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Mindfulness and PERMA Well-Being: Intervention Effects and Mechanism of Change

Bingqian Liu[1], Ye Guan[1], Hai Jing[2], Stefan G. Hofmann[3], Xinghua Liu[1*]

[1]Beijing Key Laboratory of Behavior and Mental Health, School of Psychological and Cognitive Sciences, Peking University, Beijing, China
[2]Faculty of Mathematics, Sorbonne University, Paris, France
[3]Department of Psychological and Brain Sciences, Boston University, Boston, MA, USA
Email: *xinghua_liu@pku.edu.cn

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Abstract

Studies have shown that mindfulness-based interventions (MBI) can improve well-being. However, well-being is difficult to quantify. Guided by the multidimensional PERMA model (Positive Emotions, Engagement, Positive Relationships, Meaning, and Achievement), two randomized controlled trials were successively conducted to examine the effects of MBI on well-being. The Random-Intercept Cross-Lagged Panel Model was adopted to investigate its underlying mechanism. Our findings repeatedly showed that the intervention led to significant improvement in mindfulness, alleviation of emotional distress, and an increase in PERMA-Meaning, compared to the control group. Independent models indicated that baseline describing negatively predicted week 3 meaning; week 3 meaning positively predicted week 6 non-reactivity to inner experience. These findings suggest that the mindfulness intervention for participants with emotional distress improved well-being based on the PERMA perspective and that describing and meaning could be potential mechanism variables. Further work is warranted to explore the therapeutic mechanism of mindfulness in fostering well-being.

Keywords

Mindfulness, Emotional Distress, PERMA, Well-Being, Meaning

1. Introduction

Interest in mindfulness-based interventions (MBI) has grown considerably in recent years. MBI refers to psychological interventions aimed at cultivating one's non-judgmental attention to present-moment experiences (e.g. Mindfulness-based cognitive therapy, MBCT; Mindfulness-based stress reduction, MBSR) (Chiesa &

Malinowski, 2011; Tang et al., 2015). Although MBIs have been repeatedly shown to reduce psychiatric symptoms and emotional distress (Hofmann et al., 2010; Khoury et al., 2013), heterogeneity exists in their effects on well-being. Whereas some studies showed an increase in psychological well-being after MBIs (De Vibe et al., 2018; Maddock et al., 2019; Wingert et al., 2022; Zemestani & Fazeli Nikoo, 2019), others did not achieve the intended goal (Johnson et al., 2016; McConachie et al., 2014; Perez-Blasco et al., 2013). A potential factor that contributed to this heterogeneity on interventional effects was the measure of well-being *per se*.

Currently, there are two major gaps in investigating well-being. Firstly, hedonic vs. eudaimonic. Ryan and Deci (2001) noted that most research in hedonic psychology examined life satisfaction, the presence of positive mood, and the absence of negative mood, whereas eudaimonic well-being measured the degree to which a person is fully functioning, including self-acceptance, personal growth, purpose in life, positive relation with others, environment master, competence, and autonomy (Ryan & Deci, 2001; Ryff, 1989). Secondly, whether it's a single-dimensional or a multidimensional construct. Although many studies used an overall score of a certain questionnaire to facilitate the comparison between different constructs (e.g. subjective feeling of happiness, the total score of Ryff's inventory, etc.), they also assumed that the underlying construct is unidimensional (Butler & Kern, 2016). However, many researchers who questioned this monophyletic theory on well-being assume that well-being is a complex construct that should be interpreted and assessed from a multi-perspective approach (Diener et al., 2010; Hone et al., 2014; Huppert & So, 2013; Seligman, 2011).

This study aims to gain a global understanding of the effect of MBI on well-being, as well as to go a step further to understand how it works. For this purpose, we considered both gaps in well-being. Seligman (2011) put forward the PERMA model in his updated reflection of well-being, considering it to be composed of five domains: *Positive emotions* (P), *Engagement* (E), *positive Relationships* (R), *Meaning* (M), and *Achievement* (A), which blend hedonic (e.g. emotions, engagement) and eudaimonic domains (e.g. meaning, relationships, achievement). Each component independently predicts several well-being measures (Catalino & Fredrickson, 2011; Peterson & Ruch, 2009). The theory suggests that these five domains also represent pathways to a flourishing life. In other words, according to the PERMA model, well-being does not equal an overall score of happiness, but rather an optimal state of psychosocial functioning that arises from functioning well across multiple psychosocial domains (Butler & Kern, 2016). Previous studies demonstrated that the PERMA model was effective in gauging one's well-being (Tansey et al., 2018; Umucu et al., 2019) and highlighting opportunities and challenges for intervention (Lambert D'raven & Pasha-Zaidi, 2016). To our knowledge, only one study performed on healthy adults has addressed the effects of MBI on PERMA well-being. Wingert et al. (2022) provided 52 working undergraduates with an 8-week Mindfulness-based strengths

practice (MBSP) and found that students in the intervention group showed significant increases in engagement, meaning, and self-perceived health compared with a control group with no intervention. No study has yet addressed the underlying mechanism of change.

2. Study Overview

Our first goal was to get a better understanding of MBI's effects on well-being based on a PERMA model. The second goal of our study was to investigate the bidirectional associations between different components of mindfulness skills and pillars of PERMA, which might shed light on the mechanism of MBI for well-being. In study 1, we conducted an RCT on 69 participants with high emotional distress from September 11th, 2019 to June 1st, 2020 to explore the effect of an 8-week MBI on PERMA and whether the enduring effects could be found at follow-up. In study 2, we performed another RCT on a new sample of 129 subclinical participants from March 20th, 2020 to May 24th, 2020, additionally including an online self-help intervention group to ensure the reproducibility of results. Finally, in study 3, the cross-lagged effects over time were analyzed with a random-intercept cross-lagged panel model (RI-CLPM) (Hamaker et al., 2015) by using four waves of data from subsamples of the second RCT. All studies were approved by the Association for Ethics and Human and Animal Protection in the School of Psychological and Cognitive Sciences, Peking University. All data were analyzed following the intention-to-treat (ITT) principle by Bingqian Liu (Boutron et al., 2008), then independently checked by Ye Guan and Hai Jing.

3. Study 1

In the first study, we explored the effect of an 8-week MBI by assessing mindfulness, emotional distress, and well-being at pre, post, and 6-month follow-up. The current study was an initial attempt to address the MBI's effect on PERMA with subclinical individuals, there was no a priori prediction on the observed effects.

3.1. Materials and Methods

Procedure

We adhered to the extended version of the Consolidated Standards of Reporting Trials (CONSORT) guidelines for nonpharmacologic treatment (Boutron et al., 2008). Participants were recruited using online advertisements published on Wechat Public Page (Zhengnianyanxi, 2019). Of 336 individuals who completed our online questionnaires of recruitment, 230 who met our inclusion criteria were invited to go through a screening interview given by a mindfulness teacher, Xiaoming Wang. Participant flow is shown in **Figure 1**. 69 participants who did not meet the exclusion criteria were randomly assigned to either an 8-week intervention group or a waiting-list control group using a stratified random method independently by Ye Guan. The strata were calculated based

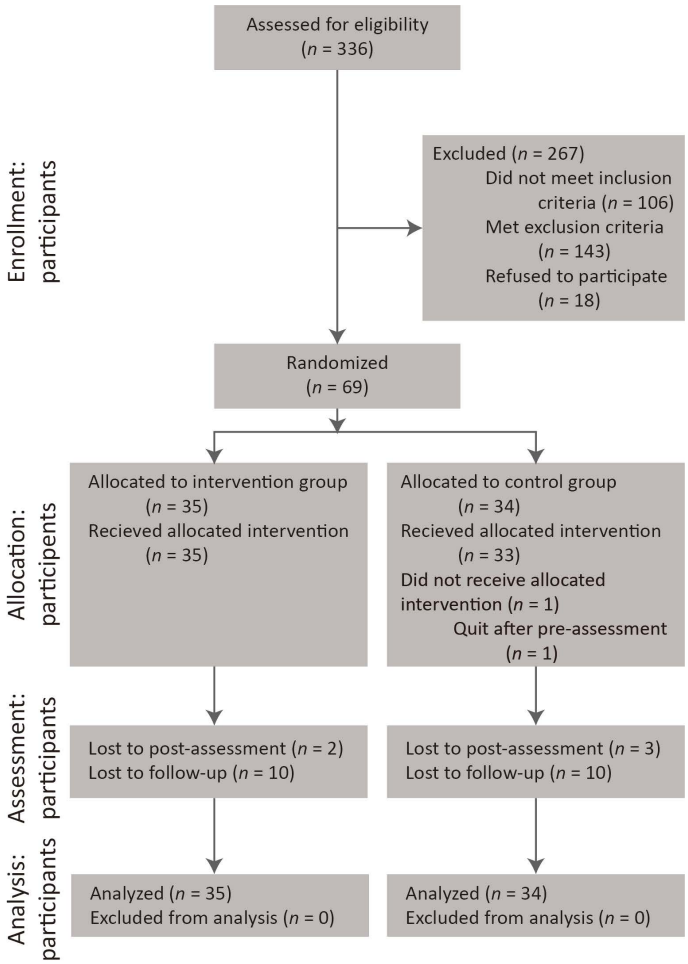


Figure 1. CONSORT flowchart of participants in sample 1.

on the age range and the final strata were determined when the gender ratio approached 1:1 within each stratum. Participants of both groups were required to accomplish the online assessments at all time points, which also included questionnaires and behavioral tasks unrelated to the current study. Demographic information is presented in Table 1. All participants signed informed consent. Participants in the intervention group received a certificate as a reward. We provided a 2-day mindfulness training as remuneration after post-assessment for those who were on the waiting list for ethical consideration.

Eligibility criteria

Inclusion criteria for this study were: 1) to have an overall score of 10-item Kessler Psychological Distress Scale (K10) no less than 22 (Taylor et al., 2008), 2) no prior training experience of 8-week MBI, 3) no regular practice of other forms of meditation (less than 20 mins/week), 4) no serious physical illness, 5) aged 18 years or older, and 6) availability to attend the whole program. Participants were excluded if they met for a current or previous diagnosis of psychotic disorders, bipolar disorders, substance abuse or dependence, antisocial or borderline disorder personality, reported low emotional distress during the interview, or

Table 1. Demographic statistics in sample 1 (for study 1) and sample 2 (for study 2 and 3).

Characteristic	Sample 1			Sample 2			
	MBI (n = 35)	Control (n = 34)	Condition difference	Online MBI (n = 43)	Self-help MBI (n = 43)	Control (n = 43)	Condition difference
Age in years (M ± SD)	31.00 ± 8.35	30.62 ± 7.80	$t_{(1, 67)} = .20$	32.16 ± 9.10	32.23 ± 9.72	32.35 ± 8.90	$F_{(2, 126)} = .00$
Sex			$\chi^2_{(1)} = 1.05$				$\chi^2_{(2)} = .10$
Female	24	27		35	35	34	
Male	11	7		8	8	9	
Education in years (M ± SD)	17.49 ± 1.92	17.38 ± 2.09	$t_{(1, 67)} = .21$	17.19 ± 2.63	17.45 ± 2.10	17.41 ± 3.00	$F_{(2, 126)} = .13$

*$p < .05$. **$p < .01$. ***$p < .001$.

presented with suicide ideation or intention.

Assessment instruments

The following measurements were adopted in the current study: The Five Facets Mindfulness Questionnaire (FFMQ) aimed to assess participants' mindfulness ability (Baer et al., 2006). Participants' states of emotional distress were evaluated using the K10 (Kessler et al., 2002). The Chinese version of the Perceived Stress Scale (CPSS) was also included as an index of emotional distress (Cohen et al., 1983). The PERMA Profiler (Butler & Kern, 2016) was applied to provide multidimensional well-being profiles. Instructed items, such as "Please select 0 for this question", were inserted to identify inattentive participants as suggested by DeSimone et al. (2014).

FFMQ

The 39-item FFMQ measures five facets of mindfulness: observing, describing, acting with awareness, nonjudging of inner experience, and nonreactivity to inner experience. Items are rated on a 5-point Likert scale from 1 to 5, with higher overall scores representing higher mindfulness levels. Cronbach's alpha was .439 to .843 in the previous literature (Deng et al., 2011). Since it was suggested by some researchers that the superordinate "mindfulness" factor was unstable (Van Dam et al., 2012), the overall score, as well as individual subscales of FFMQ were used in the current study (α = .672 to .890).

K10

The K10 measures participants' emotional distress (e.g. depressed and anxious mood, anhedonia, etc.). Items are rated on a 5-point Likert scale from 1 to 5, with higher overall scores representing poorer psychological health. Good internal consistency has been reported (α = .877) in the previous literature (Liu et al., 2014). In the present study, Cronbach's alpha was .844.

CPSS

The 14-item CPSS measures participants' stress levels. Items are rated on a 5-point Likert scale from 0 to 4, with higher overall scores representing a higher

level of perceived stress. The CPSS showed a higher internal consistency (α = .900) in Yang et al. (2007). In the current study, Cronbach's alpha was .799.

PERMA Profiler

The 23-item PERMA Profiler is a brief, validated measure of Seligman's PERMA theory. 15 core items measure five pillars of well-being: *positive emotions*, *engagement*, *relationships*, *meaning*, and *achievement*. 8 filler items measure *negative emotions*, *loneliness*, *self-perceived physical health*, *self-perceived happiness*, and *overall well-being*. We adopted the multidimensional approach of well-being, thereby the *overall well-being*, the grand average of all five pillars, was considered not optimal to represent one's dynamic optimal state of psychosocial functioning and was thus not included in this study. The two single-item subdimensions, *loneliness* and *self-perceived happiness*, were also excluded from the current study since it was recommended to incorporate more than one item to achieve a stable measurement (Hone et al., 2014). Items are rated on an 11-point Likert scale from 0 to 10, with higher overall scores of each dimension representing a higher level of that well-being component. Internal consistencies were acceptable (α = .600 to .900) in the previous literature (Butler & Kern, 2016) and in the present study (α = .561 to .920).

Intervention

The intervention program was adjusted based on the MBSR/MBCT. The intervention group completed an 8-week training: Sessions lasted 2.5 hours and were held once per week, as well as a silent day of 8 hours between weeks 6 and 7. Two experienced mindfulness teachers, Xiaoming Wang and Xinghua Liu provided the intervention, both of whom had received their training from the MBSR and MBCT teacher training system. Formal meditation (i.e., the body-scan technique, mindful hatha yoga, sitting meditation, and walking meditation) has been included as the main intervention. Additionally, participants were asked to practice for 15 mins per day, using both formal mindfulness activities following given recordings and informal activities as their homework.

Data analysis

All data were analyzed using SPSS (20.0; SPSS, Inc, Chicago) with a significance level set at .05. For those who wrongly answered any instructed items or did not attend any assessment, their responses of that time were considered missing data. For all the variables, Little's MCAR (Missing completely at Random) test showed that the MCAR assumption could not be rejected ($ps > .05$). Missing data were handled using multiple imputations as recommended (Bell et al., 2014). We performed a baseline comparison using a chi-square test for categorical variable and independent *t*-tests for continuous variables. The intervention effects were analyzed with two-factor mixed-design ANOVAs (time as a within-subjects factor, group as a between-subjects factor). The Huynh-Feldt correction was used to compensate for sphericity violations. The Partial eta-squared (η_p^2) was reported as an indicator of effect size in ANOVA tests, where .06 represents a medium effect and .14 a large effect (Cohen, 1988).

3.2. Results

Baseline condition

Independent *t*-test showed that no significant difference was found at baseline in FFMQ (*ps* > .05), K10 (p = .104), CPSS (p = .741), or PERMA Profiler (*ps* > .05) between the intervention group and the control group. See Table 2 for the means and standard deviations of all the measures for both groups.

Manipulation check

2 (Time: Pre-/Post-) × 2 (Group: Intervention/Control) mixed-design ANOVAs were conducted separately for total FFMQ, observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience (see Table 2 for details). It was shown that the time by group interaction was found to be significant in total FFMQ (p = .001), acting with awareness (p = .003), nonjudging (p = .022), and non-reactivity (p = .012). Participants of MBI groups showed significant improvement in mindfulness levels across time.

Intervention effects on emotional distress and PERMA wellbeing

We conducted separately two 2 (Time: Pre-/Post-) × 2 (Group: Intervention/Control) mixed-design ANOVAs for K10 and CPSS. Results showed that the time by group interaction was significant for K10 (p < .001) and CPSS (p = .001) (Table 2). Participants who received intervention got greater alleviation in emotional distress than others.

2 (Time: Pre-/Post-) × 2 (Group: Intervention/Control) mixed-design ANOVAs revealed a significant time by group effect for meaning (p = .013), negative emotions (p = .004), and self-perceived physical health (p = .023) (Table 2). Compared to baseline, a greater level of meaning and health, as well as fewer negative emotions were found in the MBI group than in the other group at post-assessment.

Follow-up changes in mindfulness, emotional distress, and PERMA well-being

We performed 3 (Time: Pre-/Post-/Follow-up) × 2 (Group: Intervention/Control) mixed-design repeated-measures ANOVAs to investigate changes in intervention effects between baseline, post-assessment, and 6-month follow-up. To facilitate the understanding, only total FFMQ was included in the following analysis as representative of the change in mindfulness level.

Similarly, significant time by group interaction was found in total FFMQ ($F_{(2, 134)}$ = 7.49, p = .001, η_p^2 = .10), K10 ($F_{(2, 134)}$ = 11.54, p < .001, η_p^2 = .15), CPSS ($F_{(2, 134)}$ = 7.76, p = .001, η_p^2 = .10), meaning ($F_{(2, 134)}$ = 4.10, p = .019, η_p^2 = .06), negative emotions ($F_{(2, 134)}$ = 4.81, p = .010, η_p^2 = .07), and self-perceived physical health ($F_{(2, 134)}$ = 3.24, p = .042, η_p^2 = .05).

Both groups showed significant simple main effects on total FFMQ (MBI group, $F_{(2, 134)}$ = 31.73, p < .001, η_p^2 = .321; control group, $F_{(2, 134)}$ = 3.41, p = .036, η_p^2 = .048) and CPSS (MBI group, $F_{(2, 134)}$ = 33.35, p < .001, η_p^2 = .33; control group, $F_{(2, 134)}$ = 3.30, p = .040, η_p^2 = .047). Only MBI group showed significant simple main effects on K10 ($F_{(2, 134)}$ = 32.89, p < .001, η_p^2 = .33), meaning

Table 2. Baseline, post-intervention, 6-month follow-up estimated means, standard deviations, ANOVA and effect sizes for outcome measures in study 1.

Measure	Pre		Post		Follow-up		Statistics	
	MBI (M ± SD)	Control (M ± SD)	MBI (M ± SD)	Control (M ± SD)	MBI (M ± SD)	Control (M ± SD)	Pre to Post within group (effect of time)	Pre to post between group (time by group interaction)
Mindfulness (FFMQ)								
Total	109.48 ± 13.19	110.77 ± 13.63	126.89 ± 16.34	115.07 ± 13.17	128.14 ± 15.46	117.63 ± 13.05	$F_{(1, 67)} = 35.49^{***}$, $\eta_p^2 = .35$	$F_{(1, 67)} = 12.92^{**}$, $\eta_p^2 = .16$
Observing	22.24 ± 4.36	22.71 ± 5.27	25.11 ± 5.64	23.77 ± 5.64	26.19 ± 4.62	24.61 ± 4.65	$F_{(1, 67)} = 9.53^{**}$, $\eta_p^2 = .13$	$F_{(1, 67)} = 2.01$, $\eta_p^2 = .03$
Describing	24.87 ± 5.27	24.12 ± 5.35	27.84 ± 5.00	24.79 ± 5.49	27.61 ± 4.24	25.55 ± 4.60	$F_{(1, 67)} = 9.77^{**}$, $\eta_p^2 = .13$	$F_{(1, 67)} = 3.88$, $\eta_p^2 = .06$
Acting with awareness	22.53 ± 5.53	24.00 ± 5.44	26.55 ± 4.73	23.60 ± 5.33	27.21 ± 4.15	23.73 ± 5.68	$F_{(1, 67)} = 6.29^{*}$, $\eta_p^2 = .09$	$F_{(1, 67)} = 9.39^{**}$, $\eta_p^2 = .12$
Non-Judging	22.85 ± 5.38	23.20 ± 4.97	27.30 ± 6.24	24.81 ± 4.88	25.95 ± 4.82	25.01 ± 4.71	$F_{(1, 67)} = 24.93^{***}$, $\eta_p^2 = .27$	$F_{(1, 67)} = 5.47^{*}$, $\eta_p^2 = .08$
Non-reactivity	16.57 ± 3.02	16.81 ± 4.12	20.49 ± 3.30	18.39 ± 4.40	21.90 ± 3.75	18.83 ± 3.54	$F_{(1, 67)} = 36.35^{***}$, $\eta_p^2 = .35$	$F_{(1, 67)} = 6.60^{*}$, $\eta_p^2 = .09$
Emotional distress								
K10	30.46 ± 5.77	28.16 ± 5.82	21.09 ± 5.42	26.20 ± 7.16	22.59 ± 5.01	27.59 ± 6.12	$F_{(1, 67)} = 47.735^{***}$, $\eta_p^2 = .42$	$F_{(1, 67)} = 20.45^{***}$, $\eta_p^2 = .23$
CPSS	34.90 ± 5.88	34.47 ± 5.02	25.62 ± 5.66	31.29 ± 6.51	26.22 ± 6.81	32.04 ± 7.37	$F_{(1, 67)} = 51.77^{***}$, $\eta_p^2 = .44$	$F_{(1, 67)} = 12.46^{**}$, $\eta_p^2 = .16$
Wellbeing (PERMA Profiler)								
Positive Emotion	4.62 ± 1.69	5.02 ± 1.29	5.58 ± 1.40	5.49 ± 1.49	5.89 ± 1.64	5.63 ± 1.54	$F_{(1, 67)} = 12.67^{**}$, $\eta_p^2 = .16$	$F_{(1, 67)} = 1.51$, $\eta_p^2 = .02$
Engagement	5.26 ± 1.73	5.30 ± 1.53	6.00 ± 1.74	5.69 ± 1.37	5.80 ± 1.30	5.28 ± 1.33	$F_{(1, 67)} = 7.00^{*}$, $\eta_p^2 = .10$	$F_{(1, 67)} = .68$, $\eta_p^2 = .01$
Relationship	5.46 ± 2.04	5.70 ± 1.38	5.95 ± 1.53	6.00 ± 1.37	6.41 ± 1.30	6.25 ± 1.22	$F_{(1, 67)} = 4.07^{*}$, $\eta_p^2 = .06$	$F_{(1, 67)} = .23$, $\eta_p^2 = .00$
Meaning	5.67 ± 2.00	6.25 ± 1.81	6.59 ± 2.03	6.01 ± 2.03	6.53 ± 1.34	6.03 ± 1.41	$F_{(1, 67)} = 2.29$, $\eta_p^2 = .03$	$F_{(1, 67)} = 6.52^{*}$, $\eta_p^2 = .09$
Achievement	5.67 ± 1.29	5.87 ± 1.67	6.13 ± 1.61	6.01 ± 1.55	6.74 ± 1.32	6.12 ± 1.47	$F_{(1, 67)} = 3.19$, $\eta_p^2 = .05$	$F_{(1, 67)} = .96$, $\eta_p^2 = .01$
Negative Emotion	5.90 ± 1.44	5.70 ± 1.29	4.54 ± 1.69	5.43 ± 1.47	5.70 ± 1.67	5.43 ± 1.32	$F_{(1, 67)} = 20.43^{***}$, $\eta_p^2 = .23$	$F_{(1, 67)} = 9.05^{**}$, $\eta_p^2 = .12$
Self-perceived Health	4.85 ± 1.96	5.21 ± 1.83	5.82 ± 1.86	5.15 ± 1.87	6.16 ± 1.42	5.62 ± 1.81	$F_{(1, 67)} = 4.28^{*}$, $\eta_p^2 = .06$	$F_{(1, 67)} = 5.45^{*}$, $\eta_p^2 = .08$

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

($F_{(2, 134)} = 5.28$, $p = .01$, $\eta_p^2 = .07$), negative emotions ($F_{(2, 134)} = 12.53$, $p < .001$, $\eta_p^2 = .16$), and self-perceived physical health ($F_{(2, 134)} = 9.69$, $p < .001$, $\eta_p^2 = .13$). Compared between pre- and follow-up, only participants of MBI group reported significant improvement in total mindfulness ($p < .001$) and significant decrease in CPSS and K10 ($ps < .001$). This significant difference was also shown in meaning and self-perceived physical health (from pre- to follow-up, $p = .031$, $p < .001$, respectively), but not in negative emotions ($p > .05$). Although received 2-day intervention after post-assessment, the control group did not show any significant difference between pre- and follow-up for all variables ($ps > .05$).

3.3. Discussion

Study 1 aimed to investigate the benefits of an 8-week MBI for participants with emotional distress from a PERMA perspective. Participants' mindfulness abilities, as measured by FFMQ, improved after the intervention compared with those of the control group. Consistent with our hypotheses, both K10 and CPSS showed that the intervention significantly reduced participants' emotional distress. The changes in PERMA profiles revealed that our intervention led to significant increases in *self-perceived physical health* and the PERMA well being component *meaning*. The intervention group experienced significantly fewer negative emotions than the control group. However, unlike other outcomes, this beneficial intervention effect on negative emotions was not observed at a 6-month follow-up. Our results provided a primary account of positive effects on well-being in PERMA profiles participants with high emotional distress gained from mindfulness intervention.

However, several questions remained. Firstly, among all five pillars of well-being, only meaning increased across time in the MBI group. In Wingert et al. (2022)'s study, engagement was also a beneficial effect gained by participants. Theoretically, engagement was frequently associated with mindfulness. According to Csikszentmihalyi's theory, flow is a mental state in which people are completely focused on the task when certain conditions were met (Csikszentmihalyi, 2014). While explaining the PERMA theory, Seligman (2011) also mentioned that "engagement is about flow" (p. 11). Mindfulness training has shown promising results for increasing flow experiences (Aherne et al., 2011; Bernier et al., 2009). Hence, we expected that our intervention would have similar effects on the engagement component. Secondly, one of the major limitations of this study was the lack of multi-time measurements, which were required by prevailing statistical methods for exploring casual relationships (Garland et al., 2017; Goldin et al., 2017; Labelle et al., 2014; Usami et al., 2019). Given this limitation, study 1 did not allow us to explore what happened during the intervention. These two constraints would be addressed separately in study 2 and study 3.

4. Study 2

In the second study, due to the COVID-19, another RCT was performed online

to confirm the observed effects of the 8-week MBI on PERMA well-being among individuals with high emotional distress. We expected to repeat our previous results, that is, to find significant time by group interactions on meaning, negative emotions, and self-perceived health. Particularly, we would like to find out if participants would show increased engagement after the intervention.

4.1. Materials and Methods

Procedure

Participants were initially recruited via online advertisements (Zhengnianyanxi, 2020). Inclusion and exclusion criteria were the same as in study 1. One additional exclusion criterion was showing difficulty during online communication since the whole trial would be conducted via the internet. Of 532 individuals who completed our online questionnaires, 344 met our inclusion criteria and were invited to attend the subsequent screening process. 90 participants did not answer the invitation to the interview or did not show up at the pre-determined time. 254 individuals received an online structured interview using the MINI-International Neuropsychiatric Interview given by trained interviewers (7 psychology graduate students and 1 research assistant). The CONSORT flowchart of participants is shown in **Figure 2**. In total, 129 participants (sample 2) who accomplished the online pre-assessment were randomly assigned to either an online guided MBI group, an online self-help MBI group, or a waiting-list control group independently by YG. 1 participant declared to quit the experiment upon receiving the result of group allocation because of a schedule conflict. Demographic information is presented in **Table 1**. All participants signed informed consent by an online document. All participants received certificates as remuneration. In addition, from an ethical consideration, individuals who were on the waiting list were provided with the online self-help MBI course after the post-test.

Assessment instruments

We adopted instruments of study 1 to assess participants' emotional distress (the K10 and the CPSS), and well-being (the PERMA profiler). The K10 and the CPSS were measured before, after, and each week during the intervention. For mindfulness, to reduce participants' burden, they completed the 39-items version of FFMQ as in our first study during pre- and post-assessments, and the 20-items short form of FFMQ each week within the intervention period. Scoring of the FFMQ-SF was applied to the complete version of FFMQ to enable comparisons with other variables (Hou et al., 2014). Cronbach's alpha of K10 and CPSS was .930 and .911, respectively. The PERMA profiler also showed good consistencies in *positive emotions* (α = .877), *engagement* (α = .639), *relationships* (α = .818), *meaning* (α = .850), *achievement* (α = .836), *negative emotions* (α = .711), *self-perceived physical health* (α = .924) in the present study. The overall score, as well as individual subscales of FFMQ-SF, showed good internal consistencies as well (α = .814 to .889).

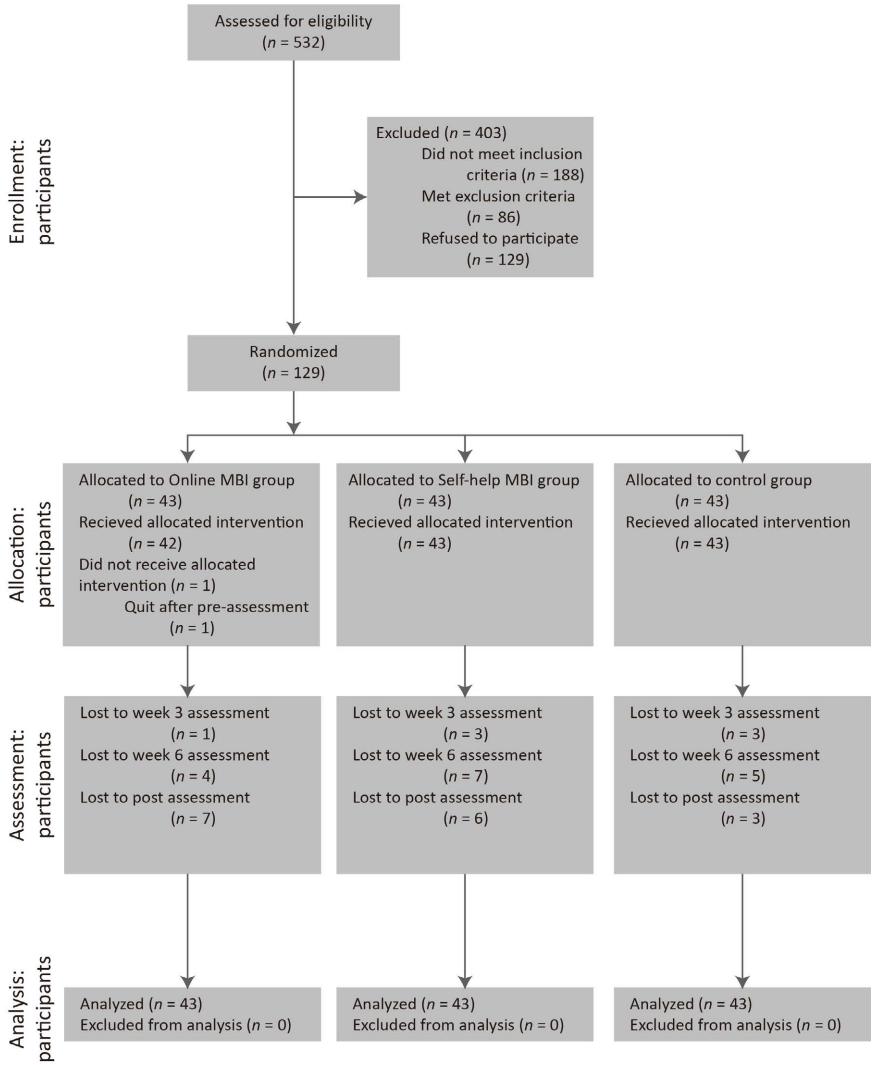


Figure 2. CONSORT flowchart of participants in sample 2.

Intervention

The corresponding author, XL, provided the guided MBI as in study 1 through Zoom meeting (Zoom, Zoom Video Communications, Inc., San Jose) because the MBI could not be performed offline due to the COVID-19 policy. The online self-help courses were provided through the WeChat App (WeChat, Tencent Inc., Shenzhen). All course materials were recorded, written, edited, and proofread by XL. Participants were required to spend 30 to 60 mins every day, practicing formal and informal mindfulness activities following given instructions during the self-help course. The online MBI course (One group session per week, 50 days in total) lasted longer than the online self-help course (49 days). The program was the same among both interventional groups, called the Mindfulness Intervention for Emotional Distress nowadays.

Data analysis

All data were first analyzed using SPSS (20.0; SPSS, Inc, Chicago) with a signi-

ficance level set at .05. We adopted a less strict standard, which allowed participants to have one false answer to the instructed items because due to the epidemic, all measurements were conducted without monitoring (e.g. at home), which might lead to a less attentive response for all participants. Kam and Chan (2018)'s study indicated that it showed a similar screening effect with the strictest cut-off value (i.e., all-or-none). Since Little's MCAR test showed that the MCAR assumption could not be rejected for all measures (*ps* > .05), missing data were handled using multiple imputations. A comparison using chi-square test and one-way ANOVAs was performed for measures of pre-assessment. The intervention effects were analyzed with two-factor mixed-design ANOVAs (2 times: Pre-, Post) × (3 groups: online MBI, self-help, waiting list). The Huynh-Feldt correction was used to compensate for sphericity violations. The Partial eta-squared (η_p^2) was reported as an indicator of effect size in ANOVA tests (Cohen, 1988). As for the comparison between study 1 and study 2, an overall effect size in Hedges'g units along with a 95% confidence interval (CI) for each study were computed through R statistical software environment using the "meta", "dmetar", and "esc" packages. To prevent the unit-of-analysis error, the effect sizes of two intervention groups were pooled to obtain one single comparison to the control group (Harrer et al., 2019).

4.2. Results

Baseline condition

One-way ANOVAs *t*-test showed that no significant difference was found at baseline in FFMQ-SF (*ps* > .05 except for observation, $p = .046$), K10 ($p = .885$), CPSS ($p = .953$), or PERMA Profiler (*ps* > .05) among all three groups.

Intervention effects

2 (Time: Pre-/Post-) × 3 (Group: online MBI/online self-help MBI/Control) mixed-design ANOVAs were conducted separately for total FFMQ, observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience, K10, CPSS, PERMA-positive emotions, engagement, relationships, meaning, achievement, negative emotions, self-perceived physical health (see **Table 3** for details). It was shown that time by group interaction was found to be significant in total FFMQ ($p < .001$), observing ($p = .001$), describing ($p = .037$), acting with awareness ($p = .028$), non-reactivity ($p = .001$), K10 ($p < .001$), CPSS ($p = .021$), meaning ($p = .022$), and negative emotions ($p = .026$).

Simple main effect analysis showed that both intervention groups showed similar effects for almost all variables. More specifically, total FFMQ (online MBI: $F_{(1, 126)} = 68.90$, $p < .001$, $\eta_p^2 = .35$; self-help: $F_{(1, 126)} = 46.59$, $p < .001$, $\eta_p^2 = .27$), observing (online MBI: $F_{(1, 126)} = 23.34$, $p < .001$, $\eta_p^2 = .16$; self-help: $F_{(1, 126)} = 19.60$, $p < .001$, $\eta_p^2 = .14$), describing (online MBI: $F_{(1, 126)} = 5.87$, $p = .017$, $\eta_p^2 = .05$; self-help: $F_{(1, 126)} = 6.87$, $p = .010$, $\eta_p^2 = .05$), acting with awareness (online MBI: $F_{(1, 126)} = 12.54$, $p < .001$, $\eta_p^2 = .09$; self-help: $p = .138$),

Table 3. Baseline, week 3, week 6, post-intervention estimated means, standard deviations, ANOVA and effect sizes for outcome measures in study 2.

Measure	Pre			Week 3			Week 6			Post			Statistics	
	Online MBI (M ± SD)	Self-help MBI (M ± SD)	Control (M ± SD)	Online MBI (M ± SD)	Self-help MBI (M ± SD)	Control (M ± SD)	Online MBI (M ± SD)	Self-help MBI (M ± SD)	Control (M ± SD)	Online MBI (M ± SD)	Self-help MBI (M ± SD)	Control (M ± SD)	Pre to Post within group (effect of time)	Pre to post between group (time by group interaction)
Mindfulness (FFMQ-SF)														
Total	56.01 ± 6.92	58.84 ± 8.55	58.32 ± 9.08	59.68 ± 8.74	59.90 ± 7.73	58.68 ± 7.74	63.13 ± 7.97	63.38 ± 7.60	59.09 ± 8.41	65.09 ± 6.97	66.31 ± 7.13	59.02 ± 7.38	$F_{(1, 126)}$ = 82.83***, η_p^2 = .40	$F_{(2, 126)}$ = 16.53***, η_p^2 = .21
Observing	11.01 ± 2.64	12.12 ± 3.05	12.58 ± 3.21	12.25 ± 2.59	12.34 ± 2.74	12.24 ± 3.31	13.00 ± 2.55	13.45 ± 2.99	12.39 ± 2.93	12.93 ± 2.63	13.88 ± 3.21	12.56 ± 3.01	$F_{(1, 126)}$ = 28.23***, η_p^2 = .18	$F_{(2, 126)}$ = 7.36, η_p^2 = .11
Describing	11.76 ± 2.80	12.04 ± 3.06	12.28 ± 3.17	11.95 ± 2.94	12.51 ± 2.43	12.38 ± 2.73	12.45 ± 2.59	13.02 ± 2.39	12.36 ± 2.62	12.79 ± 2.70	13.16 ± 2.39	12.00 ± 2.86	$F_{(1, 126)}$ = 6.39*, η_p^2 = .05	$F_{(2, 126)}$ = 3.40*, η_p^2 = .05
Acting with awareness	11.30 ± 3.06	11.97 ± 2.97	11.20 ± 3.89	11.96 ± 2.71	11.74 ± 3.20	11.14 ± 3.24	12.67 ± 2.70	11.35 ± 3.04	11.02 ± 3.45	13.09 ± 2.72	12.72 ± 2.48	11.05 ± 3.49	$F_{(1, 126)}$ = 7.47**, η_p^2 = .06	$F_{(2, 126)}$ = 3.69*, η_p^2 = .06
Non-Judging	12.12 ± 2.22	12.90 ± 2.64	11.74 ± 3.02	13.16 ± 2.51	12.65 ± 3.14	12.18 ± 2.60	13.10 ± 2.93	13.24 ± 2.98	12.12 ± 2.83	14.14 ± 2.23	14.33 ± 2.60	12.71 ± 2.51	$F_{(1, 126)}$ = 36.82***, η_p^2 = .23	$F_{(2, 126)}$ = 1.57, η_p^2 = .02
Non-reactivity	9.97 ± 2.35	9.90 ± 2.57	10.40 ± 3.13	10.60 ± 2.29	10.88 ± 2.24	11.07 ± 2.35	11.79 ± 2.10	12.32 ± 2.09	11.22 ± 2.60	11.93 ± 2.18	12.29 ± 2.00	10.54 ± 2.22	$F_{(1, 126)}$ = 33.80***, η_p^2 = .21	$F_{(2, 126)}$ = 7.12**, η_p^2 = .10
Emotional Distress														
K10	27.29 ± 5.92	26.99 ± 7.92	27.78 ± 8.44	23.53 ± 6.84	25.21 ± 8.20	27.53 ± 7.97	22.15 ± 7.61	22.74 ± 8.47	25.81 ± 8.54	21.35 ± 6.53	20.52 ± 7.34	27.50 ± 8.16	$F_{(1, 126)}$ = 54.39***, η_p^2 = .30	$F_{(2, 126)}$ = 11.90***, η_p^2 = .16
CPSS	33.00 ± 7.27	33.28 ± 8.19	32.77 ± 7.44	29.59 ± 7.64	30.58 ± 8.29	32.12 ± 6.82	29.20 ± 8.17	27.93 ± 7.55	31.25 ± 6.95	26.61 ± 6.14	27.54 ± 7.27	30.29 ± 7.03	$F_{(1, 126)}$ = 64.26***, η_p^2 = .34	$F_{(2, 126)}$ = 3.96*, η_p^2 = .06
Wellbeing (PERMA)														
Positive Emotion	5.01 ± 1.84	5.21 ± 1.80	5.04 ± 1.68	5.33 ± 1.86	5.39 ± 1.86	5.19 ± 1.68	5.68 ± 1.67	5.61 ± 2.01	5.30 ± 1.93	6.18 ± 1.70	6.33 ± 1.90	5.52 ± 1.72	$F_{(1, 126)}$ = 44.00***, η_p^2 = .26	$F_{(2, 126)}$ = 2.61, η_p^2 = .04
Engagement	5.18 ± 1.69	5.42 ± 1.62	4.89 ± 1.59	5.37 ± 1.58	5.36 ± 1.63	4.92 ± 1.73	5.51 ± 1.65	5.88 ± 1.62	5.25 ± 1.67	6.06 ± 1.79	6.20 ± 1.47	5.16 ± 1.79	$F_{(1, 126)}$ = 20.75***, η_p^2 = .14	$F_{(2, 126)}$ = 1.85, η_p^2 = .03
Relationship	5.53 ± 1.82	5.56 ± 1.87	5.52 ± 1.72	6.04 ± 1.77	5.97 ± 1.84	5.65 ± 1.76	6.19 ± 1.59	6.09 ± 1.71	5.84 ± 1.45	6.35 ± 1.53	6.22 ± 2.08	5.70 ± 1.74	$F_{(1, 126)}$ = 17.21***, η_p^2 = .12	$F_{(2, 126)}$ = 2.13, η_p^2 = .03
Meaning	6.25 ± 1.78	5.99 ± 2.09	6.03 ± 2.00	6.26 ± 1.57	6.15 ± 2.31	6.02 ± 1.83	6.44 ± 1.55	6.34 ± 1.71	6.36 ± 1.62	6.82 ± 1.65	6.61 ± 2.05	5.82 ± 1.76	$F_{(1, 126)}$ = 5.81*, η_p^2 = .04	$F_{(2, 126)}$ = 3.96*, η_p^2 = .06

Continued

Achievement	5.65 ± 2.12	5.72 ± 2.10	5.67 ± 1.68	5.84 ± 1.56	5.76 ± 1.96	5.66 ± 1.53	6.04 ± 1.47	6.20 ± 1.48	6.03 ± 1.55	6.57 ± 1.54	6.38 ± 1.56	5.90 ± 1.53	$F_{(1, 126)}$ = 15.77***, η_p^2 = .11	$F_{(2, 126)}$ = 1.76, η_p^2 = .03
Negative Emotion	5.10 ± 1.53	5.40 ± 1.67	5.14 ± 1.62	4.69 ± 1.70	5.17 ± 1.78	4.93 ± 1.48	4.37 ± 1.48	5.01 ± 1.75	5.25 ± 1.86	4.29 ± 1.54	4.46 ± 1.62	5.08 ± 1.53	$F_{(1, 126)}$ = 18.05***, η_p^2 = .13	$F_{(2, 126)}$ = 3.74*, η_p^2 = .06
Self-perceived Health	5.66 ± 1.87	5.81 ± 2.04	5.87 ± 1.89	5.82 ± 1.77	5.87 ± 1.95	5.93 ± 1.70	6.18 ± 1.73	5.81 ± 1.91	5.82 ± 1.41	6.39 ± 1.86	6.20 ± 2.01	5.90 ± 1.74	$F_{(1, 126)}$ = 5.27*, η_p^2 = .04	$F_{(2, 126)}$ = 1.44, η_p^2 = .02

*p < .05. **p < .01. ***p < .001.

non-reactivity (online MBI: $F_{(1, 126)}$ = 19.25, p < .001, η_p^2 = .13; self-help: $F_{(1, 126)}$ = 28.68, p < .001, η_p^2 = .19), K10 (online MBI: $F_{(1, 126)}$ = 35.77, p < .001, η_p^2 = .22; self-help: $F_{(1, 126)}$ = 42.34, p < .001, η_p^2 = .25), CPSS (online MBI: $F_{(1, 126)}$ = 36.83, p < .001, η_p^2 = .23; self-help: $F_{(1, 126)}$ = 29.80, p < .001, η_p^2 = .19), meaning (online MBI: $F_{(1, 126)}$ = 5.87, p = .017, η_p^2 = .04; self-help: $F_{(1, 126)}$ = 7.05, p = .009, η_p^2 = .05), and negative emotions (online MBI: $F_{(1, 126)}$ = 10.77, p = .001, η_p^2 = .08; self-help: $F_{(1, 126)}$ = 14.70, p < .001, η_p^2 = .10). A significant simple main effect was found only on CPSS ($F_{(1, 126)}$ = 5.56, p = .020, η_p^2 = .04), but not on other variables for the control group.

Comparison between study 1 and study 2

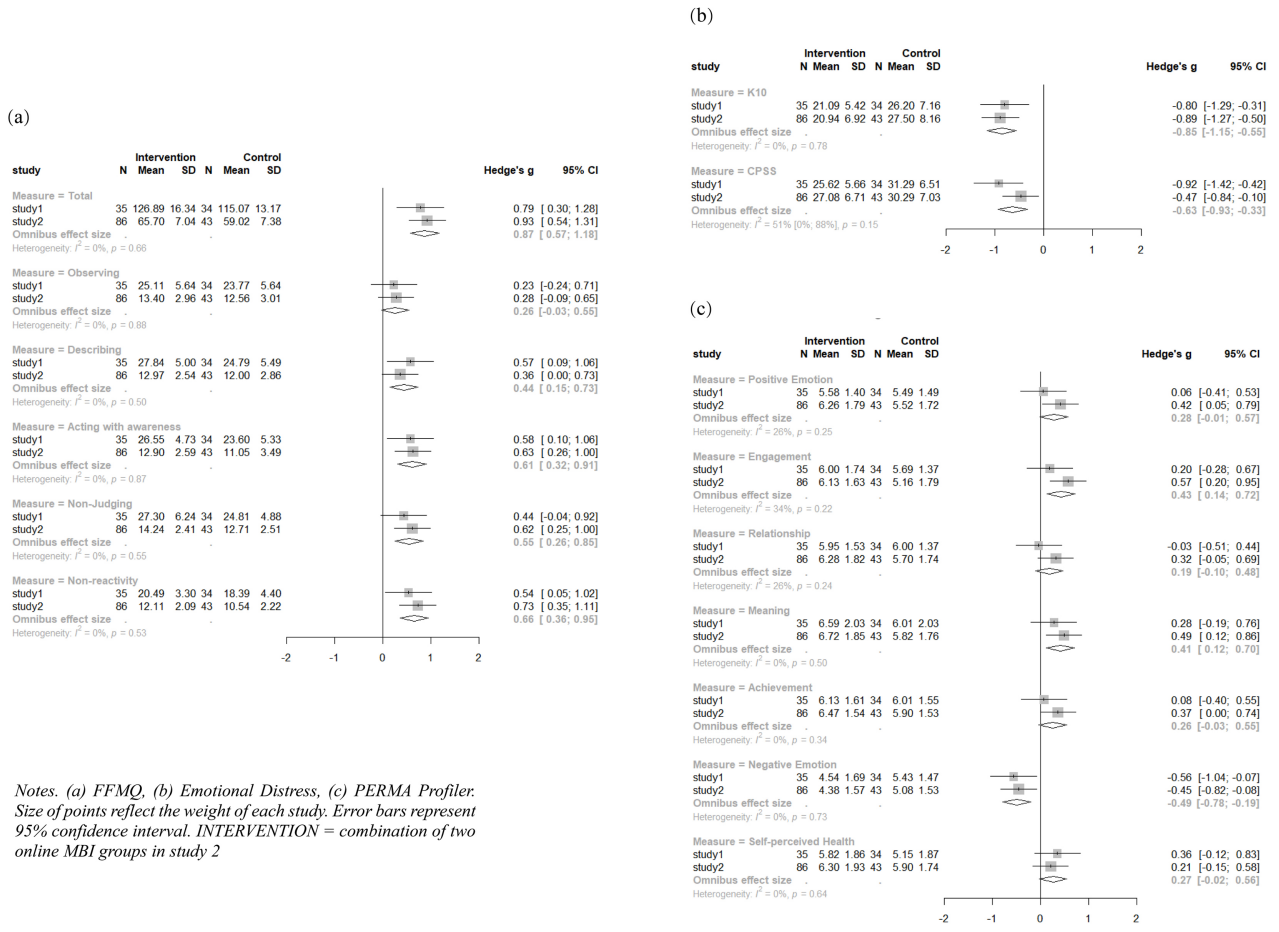
An overall omnibus effect was calculated for each outcome variable by aggregating the post-assessment results of study 1 and study 2. The fixed-effect model was adopted since our intervention targeted the same population and thus, we considered two studies to share common "true" effects (Gurevitch et al., 2018). Low heterogeneity was found across all variables (**Figures 3(a)-(c)**).

4.3. Discussion

Study 2 aimed to confirm the benefits of the 8-week MBI for participants with emotional distress obtained from study 1. ANOVA results indicated that the online MBI repeatedly led to increases in mindfulness abilities and PERMA-meaning, and decreases in emotional distress and PERMA-negative emotions. The meta-analytic results confirmed that our intervention effects were similar for all variables across studies.

5. Study 3

Previously we have demonstrated by two RCTs that among all five pillars of well-being, our MBI led to an increase in meaning. Our results were consistent with previous studies (Chu & Mak, 2019). The next step was to investigate which constructs, cultivated by MBI, led to the enhanced meaning. The previous meta-analysis indicated that mindfulness skill was an important mechanism of change for people with physical and psychological conditions (Alsubaie et al., 2017; Martin, Gillath, Deboeck, Lang, & Kerr, 2017). It has also been reported



Notes. (a) FFMQ, (b) Emotional Distress, (c) PERMA Profiler. Size of points reflect the weight of each study. Error bars represent 95% confidence interval. INTERVENTION = combination of two online MBI groups in study 2

Figure 3. Size of pointsrelfect the weight of each study. Error bars represent 95% confidence interval. INTERVENTION = combination of two online MBI groups in study 2. (a) Mindfulness (FFMQ/FFMQ-SF); (b) Emotional distress; (c) PERMA-Wellbeing.

that mindfulness skill was a significant predictor of improvement of meaning in life in caregivers (Kogler et al., 2015). Therefore, in the third study, we considered mindfulness skills (i.e. observing, describing, acting with awareness, non-judging, non-reactivity, and total mindfulness level) as our potential candidates. Although mediation analysis was often adopted to demonstrate the relationships between mechanism and outcome variables based on cross-sectional data. As suggested by Kazdin (2007), the cross-sectional design did not provide enough evidence for understanding the mechanism of intervention, because the timeline of the proposed mechanism and outcome variables was vital to distinguish the real antecedent and outcome variables, thereby revealing causal relationships. Given this, we re-analyzed baseline measures of study 1 and study 2 to discover if strong associations existed between mindfulness and meaning. Then, all four wave panel data of study 2 were modeled with the RI-CLPM (Usami et al., 2019) to establish the timeline. RI-CLPM allowed to control for the stability of constructs across time by inclusion of autoregressive relationships but also accounting for trait-like, time-invariant stability through the inclusion of a random intercept, thus allowing to infer causal relationships between mechanism and outcome va-

riables (Hamaker et al., 2015). Our hypotheses were: 1) mindfulness skills would show strong correlations with meaning at a cross-sectional level, and 2) earlier changes in mindfulness skills (*mechanism*) could predict later changes in meaning (*outcome*), but not vice versa.

5.1. Materials and Methods

Data analysis

Pearson (*r*)'s correlations were performed for baseline measures of study 1 and study 2 to provide cross-sectional relationships using SPSS (20.0; SPSS, Inc, Chicago, IL) with a significance level set at .05. Data of study 2 were independently modeled with six bivariate RI-CLPMs (Hamaker et al., 2015) through R statistical software environment using the "lavaan" package. As indicated by the results of mixed-design ANOVA, we considered individuals who received MBI, regardless if it's in the form of a guided or a self-help intervention, would show different growth trajectories than those who received nothing. We excluded individuals from the control group as in Hesser et al. (2018), which resulted in a mixed sample (sample 3, $N = 86$) of two MBI groups in study 2. Model fit measures included the chi-square test, root-mean-square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis index (TLI). Values above .10 indicated a poor fit for RMSEA (MacCallum et al., 1996), values above .10 for SRMR, and values below .90 for CFI and TLI were considered unacceptable.

5.2. Results

Cross-sectional correlations at baseline

Baseline correlations among outcomes in study 1 and study 2 were both illustrated in Table 4. Results suggested that the PERMA-meaning was correlated with FFMQ Total ($p < .001$), describing ($p = .002$), acting with awareness ($p < .001$), and non-reactivity ($p = .018$) in sample 1 at pre-assessment. In sample 2, the PERMA-meaning was strongly associated with the same measures, FFMQ Total ($p < .001$), describing ($p < .001$), acting with awareness ($p < .001$), and non-reactivity ($p = .002$).

Cross-lagged effects over time

We separately examined how meaning related to total FFMQ, observing, describing, acting with awareness (AWA), non-judging (NJ), and non-reactivity (NR) across four time-points in sample 3 ($N = 86$). Model fits were depicted in Table 5. Except for Meaning-Observing, other models showed acceptable fit. Figure 4 illustrated correlations of between-person or trait-level variables, within-person or state-level variables, and standardized autoregressive and cross-lagged estimates for state variables. Between-level correlations were significant for total FFMQ ($p = .004$), observing ($p = .007$), describing ($p = .022$), acting with awareness ($p = .029$), and non-reactivity ($p = .014$), but not for non-judging ($p = .570$). Within-level were significant for observing at week 6

Table 4. Intercorrelations for baseline outcome measures disaggregated by sample.

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. FFMQ Total	-	.54***	.64***	.61***	.43***	.48***	−.36**	−.42***	.51***	.53***	.45***	.52***	.57***	−.28*	.34**
2. FFMQ Observing	.49***	-	.39**	−.01	−.15	.32**	−.04	.07	.15	.19	.14	.23	.26*	−.07	.09
3. FFMQ Describing	.67***	.26**	-	.20	−.06	.18	−.17	−.21	.26*	.26**	.37**	.36**	.45***	.02	.11
4. FFMQ Acting with awareness	.67***	−.06	.32***	-	.26*	.07	−.47***	−.46***	.49***	.57***	.36**	.44***	.51***	−.25*	.20
5. FFMQ Non-Judging	.45***	−.30**	.13	.48***	-	.03	−.16	−.27*	.18	.11	.06	.02	−.06	−.24*	.24*
6. FFMQ Non-reactivity	.58***	.55***	.23*	.05	−.03	-	−.10	−.29*	.20	.24*	.24	.29*	.37**	−.21	.31*
7. K10	−.37***	.21*	−.21*	−.51***	−.42***	−.11	-	.63***	−.51***	−.39**	−.36**	−.49***	−.35**	.44***	−.35**
8. CPSS	−.59***	−.05	−.31***	−.51***	−.36***	−.46***	.62***	-	−.51***	−.38**	−.28*	−.48***	−.49***	.39**	−.49***
9. PERMA Positive Emotion	.54***	.16	.35***	.43***	.27**	.37***	−.56***	−.64***	-	.75***	.59***	.72***	.51***	−.33**	.54***
10. PERMA Engagement	.51***	.16	.30**	.53***	.20*	.22*	−.42***	−.47***	.72***	-	.49***	.64***	.49***	−.17.	.33**
11. PERMA Relationship	.35***	.03	.33***	.31***	.15	.18*	−.50***	−.49***	.73***	.48***	-	.51***	.40**	−.34**	.37**
12. PERMA Meaning	.42***	.16	.34***	.34***	.12	.27**	−.41***	−.48***	.74***	.60***	.65***	-	.75***	−.18	.39**
13. PERMA Achievement	.44***	.12	.35***	.45***	.08	.23**	−.35***	−.54***	.68***	.62***	.55***	.79***	-	.02	.42***
14. PERMA Negative Emotion	−.18*	.06	.06	−.21*	−.23**	−.20*	.48***	.55***	−.34***	−.19*	−.26**	−.15	−.14	-	−.21
15. PERMA Self-perceived Health	.27**	.03	.14	.26**	.17	.15	−.39***	−.45***	.56***	.42***	.46***	.51***	.43***	−.29**	-

Note. The results for the sample 1 (n = 69) are shown above the diagonal. The results for the sample 2 (n = 129) are shown below the diagonal. *$p < .05$. **$p < .01$. ***$p < .001$.

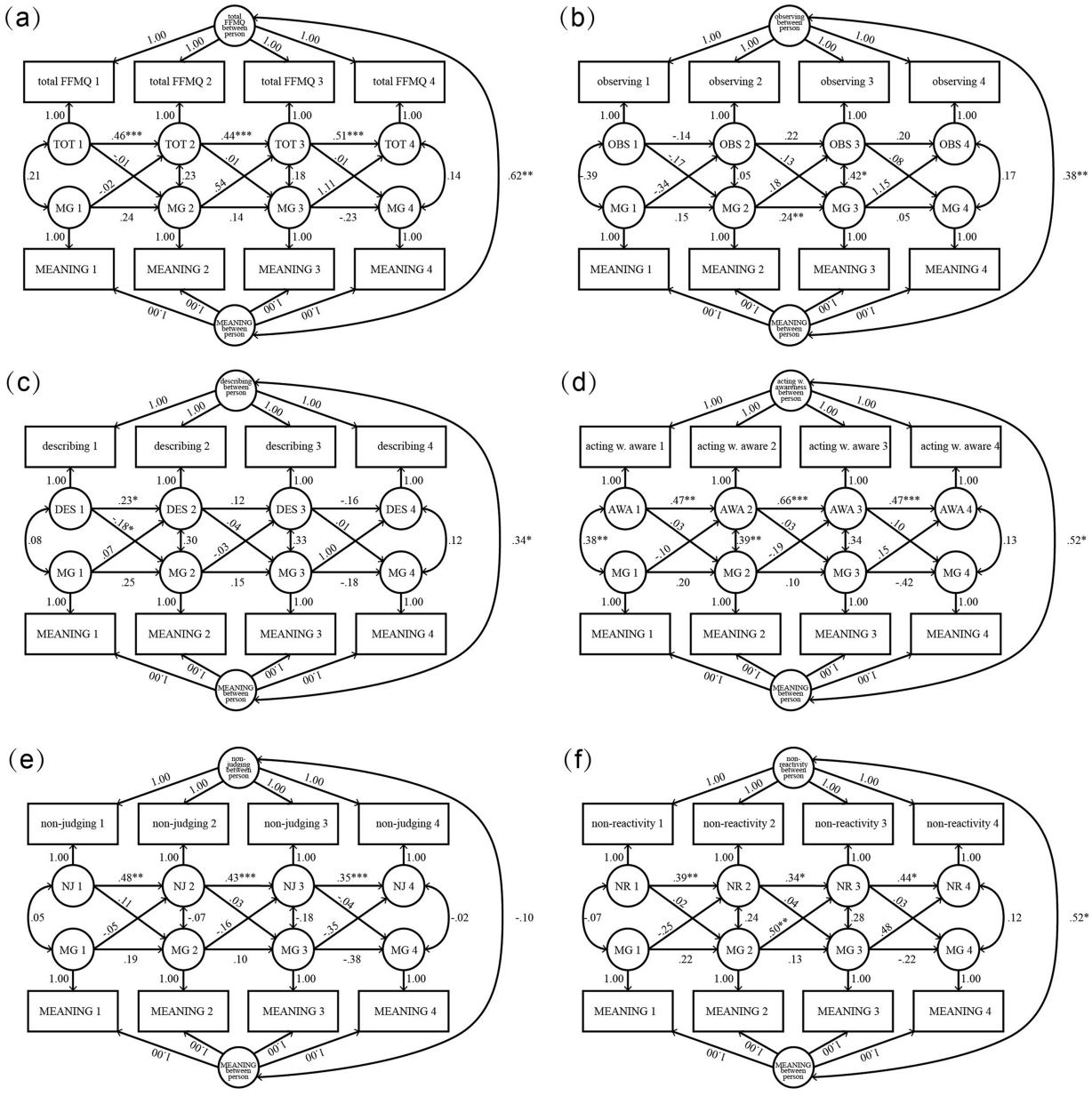
Table 5. Model fit measures for bivariate random intercept cross-lagged panel models (RI-CLPM).

Fit measure	Bivariate RI-CLPM					
	FFMQ Total	FFMQ Observing	FFMQ Describing	FFMQ Acting with awareness	FFMQ Non-Judging of inner experience	FFMQ Non-reactivity to inner experience
χ^2	16.57	24.68	11.23	4.181	3.89	16.01
df	9	9	9	9	9	9
RMSEA	.099, 90% CI [.00, .17]	.142, 90% CI [.08, .21]	.054, 90% CI [.00, .14]	.000, 90% CI [.00, .05]	.000, 90% CI [.00, .04]	.095, 90% CI [.00, .17]

Continued

SRMR	.05	.06	.05	.03	.02	.05
CFI	.98	.97	1.00	1.00	1.00	.98
TLI	.94	.89	.98	1.04	1.05	.94

Note. In all models, the Meaning of PERMA Profiler was included as the other dependent variable. RMSEA = root-mean-square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker-Lewis index.



Notes. Models depicting the relationship between PERMA meaning and FFMQ (a) total mindfulness level, (b) observation, (c) description, (d) act with awareness, (e) non-judging, (f) non-react over four time points. MG = meaning within person, TOT = total mindfulness level within person, OBS = observing within person, DES = describing within person, AWA = acting with awareness within person, NJ = non-judging of inner experience within person, NR = non-reactivity to inner experience within person. Specific time points are indicated by numbers after each variable: 1 = Pre, 2 = Week 3, 3 = Week 6, 4 = Post. * $p < .05$. ** $p < .01$. *** $p < .001$

Figure 4. Random intercept cross-lagged panel model depicting relationships between meaning and mindfulness.

(p = .042), acting with awareness at pre-assessment (p = .008) and week 3 (p = .008). After controlling the autoregressive effects, baseline describing negatively predicted meaning at week 3 (p = .023), while baseline meaning did not influence describing at week 3 (p = .752). Meaning at week 3 positively predicted non-reactivity at week 6 (p = .006). Inversely, non-reactivity at week 3 did not predict meaning at week 6 (p = .569). All remaining cross-lagged effects were not significant (see **Figure 4** for details).

5.3. Discussion

The present study focused on exploring the potential causal relationships between mindfulness skills and meaning. The overall mindfulness ability was found to be strongly correlated with meaning. As for the five facets of mindfulness abilities, our findings indicated that baseline level meaning was strongly associated with the overall as well as three distinct facets of mindfulness, i.e., describing, acting with awareness, and non-reactivity. Across four time points, trait-level meaning also showed strong correlations with trait-level describing, acting with awareness, and non-reactivity. Timelines were established between these potential mechanisms of action and outcome, and surprisingly, we found that describing negatively predicted the subsequent meaning change. An earlier increase in meaning predicted a later increase in non-reactivity. Neither the general mindfulness ability nor any of the independent facets of mindfulness ability was found to be a causal factor of the enhanced meaning. Conjointly, our findings might shed light on understanding the antecedents to mindfulness.

Cross-sectionally, describing, acting with awareness, and non-reactivity was positively correlated with meaning. The between-person level intercepts of these components were also found to be positively correlated with between-level meaning across four waves. These results showed a large level of consistency with previous literature in terms of describing, but some degree of discrepancy regarding acting with awareness and non-reactivity (Bloch et al., 2017; Hunecke & Richter, 2019; Iani et al., 2017; Kogler et al., 2015; Nolte et al., 2016). Mostly, previous findings highlighted that meaning, or purpose in life could be considered an integrated process. For instance, it was found by Bloch et al. (2017) that describing was positively correlated with the presence of meaning, but not with the search for meaning. However, in another study (Hunecke & Richter, 2019), describing was found to be positively correlated with the construction of meaning. Similarly, non-reactivity was significantly correlated with meaning in life (Kogler et al., 2015), construction of meaning (Hunecke & Richter, 2019), and presence of meaning, but not with the search of meaning (Bloch et al., 2017) or purpose in life (Iani et al., 2017; Nolte et al., 2016). In the present study, we found that earlier meaning positively predicted change in non-reactivity, and unexpectedly, baseline describing negatively predicted later meaning. Although no previous research has addressed this causal relationship using models containing cross-lagged effects, we could draw inspiration from the contradictory

cross-sectional findings and explore the temporal correlations between mindfulness and different perspective of meaning in the future.

6. General Discussion

Our study aimed to investigate the intervention effect of an 8-week MBI as well as its mechanism of change. We evaluated the interventional effects on both emotional distress and PERMA well-being. Results revealed that the MBI effectively alleviated participants' emotional distress, in the meanwhile, showed divergent effects on fostering different components of well-being. Seligman's five-element model was adopted to look in more detail into the MBI effect on well-being, among which, the meaning was consistently enhanced through the intervention. Subsequently, we explored how the intervention achieved such an effect by establishing timelines enabling inferring causal relationships between meaning and mindfulness abilities. We found that baseline describing negatively predicted week 3 meaning. The week 3 meaning was found to be a significant predictor of the week 6 non-reactivity in another independent model. Although we were unable to find the causal factor of increased meaning that existed in the intervention, we discovered the role meaning played in promoting mindful non-reactivity to inner experience. As such, the current work provides preliminary evidence for further exploration of the therapeutic mechanism of mindfulness in fostering well-being.

Repeatedly, we did not discover a significant improvement in positive emotions but did in negative emotions at post-assessment. Although negative emotions were not considered components of well-being in the PERMA model, it was frequently reported in the previous literature on subjective well-being. Previous RCT results of MBI effect on positive and negative emotions have shown inconsistency. The meditation awareness training conducted by Van Gordon, et al. (2014) reported an increase in positive emotions as well as a decrease in negative emotions. Some studies reported a significant improvement only in positive emotions (Fredrickson et al., 2017; Harris, Jennings, Katz, Abenavoli, & Greenberg, 2016; Howells, Ivtzan, & Eiroa-Orosa, 2016), while others, congruent with our study, only showed a reduction of negative emotions (Bhayee et al., 2016; Bluth, Gaylord, Campo, Mullarkey, & Hobbs, 2016). If we considered the retrospectively self-reported experienced emotions as an overlay of the processing of emotion generation and emotion regulation for the regulatory process durably accompanying the development of emotion over time (O'Day, Morrison, Goldin, Gross, & Heimberg, 2019), the contradictory results between effects on negative emotions and positive emotions might originate from differences in training components. For instance, novice, a representative population of MBI studies, frequently reported experiencing negative emotions (e.g. boring, anxious, etc.) rather than low-arousal positive emotions (e.g. peaceful, gratitude, etc.) during the body-scanning practice. On the other hand, some scholars have tried to answer the question about the different outcomes resulting from various

regulatory strategies (see Brockman, Ciarrochi, Parker, & Kashdan (2017) for an example). However, only a few studies have investigated the effects of different components of mindfulness training on well-being. One study compared different mindfulness-based strategies (i.e., sitting meditation, body scan, and mindful yoga) and found differential effects on psychological well-being, difficulties with emotion regulation, and the tendency to take a nonevaluative stance toward observed stimuli (Sauer-Zavala, Walsh, Eisenlohr-Moul, & Lykins, 2013). The mixed results suggested that further efforts might be needed to investigate intervention effects on specific types of emotions by comparing different practice components on multiple populations.

Against instinct, the time by group interaction on engagement was not significant in study 1 and study 2. In Wingert et al. (2022), the MBSP improved engagement in undergraduates. One reason that led to this difference could be that the MBSP program was a combination of two positive psychology approaches: mindfulness training and character strengths. A traditional MBI considered the body as an anchor which allowed one to connect with the present. Individuals learned to detect "thought", disengage from it, or just non-reactively monitor it (Kabat-Zinn, 2018). The mindfulness practice of MBSP encouraged individuals to mindfully develop one's strength, for instance, to direct and sustain attention on a thought (e.g. a strength) or an image (e.g. how to use one's signature strength to overcome an obstacle) during a mindfulness practice (Niemiec, 2014). This combination may, as the authors purposed, yield a larger effect on promoting engagement. Our results might also suggest that engagement in PERMA profiler and flow are different in terms of generalizability. Thirteen athletes participated in Aherne, et al. (2011)'s RCT study of a 6-week mindfulness training and found a significant main effect of time, a non-significant main effect of group, and a significant group × time interaction (η_p^2 = .51) on self-report flow experience. The flow questionnaire employed in Aherne, et al. (2011)'s study was "designed to be answered *after a specific event* to assess the experience of flow in that event" (p. 180). In our study, items regarding engagement were assessed more generally, for example, "How often do you become absorbed in what you are doing?", and "In general, to what extent do you feel excited and interested in things?" (Zeng & Kern, 2021). Besides, achieving flow requires a present-moment, non-self-conscious concentration on a particular activity that matches one's challenge-skill balance (Csikszentmihalyi, 2014). We speculate that long-term mindfulness practice would foster engagement in general.

Concerning the intervention outcomes, our findings consistently supported that the standardized MBI led to an increase in meaning. Further, we found that changes in meaning temporally preceded changes in mindfulness, which demonstrated that it could also be seen as a mechanism variable. However, the question regarding which components cultivated by MBI led to the enhanced meaning is still left unknown. Acting with awareness was a potential variable, for it

showed a stable association with meaning cross-sectionally and over time. The nonsignificant cross-lagged effects suggested that unobserved mechanism variables may exist in this relationship. One paramount target was authentic self-awareness (Brown & Ryan, 2003). Mindfulness meditation cultivates a non-elaborative, non-judgmental, present-centered attention (Bishop et al., 2006), or "bare" attention (Chiesa & Malinowski, 2011). The increased "bare" attention could contribute to forming a clearer vision of one's inner and outer worlds, subsequently enhance awareness of one's value and purpose (Chu & Mak, 2019), and in turn, lead to increased non-elaborately meaningful experiences in everyday life. Notably, more than one construct might be involved in this process (Kazdin, 2007). One potential hypothesis was put forward by Garland et al. (2015), the mindfulness-to-meaning theory. This theory suggests that mindfulness practice could "introduce flexibility into the creation of autobiographical meaning" (p. 295). The flexibility of the cognitive system (e.g. autobiographical memory) could be a potential target. Decentring was also proposed in this theory as an important mechanism variable, by which we might achieve the desired state of awareness or meta-awareness. Further work on investigating the mechanism underlying MBI's effect on well-being is warranted.

The present MBI led to significant gains in relationships and achievement as well, although lack of significant time for group interaction. The meta-analytic results coincided with previous findings (Wingert et al., 2022) and revealed relatively smaller effect sizes for these two components compared to other PERMA dimensions. It could be linked to the fact that the MBI course principally taught participants to cope with their inner experiences in a mindful way. Participants might gain more benefits at an intrapersonal level. Many studies suggested that the MBIs could lead to improvements in self-compassion, that is compassion and love towards oneself, which might contribute to the elevation of interpersonal relationships but in a limited way (Hofmann et al., 2011). The mindful communication practices during the guided session, where participants were required to listen and speak with intention and non-judgmental awareness, could be another origin of this beneficial effect. A greater number of practices might introduce desired changes in participants' lives. We inferred that the gain in the achievement component might come from two aspects: daily practices and psychoeducational content. Negative emotions (e.g. boring) experienced during mindfulness meditation practices are often one of the major obstacles for beginners. People who overcame these barriers and completed the whole program might benefit from the process of habit formation in addition to mindfulness-relevant content (Wood and Runger, 2016). On the other hand, participants gradually learned who they are and what they value as the course progresses. It might lead to changes in achievement if the habit of practicing could be kept.

The self-perceived physical health, measured by one of the filler dimensions of the PERMA-profiler, showed incongruity with previous literature. Several exist-

ing reviews and meta-analyses summarized the application of MBI in medicine and found that MBSR was reported to indeed have favorable effects in the area of HIV/AIDS (Yang et al., 2015), menopausal syndrome (Innes et al., 2010), etc. We considered two possible explanations: firstly, we questioned if this unstable finding was affected by the COVID-19. The first three time-points of measurement were performed during the epidemic, while at post-assessment, the spreading of the disease has been effectively controlled and people returned to work across the whole country (NHC, 2020). Secondly, the self-reported index may not be suitable for reflecting the intervention outcome on physical health.

As mentioned above, one of the major limitations of the current study was the lack of objective measures, e.g. behavioral, physiological, or neural indices of well-being. For example, Seligman (2011) mentioned that engagement was only accessible by retrospective self-report measures. However, what might occur during the intervention was that participants might believe they were engaged in life at the beginning, but as the program progressed, participants started to become aware of how frequently they are in a state of mind-wandering (IPPA, 2019). This beneficial intervention effect might, on the contrary, turn into a more modest estimation of one's engagement level than those reported in the baseline condition. In this case, adding an objective measure of engagement might contribute to explaining the discrepancy. Besides, physiological measures, such as heart rate variability, mean arterial blood pressure, cardiac output, or total peripheral resistance, could be compared with existing findings of self-perceived physical health (Mauss et al., 2007; Wang et al., 2013). Neural correlates of positive and negative emotions could also be addressed in future investigations on specific components of mindfulness for a more precise understanding of the beneficial effects of MBI on well-being (Aftanas et al., 2006; Egan et al., 2018; Hu et al., 2017). Secondly, more personal-level measures would be desired in future studies. For example, an additional investigation of the level or frequency of practice during the follow-up period could be added to see if it would explain the regained negative emotion at the 6-month follow-up in study 1. Another example would be the inclusion of a baseline measure of perceived barriers to meditation to investigate if it would moderate the intervention effects (Hunt et al., 2020). Thirdly, to narrower the confidence interval of the estimated parameters (Wolf et al., 2013), we augmented the sample size by combining the two intervention groups of study 2 when establishing the timelines between mechanism and outcome. However, although fit measures of models were acceptable, the final sample size ($N = 86$) was still quite small, which might lead to an inaccurate approximation of estimated parameters, by which true relationships between variables could be overestimated. The unexpected cross-lagged effect between describing and meaning needs to be verified as well. A validation of our results performed in other populations as well as in larger samples would also be desirable to strengthen the current evidence.

Clinical psychologists and mindfulness practitioners could draw inspiration from the current results. The course materials targeting the describing skill

might not need to be emphasized to optimize interventional outcomes on the condition that the current finding could be replicated. The non-reacting strategy or behavior in daily life might be a core indicator of a participant's progress in the MBI course for it is developed in a later stage, building on the improvements of other components such as meaning. It was suggested that all five pillars of PERMA represent one's optimal state of psychosocial functioning but also pathways to a flourishing life (Seligman, 2011). The diverse effects of each aspect of PERMA-wellbeing might suggest that mindfulness-based intervention programs with longer duration or tailored design were needed if aimed at helping people to achieve a flourishing life.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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