



Meditation experience is associated with lower levels of repetitive negative thinking: The key role of self-compassion

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Abstract

The primary aim of this study was to investigate the relationship between meditation experience and repetitive negative thinking (RNT) in regular meditators with a wide range of experience, and to examine the extent to which self-compassion and mindfulness mediate this relationship. RNT is a transdiagnostic process that is implicated in the development and maintenance of several mental health disorders. Converging evidence suggests that meditation practice is associated with improved mental health and may reduce levels of RNT. Increased levels of self-compassion and mindfulness have been associated with decreased levels of RNT and proposed as theoretically consistent mediators by which meditation practice exerts its beneficial effects; however, they are seldom considered in combination. In a cross-sectional design, 1281 meditators (mean age = 44.7 years, SD = 13.9, 53.7% female) completed questionnaires about meditation experience, RNT, self-compassion, and mindfulness. Linear regression and generalised structural equation models were used to examine the data. Longer duration of meditation experience was associated with lower levels of RNT and higher levels of self-compassion and mindfulness. Meditation experience was associated with RNT indirectly through self-compassion, but not through mindfulness. The results offer preliminary support for longer-term meditation as a potential means for reducing the maladaptive process of RNT. Clinically, self-compassion could be identified as a promising treatment target for interventions.

Keywords Repetitive negative thinking · Meditation · Self-compassion · Mindfulness · Structural equation modelling

Introduction

Repetitive negative thinking (RNT) is a process characterised by intrusiveness, repetitiveness, and difficulties to disengage from negative cognitive and affective content (Ehring and Watkins 2008; McEvoy et al. 2013). Heightened levels of RNT, which encompasses worry (future-directed negative thought) and rumination (past-directed negative thought), have been found across several clinical disorders, most notably in depression and anxiety (Watkins 2008). For example, research indicates that RNT is causally implicated in the development and maintenance of depression (Just and Alloy 1997; Spasojević and Alloy 2001; Trick et al. 2016). Similarly, evidence indicates that RNT is predictive of anxiety symptoms during brief therapeutic interventions (Kertz et al.

2015; Wadsworth et al. 2018). Although the content of RNT seems disorder-specific, the process of this style of thinking is shared among disorders (Ehring and Watkins 2008). Given its manifestation across a wide spectrum of mental health disorders, RNT has been conceptualised as a transdiagnostic process (Harvey et al. 2004; McEvoy et al. 2013). As such, RNT describes a dimensional rather than categorical process and is, therefore, also active, although to a much lesser degree, in non-clinical populations (Ehring and Watkins 2008). In non-clinical populations, RNT is also associated with detrimental health effects (McLaughlin et al. 2007; Segerstrom et al. 2000) and predictive of the development of affective disorders including depression (Just and Alloy 1997). Therefore, lifestyle habits that impact on RNT may hold promise for reducing or preventing a range of mental health problems in both healthy and clinical populations. Of particular interest in this context is the practice of meditation.

Meditation is a broad term that can cover many similar yet distinct practices (Van Dam et al. 2018). Building on the widely-cited distinction between two styles of meditation practice, namely focussed attention and open monitoring (Lutz et al. 2008), a recently proposed taxonomy categorised

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meditation practices into attentional, constructive, and deconstructive types (Dahl et al. 2015). These categories are theoretically informed by their primary cognitive mechanisms. Attentional meditation types systematically train the ability to initiate, direct, and sustain attentional processes and to be aware of thoughts, feelings, and perceptions (i.e. meta-awareness) without becoming automatically absorbed in their content (i.e. experiential fusion). Constructive types cultivate skilful interpersonal dynamics, commitment to ethical values, and prosocial qualities. Perspective taking and cognitive reappraisal are the core cognitive mechanisms hypothesised to undermine negative self-schema. Deconstructive types aim to weaken and dissolve maladaptive cognitive patterns by investigating the emotional, cognitive, and perceptual dynamics of lived experience, a cognitive process referred to as self-inquiry. Self-inquiry can reduce cognitive reification, which can be defined as the implicit belief in the inherent, enduring, and independent existence of objects of consciousness (and of consciousness itself). Thus, deconstructive practices aim to cultivate insights into the nature of all phenomena including body sensations, thoughts, conceptual frameworks, and models of the self and others. Relating the definitions and cognitive mechanisms of practice types to the context of the present study, RNT can be hypothesised to be primarily affected by attentional types and to a lesser extent by non-attentional types (i.e. constructive and deconstructive) as they also strengthen meta-awareness, although more indirectly (Dahl et al. 2015; Dahl and Davidson 2019).

A number of systematic reviews and meta-analyses have indicated that several modalities of meditation training (e.g. secular mindfulness programmes, traditional meditation retreats) are associated with positive effects on a variety of psychological outcomes in both clinical and non-clinical populations (e.g. Goyal et al. 2014; Khoury et al. 2017; Sedlmeier et al. 2012). Specifically, in previous studies mindfulness meditation reduced rumination (Jain et al. 2007), Zen meditation reduced worry (Gillani and Smith 2001), and lifetime experience with mindfulness meditation was associated with lower levels of rumination (Lykins and Baer 2009). Contemporary theoretical frameworks for the effects of meditation practice have been formulated; however, meditation research generally lacks precise theory-driven approaches (see Van Dam et al. 2018). In the search for psychological mechanisms of action, mindfulness and self-compassion have frequently been posited as theoretically consistent candidate processes underlying the putative effects meditation and meditation-based interventions exert on constructs including well-being, depression, anxiety, and stress (e.g. Baer et al. 2012; Josefsson et al. 2011). Importantly, mindfulness and self-compassion are lower in mental health disorders and are negatively associated with RNT (self-compassion: Barnard and Curry 2011; Diedrich et al. 2014; mindfulness: Burg and Michalak 2011; see Keng et al. 2011).

Mindfulness is a broad term that has its historical roots in Buddhist traditions and does not have a universally agreed upon definition (Grossman 2019; Williams and Kabat-Zinn 2011). A commonly employed definition refers to mindfulness as a mental faculty that allows attention to be paid to present-moment experiences in a non-judgmental and non-reactive way (Baer 2019; Kabat-Zinn 1990). The ability to observe phenomenological contents without reactivity and to incline the mind towards noticing the impermanent and impersonal nature of cognitive and affective objects can reduce how strongly the experiential flow of RNT is appropriated by the (sense and view of) self and taken as a definite depiction of reality. With increasing levels of mindfulness, the ability to weaken the representational meaning and integrity of the negative content – and thereby let go of it – might become an available coping skill (Frewen et al. 2008). Related clinical research suggests that RNT mediates the effects of mindfulness-based interventions on mental health outcomes including anxiety, stress, and depression (for a review see Gu et al. 2015).

Self-compassion is a multidimensional construct that has also been defined in a variety of ways (Strauss et al. 2016). Here, self-compassion is defined as an emotionally positive attitude towards oneself in the face of personal suffering: to be kind rather than judgmental, to feel connected through a common humanity rather than isolated, to be mindful of distress rather than over-identified with it (Neff 2003a). Evidence from a cross-sectional study of undergraduate students indicates that aspects of RNT (i.e. rumination and worry) partially mediated the relationship between self-compassion and measures of depression and anxiety (Raes 2010). Experimental studies using healthy student samples also offer support for a close link between self-compassion and psychopathological processes related to RNT. For instance, inducing self-compassion caused participants to be more emotionally resilient in the face of acute stressors (Neff et al. 2007) and higher levels of self-compassion were predictive of more positive emotional and less maladaptive cognitive responses after receiving ambivalent feedback on an experimental task (Leary et al. 2007). Individuals with higher levels of self-compassion may be able to defuse RNT by re-appraising negative experiences in a self-supportive, situational, and emotionally flexible context. Related research conducted in clinical populations also evidenced a potential role for RNT as a pathway via which self-compassion may improve anxiety and depression symptoms (Krieger et al. 2013; Wadsworth et al. 2018). In brief, evidence indicates that meditation cultivates mindfulness and self-compassion, which, in turn, may constitute adaptive transdiagnostic buffers that reduce heightened levels of RNT.

The primary aim of the present study was to elucidate the relationship between meditation experience (operationalised as years of regular practice) and RNT in a cross-sectional

sample of regular meditators with a wide range of experience. Using generalised structural equation models (GSEM), the aim was to specifically advance the understanding of the combined contribution of mindfulness and self-compassion as potential mediators of the relationship between meditation experience and RNT. Meditation experience was hypothesised to be negatively associated with RNT and positively associated with mindfulness and self-compassion, and that self-compassion and mindfulness would mediate the relationship between meditation experience and RNT.

Method

Participants

Inclusion criteria for participation were a minimum age of 18 years, a good understanding of the English language, and a current regular meditation practice (at least once a week). An online survey was developed. This survey was started 2599 times, and completed by 1706 participants. Participants were asked to exclude yoga, tai chi, and chi gong practices. A total of 425 participants indicated ‘other practices’ only and then wrote yoga in the free text box ($n = 383$) or left it blank ($n = 42$). Data from these individuals were not considered in the analysis. Therefore, the analyses reported here included a total of 1281 participants.

Procedure

A link to an online survey was shared on the study’s designated Facebook and Twitter pages and sent to international mindfulness associations, meditation centres, and Buddhist communities. The survey was completely anonymous, took approximately 20 min to complete, and was accessible between April and August 2017. The study received ethical approval from the first author’s institutional ethics board (ref no: 10043/001) and was performed in accordance with the 1964 Declaration of Helsinki. Individuals indicated their consent to participate in the study by submitting a survey. No financial compensation for participation was offered. A subsample of the current sample has previously been utilised to answer unrelated and non-overlapping research questions regarding unpleasant meditation-related experiences (Schlosser et al. 2019).

Measures

Demographic and Meditation Information

Participants were asked to indicate for how long they have meditated regularly using a dropdown box with months (1 to 11 with 1-month intervals) and years (1 to 10 with 0.5-year

intervals and 1-year intervals for >10 years). Months were transformed to years for all subsequent analyses. Years of practice (meditation experience) was used as the explanatory variable as it was judged to be less subject to recall bias and measurement error than frequency (per week) and session length (in minutes). Participants were also asked to choose the categories that best approximate the types of meditation (i.e. attentional, constructive, and/or deconstructive) they practiced regularly using pre-specified categories and/or using a free text box to name other types of meditation, which were distinctively different from the listed categories. The following practices were categorised as attentional meditation types: mindfulness of breathing, breath counting, jhana practice, samatha/samadhi practice, visualisation, mantra, kirtan kriya, choiceless awareness, mindfulness meditation (e.g. as taught by mindfulness-based stress reduction programmes). Loving-kindness and compassion meditation were listed as constructive types, and deconstructive types included vipassana/insight meditation, mahamudra, dzogchen, shikantaza/‘just sitting’, self-inquiry, and koan practice.

Psychological Outcome Measures

RNT was measured by the Perseverative Thinking Questionnaire (PTQ; Ehring et al. 2011). The PTQ consists of 15 items that assess content-independent characteristics of RNT. Participants rate each item on a 5-point Likert scale ranging from 0 (*never*) to 4 (*almost always*) with higher scores indicating higher levels of self-reported RNT. A total score (possible range: 0 to 60) is obtained by summing the scores on all 15 items. The PTQ has been validated and shown high internal consistency across samples (Cronbach’s alpha from 0.94 to 0.95; Ehring et al. 2011). In the present study, Cronbach’s alpha for the PTQ was 0.92.

Self-compassion was measured by the Self-Compassion Scale (SCS; Neff 2003b), a 26-item measure comprising six dimensions that are assessed using 5-point Likert scale ranging from 1 (*almost never*) to 5 (*almost always*). The total score (possible range: 1 to 5) is the grand mean of the positive scales and the reverse coded negative scales. Higher total scores are indicative of higher levels of self-compassion. In the most comprehensive study of the SCS to date (20 diverse samples; $n = 11,685$), 95% of item variance was explained by a general factor, thus supporting the use of a total SCS score to represent overall self-compassion (Neff et al. 2019). The SCS has been widely validated and shown to possess high reliability across samples (e.g. Neff et al. 2019). Cronbach’s alpha in the present study was 0.90.

Mindfulness was measured by the Mindsens (Soler et al. 2014). The Mindsens is a 19-item composite index comprising selected items from the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al. 2008) and the Experience Questionnaire (EQ; Fresco et al. 2007). Both the FFMQ and

EQ have shown to possess good psychometric properties (Baer et al. 2008; Fresco et al. 2007). The Mindsens was created using exploratory factor analysis on all FFMQ and EQ items and on three meditation practice variables (total months of meditation practice, total days per month, and average session length). The Mindsens could discriminate regular meditators from non-meditators in 82% of cases (Cronbach's alpha of 0.91; Soler et al. 2014). The Mindsens uses 5-point Likert scales ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*) to measure the ability to be mindful and the capacity to observe mental objects as transient and impersonal. A total Mindsens score (possible range: 1 to 5) is computed by averaging the scores on all items. Higher scores are indicative of higher levels of self-reported mindfulness. Cronbach's alpha for the Mindsens was 0.93 in the present study.

Statistical Analysis

Given that the relationship between meditation experience and the outcome variables of interest was not assumed to be linear, meditation experience was categorised into five groups of similar sizes (<2 years, 2 to <5 years, 5 to <10 years, 10 to <20 years, ≥ 20 years). To investigate the associations between meditation experience and outcome variables of interest, separate simple linear regression models were fitted with meditation experience as the categorical explanatory variable and either mindfulness, self-compassion, or RNT as the outcome variable.

Generalised structural equation modelling (GSEM) includes both a measurement component and a structural component. The measurement model was constructed using confirmatory factor analysis. Items from the SCS, Mindsens, and PTQ were grouped into three parcels per scale by averaging the respective item scores (Little et al. 2002). A domain-representative parcelling technique was employed for items from the SCS and PTQ so that each of the three parcels presented all sub-dimensions of the SCS and PTQ; items from the Mindsens were randomly assigned to one of the three respective parcels. Self-compassion, mindfulness, and RNT were then modelled as single latent variables derived from the parcels of the SCS, Mindsens, and PTQ, respectively. Nine parcels instead of 60 items (total number of items from the SCS, Mindsens, and PTQ) were therefore included in the model because the focus of the present study was the exploration of the structural relationship between the latent factors, rather than the specific evaluation of the psychometric properties of the respective scales.

In line with recommendations for model fit indices in the context of large sample sizes (Barrett 2007), the comparative fit index (CFI), the Tucker-Lewis Index (TLI), and the root mean square error of approximation (RMSEA) were judged to be the most informative model fit indices. Values larger than

0.95 for the CFI and TLI and values smaller than 0.06 for the RMSEA are typically interpreted to indicate excellent fit to the data (e.g. Hu and Bentler 1999). Results from the chi-square test were also reported; however, the chi-square test statistic is very sensitive to sample size and minor model fit problems (Byrne 2001).

GSEM with maximum likelihood estimation was used to fit the hypothesised structural model. GSEM does not require the full joint-normality assumption of structural equation models. Rather, GSEM computes estimates conditional on the values of the observed exogenous variables. Thus, for ease of interpretation meditation experience was treated in the GSEM as a continuous observed explanatory variable, RNT as a latent outcome variable, and self-compassion and mindfulness as latent mediator variables. Age was added as a covariate in the structural model. A sensitivity analysis was conducted to evaluate if including sex and education as additional covariates changed the findings substantially.

A binary variable (meditation type) to denote attentional and non-attentional meditation types was generated. The attentional group ($n = 487$) included meditators who only used attentional types, whereas the non-attentional group ($n = 229$) included meditators who only used constructive and/or deconstructive types. To explore whether the relationship between meditation experience and RNT varied according to meditation type, a linear regression model was fitted with meditation experience, meditation type, and their interactions as categorical explanatory variables and RNT as the outcome. Meditators who used both attentional and non-attentional types of meditation were not included in these analyses since a mixed group would not differentiate meditators who regularly engage in both types of meditation from those who almost exclusively engage in either an attentional or a non-attentional type, and would be conceptually too broad to produce meaningful results.

Assumptions of linear regression – namely, independence, normality, and homoscedasticity of residuals, and linearity – were judged to be adequately met; no multicollinearity was detected. The assumptions of GSEM were also judged to be met: the minimum ratio of observations to free parameters was above 5:1 (Kline 2015), and model fit specifications indicated adequate fit. All analyses were conducted in Stata version 13 and Mplus version 7.11.

Results

Descriptive statistics are displayed in Table 1. There was strong evidence that longer durations of meditation experience were associated with lower levels of RNT and higher levels of self-compassion and mindfulness (*all p values for tests for trend across categories of meditation experience* < .001). There was strong evidence that RNT levels in meditators with

Table 1 Demographic and descriptive characteristics

Variable	Observations	Missing	<i>n</i> (%), mean (SD), or median (IQR)
Age (years) – mean (<i>SD</i>)	1281	0	44.7 (13.9)
Sex	1275	6 (0.5%)	
Female			688 (53.7%)
Education	1263	18 (1.4%)	
Completed a university degree			931 (72.7%)
Religion	1249	32 (2.5%)	
Religious			787 (61.4%)
Continent of residence	1244	37 (2.9%)	
Europe			454 (35.4%)
Asia			396 (30.9%)
North America			291 (22.7%)
Australia and New Zealand			78 (6.1%)
South America			17 (1.3%)
Africa			8 (0.6%)
Meditation practice variables	1281	0	
Meditation experience (years) – median (<i>IQR</i>)			6 (2 to 13)
<2 years – median (<i>IQR</i>)	270		0.7 (0.3 to 1)
2 to <5 years – median (<i>IQR</i>)	270		3 (2 to 4)
5 to <10 years – median (<i>IQR</i>)	274		7 (5 to 8)
10 to <20 years – median (<i>IQR</i>)	261		12 (10 to 15)
≥20 years – median (<i>IQR</i>)	206		30 (23 to 39)
Starting age (years) – mean (<i>SD</i>)			34.9 (12.6)
Session frequency (per week) – mean (<i>SD</i>)			10.1 (6.6)
Session length (minutes) – mean (<i>SD</i>)			27 (16)
Retreat experience			800 (62.5%)
Meditation types ^a		0	
Attentional			1052 (82.1%)
Deconstructive			692 (54.0%)
Constructive			443 (34.6%)
Repetitive negative thinking – mean (<i>SD</i>) ^b	1281	0	22.6 (9.6)
Mindfulness – mean (<i>SD</i>) ^b	1281	0	3.7 (0.7)
Self-compassion – mean (<i>SD</i>) ^b	1281	0	3.6 (0.6)

SD, standard deviation; *IQR*, inter-quartile range

All statistics are *n* (%) unless otherwise specified

^a The total percentage exceeds 100% as almost half of meditators (47.5%) practiced more than one meditation type

^b Repetitive negative thinking was measured by the Perseverative Thinking Questionnaire (possible range: 0 to 60). Self-compassion was measured by the Self-Compassion Scale (possible range: 1 to 5). Mindfulness was measured by the Mindsens (possible range: 1 to 5)

2 to <5 years of experience were lower than in meditators with <2 years of meditation experience (-3.56 , 95% CI $[-5.13, -1.99]$, Cohen's $d = 0.37$). The pattern of results was similar for self-compassion and mindfulness and for analyses adjusting for age, sex, and education as possible confounding variables (Table 2).

There was strong evidence that longer durations of meditation experience were associated with lower levels of RNT in both the attentional group (p value for test for trend < 0.001) and the non-attentional group (p value for test for trend =

0.003) but that the relationship between meditation experience and RNT differed according to meditation type (p value for interaction = 0.009). Differences in RNT between attentional and non-attentional groups for all meditation experience categories are presented in Table 3 and graphically shown in Fig. 1.

Confirmatory factor analyses were conducted for each latent construct derived from the parcels of the PTQ, SCS, and Mindsens separately, as well as for the full measurement model, with results suggesting that the observed data supported

Table 2 Associations between meditation experience and repetitive negative thinking, self-compassion, and mindfulness

Meditation experience	mean (SD)	Unadjusted model		Adjusted model ^a	
		Estimated difference [95% CI]	<i>p</i> value for tests for trend across categories of meditation experience	Estimated difference [95% CI]	<i>p</i> value for tests for trend across categories of meditation experience
Repetitive negative thinking^b					
<2 years	26.9 (9.4)	–	–	–	–
2 to <5 years	23.4 (9.4)	–3.56 [–5.13, –1.99]	<0.001	–3.74 [–5.33, –2.15]	<0.001
5 to <10 years	21.6 (9.7)	–5.31 [–6.87, –3.74]		–5.54 [–7.13, –3.95]	
10 to <20 years	19.9 (9.7)	–7.02 [–8.60, –5.43]		–7.33 [–8.98, –5.68]	
≥20 years	20.6 (7.9)	–6.27 [–7.96, –4.58]		–7.45 [–9.36, –5.53]	
Self-compassion^b					
<2 years	3.3 (0.6)	–	–	–	–
2 to <5 years	3.6 (0.6)	0.24 [0.14, 0.34]	<0.001	0.21 [0.11, 0.31]	<0.001
5 to <10 years	3.6 (0.6)	0.28 [0.18, 0.38]		0.24 [0.14, 0.34]	
10 to <20 years	3.8 (0.6)	0.43 [0.33, 0.53]		0.37 [0.26, 0.47]	
≥20 years	3.9 (0.5)	0.54 [0.44, 0.65]		0.42 [0.30, 0.55]	
Mindfulness^b					
<2 years	3.4 (0.6)	–	–	–	–
2 to <5 years	3.6 (0.6)	0.26 [0.16, 0.37]	<0.001	0.25 [0.14, 0.35]	<0.001
5 to <10 years	3.6 (0.6)	0.27 [0.17, 0.38]		0.25 [0.14, 0.35]	
10 to <20 years	3.8 (0.7)	0.43 [0.33, 0.54]		0.39 [0.28, 0.50]	
≥20 years	4.0 (0.6)	0.69 [0.57, 0.80]		0.60 [0.47, 0.72]	

SD, standard deviation; *CI*, confidence interval

^a Adjusted for age, sex, and education ($n = 1257$)

^b Repetitive negative thinking was measured by the Perseverative Thinking Questionnaire (possible range: 0 to 60). Self-compassion was measured by the Self-Compassion Scale (possible range: 1 to 5). Mindfulness was measured by the Mindsens (possible range: 1 to 5)

single-factor solutions for RNT, self-compassion, and mindfulness. In other words, each set of three parcels was judged to meaningfully capture its respective latent construct (all factor loadings >0.81 and associated with $p < .001$). Three fit indices suggested that the measurement model had an excellent fit (CFI = 0.99, TLI = 0.98, RMSEA = 0.06, 90% CI [0.05, 0.07]), while the sample size dependent chi-square test statistic indicated less than adequate fit (chi-square test = 139.31,

degrees of freedom = 24, $p < .001$). Overall, the measurement model was judged to be adequate to proceed with structural modelling.

Results from the GSEM including all standardised direct, indirect, and total effects, and proportions, and their accompanying 95% confidence intervals are shown in Table 4. There was strong evidence for a unique indirect effect via self-compassion ($\beta = -0.12$, 95% CI [–0.16, –0.08], $p < .001$).

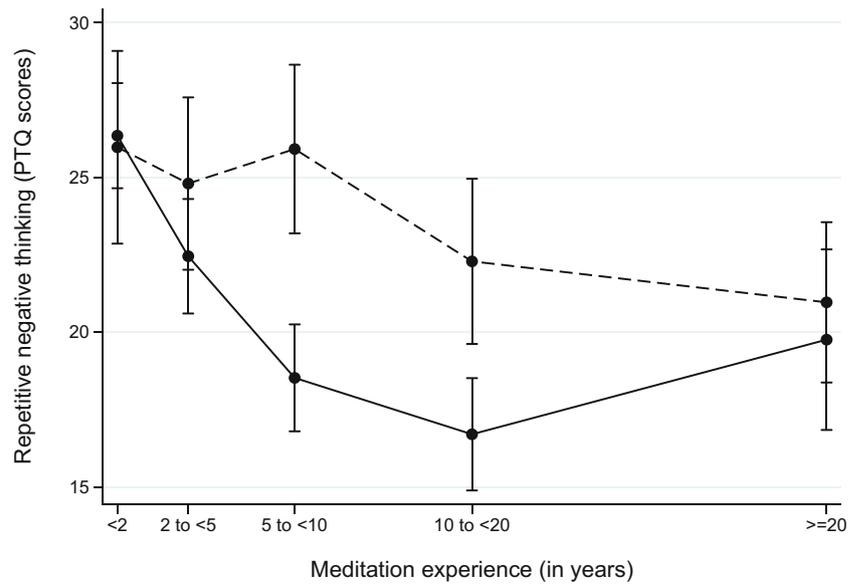
Table 3 Association between meditation experience and repetitive negative thinking by meditation type

Meditation experience	Attentional type		Non-attentional type		Unadjusted model		Adjusted model ^a	
	<i>n</i>	mean (SD)	<i>n</i>	mean (SD)	Estimated group difference [95% CI]	Overall interaction <i>p</i> value	Estimated group difference [95% CI]	Overall interaction <i>p</i> value
<2 years	121	26.3 (9.5)	36	26.0 (10.7)	–0.37 [–3.92, 3.17]	0.009	–0.58 [–4.13, 2.96]	0.018
2 to <5 years	102	22.5 (9.5)	45	24.8 (10.7)	2.35 [–0.99, 5.69]		2.19 [–1.23, 5.61]	
5 to <10 years	117	18.5 (9.6)	47	25.9 (10.0)	7.39 [4.17, 10.62]		6.86 [3.61, 10.12]	
10 to <20 years	106	16.7 (9.8)	49	22.3 (9.0)	5.59 [2.36, 8.81]		4.83 [1.51, 8.15]	
≥20 years	41	19.8 (8.3)	52	21.0 (7.5)	1.21 [–2.70, 5.11]		0.91 [–3.10, 4.93]	

SD, standard deviation; *CI*, confidence interval

^a Adjusted for age, sex, and education

Fig. 1 Association between meditation experience and repetitive negative thinking by meditation type. The group practicing attentional meditation types only ($n = 487$) is represented by the solid line. The group practicing non-attentional meditation types only ($n = 229$) is represented by the dotted line. The vertical bars represent 95% confidence intervals. *PTQ*, Perseverative Thinking Questionnaire



However, the model did not provide evidence for a unique indirect effect via mindfulness ($\beta = 0.004$, 95% CI [-0.018, 0.025], $p = 0.743$). The structural model accounted for 9% of the variance in self-compassion, 12% in mindfulness, and 33% in RNT (overall $R^2 = 0.15$). Figure 2 displays the path diagram of the structural model with all standardised path coefficients. The structural model displayed excellent fit (CFI = 0.99, TLI = 0.98, RMSEA = 0.05, 90% CI [0.04, 0.06]). Results were supported by a sensitivity analysis that included sex and education as additional covariates in the GSEM.

Discussion

Using a sample of over one thousand regular meditators this study provided evidence that more meditation experience (years of regular practice) is associated with lower levels of RNT and higher levels of self-compassion and mindfulness. RNT was the focus of this study because it is implicated in the development and maintenance of several mental health

disorders (Ehring and Watkins 2008), it is a potential psychological risk factor for dementia (Marchant and Howard 2015), and because it presents a promising treatment target (Topper et al. 2010). Previous research indicated that meditation can reduce levels of worry and rumination (e.g. Gillani and Smith 2001; Jain et al. 2007) but evidence on the relationship between meditation practice and transdiagnostic, time-independent measures of repetitive negative thought had been lacking. Also, previous cross-sectional research on meditators using psychological outcomes focused mostly on group comparisons between meditators and non-meditators (e.g. Josefsson et al. 2011; Nielsen and Kaszniak 2006; Soler et al. 2014) or, when explicitly assessing the extent of meditation experience, used a mixed sample of meditators and non-meditators (e.g. Baer et al. 2012; Baer et al. 2008; Lykins and Baer 2009). Our findings complement the transdiagnostic and meditation literature by showing that even within a population of regular meditators, there is clear evidence for a dose-response relationship between meditation experience and RNT, self-compassion, and mindfulness. This points to regular meditation practice as a potential lifestyle aspect that could

Table 4 Standardised direct, indirect, and total effects from mediation model for the relationship between meditation experience and repetitive negative thinking

Pathway	Meditation experience to mediator [95% CI]	Mediator to repetitive negative thinking [95% CI]	Indirect effect [95% CI]	Proportion of total effects [95% CI]
Via Self-compassion	0.21 [0.15, 0.27]	-0.57 [-0.64, -0.51]	-0.12 [-0.16, -0.08]	54% [37%, 71%]
Via Mindfulness	0.29 [0.23, 0.34]	0.01 [-0.06, 0.09]	0.004 [-0.018, 0.025]	-2% [-11%, 8%]
Total indirect	-	-	-0.12 [-0.16, -0.08]	52% [35%, 69%]
Total direct	-	-	-0.11 [-0.17, -0.05]	48% [31%, 65%]
Total effect	-	-	-0.23 [-0.29, -0.16]	100%

CI confidence interval

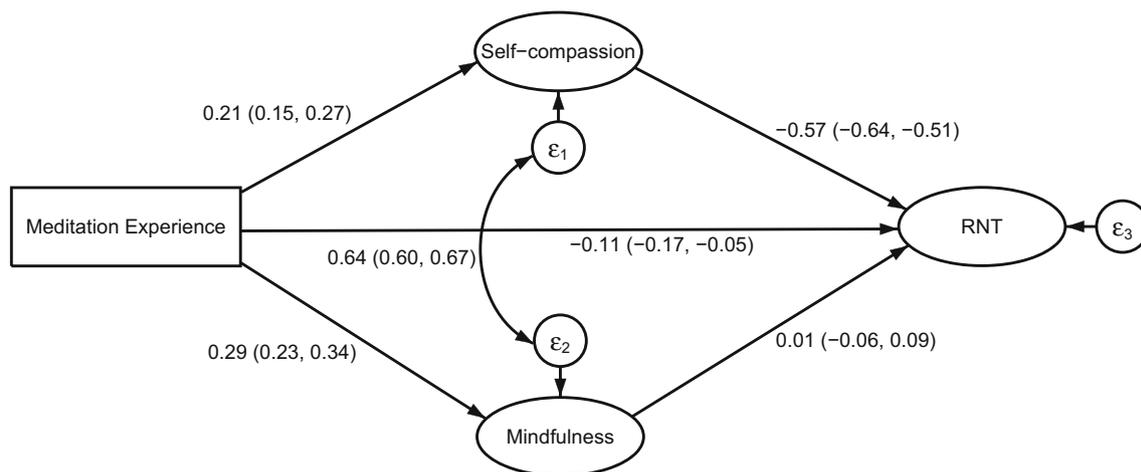


Fig. 2 Generalised structural model for the relationship between meditation experience, self-compassion, mindfulness, and repetitive negative thinking. Pathways are represented by straight single-headed arrows and covariance by curved two-headed arrows. Observed variables, unobserved variables, and error terms are represented by rectangular, oval, and circular shapes, respectively. To simplify the interpretation of structural estimates, all the displayed path coefficients, covariance estimates, and their accompanying 95% confidence intervals are standardised. Self-compassion, mindfulness, and repetitive negative thinking were modelled as unobserved variables derived from parcels of

the items of the Self-Compassion Scale, Mindsens, and Perseverative Thinking Questionnaire, respectively. Self-compassion and mindfulness were modelled as not causally related. However, the covariance between the two constructs was not expected to be completely explained by their antecedent variable. Therefore, the unexplained variance in self-compassion was assumed to be correlated with the unexplained variance in mindfulness. Parcels, their error variances, and the covariate (age) are not presented. Model fit was good: CFI = 0.99, TLI = 0.98, RMSEA = 0.05. RNT, repetitive negative thinking. ϵ , error

contribute to the reduction and prevention of heightened levels of RNT that are present in a wide range of mental health problems in both healthy and clinical populations (Ehring and Watkins 2008).

The relative importance of self-compassion and mindfulness as mediators of the relationship between meditation experience and RNT was specifically investigated. Self-compassion partially mediated the relationship between meditation experience and RNT. Importantly, mindfulness did not contribute to the mediation process. The absence of a unique mediating role of mindfulness is a surprising finding in the light of the extensive research literature that has focussed primarily on mindfulness as the core construct underlying the putative health benefits of meditation and meditation-based interventions (e.g. Gotink et al. 2015; Gu et al. 2015). The nature of our data limits the extent to which definite reasons for this absence can be drawn out. Nonetheless, we would like to tentatively suggest three potential explanations. Firstly, the Mindsens might not capture the facets of mindfulness that are related to a reduction of RNT when self-compassion is simultaneously considered in the model. Secondly, mindfulness, as conceptualised here, might not play as important a role in reducing RNT in non-clinical, meditating populations as it is purported to do in clinical populations and non-clinical populations with high levels of RNT. Thirdly, non-reacting, observing, and decentering – the mindfulness facets comprised by the Mindsens – may be less central for explaining the relationship between meditation experience and RNT than the qualities of self-compassion elaborated upon in

the introduction. While appreciating these alternative explanations, our results suggest that self-compassion is the more important construct for predicting RNT in regular meditators. Clinically, promoting self-compassion could be a particularly valuable treatment target that should be considered in the development of future studies aimed at reducing or preventing heightened levels of RNT. Related theoretical models have purported that self-compassion affects depression and anxiety by impacting levels of RNT (e.g. Allen and Knight 2005; Leary et al. 2007) and self-compassion has even been proposed as a resilience mechanism protecting individuals against psychopathology more generally (Muris and Petrocchi 2017; Trompeter et al. 2017).

In general, self-compassion has been much less researched than mindfulness, and has only more recently been examined in combination with mindfulness to predict psychological outcomes. For example, related research using a non-meditating, help-seeking community sample found self-compassion to be a much stronger predictor of worry, depression, and anxiety than mindfulness (Van Dam et al. 2011). In contrast, Baer et al. (2012) found that both self-compassion and mindfulness facets contributed similarly to mediating the relationship between meditation experience and psychological well-being in a mixed sample of meditators and non-meditators. In two cross-sectional studies in non-meditating, non-clinical samples both mindfulness and self-compassion contributed to predicting psychological well-being (Hollis-Walker and Colosimo 2011) and depression (Soysa and Wilcomb 2015). Our findings expand this nascent literature and underline the

value of considering self-compassion in research on RNT, meditation, and meditation-based interventions. Recently, programmes have been designed to explicitly cultivate self-compassion including Compassion Focused Therapy (Gilbert 2014) and Mindful Self-Compassion (Neff and Germer 2013), which could present promising candidate interventions for reducing RNT.

Regarding the conceptual relationship between RNT and self-compassion, it is interesting to note that meditation practices – including (self-)compassion practices – can be conceived of as training in helpful ways of seeing and relating to experience (Burbea 2014). For instance, the repetitive engagement of self-compassionate ways of seeing could be described as the re-habituation of the mind from maladaptive habit patterns (e.g. RNT, self-judgment) to more adaptive ones (e.g. self-kindness) and thus, with practice, turning meditation-induced intentions and states into enduring traits. Alternatively, through cultivating the ability to receive – or even welcome – phenomena with self-compassion, the intrusiveness and the pervasive cognitive and affective content of RNT may be reduced. Here, we propose that framing self-compassion as a process that weakens RNT could benefit future clinical research and inform the ongoing Buddhism-science dialogue (Hasenkamp 2019).

Our exploratory analyses offer preliminary empirical evidence for a novel theoretical framework for categorising meditation practices based on their central cognitive mechanisms (Dahl et al. 2015). A particular strength of this threefold taxonomy – comprising attentional, constructive, and deconstructive practices – lies in its potential to generate first- and third-person hypotheses for a wide range of research domains spanning cognitive science, neuroscience, clinical psychology, and (neuro)phenomenology. Here, we explored whether reductions in RNT would be most closely associated with attentional practices because these practices are purported to primarily cultivate meta-awareness, i.e. the ability to be aware of thoughts, feelings, perceptions without becoming strongly absorbed in their content. In line with this theory, our findings indicate that meditators who only engaged in attentional types showed, overall, lower levels of RNT than meditators who did not engage in any attentional types. When taking meditation experience into account, the attentional group displayed lower levels of RNT only between 5 to <20 years of meditation experience, but no differences were found for less than 2 or more than 20 years of meditation experience. One potential interpretation of this finding is that attentional types seem to affect levels of RNT sooner, but in the long-term the effects of both attentional and non-attentional meditation types on RNT converge. Importantly, this differential effect would also be predicted by the threefold taxonomy in which non-attentional types are conceptualised to also strengthen meta-awareness, although more indirectly and to a lesser extent than attentional

types and, thus, requiring more time to be effective in reducing RNT (Dahl et al. 2015).

Limitations and Future Research

The present study has several important limitations. The cross-sectional nature of this study does not allow clear causal inferences to be drawn. A more convincing demonstration of causality requires, at a minimum, the ability to detect if changes in the explanatory and mediator variables precede changes in the outcome variable. The results of the GSEM should therefore be interpreted with caution. However, given that the mediational hypothesis was grounded in a clear theoretical framework based on previously published empirical data, we believe that a cross-sectional mediation analysis was justifiable. Nonetheless, future longitudinal studies – although they are subject to the constraints mentioned below – that track measures of self-compassion, mindfulness, and RNT, as well as potential treatment moderators in individuals who start a regular practice, would help to draw firmer conclusions about the direction of the relationship between self-compassion and RNT. Further, despite the large sample size and the psychometric strength of the employed measures, demand characteristics may still have inflated the association between variables as only a single method of data collection was used (i.e. the internet), which relied entirely on self-report. Relatedly, our findings may be more a reflection of the measures employed rather than the constructs that they were intended to operationalise. The sample was nonclinical and highly educated with almost three-quarters of participants having received a university degree. Future studies should examine to what degree our findings generalise to clinical and socio-demographically more diverse samples. Additionally, the present results indicate a direct association of meditation experience with RNT and do not imply that self-compassion is the only mediator of this relationship. Other candidate mediators might include self-criticism, self-esteem, and sense of mastery (Allen and Knight 2005; Kannan and Levitt 2013).

One should be cautious in assuming that any observed cross-sectional differences can be attributed to the long-term practice of meditation. Given that the commitment to dedicate a large proportion of one's life to meditation is likely to be associated with a set of potentially rare individual predispositions, self-selection bias remains an important consideration when interpreting results. To date, no long-term longitudinal studies – preferably utilising randomised designs with an active control condition – have been conducted. Despite their promise of demonstrating causal relations, such long-term longitudinal studies are significantly limited by feasibility constraints. Attrition rates may be high and funding constraints will likely demand intervention periods that would seldom exceed a couple of years. For example, the ongoing international Silver Santé Study includes a randomised trial

that allocates a proportion of participants to 18 months of meditation training – the longest meditation intervention conducted to date (Poinsel et al. 2018). In the light of these financial and methodological constraints, cross-sectional investigations such as the present study – especially when carefully controlling for important confounding variables (e.g. diet, exercise, personality, worldview) – will continue to be valuable to meditation research.

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Data Availability All data are available at the Open Science Framework (<https://osf.io/uq46g/>).

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