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Mindfulness mechanisms and psychological effects for aMCI patients: A comparison with psychoeducation

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ABSTRACT

Amnestic mild cognitive impairment (aMCI), an Alzheimer's disease prodrome, is characterized by cognitive and psychological symptoms, the latter aggravating prognosis. A mindfulness-based intervention (MBI) represents a promising non-pharmacological framework for Alzheimer's disease prevention. The Monitoring + Acceptance Theory (MAT) postulates that MBI improves cognition through monitoring, and psychological well-being, through acceptance. This single-blind preliminary randomized-controlled study investigated the effects of a MBI on anxio-depressive symptoms, quality of life, and memory, compared to a psychoeducation-based intervention in older adults with aMCI. The contribution of MAT components and of ruminations' reduction to intervention efficacy were examined. Participants assigned to both conditions experienced similar benefits regarding anxio-depressive symptoms and aging-related quality of life. General quality of life and memory remained unchanged. A partial support of the MAT and of ruminations reduction to the MBI's efficacy was found. The findings provide new insights on the effects and mechanisms of a MBI on aMCI symptoms.

1. Introduction

Prevention research is central to Alzheimer's disease (AD) management efforts. Seven modifiable risk factors, including depression and cognitive inactivity, could explain up to 30% of AD cases. A reduction by 10–20% of these factors' incidence could prevent 8.8 to 16.2 million cases worldwide [1] and postponing by merely a year AD diagnosis could reduce its incidence by 10% [2].

Amnestic mild cognitive impairment (aMCI), a probable prodromal phase of AD, includes cognitive deficits that do not significantly alter functioning or autonomy [3,4]. To be identified with aMCI, older adults must present with an episodic memory impairment (with or without deficits in other cognitive domains) but no significant functional deficits. Non-cognitive symptoms such as apathy, irritability, and depressive and anxious manifestations, affect up to 80% of the aMCI population [5,6]. The presence of non-cognitive (or psychological) symptoms increases the risk of further cognitive and functional decline in individuals with aMCI [7–10].

Consequently, aMCI affects quality of life [11–13]. Moreover, living with this condition has been associated with more self-judgment, greater difficulty to accept losses, and stronger emotional reactivity than in healthy cognitive aging [14,15]. Older adults with aMCI also reported pervasive feelings of frustration, depression, and personal inadequacy when experiencing memory lapses [14]. Hence, psychocognitive symptoms threaten one's ability to function within the normal age range or to maintain autonomy, and negatively impact life appreciation. Implementing interventions tailored for people with aMCI and concomitant depressive and anxious symptoms is warranted to sustain functional autonomy and quality of life.

The majority of non-pharmacological intervention studies conducted with aMCI individuals investigated the efficacy of cognitive training, which teaches compensatory or restorative cognitive strategies [16]. Literature supports the efficacy of cognitive interventions for memory (See reviews: [16,17]), but inconsistent effects on depressive and anxious symptoms were found, with the majority of studies showing no effect [see reviews by 16, 18]. While it is encouraging that cognition in aMCI can be ameliorated through cognitive interventions, the amplitude of change is often small and gain maintenance over time is not well established [18]. Furthermore, the absence of generalized benefits to depressive mood and anxious symptoms is preoccupying considering their detrimental repercussions on AD prognosis [8,10]. Secondarily, a meta-analysis recently showed that psychosocial interventions can improve psychological symptoms in aMCI, but do not improve cognition [19]. Therefore, no intervention as of yet consistently showed holistic effects benefiting both psychological and cognitive symptoms of aMCI.

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While dementia differs from aMCI in terms of symptoms' severity, high distress in aMCI was associated with adherence to negative social representations of AD and with an inability to distinguish the actual aMCI state from AD [20]. Facts dissemination about the course and evolution of AD attempts to lessen such confusion, but basic information provided by physicians during medical consultations is insufficient [21]. Thus, in addition to usual care, there is a need in the aMCI population for comprehensive psychoeducation curriculums about cognitive aging and AD pathology [21]. Interestingly, the use of a psychoeducation-based intervention (PBI) showed success in alleviating psychological stress and depression in dementia [22]. Similarly, a PBI led to a reduction of negative emotional reactions towards cognitive decline in older women with cognitive complaints [23]. No previous research supports a PBI's potential to improve cognition in general or memory. Nevertheless, it remains to be demonstrated if PBI's benefits extend to psychological and cognitive symptoms in aMCI.

In a recent critical literature review, the present authors argued in favor of the potential of a mindfulness-based intervention (MBI) to remit psycho-cognitive symptoms in aMCI [24]. Typically, a MBI involves eight weekly group sessions with trained facilitators as well as homework assignments between sessions. The main goal is to develop participants' capacity to live in greater awareness and acceptance of the present moment through mindfulness meditation and attitudes [25]. In mindfulness meditation, participants bring a stable, open, and non-judgmental attention on inner (ex., breath, body sensations) or outer (ex., sounds, feeling of the floor under the feet) experiences with the instructions to avoid as much as possible conceptual thinking and mind-wandering or dulling [25]. The leading-edge Monitoring + Acceptance Theory (MAT) [26] proposes pathways by which a MBI may yield symptoms reduction, such as the one envisioned by Larouche et al. for aMCI [24].

The MAT postulates that monitoring and acceptance skills interact as the main mechanism of a MBI's efficacy to improve stress, affect, cognition, and other health-related outcomes [26]. Accordingly, mindfulness meditation alone builds up the capacity to be aware of moment-to-moment experience, what MAT labels as "monitoring" [26]. The repetition of catching the mind focused on concepts, ruminations or worries, and redirecting it to present moment awareness using executive components of attention [27] is expected to yield cognitive improvements [26]. By supporting the capacity to focus on to-be recalled information with reinforced executive components of attention, repeated mindfulness meditation practice could very well benefit memory in aMCI. Additionally, both MBI's meditation and teachings improve the ability to live in acceptance of experienced suffering, corresponding to MAT's second mechanistic component, thus decreasing stress-related symptomatology and enhancing quality of life [26]. By teaching coping strategies based on acceptance, a MBI could reduce judgment towards the self and against impairments and losses that inevitably come with aging and aMCI [14,15]. It was suggested that increased acceptance and decreased psychopathological symptoms can occur through adaptive emotion regulation strategies that rely less on rumination [26,28]. Indeed, greater self-compassion, an important component of acceptance, appears to account for much of mindfulness's effects on psychopathological symptoms through reduced ruminations [29,30].

So far, only one randomized-controlled trial by Wells, Kerr, Wolkin, Dossett, Davis, Walsh, Wall, Kong, Kaptchuk, Press, Phillips and Yeh [31] examined the effects of Mindfulness-based Stress Reduction, the original MBI program developed by Kabat-Zinn [25], compared to usual care in older adults with aMCI [31]. Participants showed a tendency towards improvement for general cognitive functioning, hope, perceived stress, resilience, quality of life, and mindfulness. Unfortunately, the small sample size (n = 14) prevented detection of statistically significant outcomes on most measures, but promising trends warrant further testing of a MBI's effects in aMCI.

First, this single-blind preliminary randomized-controlled trial aimed at investigating the efficacy of a MBI and a PBI to reduce anxious and depressive symptoms and to improve quality of life in older adults with aMCI. Benefits from both interventions were predicted based on extensive literature with various populations that sustained significant relief from psychopathological symptoms through MBI [for a comprehensive review, see 24] as well as on a previous finding supporting distress alleviation by means of a PBI in demented older adults [22]. Second, the current study investigated the effects of both interventions on memory. Differential impacts were anticipated considering the absence of existing report of memory gains for PBI and the postulated contribution of MBI to attention training [26] that may benefit memory. Third, this study investigated if MAT's assumptions of combined monitoring and acceptance contributions to a MBI's efficacy were supported by the results. Predictions pointed towards a positive association between monitoring and memory performance, on the one hand, and between acceptance and improved depressive/anxious symptoms and quality of life, on the other. No mechanisms of action of the PBI were investigated as no theoretical background was found to support psychological or memory mechanisms. Fourth, the role of ruminations as a mediator of a MBI's efficacy was tested. It was anticipated that a reduction of ruminations would explain a significant proportion of effects in participants that received mindfulness training, but not psychoeducation, coherent with expected gains in emotion regulation capacities [28,30].

2. Materials and methods

2.1. Participants

The present preliminary study is an active-controlled randomized trial with an allocation ratio of 1:1. At study entry, forty-eight older adults with aMCI between 56 and 87 years of age were randomly assigned to the two trial conditions. To detect an effect, a minimum of 40 participants was determined based on *a priori* power analyses conducted on Wells et al. [31] data using G*power, with power (1 - β) set at 0.80 and $\alpha = 0.05$, two-tailed [32]. Two waves of recruitment led to the formation of two cohorts of 24 participants each. From the initial 48, forty-five demonstrated interest in the clinical trial and attended at least one session. These participants were included in the demographic and neuropsychological profile characterization analyses and in the main group comparison analyses. Forty-one participants remained engaged in the intervention protocol for the eight weeks, all attending more than five intervention sessions, and were included in the analyses investigating the mechanisms of change in an "as treated" protocol [33]. In sum, the study examined data from 23 participants in the MBI condition and 22 in the PBI condition in the case of "intent-to-treat" analyses, and from 20 MBI and 21 PBI participants in "as treated" analyses. Fig. 1 presents a flowchart including reasons for participants' withdrawal from the research.

At screening, exclusion criteria were self-reports of: history of neurological disease, traumatic brain injury, intracranial surgery, or stroke; current psychiatric illness according to the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5) [34] criteria; substance abuse in the last 12 months; general anesthesia or oncologic treatment in the past six months; uncorrected vision or hearing impairments; untreated or unstable metabolic condition (e.g., Type 2 diabetes, hypothyroidism); recent treatment that may impact cognition; recent or sustained meditative experience; and anticipated unavailability to attend one or more of the first four intervention sessions.

Participants with aMCI met the following criteria: (a) complaint about cognitive changes expressed by the patient, a relative, or a clinician; (b) objective impairment in one or more cognitive domains, including at least episodic memory, with a performance under −1.5 standard deviation based on local norms [35]; (c) preserved overall functional autonomy; and (d) absence of dementia [4,36]. Episodic memory was considered impaired in this study when there were altered performance on at least two task trials (free and/or free + cued recall).

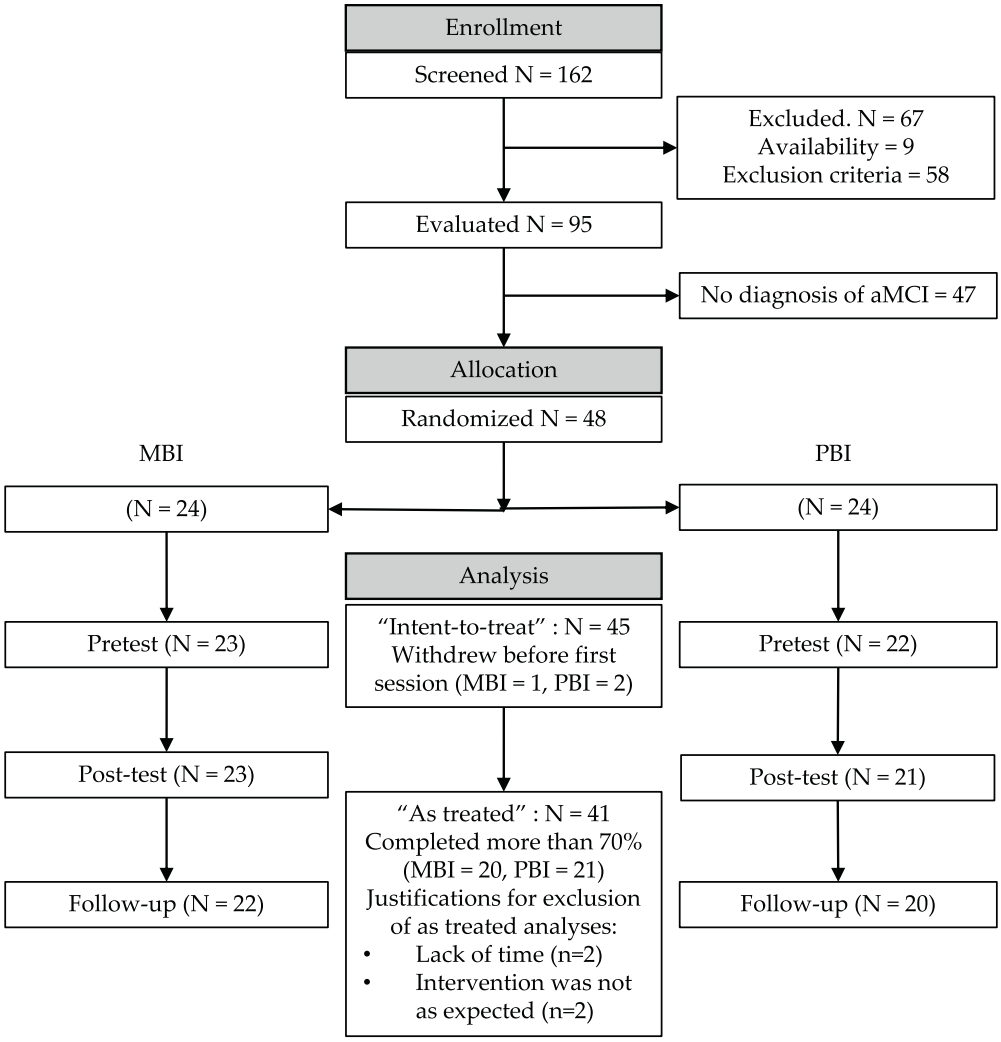

Fig. 1. Flowchart of participants' inclusion. MBI = Mindfulness-based intervention; PBI = Psychoeducation intervention.

Diagnosis of aMCI was validated in consensus meetings supervised by two licensed neuropsychologists. The project was reviewed and approved by the Ethics Research Board of the *Institut universitaire en santé mentale de Québec* (IUSMQ #398). The study was not registered as a clinical trial to the National Institute of Health.

2.2. Materials

2.2.1. Clinical and neuropsychological battery

A complete clinical and neuropsychological battery was administered to participants to verify inclusion/exclusion criteria. Results of this assessment are provided in Table 1. The presence of an objective cognitive impairment was determined based on normative data. General cognitive functioning and cognitive complaint were evaluated using the Montreal Cognitive Assessment (MoCA) [37,38] and the *Questionnaire de plainte cognitive* [39], respectively. Verbal episodic memory was assessed with the *Test de rappel libre/rappel indicé à 16 items* (RL/RI-16) [40] and semantic memory, with the Pyramids and Palm Trees Test [41], for which Dion, Potvin, Belleville, Ferland, Renaud, Bherer, Joubert, Vallet, Simard, Rouleau, Lecomte, Macoir and Hudon [35] and Callahan, Macoir, Hudon, Bier, Chouinard, Cossette-Harvey, Fradette, Gagnon and Potvin [42] normative data were used, respectively. The Rey-Osterrieth Complex Figure Test [43,44] targeted both visuo-constructive abilities with the copy, and visual episodic memory with the immediate recall condition after 3 min, normality being based on Tremblay, Potvin, Callahan, Belleville, Gagnon, Caza, Ferland, Hudon and Macoir [45]. Visuo-perception was measured with the size-match task from the Birmingham Object Recognition Battery [46] and processing speed, with the Coding subtest from the WAIS-III [47]. Language was tested by the 15-item Boston Naming Test [48] and the phonemic (T-N—P) and semantic (animals) fluency tests [49], the latter normalised by St-Hilaire, Hudon, Vallet, Bherer, Lussier, Gagnon, Simard, Gosselin, Escudier, Rouleau and Macoir [50]. Executive functioning was inferred from the D-KEFS version of the Stroop [51].

2.2.2. Primary outcomes

The 30-item version of the Geriatric Depression Scale (GDS) was used to measure interventions' impacts on depressive symptoms [52]. The GDS was validated with older adults with cognitive impairment [53] and was granted good psychometric properties, no matter the presence of cognitive impairment or not [54]. The French-validated version [55] was used in the present protocol. For each item, participants indicated if the described situation corresponded or not to how they felt in the past week. Scores ranged between 0 and 30.

The 20-item version of the Geriatric Anxiety Inventory (GAI) evaluated the effects of interventions on anxiety symptoms [56]. It was validated for use in older adults with aMCI [57,58]. The French-validated version was used [59]. For each item, participants indicated if they agreed or not with statements describing how they could have felt in the past week. Scores ranged between 0 and 20.

General quality of life (gQOL) was measured using the 26-item World Health Organisation Quality of Life Brief scale (WHOQOL-Brief)

Table 1
Mean (standard deviation) Z-scores or values for sociodemographic, clinical and neuropsychological variables for the two conditions of intervention.

	Instrument	MBI		PBI		*t* value	df	*p*
		n	Mean (SD)	n	Mean (SD)			
Sociodemographic characteristics								
Age (years)		23	71.4 (7.7)	22	70.5 (5.6)	-.44	43	.659
Education (years)		23	13.8 (2.8)	22	14.1 (3.3)	.29	43	.773
Sex (% male) ‡		23	61%	22	55%	.18	1	.668
General cognitive functioning and complaint								
Complaint (/10)	CCQ	23	5.6 (2.4)	22	4.7 (2.2)	−1.26	43	.214
General cognition (/30)	MoCA test	23	24.3 (2.7)	22	24.3 (2.5)	-.04	43	.970
Episodic verbal memory								
Free recall 1	16-word free and cued recall	23	−1.37 (1.05)	22	−1.14 (1.05)	.72	43	.475
Free recall 2		23	−1.39 (1.37)	22	−1.10 (1.36)	.70	43	.489
Free recall 3		23	−1.38 (0.87)	22	−1.68 (1.18)	-.98	43	.332
Delayed recall		23	−1.72 (1.35)	22	−1.82 (1.83)	-.21	43	.832
Episodic visual memory								
Visual memory	Rey-Osterrieth Complex Figure task	23	0.28 (1.60)	22	−0.41 (1.76)	−1.37	43	.178
Semantic memory								
Semantic (% normal)	PPTT	13	100%	9	100%	–	–	–
Verbal fluency								
Lexical	T-N−P fluency	23	−0.56 (0.74)	22	−0.69 (0.99)	-.49	43	.628
Semantic	Animal fluency	23	−0.41 (0.78)	22	−0.35 (1.38)	.20	43	.841
Confrontation naming								
Spontaneous	15-items Boston naming test	23	0.01 (0.74)	22	−0.11 (0.85)	-.51	43	.610
Total		23	0.14 (0.77)	22	−0.06 (0.77)	-.86	43	.393
Visual functions								
Construction	Rey-Osterrieth Complex Figure task	23	−0.69 (1.35)	22	−0.93 (1.19)	-.64	43	.527
Perception	BORB circles	23	−0.12 (0.84)	21	−0.11 (1.16)	.05	42	.958
Executive functions								
Inhibition time	Stroop D-KEFS	23	−0.19 (1.07)	21	−0.03 (1.14)	.47	42	.640
Switching time		22	0.03 (1.12)	21	−0.17 (1.31)	-.55	41	.584
Inhibition errors		23	0.09 (0.87)	21	0.02 (0.99)	-.26	42	.799
Switching errors		22	−0.23 (1.12)	21	−0.13 (1.10)	.32	41	.754
Processing speed								
Substitution	Code WAIS-III	23	0.09 (0.71)	22	−0.20 (0.81)	−1.25	43	.219

Notes. Standardized Z scores are presented for variables when no value is indicated at the end of the variables name. ‡ Chi-square analysis. n = number of observations; MBI = Mindfulness-based intervention; PBI = Psychoeducation-based intervention; dfd = Degrees of freedom denominator; SD = Standard deviation; BORB = Birmingham Object Recognition Battery; CCQ = Cognitive Complaint Questionnaire; D-KEFS = Delis-Kaplan Executive Function System; MoCA = Montreal Cognitive Assessment; PPTT = Pyramids and Palm Trees Test; WAIS = Weschler Adult Intelligence Scale.

[60]. In this questionnaire, participants must indicate for each item how they feel about the statements at the present time. Satisfaction with physical and psychological health, social relationships, and the environment is the focus. The questionnaire was validated with older adults [61] and was used in the present study in its French version [62]. For each item, participants expressed their response to the statement on a 5-point Likert scale. Each item was coded from 0 to 4, for a total score ranging from 0 to 104.

The 24-item World Health Organisation Quality of Life Old scale (WHOQOL-Old) allowed for sizing interventions' effects on aging-related quality of life (arQOL) [63]. The original version of the questionnaire is in French. For each item, participants indicated their response to the statements on a 5-point Likert scale. The questionnaire comprises five aspects of quality of life evaluating the participant's sensory capacities, autonomy, feeling of life fulfillment, current occupation level, relation to death and suffering, and current satisfaction with intimacy. Each item was coded from 0 to 4 for a total score ranging from 0 to 96.

A free recall (word list) verbal episodic memory task was adapted from Moulin, James, Freeman and Jones [64] to measure the effects of interventions on episodic memory. Three semantically equivalent lists of 15 words were created to be learned and recalled at each time of measurement (more details on the word lists can be provided on request). The three lists were presented in a random order to the participants. The selected words were equivalent in terms of three psycholinguistic parameters based on Omnilex Database [65]: subjective frequency, length, and imagery level. Words were composed of two syllables bearing high subjective frequency and imagery level (ex.: *Canard*, *Chapeau*, *Raisin*, *Laitue*, etc.). Each administration of the task included three immediate recall trials and a delayed recall trial after 20 min. The test was administered on E-Prime 2.0 (Psychology Software Tools) and for each immediate recall trial, the words were shown for 3 s on a computer screen, with a 0.5 s delay between items. Participants were asked to read aloud the words on the screen with the instruction to memorize as many words as they could. Between the presentation of the 15 words and the recall trials, participants were asked to count backwards from 100 for 20 s to prevent subvocal repetition of the items. Participants completed questionnaires during the delay between the last immediate free recall trial and the delayed recall trial. The score for immediate recall corresponded to the sum of the three successive trials and ranged between 0 and 45. The score for delayed recall ranged between 0 and 15 recalled words.

2.2.3. Secondary outcomes

The 22-items Ruminative Response Scale (RRS) was used to assess changes in ruminations as a mechanism of action of the interventions [66]. For each item, participants indicated at which frequency the statement applies to them when they feel depressed. Each item was coded from 1 to 4, for a total score ranging between 22 and 88.

The Five-Facet Mindfulness Questionnaire (FFMQ) (Baer et al.,

2006) aimed at assessing mindfulness as a mechanism of action of the interventions and was used in its validated French version (Heeren et al., 2011). This 39-item questionnaire provides five facet scores and a total mindfulness trait score when summed. The five facets are observation, description, mindful action, non-reactivity, and non-judgment. In the perspective of testing the MAT (Lindsay & Creswell, 2017), acceptance was measured by the non-judgment and non-reaction subscales of the FFMQ and monitoring, by the observation subscale. Each item was coded from 1 to 5, with a score ranging between 8 and 40 for all subscales, except for non-reaction where the score ranged between 7 and 35. The total score of the FFMQ ranged between 39 and 195.

2.3. Interventions

Participants were randomly assigned to one of two intervention programs. Both programs comprised eight sessions of two and a half hours, which were administered to groups of 10–12 participants. Both interventions were built with similar structures, including segments on education about weekly themes, segments where participants completed concrete exercises, and segments allocated for group discussions.

The MBI was based on Kabat-Zinn's Mindfulness-Based Stress Reduction [25], and Segal, Williams, and Teasdale's (2002) Mindfulness-Based Cognitive Therapy. It also incorporated tools and exercises from other sources [67–69]. On top of accommodations already reported in mindfulness studies with older adults, such as shorter group meditation duration, no full-day retreat, and shorter home practices [70], the authors proceeded to minor adaptations of the program to meet the specificities of aMCI. The main changes made were grouped under three themes, namely being more concrete (i.e. rely on more visual content for explanations, use imagination-striking examples to solicit responses, provide continuous verbal guidance during group and at-home meditative practices), foster commitment through weekly phone calls, and facilitate active participation (i.e. schedule guided meditation in first half of group meetings when concentration is better, encourage personal adjustments to practices such as allowing temporarily movement in a body part where sensations appear absent during early sessions of bodyscan). The essence and goals of leading mindfulness programs were respected. Every session comprised a guided meditation, group discussions on meditation and home practices, and psychoeducation about mindfulness themes along with stress management and obstacles (Week 1: autopilot vs. mindfulness; Week 2: handling obstacles and supporting meditation practice efforts; Week 3: wandering mind; Week 4: acknowledging stress and its impact of one's life to better manage it; Week 5: reflecting on how one could live in increased acceptance of one's situation; Week 6: the role thoughts play in the maintenance of distress and stress; Week 7: how to take better care of oneself; Week 8: sustaining a meditation practice beyond the program). Participants were asked to complete at-home formal meditation practices six days a week in addition to daily informal practices (for instance, eating one meal a day mindfully). They were required to record compliance to instructions in weekly paper calendars, designed to be explicit and simple of use (e.g. circle an X for every practice performed). Because formal practices were all performed with provided audio recordings, duration was standardized. Weekly phone calls were made to ensure that participants understood the assignments and remained motivated throughout the program. Details on the program have been presented at an international conference [71] and are published in a collective manual about mindfulness [72].

The MBI program was co-facilitated by S. Goulet, and post-graduate psychology students E. Larouche, and/or A.-M. Chouinard. All were trained by Dr. Claude Fournier, a well-respected MBCT instructor in Quebec City area. S. Goulet was also trained in MBSR at Omega Institute (New York, USA) by Jon Kabat-Zinn and Saki Santorelli, in Mindfulness-Based Cancer Recovery (MBCR) at the Tom Baker Cancer Centre (University of Calgary, CA) by Linda Carlson, Michael Speca, and Shirley McMillan, and in MBCT at the CSSSVC (Quebec, CA) by Lucille Shaw and Ginette Dostie.

The PBI [73] was based on recent literature on aging and on a popular book about healthy aging [74] (Week 1: normal vs. pathological cognitive aging; Week 2: dementia continuum and types of dementia; Week 3: memory function and other cognitive issues in aMCI; Week 4: AD risk factors and pharmacological treatments; Week 5: medical follow-ups and discussions with physicians about cognitive concerns; Week 6: relationships and discussions about cognitive decline with close relatives; Week 7: everyday living with cognitive decline and coping with difficulties; Week 8: what to do next with all the new knowledge participants acquired in the program). The PBI excluded all forms of memory training or mindfulness/relaxation practices and did not require any home practice. Every session comprised psychoeducation about the weekly theme, reflecting about one's situation with the help of exercises, and group discussions on the theme. Weekly phone calls were made to answer participants' questions, to inquire about their experience, and to sustain motivation. The PBI was co-facilitated by A. Parent and post-graduate students E. Larouche, A.-M. Chouinard, and/or V. Morin-Alain, who underwent training in clinical neuropsychology and were supervised by Professor C. Hudon, a licensed neuropsychologist.

2.4. Procedure

Participants were recruited from the community through newspaper advertising, brochures available in local clinics, or referred directly by local physicians suspecting cognitive decline (two participants in the latter case). A research professional in charge of recruitment contacted all potential participants to ensure they did not meet exclusion criteria presented in the Participants section. If no exclusion criteria were present at this stage, all were invited to meet a trained evaluator at the CERVO Brain Research Centre to obtain written informed consent and to undertake the complete clinical and neuropsychological assessment (see above). Conducting the same complete assessment by the same research professionals ensured reliability of the diagnosis and of the cognitive profile of participants recruited. Participants meeting the aMCI criteria were invited to join the project and scheduled for a pre-intervention evaluation.

The 48 participants who went through randomization, in two separate cohorts of 24 participants, completed a baseline evaluation in which they filled up the questionnaires presented in the *Materials* section. As requirements for a broader study, participants also provided saliva and blood samples, were administered other questionnaires as well as computerized attention tasks, and underwent a structured interview post-intervention about the psychological and cognitive outcomes and about their general appreciation of the intervention. At the end of the baseline evaluation, participants were given one out of 24 numbered envelops assigned by the main investigator of the study using Microsoft Excel random function, with an invitation for one of the two interventions. Evaluators at the three times of measurement were blinded to the participant's assigned condition and participants were blinded for the baseline evaluation only. Intervention facilitators were not blinded. The two cohorts were conducted in September to December 2015 and January to April 2016, with a follow-up 3 month later. Therefore, measures were collected at baseline (T0), one week after the intervention (post-test; T1), and three months after the post-test evaluation (T2). The trial ended when the expected recruitment goal was attained.

2.5. Statistical analyses

An “intent-to-treat” paradigm was used to characterize the demographic and neuropsychological profile of the participants and for group comparison analyses. Differences between participants assigned to each treatment condition regarding demographic characteristics and neuropsychological performance at baseline were compared using χ^2

tests for categorical data and t-tests for continuous data. Repeated measures ANOVA compared the efficacy of both interventions with Time of measurement, Condition, and Condition*Time of measurement interaction as fixed factors. The Toeplitz covariance structure was used to account for the covariance difference between close measure times (T0 and T1, or T1 and T2) and more distant measure times (T0 and T2) [75]. Partial eta-square (η_p^2) effect sizes were calculated for every fixed factor effect [76].

The following analyses, which were aimed at inferring intervention mechanisms, were conducted using an "as treated" paradigm, including only participants who attended at least 5 intervention sessions. To investigate the association between potential mechanism variables and the outcome measures, Pearson correlation analyses were carried out. The difference between the first post-test and the pre-test was computed for every variable to investigate the relation between outcomes and potential mechanisms changes over time.

Moderation analyses were then used to investigate the association between non-judgment and each outcome variable and the specificity of the mechanisms of action identified in the correlation analyses (see Fig. 2a). Using moderation analyses allowed to avoid conducting separated correlation analyses for each condition. Separate correlations would have compromised statistical power and it would not have allowed to account for shared variance and to compare conditions. To obtain all information of interest, the presence of significant associations for each condition was investigated even if the moderator was not significant.

At last, the contribution of ruminations to the relation between changes in mindfulness facets and main outcome changes was further analyzed for the two conditions using moderated mediation analyses (see Fig. 2b). The moderated mediation strategy was based on Preacher and Hayes' [78,79] work and mainly focused on the statistical significance of the *a* and *b* coefficients (*a*b*), calculated with a nonparametric bootstrapping method that does not require any distributional assumptions and that is appropriate for small samples. For the bootstrapping method, 5000 samples of identical sizes were drawn from the study sample and used to calculate confidence intervals for *a*b* values using a *z*-score-based bias correction. The Condition factor was included as a moderator to test whether the effects on the outcome measures were shared by the interventions or was specific to one. Again, adding a moderator allowed to conduct single analyses including both conditions, but still investigate specific effects. A moderated mediation was considered significant when zero was not comprised between the lower limit and the upper limit of the confidence interval.

Effect sizes (R^2_{med}) were also calculated for each indirect effect of the moderated mediations, to obtain a comparable measure of the importance of the mediator in the model (for the formula and extensive explanations, see [80]). It presents the expected characteristics of a good effect size measure, such as a sensitivity to effect increases and independence from sample size [77]. The values used to compute effect sizes for the conditions in the moderated mediation analyses were calculated for each condition separately. An alpha of .05 determined statistical significance. Analyses were conducted using SPSS version 21.0 and mediation analyses required the use of the PROCESS tool in SPSS [81].

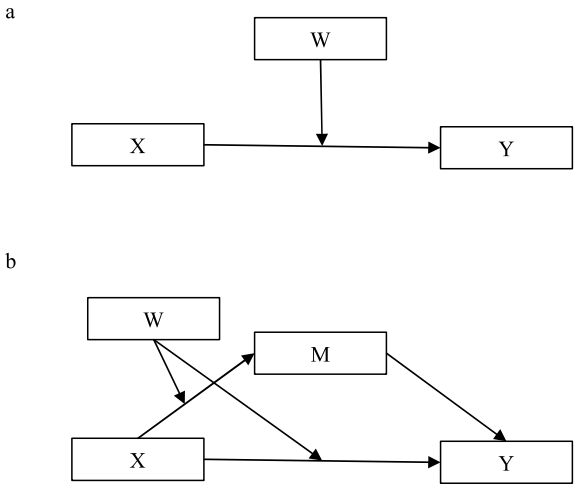

Fig. 2. Moderation and moderated mediation models. Fig. 2a illustrates a moderation model of the simple effect of X on Y. Fig. 2b illustrates a moderated mediation. In mediation models, a nonparametric bootstrapping approach is used to test the coefficient of the crossed products of the predictor (X) to mediator (M) relation, or *a* path, and of the mediator (M) to outcome (Y) relation, or *b* path. Mediation analysis investigates the difference between the total effect of X on Y, or *c* path, and the indirect effect of X on Y through M, or *a*b* path. The c' path represents the remaining direct effect once the variance from M is accounted for. In moderated mediation analysis, a moderator (W) is applied on the *a* and *c*' paths to specifically moderate the effects of X on both M and Y. The diagrams were inspired by the work of Preacher and Kelley [77].

3. Results

3.1. Demographic and neuropsychological profile

Table 1 presents the complete details about demographic and neuropsychological profiles of the sample. Participants were aged between 56 and 87 years, had between 5 and 22 years of education, and were composed of more men than women. Participants from both groups were equivalent in terms of age, education, sex distribution, as well as baseline clinical and neuropsychological scores. Several participants were not administered the Pyramids and Palm Trees Test, due to evaluation duration issues. Diagnosis of aMCI required impaired episodic memory on at least two measures, but participants could additionally present with non-mnemonic cognitive impairments. In other words, aMCI participants were either single- or multiple domains. Overall, 64.4% of participants were impaired in at least two different cognitive domains. Six and 10 participants in MBI and PBI, respectively, were only impaired on the episodic memory test. Because the proportion did not significantly differ between conditions, X^2 (1, N = 45) = 1.29, p = .256, the single vs. multiple-domain aMCI subtypes were not entered as a covariable in statistical analyses.

3.2. Adherence

Participants who completed the MBI reported meditating between 327 and 1485 min in total with an average of 980 min (SD = 361 min). Per week, participants accumulated an average of 140 min of at-home meditation practice, fairly close to the instructed weekly 180 min.

3.3. Primary outcomes

Longitudinal mixed model analyses were conducted to determine if both conditions exerted an effect on depressive and anxious symptoms as well as on quality of life and if so, if they did so distinctively. Table 2 presents the model's estimated marginal means of the three times of measurement for depressive and anxious symptoms as well as for quality of life and memory. Time had a significant effect on depressive symptoms, but not Condition. The interaction Condition*Time did not reach significance. The same pattern of results was obtained for anxiety symptoms and arQOL, with only Time exerting a significant impact on these variables. No significant effect was found for gQOL or for memory immediate and delayed recall.

3.4. Secondary outcomes and mechanisms of change

Table 3 presents the estimated marginal means for both conditions and the three times of measurement for the variables representing

Table 2
Adjusted means of outcomes as a function of time of measurement and condition.

Variable	Condition	Time of measurement																	
		Pre (T0)		Post (T1)		Follow up (T2)		Time effect				Condition effect				Time*Condition effect			
		Adjusted mean	SE	Adjusted mean	SE	Adjusted mean	SE	F	df	p	η2p	F	df	p	η2p	F	df	p	η2p
Depressive symptoms (/30)	MBI	8.2	1.2	7.1	1.2	6.6	1.2	3.56	2, 70.8	.033	.09	.21	1, 43.1	.652	.00	.15	2, 70.8	.864	.00
	PBI	7.7	1.2	6.0	1.2	6.2	1.2												
Anxious symptoms (/20)	MBI	5.9	1.2	5.4	1.2	4.6	1.2	3.97	2, 61.7	.024	.11	.01	1, 43.3	.905	.00	.22	2, 61.7	.805	.01
	PBI	6.2	1.2	5.1	1.2	4.1	1.2												
General QOL (/104)	MBI	75.7	2.6	76.7	2.6	76.8	2.6	.11	2, 82.4	.985	.00	.00	1, 43.2	.985	.00	.71	2, 82.4	.492	.01
	PBI	76.8	2.6	75.8	2.6	76.4	2.6												
Aging-related QOL (/96)	MBI	63.5	2.1	64.7	2.1	67.2	2.1	4.29	2, 75.5	.017	.10	.04	1, 43.2	.837	.00	.81	2, 75.5	.451	.02
	PBI	63.9	2.1	64.4	2.2	65.3	2.2												
Immediate recall (/45)	MBI	21.1	1.3	21.0	1.3	21.5	1.4	.34	2, 54.1	.711	.01	.09	1, 41.7	.769	.00	.01	2, 54.1	.995	.00
	PBI	20.6	1.4	20.4	1.4	21.0	1.4												
Delayed recall (/15)	MBI	8.0	0.7	7.2	0.7	7.5	0.7	2.56	2, 49.6	.088	.09	.33	1, 42.2	.566	.01	.66	2, 49.6	.522	.03
	PBI	7.5	0.7	7.0	0.7	6.8	0.7												

Notes. SE = Standard error; MBI = Mindfulness-based intervention; PBI = Psychoeducation-based intervention; df = Degrees of freedom; QOL = Quality of life.

potential mechanisms of change. The longitudinal mixed model analyses showed a significant Time effect for ruminations, but no Condition and Condition*Time effects. Furthermore, no FFMQ facet effect reached statistical significance.

Correlation analyses between outcomes and potential mechanisms of changes with regards to MAT's assumptions, namely monitoring measured by observation, and acceptance measured by non-judgment and non-reactivity, were conducted. The absence of significant Condition or Condition*Time effects led to merging the results from both conditions. Doing so increased statistical power and accounted for possible shared parts of the suspected mechanisms. The results from correlation analyses are presented in Table 4. Change in non-judgment was the only subscale of FFMQ that significantly correlated with change in depressive and anxious symptoms. Non-reaction was correlated with gQOL and arQOL, and observation, with delayed recall. There was no observed correlation with immediate recall. Ruminations were correlated with depressive and anxious manifestations, justifying their inclusion as a potential mediator between non-judgment and symptoms in the following analyses.

No harms were reported by the participants after the interventions during the interviews. Unintended benefits on sleep quality, interpersonal relationships quality, openness to others and knowledge about self (strengths and limits) were reported in the interviews.

In order to determine if the significant correlations were specific to MBI participants, moderation analyses were conducted for relevant significant associations, as described below. First, the effect of condition as a moderator of the relation between non-judgment and depressive manifestations was tested. The moderation model did not predict depressive symptoms significantly, $R^2 = 0.14$, $F(1,37) = 2.04$, $p = .124$ and the moderator did not significantly increase the explained variance, $R^2_{inc} = 0.02$, $F(1,37) = 1.07$, $p = .308$. The effect of non-judgment on depressive symptoms was significant for MBI participants only $\beta = -0.38$, $t(40) = -2.43$, $p = .020$, the PBI condition showing no significant association, $\beta = -0.01$, $t(40) = -0.04$, $p = .970$. A significant effect of non-judgment on depressive symptoms was therefore only found in the MBI condition, but was not specific as the moderation interaction did not significantly increase explained variance.

Second, the same analysis was conducted for the relation between non-judgment and anxious symptoms. The moderation model did not

Table 3
Adjusted means of mechanism variables as a function of time of measurement and condition.

Variable	Condition	Time of measurement																	
		Pre (T0)		Post (T1)		Follow-up (T2)		Time effect				Condition effect				Condition X Time effect			
		Adjusted mean	SE	Adjusted mean	SE	Adjusted mean	SE	F	df	p	η^2p	F	df	p	η2p	F	df	p	η^2p
Observation (/40)	MBI	26.1	1.2	27.1	1.2	26.8	1.2	2.15	2, 59.4	.125	.07	.10	1, 43.5	.751	.00	.14	2, 59.4	.869	.00
	PBI	25.4	1.2	27.0	1.2	26.2	1.2												
Description (/40)	MBI	25.2	1.2	24.7	1.2	24.7	1.2	.24	2, 55.1	.787	.01	.56	1, 45.7	.457	.01	1.06	2, 55.1	.354	.04
	PBI	25.5	1.2	26.0	1.2	26.7	1.3												
Mindful action (/40)	MBI	25.4	1.1	23.9	1.1	25.9	1.1	2.23	2, 54.5	.117	.08	1.56	1, 43.2	.219	.03	1.92	2, 54.5	.156	.07
	PBI	26.2	1.1	26.8	1.1	27.4	1.2												
Non-reaction (/35)	MBI	20.9	0.8	21.6	0.8	20.9	0.8	2.10	2, 59.3	.131	.07	.84	1, 43.7	.365	.02	.34	2, 59.3	.713	.01
	PBI	21.4	0.9	22.6	0.9	22.4	0.9												
Non-judgment (/40)	MBI	25.5	1.0	26.3	1.0	26.4	1.0	1.60	2, 60.8	.211	.05	3.15	1, 43.2	.085	.07	.53	2, 60.8	.590	.02
	PBI	27.6	1.0	27.8	1.1	29.4	1.1												
Ruminations (/88)	MBI	43.4	2.4	44.1	2.4	40.3	2.5	3.16	2, 54.6	.050	.10	.08	1, 43.7	.775	.00	.18	2, 54.6	.834	.01
	PBI	44.8	2.5	44.2	2.5	41.5	2.6												

Notes. SE = Standard error; MBI = Mindfulness-based intervention; PBI = Psychoeducation-based intervention; df = Degrees of freedom.

Table 4
Correlation (r) between changes (post - pre) on clinical outcomes and on potential mechanisms of action of interventions.

	n	FFMQ Observation[1]	FFMQ Description[1]	FFMQ Action[1]	FFMQ Non-reaction[1]	FFMQ Non-judgment[1]	Ruminations[2]
Depressive symptoms[2]	41	−0.10	0.16	0.09	−0.07	**−0.33***	**0.32***
Anxious symptoms[2]	41	0.10	0.16	0.15	−0.16	**−0.37***	**0.46***
General QOL[1]	41	−0.16	−0.12	0.07	**0.33***	0.22	−0.15
Aging-related QOL[1]	41	0.18	−0.14	0.04	**0.35***	0.27	0.09
Immediate recall[1]	41	−0.17	−0.07	−0.27	−0.11	−0.05	−0.11
Delayed recall[1]	41	**−0.35***	−0.05	−0.13	−0.29	−0.04	−0.24

Notes. *p < .05.[1] = Higher score is better. [2] = Lower score is better. FFMQ = Five-Facet Mindfulness Questionnaire; QOL = Quality of life.

predict anxious symptoms, $R^2 = 0.18$, $F(1,37) = 2.70$, $p = .060$ and the inclusion of the moderator left the explained variance unchanged, $R^2_{inc} = 0.04$, $F(1,37) = 1.67$, $p = .205$. The effect of non-judgment on anxiety symptoms was significant for MBI participants, $\beta = -0.43$, $t(40) = -2.82$, p - .007, but not for PBI, $\beta = 0.02$, $t(40) = 0.06$, $p = .954$. The effect of non-judgment on anxious symptoms was therefore only observed in MBI participants, but specificity cannot be concluded.

To test the quality of life mechanism of change, a simple moderation analysis was performed to determine whether the effect of non-reaction on arQOL was shared by both conditions or specific to one. The full moderation model significantly predicted arQOL changes, $R^2 = 0.28$, $F(3,37) = 4.80$, $p = .006$. The inclusion of the moderator lead to a significant increase in explained variance, $R^2_{inc} = 0.16$, $F(1,37) = 8.27$, $p = .007$. The effect applied to the MBI condition, $\beta = 1.79$, $t(40) = 3.79$, $p < .001$, but not the PBI condition, $\beta = 0.02$, $t(40) = 0.05$, $p = .956$. This effect of non-reaction on arQOL was present in the MBI condition and specific to it.

For the memory mechanism of change, simple moderation analyses aimed at testing whether the negative association between observation and delayed recall was shared by both conditions or specific to one. The full moderation model did not significantly predict delayed recall changes, $R^2 = 0.14$, $F(3,37) = 2.06$, $p = .122$. The inclusion of the moderator did not lead to a significant increase in explained variance, $R^2_{inc} = 0.005$, $F(1,37) = 0.19$, $p = .660$. The effect did not reach statistical significance for the MBI condition, $\beta = -0.15$, $t(40) = -1.55$, $p = .129$, nor for the PBI condition, $\beta = -0.22$, $t(40) = -1.88$, $p = .069$. No effect was found for any condition, similarly to the correlation analyses.

Ruminations were investigated as a potential mediator of the relation between non-judgment and depressive symptoms. To investigate whether this mechanism of change was shared by both interventions or not, moderated mediation analyses were conducted with Condition as a moderator, as described above (see Fig. 2b). Table 5 presents the moderated mediation coefficients including the moderator's effect and interaction with the independent variable.

First, the moderated mediation model for depressive symptoms did not significantly predict depressive symptom changes. For the MBI condition, the indirect effect through ruminations was not significant, nor was the direct effect. In the PBI condition, the indirect effect through ruminations also was not significant, and neither had a direct effect. The moderated mediation index, accounting for the difference between the indirect effect for both conditions, was not significant, $\beta = -0.08$, 95% CI [-0.42, 0.03]. Even though no mediation effect was significant, the ruminations' impact on depressive score variance was marginally greater in the MBI condition, as supported by the observed effect sizes for both conditions.

Second, the same analysis was conducted for anxious symptoms changes, which were significantly predicted by the full model, $R^2 = 0.27$, $F(4,36) = 3.28$, $p = .022$. For the MBI condition, the indirect effect was statistically significant, and the direct effect was not. In the PBI condition, neither the indirect effect through ruminations, or the direct effect were significant. The moderated mediation index was also not significant, $\beta = -0.14$, 95% CI [-0.54, 0.01]. The mechanism of change was only significant in the MBI condition, as confirmed by the obtained effect sizes that showed a null effect for the PBI condition. Non-significance of the moderator does not allow to conclude this effect was specific to the MBI condition.

Third, as exploratory analyses, the non-judgment and rumination mechanisms were tested for possible involvement in arQOL changes. The full moderated mediation model did not significantly predict arQOL changes, $R^2 = 0.18$, $F(4,36) = 2.04$, $p = .110$. For the MBI condition, the indirect effect through ruminations, and the direct effect, were significant. In the PBI condition, the indirect effect through ruminations was not significant, similar to the direct effect. The moderated mediation index, or moderator interaction, accounting for the difference between the indirect effect for both conditions, was not significant, $\beta = -0.20$, 95% CI [-0.77, 0.03]. Therefore, it cannot be determined that the observed effect was specific to the MBI condition. The mechanism of change was only significant in the MBI condition, as confirmed by the obtained effect sizes that showed a null effect for the PBI condition. A suppression effect was found, where the direction of indirect effect was the opposite of what was expected, but accompanied by an increase of the direct effect [82,83]. Indeed, for the indirect effect, increases in non-judgment were associated with decreases in ruminations that led to decreases in arQOL. This came with an increase of the direct effect compared to the total effect, passing from .37 to .53 and reaching statistical significance when the mediation variance was

Table 5
Summary of moderated mediation coefficients (and standard errors) of non-judgment's effect (X) on outcomes (Y) with Ruminations as a mediator (M) and Condition as a moderator (W).

Dependant variable (Y)	Condition (W)	X on M (a)	M on Y (b)	W on M	Interaction on M	W on Y	Interaction on Y	Indirect (a*b)	95% CI [LI, UI]	R^2_{med}	Direct (c')
Depressive symptoms	MBI	-.16	.08	2.17	-.94	.79	-.30	-.09	[-.43, .03]	.11	-.29
	PBI							-.01	[-.24, .04]	.00	.00
Anxious symptoms	MBI	-.16	.15*	2.17	-.94	.51	-.31	-.17*	[-.50, −.01]	.21	-.26
	PBI							-.02	[-.27, .07]	.00	.04
Aging-related quality of life	MBI	-.16	.22	2.17	-.94	−1.28	.86	-.24*	[-.66, −.02]	.12	-.74*
	PBI							-.03	[-.36, .14]	.00	-.12

Notes. *p < .05. MBI = Mindfulness-based intervention. PBI = Psychoeducation-based intervention. X = Predictor, here non-judgment. Y = Outcome variable. M = Mediator. W = Moderator. CI = Confidence interval. LI = Lower interval. UI = Upper interval. R^2_{med} = Partial-R2 of mediation.

accounted for. In summary, controlling for rumination revealed a significant beneficial effect of non-judgment on arQOL after a MBI.

4. Discussion

This preliminary randomized-controlled trial investigated the efficacy of a MBI and a PBI in reducing anxious and depressive symptoms and in improving the quality of life and memory of older adults with aMCI. The study also investigated potential mechanisms of action of the MBI. It was first expected to find beneficial effects following both the MBI and PBI for depressive and anxious symptoms, along with improved quality of life, in the elderly diagnosed with aMCI. Effects on memory were also investigated and are discussed in a distinct section. An effect of Time (pre-vs. post-intervention), for the two interventions combined was found for depressive moods, anxious affects, and arQOL, but surprisingly not gQOL. Efficacy of both interventions was equivalent on all psychological outcomes post-test or three months later. The specific effect of the interventions on aging-related aspects of quality of life could be explained by the absence of intervention focus on gQOL. Indeed, the WHOQOL-Brief investigates general aspects of life satisfaction rather than aspects directly associated with aMCI participants' sources of distress. As no passive control group was included and the PBI was expectedly efficient in aMCI based on its previously found efficacy in older adults with dementia [22], these results relatively support MBI's efficacy for alleviating psychopathological symptoms in older adults with MCI, as theorized previously [24,31]. Although it was expected to find benefits for both interventions, it cannot be determined with precision if efficacy can be attributable to specific or to common factors associated with participating in a study, interacting with a group, or being supported by a facilitator. Meta-analyses found a similar absence of differential effect or weak MBI effects over other active control groups for a wide range of clinical populations [84,85]. Overall, this study supports the usefulness of non-pharmacological interventions to improve affect and mood as well as age-related quality of life in aMCI elders.

A concern about interpretation of the results is the somewhat small means' change between times of measurement, which bring into question clinical significance. The presence of small means variations and significant time effects is attributable to the large intra-group variability at each time of measurement, including at baseline. Indeed, less than 45% of participants of both groups had probable clinical level of depressive or anxious symptoms and scores varied a lot even within these individuals. Overall, participants self-reported a decrease in symptoms severity that was not reflected in the means, still because of important intra-group variability. This is where effect sizes come into play and allow to see that, in fact, effects of the interventions over time can be interpreted as moderate. Although these results are promising, it must be kept in mind that the absence of a passive control group does not allow to confirm this claim with more confidence. Such control group would have allowed to determine clinical significance of the obtained results with effect size values reflecting the impact of participating in an interventions compared to mere passage of time [86]. Finally, working with having a neurodegenerative condition implies that the passage of time is accompanied by a worsening of symptoms. Bearing this in mind, a slight means' variation could be a large effect of interventions, compared to decline.

This study also investigated whether a MBI could provide memory benefits when compared to a PBI, for which no memory changes were expected. Neither intervention improved memory of older adults with aMCI, despite previous reports supporting meditation's potential with that respect [87]. Although there is a growing body of evidence converging on the capacity of non-pharmacological interventions, such as cognitive training, to improve memory of people with aMCI [88–90], interventions with a focus on psychosocial management of cognitive decline do not seem to provide similar results [22]. Findings of memory benefits in mindfulness meditation clinical studies with older adults with or without cognitive impairments have been scarce [87,91,92]. Possible explanations include that an 8-week MBI program might not grant sufficient attention training to benefit memory in patients at such a stage of cognitive decline. Indeed, an 8-week meditation training in aMCI might only benefit dynamic functional connectivity of the already compromised brain, allowing for attention improvement, rather than both functional and structural changes required for memory gains, such as seen in experienced meditators or in populations without memory impairments [93]. Interestingly, the most consistent memory effect of MBI in older adults is observed for subjective memory [92]. Although such reports are encouraging, subjective memory presents a small correlation with objective memory in older adults with aMCI, calling subjective memory's validity as a memory measure in aMCI into question [94]. Future clinical studies should include both objective and subjective measurements of memory in order look into the interaction between the two in intervention settings. Including ecologically validated measures of memory in future studies could also provide a different insight on the efficacy of non-pharmacological to improve memory.

4.1. Testing the MAT

Potential mechanisms of MBI-related changes on studied variables were also investigated using the assumptions of the MAT (Lindsay & Creswell, 2017). This theory suggests that acceptance, here measured by the non-judgment and non-reactivity subscales of the FFMQ, is a central mechanism of change in an MBI, along with monitoring, here measured by the observation subscale of the FFMQ. The MAT's postulates were partially supported by the findings of the present study. Namely, the role of acceptance was confirmed, but not that of monitoring. To be more precise, the non-judgment facet of mindfulness predicted depressive and anxious symptoms, and both non-judgment and non-reaction facets predicted arQOL changes. Every moderation or moderated mediation analyses endorsed the presence of relations in the MBI condition, but the present study does not allow to conclude it is specific. A larger sample size would be required to confirm statistical specificity of the mechanism.

The monitoring-related observation facet of mindfulness was not associated with immediate recall for either condition, and observation increases were associated with decreases in delayed recall performance. While it was postulated that memory changes occurred through monitoring capacity changes [26], the present results showed no association. A possible explanation for the absence of the expected association could be that the observation facet does not provide an assessment of attentional capacities, such as is implied by the MAT [26]. Unexpectedly, FFMQ validation studies found that the observation facet was the only one excluded from the overarching constructs of mindfulness in factorial analyses [95,96]. Observation was also positively correlated with maladaptive constructs, such as mindlessness and thought suppression behaviors in participants without meditation experience [95,96]. These authors argued that a greater observation tendency might be detrimental in unexperienced meditators who lack attentional control and simply notice (and possibly judge and ruminate on) more thoughts and experiences. Other research also suggested that rather than being a barometer of the capacity to observe mindfully and intentionally, the observation facet taken alone only measures the extent of thoughts and sensations perceived, without consideration for the quality or intention of the attention allocated [28]. Therefore, depressed individuals with worsening symptoms of ruminations could report increased observation, without experiencing increased well-being. A revised version of the observation facet would be needed to better test the monitoring proposition of the MAT. A recent study investigating mechanisms of mindfulness found that increases in effortful control, which is the capacity to focus and shift attention when desired, was associated with reductions in psychological symptoms [97]. Therefore, effortful control could be an interesting alternative to

observation when investigating cognitive mechanisms of action. Overall, the present study shows that the MAT-proposed association between monitoring, as measured here by the observation facet of the FFMQ, and attention function cannot be extended to memory benefits in older adults with aMCI with limited meditation experience.

4.2. The central role of ruminations in Non-Judgment's effect

This study expected to find a role of rumination reduction in mindfulness's effect on psychological symptoms and quality of life. It was postulated that by promoting acceptance, the MBI would also reduce the use of maladaptive cognitive emotion regulation strategies, such as ruminating [26,28,98]. Mediation analyses showed that rumination decrease accounted for a significant part of the relationship between non-judgment increase and the alleviation of depressive and anxious symptoms after the MBI. When investigated on its own, non-judgment was not associated with arQOL changes, but exploratory analyses revealed that non-judgment did predict arQOL when mediation analyses accounted for ruminations changes' variance (see Fig. 3). This therefore confirms that by leading to a more non-judgmental appraisal of one's experience, the MBI can reduce the extent of ruminations, leading to psychological benefits. These findings are consistent with much work done with regards to self-compassion, which found that less rumination and more self-compassion explained the association between mindfulness and depressive symptoms [29,30]. Here again, the results of the present study do now allow to conclude this effect was specific to the MBI condition, and studies with larger sample size will be required to confirm these findings. No data available allowed for investigation of specific mechanisms for the PBI.

As mentioned earlier, self-judgment and self-criticism in the context of cognitive decline is associated with more experience of distress in older adults with aMCI [14,15]. Furthermore, depressive and anxious symptoms are triggered and arQOL is impaired by pervasive patterns of ruminations about one's forgetfulness or possible future decline [14]. The present study supports the relevance of compassion and acceptance promotion for older adults with aMCI who rely on maladaptive cognitive emotion regulation strategies, such as ruminating.

4.3. Limitations and future research

Although this study is the first published single blind randomized-controlled trial comparing a MBI with an active control intervention in older adults with aMCI, it presents some limitations. First, the relatively small sample restricts the power of the study, especially in the context of moderated mediation analyses. The use of non-parametric bootstrapping [78,79] is an adequate compromise because it does not require sample normality, but regression models are optimal when used in larger samples and might have allowed to detect an indirect effect for depressive symptoms also. A larger sample might also have allowed to confirm specificity of the mechanisms of action for the MBI condition, as postulated.

Second, no passive control group, receiving no intervention or minimal care only, was included in the study. Such a control group would have allowed for assessment of the effect of solely being part of a study, being evaluated, and passing time, and would increase statistical power. It was chosen not to include a third condition in consideration for recruitment challenges, but inclusion of a wait-list or passive control group is needed in future research.

A third limit is that the design and administration of both interventions were done in part by the main investigator of the study. The first author played a central role in designing both intervention programs and he administered the interventions to both MBI cohorts and one PBI cohort. No impact on the outcomes can be confirmed.

Future studies need to further explore the mechanisms of change of psychosocial interventions designed for older adults with aMCI. Unfortunately, this study did not allow for identification of PBI's specific mechanism of change or common factors to both interventions' effects on the outcomes. A potential mechanism could be that, by dispensing knowledge on age-related changes, PBI helps normalize the experience of cognitive impairments with positive repercussions on depressive and anxious symptomatology and quality of life. An increase of the sense of control over cognitive decline and the reduction of feelings of helplessness could also be potential mechanisms of action of the PBI. Finally, future studies could also investigate interventions' effects on ecologically validated measures of memory to unveil effects or mechanisms unseen in the present study.

5. Conclusion

This study confirms the potential of both MBI and PBI to reduce depressive and anxious symptoms and to improve arQOL in older adults with aMCI. No effects were found for gQOL and memory. The study also partially supports the MAT mechanisms for a MBI, by highlighting the contribution of acceptance-related non-judgment and non-reaction to clinical outcomes but the absence of monitoring contribution. The present results also bring out the contribution of rumination reduction in non-judgment's effect in MBI's alleviation of psychological distress. No mechanisms of PBI were detected in the present data. More studies

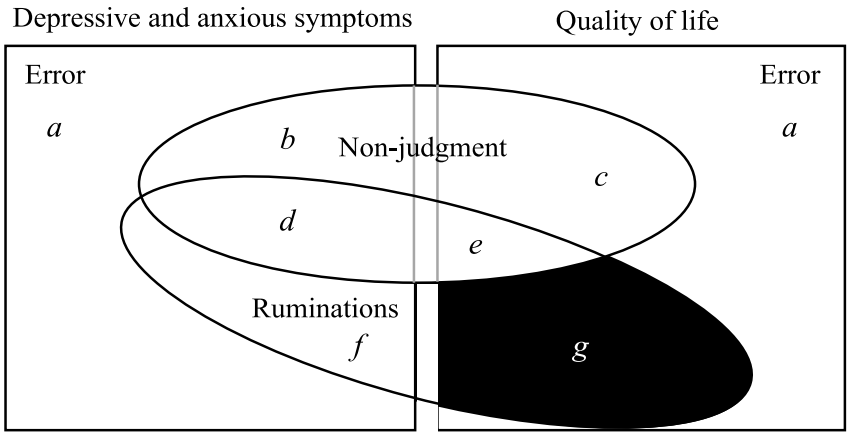

Fig. 3. MBI's mediation and suppression effects illustration. This figure illustrates the role played by ruminations in a global portrait, including mediation and suppression effects. The portrayed effects are not representative of the proportions of variance obtained in this study, but only aim to demonstrate the effects. The two squares each represent the outcome variables (OV), with depressive and anxious symptoms that share a similar effect of ruminations to the left and arQOL, to the right. Since the independent variables, here non-judgment and ruminations, do not explain 100% of the OVs' variance, *a* represents the variance unexplained by the models for both OVs. For depressive and anxious symptoms, a regular mediation effect was obtained, where *b* illustrates non-judgment's effect on the OVs, *f* ruminations' effect and *d* the shared effect of non-judgment and ruminations, or the indirect effect. For quality of life, the effect of ruminations was found to be different. Indeed, while the effect size of the indirect effect was similar, its impact on non-judgment differed. Instead of reducing non-judgments' single effect, or *c*, on the OV, it increased its relative importance by reducing the unexplained error, or *a*. By doing so, *g*, which illustrates rumination's effect on the IV, benefits the effect-error ratio of non-judgment that reduced power and uncovers its relation to arQOL, such as a covariate would have done. Therefore, the indirect effect *e* needs not to be interpreted for its effect on the OV, but as suppression or covariate effect [82].

are needed to understand how specific factors of psychosocial interventions provide clinical benefits.

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Conflicts of interest

The authors declare no conflict of interest.

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