler & Bonett, 1980; Browne & Cudeck, 1993; Hu & Bentler, 1999). In line with recommendations for not computing the root mean square error of approximation (RMSEA) for models with small degrees of freedom and small sample size (Kenny et al., 2015), we decided to not use the RMSEA to assess model fit. Analyses were conducted in Stata/MP version 16.0 and R version 4.0.2. Data used in the Medit-Ageing project and the Brain & Mindfulness project are available upon request.

Results

Scale and Item Assessment

Among the measures administered to participants of the Age-Well trial, the SCD-Well trial, and the Brain & Mindfulness project, seven scales were judged to primarily capture attentional aspects: noticing (MAIA subscale), attention regulation (MAIA), emotional awareness (MAIA), self-regulation (MAIA), body listening (MAIA), observing (FFMQ), and acting with awareness (FFMQ). Five scales were judged to primarily capture constructive aspects: the CLS, empathic concern (IRI subscale), perspective taking (IRI), the Prosocialness Scale, and the Compassion Scale. Another four scales were judged to primarily capture deconstructive aspects: the DDS, non-judging (FFMQ), non-reactivity (FFMQ), and personal distress (IRI). Although the definition of defusion (Forman et al., 2012; Hayes et al., 1999) comprises aspects of both dereification and meta-awareness, defusion, as measured by the DDS, was judged to primarily capture deconstructive capacities and to a lesser extent attentional capacities. Table 1 reports the mean (SD) of all scale scores.

The 6-item reappraisal subscale (ERQ; Gross & John, 2003) was not included in the constructive composite because its items reflect conceptualisations of cognitive reappraisal that differ in important ways from those commonly employed in meditation and mindfulness research. For example, items such as "When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation" [original italics] seem to suggest a more forced change in evaluating than the gentle process of interrogating meaning that is typical of meditative approaches and may be difficult to unambiguously differentiate from cognitive forms of avoidance. However, given that this is a debated issue in the mental health literature, we also conducted a sensitivity analysis that included the reappraisal subscale in the three-factor model to see whether our theory-based omission of this scale would be empirically corroborated. The reappraisal scale was included in the Age-Well trial to answer research

questions not addressed in the present study. Table 1 presents the scales that comprised the meditation composite scores in the three independent samples.

Meditation-naïve Healthy Older Adults

Floor and ceiling effects. The distributions of the three meditation composite scores did not markedly diverge from normality as indicated by estimates of skewness (attentional: -0.59; constructive: -0.42; deconstructive: 0.14) and kurtosis (attentional: 3.36; constructive: 3.46; deconstructive: 2.81) and visual inspection of the histograms. The meditation composite scores captured a wide range of values and did not display floor or ceiling effects.

Interpretability. As expected, female participants displayed higher constructive scores than male participants (estimated mean difference = 0.45, 95% CI: 0.10 to 0.80, p = 0.011), whereas attentional and deconstructive scores did not display sex differences. The three meditation composite scores were not linked to age or education.

Composite intercorrelations and convergent validity. Attentional scores were correlated with deconstructive scores (Pearson's correlation coefficient r = 0.20, 95% CI: 0.03 to 0.36, p = 0.019), but not with constructive scores (r = 0.17, 95% CI: -0.001 to 0.33, p = 0.051). Constructive and deconstructive scores were uncorrelated (r = -0.02, 95% CI: -0.19 to 0.15, p = 0.789). Correlations of the composite scores with levels of anxiety, depression, and well-being are displayed in Table 2.

Sensitivity analyses that used the COS-7 instead of the CLS to compute the constructive composites scores replicated this pattern of results. The COS-7 and CLS were highly correlated (r = 0.96, 95% CI: 0.94 to 0.97, p < 0.001).

Meditation-naïve Older Adults with SCD

No constructive scores were computed because SCD-Well included only one of the scales assigned to the constructive composite (Table 1).

Floor and ceiling effects. The distributions of the attentional and deconstructive scores did not markedly diverge from normality as indicated by estimates of skewness (attentional: -0.16; deconstructive: -0.56) and kurtosis (attentional: 3.46; deconstructive: 3.2) and visual inspection of the histograms. Both composite scores captured a wide range of values and did not display floor or ceiling effects.

Interpretability. As expected, the two meditation composite scores computed in SCD-Well (i.e., attentional and deconstructive scores) did not display sex differences. More years of education were associated with higher deconstructive scores (estimate = 0.05, 95% CI: 0.01 to 0.10, p = 0.020). Attentional scores were not associated with education. None of the two composite scores was linked to age.

Composite intercorrelations and convergent validity. Attentional scores were moderately correlated with deconstructive scores (r = 0.22, 95% CI: 0.05 to 0.38, p = 0.010). Table 2 displays the correlations of the composite scores with levels of anxiety, depression, and well-being.

Healthy Long-term Meditators

Floor and ceiling effects. The distributions of the meditation composite scores did not markedly diverge from normality as indicated by estimates of skewness (attentional: 0.16; constructive: 0.28; deconstructive: -0.27) and kurtosis (attentional: 2.96; constructive: 2.34; deconstructive: 1.84). However, visual inspection of the histograms indicated that the distribution of the deconstructive scores included more scores at the lower and higher ends of the distribution than in the centre.

Interpretability. The three meditation composite scores were not related to age, sex, or education. Although not statistically significant, the sex difference in constructive scores (estimated mean difference = 0.50, 95% CI: -0.19 to 1.18, p = 0.156) was similar in direction and magnitude to the one found in meditation-naïve healthy older adults.

Composite intercorrelations and convergent validity. Attentional scores were moderately correlated with constructive scores (r = 0.48, 95% CI: 0.13 to 0.72, p = 0.009) and highly correlated with deconstructive scores (r = 0.62, 95% CI: 0.32 to 0.81, p < 0.001). Constructive and deconstructive scores were moderately correlated (r = 0.43, 95% CI: 0.07 to 0.69, p = 0.023). Correlations of the composite scores with levels of anxiety, depression, and well-being are displayed in Table 2.

Equality tests of correlation coefficients. Long-term meditators displayed higher correlations between attentional scores and deconstructive scores (r = 0.62) than meditation-naïve healthy older adults (r = 0.20; difference = 0.42, p = 0.008) and meditation-naïve older adults with SCD (r = 0.22; difference = 0.40, p = 0.011). Long-term meditators also displayed higher correlations between constructive scores and deconstructive scores (r = 0.43) than meditation-naïve healthy older adults (r = -0.02; difference = 0.45, p = 0.014). However, long-term meditators did not display higher correlations between attentional scores and constructive scores (r = 0.48) than meditation-naïve healthy older adults (r = 0.17; difference = 0.31, p = 0.051). This pattern of results remained unchanged after applying the Benjamini-Hochberg to control for multiple testing. These findings largely confirmed our prediction that meditation scores are more interrelated in long-term meditators than in meditation-naïve older adults.

Secondary Confirmatory Factor Analysis

We used Age-Well data to compare a one-factor solution to a three-factor solution. We did not use SCD-Well data because this trial included only one of the scales we had assigned to the constructive composite, which did not allow us to meaningfully model the theory-based three-part division. We did not use Brain & Mindfulness data to avoid introducing replicability issues related to the small sample size (n =29).

The comparative measures of fit suggested that the three-factor solution (AIC = 9125, BIC = 9264) displayed a better model fit than the one-factor solution (AIC = 9298, BIC = 9428). Based on global measures of model fit, the three-factor solution displayed a slightly less than acceptable fit (CFI = 0.84, TLI = 0.80, SRMR = 0.107). Standardised factor loadings ranged from 0.27 to 0.84 (all associated with $p < 0.005$, mean = 0.68) for the attentional factor, from 0.32 to 0.79 (all associated with $p < 0.001$, mean = 0.64) for the constructive factor, and from 0.35 to 0.75 (all associated with $p < 0.001$, mean = 0.58) for the deconstructive factor. Intercorrelations among the composite factors were consistent with those among the observed composite scores. Standardised factor loadings and correlations are displayed in Table 3. Based on global measures of model fit, the one-factor solution displayed a poor model fit (CFI = 0.61, TLI = 0.54, SRMR = 0.145). Standardised factor loadings ranged from -0.04 to 0.85 (mean = 0.40; Table 3).

A sensitivity analysis indicated that additionally including the reappraisal subscale of the ERQ in the three-factor solution resulted in a decline in model fit (CFI = 0.80, TLI = 0.76, SRMR = 0.122). Reappraisal loaded only weakly onto the constructive factor (0.20, associated with $p = 0.045$), offering empirical support for our theory-based omission of this subscale.

Discussion

The present study aimed to empirically test if a selection of commonly used psychological self-report measures can be meaningfully categorised in line with an established theoretical model of meditation-related mechanisms (Dahl et al., 2015). Our findings offer preliminary empirical support for the theory-based delineation of attentional, constructive, and deconstructive capacities in meditation practice. Using this threefold taxonomy to group psychological self-report measures, we were able to derive three meditation composite scores with adequate psychometric properties.

In line with previous research that found sex differences in compassion for others, empathy, and prosocial behaviour (Caprara et al., 2005; Eisenberg & Lennon, 1983; Pommier et al., 2020; Schlosser et al., 2021), meditation-naïve healthy older women displayed higher constructive composite scores than meditation-naïve healthy older men. However, our findings did not support the hypothesis that sex differences in constructive capacities would be attenuated by intensive meditation practice and, therefore, less pronounced in the smaller sample of long-term meditators (i.e., >10,000 hours of practice). The sex differences in constructive capacities, although not statistically significant, were similar in direction and magnitude to those found in meditation-naïve healthy older adults. The absence of the predicted attenuation in sex differences could imply that older women and men show similar meditation-related increases in constructive capacities, even though women already display higher constructive capacities prior to meditation training. Future longitudinal work is needed to investigate contextual factors (e.g., intentions, practice intensity, teacher-student relations) that potentially moderate meditation training responses related to sex. Further, neither age nor levels of education were related to meditation-related capacities, except for the link between greater deconstructive capacities and higher levels of education in meditation-naïve older adults with SCD.

Another theory-based assumption was that psychological mechanisms primarily trained by one family of practices would also be indirectly cultivated by or necessary for practices in other families. Thus, we predicted that a relationship between meditation composites would be present in meditation-naïve healthy older adults and long-term meditators, but that this link would be accentuated in long-term meditators because of the extensive time they had spent cultivating attentional, constructive, and deconstructive capacities, either directly (e.g., training perspective taking through loving-kindness practices) or indirectly (e.g., training meta-awareness through compassion practices). Our findings

largely confirmed this prediction. The relationship between attentional and deconstructive capacities as well as between constructive and deconstructive capacities was stronger in long-term meditators, whereas the association between attentional and constructive capacities did not significantly differ between the samples ($p = 0.051$), possibly due to unequal or insufficient sample sizes. In meditation-naïve healthy older adults, attentional capacities were associated with deconstructive capacities. One possible explanation is that mobilising deconstructive capacities requires at least a minimal level of attentional capacities (i.e., meta-awareness), thus leading to a shared variance between these dimensions, despite being statistically differentiable. An alternative interpretation is that the self-report measures used here are not specific enough to psychometrically map this typology. Further methodological and conceptual developments will be necessary to improve the measurement of theory-based meditation-related capacities. Of note, the present study constituted a principally pragmatic attempt to define meditation composite scores in the context of two large randomised controlled trials of meditation training (Marchant et al., 2021; Poisnel et al., 2018). Our findings suggest that theory-based psychological mechanisms of meditation practice can indeed be empirically differentiated and that this differentiation is less distinct in long-term meditators. Longitudinal studies are now needed to evaluate alterations in meditation-related capacities and their coupling over time.

Among meditation-naïve older adults, meditation composite scores were associated with greater well-being. This pattern was expected as the psychological capacities characterising each meditation family are hypothesised to be critical for nourishing well-being (Dahl et al., 2020). Diverging from our predictions, in long-term meditators, none of the meditation composites were linked to well-being. Perhaps even more surprisingly, the observed well-being scores of long-term meditators were similar to those of meditation-naïve older adults with SCD and lower than those of meditation-naïve older adults. As the well-

being measures used in the present study (Ryff, 1989; Ryff et al., 1995) were developed and validated in participants without intensive meditation experience, it is possible that this might be due to differential item functioning as dedicated long-term meditators may interpret well-being items, such as “I sometimes feel as if I’ve done all there is to do in life”, in other ways than meditation-naïve adults. In other words, qualities of well-being and human flourishing purported to be cultivated by dedicated long-term meditation practice (Dahl et al., 2020) might not be captured adequately by the well-being measures we employed. The development of new scales or the modification of existing scales that can measure wider and subtler ranges of human well-being might be required to meaningfully compare long-term meditators to individuals without intensive meditation experience.

In all samples, greater deconstructive capacities were strongly linked with lower levels of anxiety. The trait-STAI (Spielberger, 1983), which we used to measure anxiety here, has recently been proposed as a nonspecific measure of negative affectivity rather than a specific measure of trait anxiety (Knowles & Olatunji, 2020). Greater deconstructive capacities were also associated with lower levels of depression across samples. The relationship of attentional and constructive capacities with clinical outcomes was less consistent than expected. Greater attentional capacities were associated with lower levels of anxiety in both long-term meditators and meditation-naïve healthy older adults, but not in meditation-naïve older adults with SCD. Surprisingly, constructive capacities displayed no relationship with either anxiety or depression in both long-term meditators or meditation-naïve healthy older adults (in meditation-naïve older adults with SCD, constructive scores were not computed due to a lack of scales). The relationship between meditation-related capacities and depression should be interpreted in the context of limited variability in levels of depression in long-term meditators and meditation-naïve healthy older adults. In contrast, anxiety scores did not display a limited variability in any of our samples. Across samples,

deconstructive capacities emerged as the strongest and most consistent correlate of clinical outcomes. One potential explanation is that the skill to undermine the belief in the inherent and seemingly real existence of sensations, thoughts, and feelings plays a more central role than other meditation-related psychological capacities in reducing maladaptive cognitive and perceptual patterns characteristic of anxiety and depression. Conversely, it could be the case that older adults with lower levels of depression and anxiety are more interested, willing, or capable of actively investigating the contents of their lived experience. The cross-sectional nature of our data prevents us from drawing any causal conclusions. Future longitudinal research is required to elucidate to what extent attentional, constructive, and deconstructive capacities differentially affect mental health.

Separate secondary confirmatory factor analysis indicated that a three-factor model reflecting the threefold division into attentional, constructive, and deconstructive capacities fit the data more adequately than a one-factor model reflecting a general meditation capacity. The mean factor loading of the three-factor model was high and factor intercorrelations were consistent with the observed composite score intercorrelations.

In the present study, we judged the reappraisal scale to not clearly measure the form of cognitive reappraisal characteristic of constructive meditation practices. Specifically, we concluded that avoidant cognitive and affective patterns cannot be unambiguously differentiated from the item content of the reappraisal subscale of the ERQ. However, we wanted to acknowledge that differing conceptualisations of reappraisal continue to be debated in the literature and that our decision to exclude the reappraisal scale could be perceived as overly stringent. We therefore conducted a sensitivity confirmatory factor analysis of the three-factor solution that also included the reappraisal scale in the constructive composite. This analysis provided empirical evidence that corroborated our theoretically informed omission of the reappraisal scale: reappraisal loaded only weakly onto the constructive factor

and its addition reduced the model fit. We recommend that researchers interested in meditation-related mechanisms carefully assess whether the item-level content of their chosen reappraisal scale is sufficiently conceptually aligned with the theoretical meditation framework they intend to utilise. Overall, the literature might benefit from the introduction of a new measure of cognitive reappraisal whose development and validation are informed by cognitive, clinical, and contemplative perspectives.

Limitations and Future Research

Although promising, the findings of the present study need to be considered in the light of several important limitations. The Age-Well trial and SCD-Well trial included only older adults, the median age of long-term meditators in the Brain & Mindfulness project was >50 years, and across samples, participants' level of education was high. Future work is necessary to evaluate the psychometric properties of the meditation composite scores and the relationship between life span development and meditation-related capacities in larger and demographically more diverse samples. Importantly, a pool of gold standard instruments for measuring process-focussed mechanisms does not yet exist as the science of meditation has only just begun to clearly characterise and delineate the processes related to specific forms of meditation practice. Given this absence, the present study used self-report measures that were originally developed to measure trait-like individual differences. Using trait-based scales may be inadequate for substantially advancing our understanding of meditation-related mechanisms. It is also important to note that the development of the meditation composites required the independent evaluation of the scale items by four meditation researchers but that other meditation research teams assessing the same items might have produced composites with divergent compositions. Further, the unequal sample sizes of long-term meditators and meditation-naïve older adults might have affected the equality tests of composite intercorrelations and the assessment of sex differences in constructive composite scores. We

also acknowledge that no single classification system of meditation practices can be definitive and even widely used theoretical models will require further conceptual delineations as the field matures. We suggest that future research evaluates the utility of other theoretical models and self-report measures for measuring psychological mechanisms in meditation practice.

The science of meditation is evolving, including the theory and study of meditation-related mechanisms. Higher levels of conceptual and methodological differentiation to capture distinct mechanisms could contribute to a *precision science of meditation* (cf. precision medicine, Haendel et al., 2018) that predicts how, when, and under what circumstances particular forms of practice best serve a meditator's intentions and goals, taking into account their individual differences (e.g., personality traits, affective and cognitive style, worldviews, cultural context). In this section, we would like to suggest conceptual and methodological considerations that could be pertinent for future work in this area.

We recommend that the specific (dis)advantages of theory-based and data-driven approaches to measuring meditation-related mechanisms are assessed in light of three relevant challenges encountered in contemporary meditation research. First, a substantial number of psychological self-report measures have been published, but there is growing consensus that many scales used to capture meditation-related constructs, including established gold standard measures, are psychometrically and conceptually limited (e.g., Grossman, 2019; Strauss et al., 2016). Second, the field is witnessing the introduction of a quickly growing number of new self-report measures purported to more adequately capture already established constructs or to capture new constructs for meditation research (see Van Dam et al., 2018). Third, new and modified meditation-based programmes are increasingly complex, combining multiple practice modalities each targeting specific psychological

capacities (e.g., Cullen et al., 2021; Goldberg et al., 2020). Importantly, the evaluation of the efficacy of these programmes will be affected by methodological decisions regarding the measurement of meditation-related mechanisms (e.g., data-driven vs. theory-based approaches, established scales vs. new scales).

Data-driven approaches have the potential to reduce bias attributable to scale selection based on allegiance or researcher expectations. For instance, in a secondary analysis of a trial that compared the extent to which cognitive therapy versus mindfulness-based cognitive therapy prevented relapse/recurrence in major depressive disorder, an exploratory factor analysis of a large and varied pool of measures (i.e., 34 subscales from 17 questionnaires measuring regulatory strategies) was conducted to identify the most relevant intervention-related mechanisms (Farb et al., 2018). Three latent variables emerged: decentering, distress tolerance, and residual symptoms. These three latent variables were subsequently modelled as predictors for relapse/recurrence prevention. The authors suggest that this form of data-driven approach might elucidate patterns of change that would not emerge when administering fewer measures. However, a potential disadvantage is that data-driven approaches that include a substantial number of scales can introduce replicability issues related to model stability and factor structure, especially in the context of longitudinal studies (Kline, 2015), which seldom accrue sample sizes that would be considered sufficient for structural equation modelling.

Theory-based approaches are less reliant on specific measures, more responsive to the introduction of new measures, and allow researchers to compare studies within the context of a single theoretical framework even though distinct measures of the same construct (e.g., mindfulness) might have been administered. Theory-based approaches to scale assessment can also optimise the development of new scales for meditation research, by identifying scales that lack content validity when viewed from a particular theoretical model or that lack

psychometric quality when used alongside similar but more recently developed scales, or by informing the choice of measures used for establishing discriminant and convergent validity of new scales. Importantly, theoretical models can highlight psychological mechanisms that are purported to be of primary significance for deepening well-being (e.g., malleability of perception, subtlety of attention; Burbea, 2014), but for which no conceptually adequate and psychometrically robust measures have been developed and validated. However, the use of limited theories might result in excluding important psychological mechanisms or in combining mechanisms that might be phenomenologically distinct (e.g., meta-awareness and dereification, cf. Bernstein et al., 2015; Farb et al., 2018; Lutz et al., 2015).

Additionally, theory-based approaches can include and transcend already established meditation-related mechanisms. This can be illustrated by considering the constructs of dereification (e.g., Lutz et al., 2015), decentering (e.g., Bernstein et al., 2015), and defusion (e.g., Forman et al., 2012; Hayes et al., 1999) in the context of Dahl et al.'s (2015) deconstructive family. Conceptualisations of decentering and defusion – which, by themselves, are not embedded in a broader theoretical model of meditation – are commonly used in meditation and clinical research, such as the ability to psychologically distance oneself from objects of consciousness (e.g., sensations, thoughts, feelings) and not seeing them as accurate reflections of reality (Forman et al., 2012). Importantly though, the capacity to dis-identify from and weaken the reification of subtler objects of consciousness (e.g., the intention to pay attention) or consciousness itself (here, a sense of knowing) is neither theoretically nor psychometrically appreciated by existing measures of decentering or defusion. One advantage of the model we used in the present study (Dahl et al., 2015) is its ability to conceptually map the spectrum of increasing meditative skill, depth, and subtlety that can be cultivated through practice, even though relevant self-report measures to assess this level of meditative expertise do not yet exist.

Generally, we recommend placing more importance on the detailed assessment of mechanisms than of specific forms of practices and techniques. Two recent cross-sectional studies involving over 1,000 regular meditators (Schlosser et al., 2019, 2020) highlighted important challenges and limitations that arise when grouping participants based on generic types of meditation (e.g., loving-kindness, vipassana). Firstly, a large proportion of meditators engaged in both attentional, constructive, and deconstructive forms of meditation. The high heterogeneity in practice, a finding corroborated by other large-scale surveys of regular meditators (e.g., Vieten et al., 2018), complicates a methodologically unambiguous comparison of differential mechanisms. Secondly, if the relevant mechanisms are not explicitly measured, a given meditation practice is simply assumed to cultivate the practice-specific psychological capacities the model purports. This assumption, however, might not hold if we consider that the practice of loving-kindness, for instance, can be engaged in so as to function primarily as an attentional practice (e.g., loving-kindness meditation aimed at deepening mental collectedness), a constructive practice (e.g., loving-kindness meditation aimed at cultivating prosocial qualities), or a deconstructive practice (e.g., loving-kindness meditation aimed at investigating its effects on perception; Burbea, 2014). An advantage of the present study was its focus on psychological mechanisms targeted by specific forms of practice, not on practices themselves. In settings that do not allow for the detailed assessment of meditation-related mechanisms, more detailed descriptions provided by participants about their practice(s) could, to a certain extent, improve the validity of practice classification based on psychological mechanisms.

Declarations

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Conflicts of Interest

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Ethics Approval

Written informed consent was obtained from all participants after the procedures had been explained to them and prior to participation. The Age-Well trial received ethics approval from the Comité de Protection des Personnes CPP Nord-Ouest III in Caen (trial registration number: EudraCT 2016-002441-36). The multi-centre SCD-Well trial received ethics approval from the committees and regulatory agencies of all centres: London, UK (Queen Square Research Ethics Committee: Nº 17/LO/0056 and Health Research Authority National Health Service, IRAS project ID: 213008); Lyon, France (Comité de Protection des Personnes Sud-Est II Groupement Hospitalier Est: Nº 2016-30-1 and Agence Nationale de Sécurité du Médicament et des Produits de Santé: IDRCB 2016-A01298-43); Cologne, Germany (Ethikkommission der Medizinischen Fakultät der Universität zu Köln: Nº 17-059);

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Data Availability

Data used in the Medit-Ageing project and the Brain & Mindfulness project are available upon request.

Author Contributions

MS: wrote the first draft of the manuscript; substantial contributions to conception and design of the work; statistical analysis; interpretation of data; and incorporation of manuscript feedback. TB: substantial contributions to conception and design of the work; interpretation of data; and revision of the manuscript for important intellectual content. FR: substantial contributions to the analysis of data; and revision of the manuscript for important intellectual content. YIDA: substantial contributions to the design of the work; and revision of the manuscript for important intellectual content. OA: substantial contributions to the analysis of data; and revision of the manuscript for important intellectual content. NLM: substantial contributions to the conception of the work; and revision of the manuscript for important intellectual content. GC: substantial contributions to the conception of the work; and revision of the manuscript for important intellectual content. FC: substantial contributions to the conception of the work; and revision of the manuscript for important intellectual content. OMK: substantial contributions to the conception and design of the work; interpretation of data; and revision of the manuscript for important intellectual content. AL: substantial contributions to conception and design of the work; contributions to writing the first draft of

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References

Abdoun, O., Zorn, J., Fucci, E., Perraud, E., Aarts, K., & Lutz, A. (2018). *Brain & mindfulness project manual*. OSF. https://osf.io/dbwch/

Akaike, H. (1998). Information theory and an extension of the maximum likelihood principle. In E. Parzen, K. Tanabe, & G. Kitagawa (Eds.), *Selected Papers of Hirotugu Akaike* (pp. 199–213). Springer. https://doi.org/10.1007/978-1-4612-1694-0_15

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45. https://doi.org/10.1177/1073191105283504

Baer, R. A., Smith, G. T., Lykins, E., Button, D., Krietemeyer, J., Sauer, S., Walsh, E., Duggan, D., & Williams, J. M. G. (2008). Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment, 15*(3), 329–342. https://doi.org/10.1177/1073191107313003

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*(6), 561–571. https://doi.org/10.1001/archpsyc.1961.01710120031004

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B (Methodological), 57*(1), 289–300.

Bentler, P. M., & Bonett, D. G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin, 88*(3), 588–606. https://doi.org/10.1037/0033-2909.88.3.588

Bernstein, A., Hadash, Y., Lichtash, Y., Tanay, G., Shepherd, K., & Fresco, D. M. (2015). Decentering and related constructs: A critical review and metacognitive processes

model. *Perspectives on Psychological Science*, *10*(5), 599–617. https://doi.org/10.1177/1745691615594577

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In *K. A. Bollen & J. S. Long (Eds.), Testing structural equation models* (pp. 136–162). CA: Sage.

Burbea, R. (2014). *Seeing that frees: Meditations on emptiness and dependent arising*. Hermes Amara Publications.

Caprara, G. V., Steca, P., Zelli, A., & Capanna, C. (2005). A new scale for measuring adults' prosocialness. *European Journal of Psychological Assessment*, *21*(2), 77–89. https://doi.org/10.1027/1015-5759.21.2.77

Cullen, B., Eichel, K., Lindahl, J. R., Rahrig, H., Kini, N., Flahive, J., & Britton, W. B. (2021). The contributions of focused attention and open monitoring in mindfulness-based cognitive therapy for affective disturbances: A 3-armed randomized dismantling trial. *PLOS ONE*, *16*(1), e0244838. https://doi.org/10.1371/journal.pone.0244838

Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: Cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences*, *19*(9), 515–523. https://doi.org/10.1016/j.tics.2015.07.001

Dahl, C. J., Wilson-Mendenhall, C. D., & Davidson, R. J. (2020). The plasticity of well-being: A training-based framework for the cultivation of human flourishing. *Proceedings of the National Academy of Sciences*, *117*(51), 32197–32206. https://doi.org/10.1073/pnas.2014859117

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44*(1), 113–126. https://doi.org/10.1037/0022-3514.44.1.113

Diedenhofen, B., & Musch, J. (2015). cocor: A comprehensive solution for the statistical comparison of correlations. *PLOS ONE*, *10*(4), e0121945. https://doi.org/10.1371/journal.pone.0121945

Eisenberg, N., & Lennon, R. (1983). Sex differences in empathy and related capacities. *Psychological Bulletin, 94*(1), 100–131. https://doi.org/10.1037/0033-2909.94.1.100

Farb, N., Anderson, A., Ravindran, A., Hawley, L., Irving, J., Mancuso, E., Gulamani, T., Williams, G., Ferguson, A., & Segal, Z. V. (2018). Prevention of relapse/recurrence in major depressive disorder with either mindfulness-based cognitive therapy or cognitive therapy. *Journal of Consulting and Clinical Psychology*, *86*(2), 200–204. https://doi.org/10.1037/ccp0000266

Forman, E. M., Herbert, J. D., Juarascio, A. S., Yeomans, P. D., Zebell, J. A., Goetter, E. M., & Moitra, E. (2012). The Drexel defusion scale: A new measure of experiential distancing. *Journal of Contextual Behavioral Science*, *1*(1), 55–65. https://doi.org/10.1016/j.jcbs.2012.09.001

Goldberg, S. B., Imhoff-Smith, T., Bolt, D. M., Wilson-Mendenhall, C. D., Dahl, C. J., Davidson, R. J., & Rosenkranz, M. A. (2020). Testing the efficacy of a multicomponent, self-guided, smartphone-based meditation app: Three-armed randomized controlled trial. *JMIR Mental Health, 7*(11), e23825. https://doi.org/10.2196/23825

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*(2), 348–362. https://doi.org/10.1037/0022-3514.85.2.348

Grossman, P. (2019). On the porosity of subject and object in 'mindfulness' scientific study: Challenges to 'scientific' construction, operationalization and measurement of

mindfulness. *Current Opinion in Psychology*, *28*, 102–107. https://doi.org/10.1016/j.copsyc.2018.11.008

Haendel, M. A., Chute, C. G., & Robinson, P. N. (2018). Classification, ontology, and precision medicine. *New England Journal of Medicine*, *379*(15), 1452–1462. https://doi.org/10.1056/NEJMra1615014

Hayes, S. C., Strosahl, K., & Wilson, K. G. (1999). *Acceptance and commitment therapy: An experiential approach to behavior change*. New York: Guilford Press.

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science*, *6*(6), 537–559. https://doi.org/10.1177/1745691611419671

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Jessen, F., Amariglio, R. E., Boxtel, M. van, Breteler, M., Ceccaldi, M., Chételat, G., Dubois, B., Dufouil, C., Ellis, K. A., Flier, W. M. van der, Glodzik, L., Harten, A. C. van, Leon, M. J. de, McHugh, P., Mielke, M. M., Molinuevo, J. L., Mosconi, L., Osorio, R. S., Perrotin, A., … Wagner, M. (2014). A conceptual framework for research on subjective cognitive decline in preclinical Alzheimer's disease. *Alzheimer's & Dementia*, *10*(6), 844–852. https://doi.org/10.1016/j.jalz.2014.01.001

Kenny, D. A. (2015). *Measuring model fit*. http://www.davidakenny.net/cm/fit.htm

Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociological Methods & Research*, *44*(3), 486–507. https://doi.org/10.1177/0049124114543236

Kline, R. B. (2015). *Principles and practice of structural equation modeling, fourth edition*. Guilford Publications.

Knowles, K. A., & Olatunji, B. O. (2020). Specificity of trait anxiety in anxiety and depression: Meta-analysis of the State-Trait Anxiety Inventory. *Clinical Psychology Review, 82,* 101928. https://doi.org/10.1016/j.cpr.2020.101928

Lutz, A., Dunne, J. D., & Davidson, R. J. (2007). Meditation and the neuroscience of consciousness: An introduction. In P. D. Zelazo, M. Moscovitch, & E. Thompson (Eds.), *The Cambridge handbook of consciousness* (pp. 499–551). Cambridge University Press. https://doi.org/10.1017/CBO9780511816789.020

Lutz, A., Jha, A. P., Dunne, J. D., & Saron, C. D. (2015). Investigating the phenomenological matrix of mindfulness-related practices from a neurocognitive perspective. *American Psychologist, 70*(7), 632. https://doi.org/10.1037/a0039585

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163–169. https://doi.org/10.1016/j.tics.2008.01.005

Marchant, N. L., Barnhofer, T., Coueron, R., Wirth, M., Lutz, A., Arenaza-Urquijo, E. M., Collette F., Poisnel G., Demnitz-King H., Schild A., Coll-Padros N., Delphin-Combe F., Whitfield T., Schlosser M., Gonneaud J., Asselineau J., Walker Z., Krolak-Salmon P., Molinuevo J. L., … Klimecki, O. M. (2021). Effects of a mindfulness-based intervention versus health self-management on subclinical anxiety in older adults with subjective cognitive decline: The SCD-Well randomized superiority trial. *Psychotherapy and psychosomatics*, 1-10. https://doi.org/10.1159/000515669

Marchant, N. L., Barnhofer, T., Klimecki, O. M., Poisnel, G., Lutz, A., Arenaza-Urquijo, E., Collette, F., Wirth, M., Schild, A.-K., Coll-Padrós, N., Reyrolle, L., Horney, D., Krolak-Salmon, P., Molinuevo, J. L., Walker, Z., Maillard, A., Frison, E., Jessen, F.,

& Chételat, G. (2018). The SCD-Well randomized controlled trial: Effects of a mindfulness-based intervention versus health education on mental health in patients with subjective cognitive decline (SCD). *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, *4*(1), 737–745. https://doi.org/10.1016/j.trci.2018.10.010

Matko, K., Ott, U., & Sedlmeier, P. (2021). What do meditators do when they meditate? Proposing a novel basis for future meditation research. *Mindfulness*, 1-21. https://doi.org/10.1007/s12671-021-01641-5

Mehling, W. E., Price, C., Daubenmier, J. J., Acree, M., Bartmess, E., & Stewart, A. (2012). The multidimensional assessment of interoceptive awareness (MAIA). *PLOS ONE*, *7*(11), e48230. https://doi.org/10.1371/journal.pone.0048230

Poisnel, G., Arenaza-Urquijo, E., Collette, F., Klimecki, O. M., Marchant, N. L., Wirth, M., de La Sayette, V., Rauchs, G., Salmon, E., Vuilleumier, P., Frison, E., Maillard, A., Vivien, D., Lutz, A., & Chételat, G. (2018). The Age-Well randomized controlled trial of the Medit-Ageing European project: Effect of meditation or foreign language training on brain and mental health in older adults. *Alzheimer's & Dementia: Translational Research & Clinical Interventions*, *4*, 714–723. https://doi.org/10.1016/j.trci.2018.10.011

Pommier, E. (2010). *The Compassion Scale*. Thesis. https://repositories.lib.utexas.edu/handle/2152/ETD-UT-2010-12-2213

Pommier, E., Neff, K. D., & Tóth-Király, I. (2020). The development and validation of the compassion scale. *Assessment*, *27*(1), 21–39. https://doi.org/10.1177/1073191119874108

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, *57*(6), 1069–1081. https://doi.org/10.1037/0022-3514.57.6.1069

Ryff, C. D., Lee, C., & Keyes, M. (1995). The structure of psychological well-being revisited. *Journal of Personality & Social Psychology*, 719–727.

Schlosser, M., Jones, R., Demnitz-King, H., & Marchant, N. L. (2020). Meditation experience is associated with lower levels of repetitive negative thinking: The key role of self-compassion. *Current Psychology*. https://doi.org/10.1007/s12144-020-00839-5

Schlosser, M., Pfaff, N. G., Schweinberger, S. R., Marchant, N. L., & Klimecki, O. M. (2021). The psychometric properties of the compassionate love scale and the validation of the English and German 7-item compassion for others scale (COS-7). *Current Psychology*. https://doi.org/10.1007/s12144-020-01344-5

Schlosser, M., Sparby, T., Vörös, S., Jones, R., & Marchant, N. L. (2019). Unpleasant meditation-related experiences in regular meditators: Prevalence, predictors, and conceptual considerations. *PLOS ONE*, *14*(5), e0216643. https://doi.org/10.1371/journal.pone.0216643

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in cognitive sciences*, *15*(7), 319-326. https://doi.org/10.1016/j.tics.2011.05.006

Schwarz, G. (1978). Estimating the dimension of a model. *The Annals of Statistics*, *6*(2), 461–464. https://doi.org/10.1214/aos/1176344136

Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric depression scale (GDS): Recent evidence and development of a shorter version. *Clinical Gerontologist: The Journal of Aging and Mental Health*, *5*(1–2), 165–173. https://doi.org/10.1300/J018v05n01_09

Spielberger, C. D. (1983). *State-trait anxiety inventory for adults*. American Psychological Association. https://doi.org/10.1037/t06496-000

Sprecher, S., & Fehr, B. (2005). Compassionate love for close others and humanity. *Journal of Social and Personal Relationships*, *22*(5), 629–651. https://doi.org/10.1177/0265407505056439

Strauss, C., Lever Taylor, B., Gu, J., Kuyken, W., Baer, R., Jones, F., & Cavanagh, K. (2016). What is compassion and how can we measure it? A review of definitions and measures. *Clinical Psychology Review*, *47*, 15–27. https://doi.org/10.1016/j.cpr.2016.05.004

Trautwein, F. M., Kanske, P., Böckler, A., & Singer, T. (2020). Differential benefits of mental training types for attention, compassion, and theory of mind. *Cognition*, *194*, 104039. https://doi.org/10.1016/j.cognition.2019.104039

Vago, D. R., & David, S. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, *6*, 296. https://doi.org/10.3389/fnhum.2012.00296

Valk, S. L., Bernhardt, B. C., Trautwein, F.-M., Böckler, A., Kanske, P., Guizard, N., Collins, D. L., & Singer, T. (2017). Structural plasticity of the social brain: Differential change after socio-affective and cognitive mental training. *Science Advances*, *3*(10), e1700489. https://doi.org/10.1126/sciadv.1700489

Van Dam, N. T., van Vugt, M. K., Vago, D. R., Schmalzl, L., Saron, C. D., Olendzki, A., Meissner, T., Lazar, S. W., Kerr, C. E., Gorchov, J., Fox, K. C. R., Field, B. A., Britton, W. B., Brefczynski-Lewis, J. A., & Meyer, D. E. (2018). Mind the hype: A critical evaluation and prescriptive agenda for research on mindfulness and

meditation. *Perspectives on Psychological Science*, *13*(1), 36–61. https://doi.org/10.1177/1745691617709589

Vieten, C., Wahbeh, H., Cahn, B. R., MacLean, K., Estrada, M., Mills, P., Murphy, M., Shapiro, S., Radin, D., Josipovic, Z., Presti, D. E., Sapiro, M., Chozen Bays, J., Russell, P., Vago, D., Travis, F., Walsh, R., & Delorme, A. (2018). Future directions in meditation research: Recommendations for expanding the field of contemplative science. *PLOS ONE*, *13*(11), e0205740. https://doi.org/10.1371/journal.pone.0205740

Table 1 Demographic and descriptive characteristics

Variable	Meditation-naïve healthy older adults (Age-Well; n =135)	Meditation-naïve older adults with SCD (SCD-Well; n =147)	Long-term meditators (Brain & Mindfulness; n =29)
Age, years	68.9 (3.8), range: 65 to 84	72.7 (6.9), range: 60 to 91	52.0 (8.1), range: 35 to 65
Female, *n* (%)	83 (61.5%)	95 (64.6%)	12 (41.4%)
Education incl. university, years	13.2 (3.1)	13.6 (3.6)	15.0 (2.7)
Attentional composite			
MAIA noticing	3.4 (1.1)	2.9 (1.2)[a]	3.9 (0.8)
MAIA attention regulation	2.8 (0.9)	2.7 (1.0)[b]	4.1 (0.6)
MAIA emotional awareness	3.5 (1.0)	3.4 (1.1)[c]	4.2 (0.7)
MAIA self-regulation	3.1 (1.0)	2.6 (1.1)[d]	4.2 (0.6)
MAIA body listening	2.5 (1.2)[e]	1.8 (1.2)[f]	3.5 (1.1)
FFMQ observing[1]	9.5 (2.9)	9.5 (2.7)[g]	33.7 (3.7)
FFMQ acting with awareness[1]	11.7 (2.2)	10.5 (2.8)[g]	31.7 (5.2)
Constructive composite			
Compassionate Love Scale	90.6 (21.1)	92.3 (20.4)[a]	-
IRI empathic concern	19.8 (4.2)	-	22.3 (3.8)
IRI perspective taking	17.4 (3.5)	-	21.7 (3.4)
Prosocialness Scale	60.4 (8.3)	-	-
Compassion Scale	-	-	4.3 (0.3)
Deconstructive composite			
Drexel Defusion Scale	34.4 (5.6)	31.7 (8.5)[f]	39.1 (6.6)[h]
FFMQ non-judging[1]	11.6 (2.3)	11.8 (2.6)[g]	33.7 (4.3)
FFMQ non-reactivity[1]	9.7 (2.2)	9.5 (2.9)[g]	28.1 (4.3)
IRI personal distress[2]	10.2 (5.2)	-	5.6 (3.2)
Measures of construct validity			
STAI trait	34.6 (7.0)	39.9 (10.0)[i]	33.9 (8.4)
Geriatric Depression Scale	1.3 (1.7)	2.5 (2.3)	-
Psychological Well-being Scale[3]	5.4 (0.7)	4.5 (1.2) [g]	4.6 (0.8)
Beck Depression Inventory	-	-	3.0 (4.5)

Note. All statistics are mean (*SD*) unless otherwise specified. MAIA = Multidimensional Assessment of Interoceptive Awareness; FFMQ = Five Facet Mindfulness Questionnaire; IRI = Interpersonal Reactivity Index; STAI = State-Trait Anxiety Inventory.

[a]*n* = 141, [b]*n* = 138, [c]*n* = 139, [d]*n* = 137, [e]*n* = 134, [f]*n* = 140, [g]*n* = 142, [h]*n* = 28, [i]*n* = 146

[1]The 15-item FFMQ was used in Age-Well and SCD-Well, and the 39-item version was used in Brain & Mindfulness.

[2]Here, higher scores indicate higher levels of distress. Before their inclusion in the deconstructive composite score, these values were reverse-scored.

[3]The 42-item Psychological Well-being Scale was used in Age-Well and SCD-Well, and the 18-item version was used in Brain & Mindfulness.

Table 2 Correlations (and their accompanying 95% confidence interval) of the meditation composite scores with well-being, anxiety, and depression

	Meditation-naïve healthy older adults (n =135)			Meditation-naïve older adults with SCD (n =147)			Long-term meditators (n =29)		
	PWBS-42	STAI trait	GDS	PWBS-42	STAI trait	GDS	PWBS-18	STAI trait	BDI
Attentional	0.29**	-0.17*	0.001	0.27*	-0.14	-0.21*	0.15	-0.68**	-0.30
	(0.13 to 0.44)[a]	(-0.33 to -0.002)[a]	(-0.17 to 0.17)[a]	(0.11 to 0.42)[b]	(-0.30 to 0.031)[c]	(-0.37 to -0.04)[b]	(-0.23 to 0.49)	(-0.84 to -0.42)	(-0.60 to 0.08)
Constructive	0.21*	0.11	-0.02	-	-	-	0.05	-0.26	0.05
	(0.04 to 0.36)	(-0.07 to 0.27)	(-0.19 to 0.15)				(-0.32 to 0.41)	(-0.57 to 0.12)	(-0.33 to 0.41)
Deconstructive	0.45**	-0.61**	-0.18*	0.17*	-0.57**	-0.39**	0.08	-0.77**	-0.40*
	(0.30 to 0.57)	(-0.71 to -0.49)	(-0.33 to -0.01)	(0.004 to 0.33)[d]	(-0.67 to -0.45)[e]	(-0.53 to -0.24)[d]	(-0.30 to 0.44)[f]	(-0.89 to -0.56)[f]	(-0.67 to -0.03)[f]

Note. PWBS = Psychological Well-being Scale; STAI = State-Trait Anxiety Inventory, GDS = Geriatric Depression Scale.

[a]n = 134, [b]n = 136, [c]n = 135, [d]n = 140, [e]n = 139, [f]n = 28

*$p < 0.05$, **$p < 0.001$

Table 3 Standardised factor loadings and 95% confidence intervals of the three- and one-factor models of theory-based mechanisms of meditation practice

	Three-factor model[a]			One-factor model[a]		
	Loadings	95% CI	p-value	Loadings	95% CI	p-value
Attentional factor						
MAIA noticing	0.68	0.58 to 0.79	<0.001	0.67	0.57 to 0.78	<0.001
MAIA attention regulation	0.84	0.77 to 0.90	<0.001	0.83	0.76 to 0.90	<0.001
MAIA emotional awareness	0.80	0.72 to 0.87	<0.001	0.78	0.71 to 0.86	<0.001
MAIA self-regulation	0.84	0.77 to 0.91	<0.001	0.85	0.79 to 0.91	<0.001
MAIA body listening	0.83	0.76 to 0.90	<0.001	0.84	0.77 to 0.90	<0.001
FFMQ observing	0.53	0.40 to 0.66	<0.001	0.52	0.39 to 0.66	<0.001
FFMQ acting with awareness	0.27	0.10 to 0.44	0.001	0.27	0.11 to 0.44	0.001
Constructive composite						
Compassionate Love Scale	0.69	0.57 to 0.81	<0.001	0.15	-0.03 to 0.32	0.097
IRI empathic concern	0.74	0.62 to 0.86	<0.001	0.02	-0.16 to 0.20	0.804
IRI perspective taking	0.32	0.14 to 0.49	<0.001	0.30	0.14 to 0.47	<0.001
Prosocialness Scale	0.79	0.68 to 0.91	<0.001	0.12	-0.05 to 0.30	0.168
Deconstructive composite						
Drexel Defusion Scale	0.75	0.60 to 0.90	<0.001	0.30	0.13 to 0.46	<0.001
FFMQ non-judging	0.35	0.17 to 0.53	<0.001	-0.04	-0.22 to 0.14	0.663
FFMQ non-reactivity	0.59	0.43 to 0.75	<0.001	0.20	0.03 to 0.37	0.021
IRI personal distress[1]	0.62	0.46 to 0.77	<0.001	0.27	0.10 to 0.43	0.002
Factor intercorrelations						
Attentional and Constructive	0.13	-0.07 to 0.33	0.200			
Attentional and Deconstructive	0.33	0.13 to 0.52	0.001			
Constructive and Deconstructive	-0.04	-0.28 to 0.20	0.726			

Note. MAIA = Multidimensional Assessment of Interoceptive Awareness; FFMQ = Five Facet Mindfulness Questionnaire; IRI = Interpersonal Reactivity Index.

[a]n = 134

[1]Here, higher scores indicate lower levels of distress. Before their inclusion in the confirmatory factor analysis, these values were reverse-scored.

Supplementary Materials

Detailed descriptions of the psychological self-report scales are included in the supplementary materials.