

The Four Immeasurables Meditations: Differential Effects of Appreciative Joy and Compassion Meditations on Emotions

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Abstract The four immeasurables meditations (FIMs) cultivate four different attitudes in Buddhism. However, in psychological research, these meditations have been combined and their differences have not been directly evaluated. The current study provided the first comparison between appreciative joy meditation (AJM) and compassion meditation (CM). Ninety college students were allocated to three groups which included AJM, CM, and neutral facial visualization in a laboratory setting. The students were asked to practice corresponding meditations for friends followed by that for strangers. The self-reported emotions were measured before and after the meditations for different targets, and the emotional Stroop task was administered following the meditation for friends. The major findings included the following: (1) AJM and CM for strangers enhanced other-focused positive emotions (e.g., love) compared with the control group, indicating both AJM and CM promote pro-socialness. (2) Compared with the other conditions, CM for friends and for strangers increased sadness and CM for friends decreased happiness and overall positive emotional valence, whereas

AJM for strangers enhanced happiness and overall positive emotional valence, suggesting that the two FIMs had different effects on emotional valence. (3) There were no significant interactions for self-focused positive emotions (e.g., pride) or interpersonal negative emotions (e.g., envy), but AJM exhibited a potential effect on the suppression of interpersonal negative emotions compared with the other conditions. (4) No significant interaction was found for low arousal positive emotions (e.g., calm) and overall arousal. (5) Findings from the Stroop task indicated that AJM tended to result in longer reaction times compared with the other groups, and daily appreciative joy also affected the reaction times. These findings indicate that FIMs should be differentiated in psychological research because of their different effects. The potential mechanisms underlying the effects of FIMs and their implications for research and practice of FIMs were also discussed.

Keywords Four immeasurables · Compassion meditation · Appreciative joy · Sympathetic joy · Loving-kindness meditation · Buddhism · Envy · Emotional Stroop

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Introduction

Buddhism emphasizes the cultivation of a group of four “sublime” or “novel” attitudes, which are referred to as “catasso appamaññāyo” in Pali (catasso-appamaññāyo 2016) and translated as “four immeasurables” (FI) in English. They include (1) “metta,” translated as loving-kindness, which indicates unselfish friendliness, (2) “karuna,” translated as compassion, which indicates a willingness to cease the suffering of the distressed, (3) “mudita,” translated as appreciative joy or sympathetic joy, which indicates feeling happiness for other individuals in success, good fortune, or happiness, and (4)

“upekkha,” translated as equanimity, which indicates calm towards the fate of other individuals based on wisdom (Kraus and Sears 2009; Zeng et al. 2015). Consistent with the multi-component model of attitudes (Rosenberg and Hovland 1960), the FI integrate cognitive, affective, and behavioral components.

In Buddhism, each of the FI is cultivated by a special meditation procedure and “four immeasurables meditation” (FIM) was used as a general reference in this article. The technical details of the FIMs vary across Buddhist traditions, and there has been no clear operational definition of FIMs to date. The core psychological operation of FIMs may be described as concentrating an individual’s mind on the generation of endogenous immeasurables. That is, FIMs require the regulation of attention similar to all meditations (Dahl et al. 2015) to maintain specific mental activity, and the special mental activity of generating endogenous immeasurables makes FIMs different from other meditations. Of note, the “endogenous” limits that FIMs comprise practices that generate attitudes from oneself towards targets and differ from practices that generate the same attitudes by receiving them from other individuals (e.g., Gilbert and Procter 2006) or recalling God with these attitudes (e.g., Engström and Söderfeldt 2010). Some researchers have considered the latter practices as FIMs (e.g., Hofmann et al. 2011); however, other researchers have emphasized that they differ from FIMs in terms of the underlying philosophy (Zeng et al. 2013) or Buddhist tradition (Shonin et al. 2014). Furthermore, to achieve the previously described core psychological operation, many supporting psychological operations are also widely used, including silently repeating sentences, recalling past experiences, and/or imagining interactions, such as the golden light from one’s heart towards targets. However, none of them are necessarily included in all traditions (e.g., Sujiva 2007, p. 20; Lutz et al. 2004) or all stages of practice (e.g., Brewer et al. 2011).

The difference between the FIMs is the immeasurable they generate, as well as components of the language, memory, and/or imaginations if used. In detail, the “loving-kindness meditation” (LKM) simply imagines an individual with a neutral emotional status or peaceful smile and blesses the individual to be happy with phrases such as “may you be happy” or “may you be successful.” The “compassion meditation” (CM) imagines an individual in suffering and negative emotions and blesses the individual away from suffering with phrases such as “may you free from suffering” or “may you become happy.” In contrast, “appreciative joy meditation” (AJM) imagines an individual in success or bliss and blesses the individual to maintain (or not lose) it with phrases such as “may you not lose what you gained” or “may you gain more in the future.” Finally, “equanimity meditation” (EM), which extends beyond the former three meditations, emphasizes an understanding of the karma of an imaged individual and thereby develops a peaceful attitude with understanding and

acceptance towards an individual with phrases such as “he (she) is the bearer of his (her) karma” (Sujiva 2007, p. 65–80; Zeng et al. 2015). All FIMs follow the order from easy to difficult when selecting imaged targets, for example, AJM is initiated from friends and subsequently moves to strangers (Nanamoli 2011, p. 309).

The empirical studies on FIMs have sharply increased within the last 5 years (Galante et al. 2014). A series of studies have demonstrated that FIMs may enhance positive emotions (Zeng et al. 2015), increase pro-social attitudes (e.g., Hutcherson, Seppala, Gross, 2008) and behaviors (Condon et al. 2013), and benefit individuals with clinical problems (see Shonin et al. 2014).

However, recent reviews have noted the problem that the four different FIMs in Buddhism were not well differentiated in psychological research (Zeng et al. 2013; Shonin et al. 2014; Zeng et al. 2015). Among the FIM interventions, some interventions have used LKM (e.g., Kearney et al. 2014), some interventions have focused on compassion and adopted CM (e.g., Jazaieri et al. 2013), and other approaches have integrated all FIMs (e.g., Wallmark et al. 2013). The details of the practices have not been clearly reported in all interventions (Shonin et al. 2014; Zeng et al. 2015); however, no study has claimed that their FIM intervention mainly focused on AJM or EM. Furthermore, no empirical study directly compared the effects of different FIM interventions. A recent meta-analysis on the effects of FIMs on positive emotions reported that LKM interventions exhibited a medium effect size, whereas CM interventions included 0 in a 95% CI; however, no significant difference existed between the two types of interventions (Zeng et al. 2015).

In addition to intervention studies, 12 papers have evaluated the effects of a one-shot practice of FIMs among meditation novices in the laboratory (Barnhofer et al. 2010; Burgard and May 2010; Crane et al. 2010; Feldman et al. 2010; Hutcherson et al. 2008, 2015; Logie and Frewen 2015; Parks et al. 2014; Seppala et al. 2015; Stell and Farsides 2016; Tonelli and Wachholtz 2014; Wheeler and Lenick 2014). Among these studies, only Wheeler et al. claimed to use CM and the phrases they used were also relevant to suffering (“May I be free of suffering and pain,” p 14). However, no suffering targets were imagined (Wheeler and Lenick 2014). The remaining 11 studies may be categorized as LKM because they claimed metta or “loving-kindness” and/or the targets and phrases used in the FIM did not specifically focus on the suffering or success of other individuals as in CM or AJM. To date, no study specifically evaluates the one-shot practice of AJM or EM, and no study further compares the different subtypes of FIMs.

The comparison between different subtypes of FIMs would start with a comparison between AJM and CM for the following reasons. Appreciative joy is a pro-social reaction towards individuals in success, and compassion is a pro-social reaction towards individuals in suffering. Both AJM and CM have

standard procedures, and thus, the hypothesized differences between them are clear. In contrast, LKM blesses other individuals in a general way, which makes its psychological operation difficult to control. EM is based on the other three FIMs, which is not suitable for meditation novices.

Emotions are the most widely evaluated outcomes of FIMs (Zeng et al. 2015). Both AJM and CM induced kind intentions towards targets. Therefore, both FIMs are expected to increase similar pro-social emotions, and the effects were greater than neutral visualization without blessing (i.e., visualizing physical details of faces; Hutcherson et al. 2015). Furthermore, previous studies have demonstrated that FIMs increased low arousal or the so-called unactivated positive emotions (e.g., calm; Kearney et al. 2014). However, another study reported that the CM intervention increased physiological arousal (Lumma et al. 2015). Koopmann-Holm et al. have argued that FIMs only change the value or preference of emotions rather than the actual emotions (Koopmann-Holm et al. 2013). Thus, the effects on general arousal and low arousal positive emotions would need to be investigated.

The differentiation of emotions unique to either AJM or CM is also expected. First, because the AJM instructs the imagination of individuals in happiness or success, AJM would induce happiness in a general sense (e.g., joy; categorized as middle arousal positive emotions in Lee et al. 2013) as well as self-focused positive emotions (e.g., pride). Second, it would be expected for AJM to induce envy and other interpersonal negative emotions, such as hostility or hate, because Buddhism claims that a challenge of appreciative joy is to overcome potential envy in seeing other individuals as better than oneself (see Zeng et al. 2016). Third, in contrast to AJM, CM would be expected to induce sadness, such as sad, gloomy, and blue (categorized as middle arousal negative emotions in Lee et al. 2013) because previous articles have described phenomena in which practitioners may burst into tears (Lutz et al. 2009). In addition to self-reported emotions, the emotional Stroop task would be used as a supplementary indicator of emotions. A previous study demonstrated the effect of “mood congruence,” that is, the reaction time should be longer when the emotional valence of words was contingent on the current emotions of the responders (e.g., Gilboa-Schechtman et al. 2000). Thus, AJM would increase the reaction times to positive words and CM would increase the reaction times to negative words.

Furthermore, one previous study compared “symhedonia” (i.e., feeling happy for other individuals), which is conceptually the same as appreciative joy, with sympathy (i.e., feeling sad for other individuals) in daily life. The results indicated that both appreciative joy and sympathy were influenced by a person’s emotional attachment to their targets (i.e., more for closed than for strangers), but appreciative joy is more influenced by this emotional attachment (Royzman and Rozin 2006). This finding implied that the AJM may be more

difficult than the CM when the target changes from closed to stranger. Thus, it is necessary to conduct comparisons in different conditions. Following the order in FIM interventions and Buddhism (Weng et al. 2013; Nanamoli 2011, p. 309), practitioners should imagine a friend at the first stage followed by a stranger at the second stage. Additionally, daily positive emotions and daily appreciative joy should be measured as the controlling variables because a previous study demonstrated that daily emotions predicted the effect in the initial stage of LKM training (Fredrickson et al. 2008).

This laboratory-based experiment evaluated the similarities and differences among AJM, CM, and neutral visualization as a Control on emotions. The key hypotheses were as follows: (1) Both AJM and CM conditions would exhibit significantly increased other-focused positive emotions compared with the Control conditions. (2) The AJM condition would exhibit significantly increased happiness and overall emotional valence (i.e., pleasure) compared with the other two conditions, whereas the CM condition would exhibit significantly increased sadness and decreased overall emotional valence compared with the other conditions. (3) The AJM condition would exhibit increased self-focused positive emotions and interpersonal negative emotions compared with the other conditions. (4) Both AJM and CM conditions would exhibit significantly increased low arousal positive emotions and decreased overall emotional arousal compared with the Control condition. (5) In the emotional Stroop task, AJM would have significantly longer reaction times towards positive words compared with the other two conditions and CM would have significantly longer reaction times towards negative words compared with the other two conditions.

Method

Participants

Ninety female participants from a University in Hong Kong (mean age 20.24 ± 2.21 years old) were randomly assigned to AJM ($N = 31$), CM ($N = 31$), and Control conditions ($N = 28$). All participants were native Cantonese speakers and had no previous experience regarding meditation, yoga, qi-gong, or taichi. One hundred twenty participants were recruited, but two participants had problems with the machine (program or sound error) and three participants abandoned the experiments (sick leave or failure to follow instructions). An additional 25 participants were excluded from the final data because of previous meditation experience.

Notably, Buddhism suggests that the initial practice of FIMs should not target the opposite gender (Sujiva 2007) and that different facial pictures for different genders will further increase the confounding variations. Considering that a gender difference was not a concern of the current study, only

female participants were recruited as in previous studies on FIMs (e.g., Arch et al. 2014; Klimecki et al. 2014).

Procedure

Prior to the initiation of the experiments, the participants sat in front of a computer and completed the consent form. They selected and opened one envelope that provided instructions to run the designated e-prime, which ran the entire experiment. The procedures of this study are illustrated in Fig. 1. They were divided into five steps: (1) answering “pre-practice measurements,” (2) practicing corresponding meditation practices with a friend as a target (refer to Meditation Practices below) with Manikins and Emotional Words before and after meditation practice, (3) performing the emotional Stroop task followed by resting for 45 s, (4) viewing a facial picture of a female stranger for 30 s and practicing corresponding meditation practices for this female after the facial picture disappeared, again with Manikins and Emotional Words before and after this step, and (5) answering the “post-practice measurements.” After the experiment, the participants were debriefed and were paid with 50 HKD or 1 h credit in a psychology course.

The participants viewed a brief introduction on the screen and subsequently practiced the corresponding practices for 6 min with the guidance of a record. The introduction and script of the recorded guidance are available in the [Online Resource](#). The meditations were adopted from FIMs in Theravada Buddhism, and the participants were allowed to use flexible phrases as noted in the guidelines (Sujiva 2007, p. 65–80). In meditation practices for friends, the AJM condition involved imagining a friend of the same gender in bliss and blessed with “may you not lose what you gained, may you be happy everyday.” The CM condition involved imagining a friend of the same gender in suffering and blessed “may you cease your suffering, may you become happy.” The control

condition comprised neutral visualization adopted from a previous study (Hutcherson et al. 2008), which involved imagining a friend of the same gender in a neutral expression and observing the physical details of her face. In the meditation practice for strangers, the participants initially viewed a facial picture of a female stranger (see [Online Resource](#)) that lasted for 30 s and then practiced meditation with this female as the target. The component and structure of the meditation were matched with the meditation for friends. It is also notable that the introduction and record refer to FIMs as a “blessing” rather than “meditation” and it encouraged the participants to bless sincerely without indicating a special emotion. The records for the three groups were the same length with a similar tone and loudness and were recorded by the same female research assistant who did not know the hypothesis.

Measures

Manikin for Arousal and Valence Two nine-point manikins were used to measure the overall emotional valence (pleasant–unpleasant) and arousal (activated–unactivated) at the current time, which have been widely used in previous studies (Bradley and Lang 1994).

Emotional Word List Seventeen emotional words were presented in a randomized order and were rated from 1 (not at all) to 9 (extremely strong) according to the current intensity. Six categories were included: other focused positive emotion (love, care, friendly; selected from Hutcherson et al. 2015; Seppala et al. 2015; $\alpha = 0.841$ in current study), self-focused positive emotion (pride, self-esteem; selected from Seppala et al. 2015; $\alpha = 0.792$ in current study), low arousal positive emotions (calm, peaceful, serene; selected from Lee, Lin, Huang & Fredrickson, 2013; $\alpha = 0.759$ in current study), happiness in a general sense (delighted, happy, satisfied; selected from Lee et al. 2013; $\alpha = 0.865$ in current study),

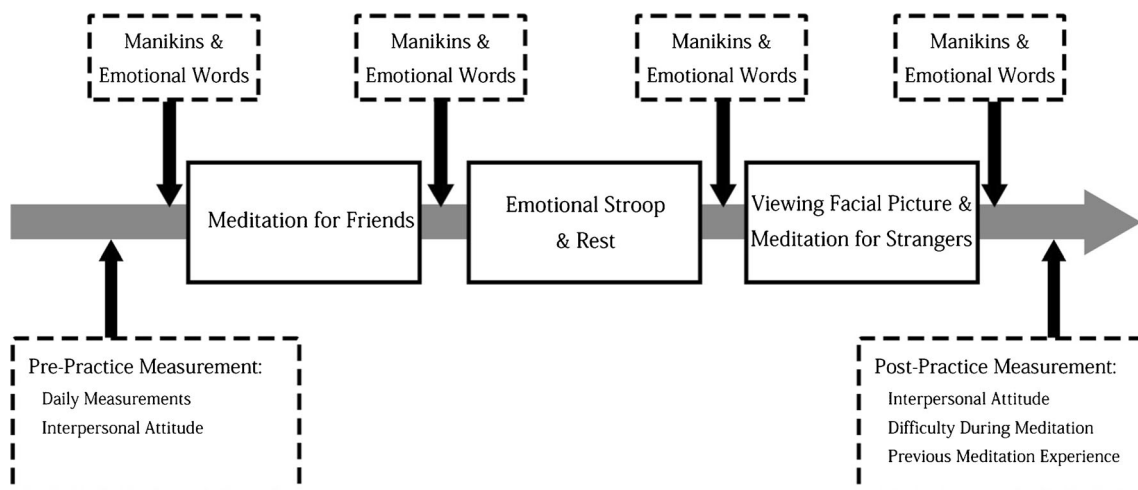


Fig. 1 Procedure of experiment

sadness in a general sense (sad, gloomy, blue; selected from Lee et al. 2013; $\alpha = 0.910$ in current study), and interpersonal negative emotions (envy, hostility, hatred; generated by authors; $\alpha = 0.856$).

Daily Appreciative Joy Daily appreciative joy was measured by the Positive Interpersonal Bias (PIB) subscale of the Appreciative Joy Scale for Friend (Zeng et al. 2016). The PIB did not explicitly involve a description of feeling happy for other individuals, which avoids an expectancy effect, and it had high correlations with other dimensions. The PIB consisted of four items (e.g., “I can always notice the many little kind acts performed by my friends.”) and was rated from 1 (not at all like me) to 9 (totally like me) points, $\alpha = 0.801$.

Daily Emotions The positive and negative emotions in daily life were measured by the Modified Differential Emotions Scale (mDES; Fredrickson et al. 2003). It measured the frequency of 10 sets of positive emotions ($\alpha = 0.835$) and 10 sets of negative emotions ($\alpha = 0.853$) in the previous week from 1 (never) to 5 (always) points. It has also been used to measure daily emotions in a previous LKM intervention (Fredrickson et al. 2008).

Emotional Stroop Task The participants were required to respond according to the color of the words on the screen as quickly as possible. Following a previous study (Hester et al. 2006), each trial presented a 250-ms blank screen and a 500-ms fixation prior to the word, and another trial was initiated after a response was provided. Four trials were used as practice trials at the beginning. Then, each block presented 20 words from one of three word lists (positive, negative, and neutral words), one time for each word in a randomized order. Three blocks with different word lists were presented in a randomized order. This process was repeated twice, and thus, 120 trials were presented in total. Each word list included 20 adjectives from the Chinese Affective Words System (Wang et al. 2008), and the ratings regarding the attribution of “pleasant” on a 1 to 9 scale for positive, negative, and neutral word lists were 7.27 ± 0.24 , 2.78 ± 0.23 , and 4.94 ± 0.41 , respectively. Words were presented in four colors (red, green, blue, and yellow) and a font size of 12 pt.

Of note, additional measurements regarding interpersonal attitudes and difficulties during meditations were used. These measurements and results are presented in the [Online Resource](#) because they are outside the range of the current report.

Data Analyses

The data were analyzed using SPSS 19.0. All effect sizes were converted to η^2 where 0.02 is small, 0.13 is medium, and 0.26 is large. ANOVAs indicated that there were no significant group differences in the daily measurements (i.e., the PIB

and mDES) or self-reported emotions (six groups of emotional words, overall arousal, and valence) prior to the meditation practices regardless of controlling for the daily measurements. Thus, the randomization of this experiment was successful.

Results

Self-Reported Emotions

The three group (AJM, CM, and Control) \times two time (before practice and after practice) ANOVAs with time as the repeated measure were conducted to analyze all self-reported emotions, and daily measurements were used as the covariance. The results of the meditation for friends are presented in Table 1 (the descriptive statistics and group \times time interactions) and Table 2 (the simple effects for within-group changes and between-group differences after practice) and the meditation for stranger results are presented in Tables 3 and 4.

Regarding the other focused positive emotions, it is unexpected that no significant group \times time interaction existed during the meditation for friends (Table 1, row 1). An investigation of the simple effect indicated that all three groups significantly increased in the other focused positive emotions, with no significant group difference after practice (Table 2, row 1). In contrast, the hypothesized effect was confirmed by the meditation for strangers because the group \times time interaction was significant with a large effect size (Table 3, row 1) and both AJM and CM had increased other focused positive emotions with large effect sizes compared with the Control group (Table 4, row 1).

Consistent with the hypothesis relevant to valence, the group \times time interactions for happiness in a general sense, sadness in a general sense, and overall emotional valence were significant and the effect sizes were medium during the meditation for friends (Table 1, rows 3, 5, and 8). Simple effects indicated that the AJM significantly increased happiness and valence, whereas the CM significantly increased sadness and decreased valence, which resulted in medium to large effect sizes of the group differences between CM and the other conditions regarding happiness, sadness, and valence (Table 2, rows 3, 5 and 8). The interactions during the meditation for strangers were significant or marginally significant with small to medium effect sizes (Table 3, rows 3, 5, and 8). Simple effects indicated that the AJM had increased happiness and overall valence compared with the other conditions with small to medium effect sizes. In contrast, CM had increased sadness compared with the other two conditions with a medium effect size, but there was no difference compared with the Control condition regarding happiness or valence (Table 4, rows 3, 5, and 8).

Special effects of self-focused positive emotions and interpersonal negative emotions in the AJM condition were also

Table 1 Descriptive statistics and group \times time interaction for self-reported emotions in meditation for friends

	Corrected marginal means \pm standardized error						Group \times time interaction: $F(p, \eta^2)$. $df = 2, 84$
	AJM Pre	AJM Post	CM Pre	CM Post	Control Pre	Control Post	
OFPE	4.41 \pm 0.32	6.34 \pm 0.29	4.58 \pm 0.33	6.06 \pm 0.30	4.83 \pm 0.33	5.70 \pm 0.31	2.926 (.059, .07)
SFPE	2.95 \pm 0.30	3.04 \pm 0.31	2.46 \pm 0.31	1.87 \pm 0.32	2.75 \pm 0.32	2.65 \pm 0.33	1.719 (.185, .04)
HGS	4.51 \pm 0.29	5.81 \pm 0.31	3.95 \pm 0.30	3.94 \pm 0.32	4.72 \pm 0.30	5.46 \pm 0.32	4.511 (.014, .10)
LAPE	6.27 \pm 0.25	6.41 \pm 0.30	5.89 \pm 0.26	5.53 \pm 0.31	5.56 \pm 0.27	5.75 \pm 0.32	0.734 (.483, .02)
SGS	2.65 \pm 0.25	2.08 \pm 0.26	2.79 \pm 0.26	3.83 \pm 0.27	2.34 \pm 0.27	1.57 \pm 0.27	9.157 (<.001, .18)
INE	2.11 \pm 0.21	1.70 \pm 0.13	1.82 \pm 0.21	1.52 \pm 0.13	1.59 \pm 0.22	1.22 \pm 0.13	0.073 (.930, <.01)
Arousal	4.54 \pm 0.29	5.79 \pm 0.30	4.67 \pm 0.30	4.93 \pm 0.31	4.48 \pm 0.31	5.75 \pm 0.32	2.183 (.119, .05)
Valence	5.81 \pm 0.21	6.72 \pm 0.26	5.53 \pm 0.22	4.86 \pm 0.27	5.98 \pm 0.23	6.47 \pm 0.28	7.955 (.001, .16)

The data were based on marginal means corrected with covariates. “Pre” refers to before practice and “Post” refers to after practice

OFPE other focused positive emotions, SFPE self-focused positive emotions, HGS happiness in general sense, LAPE low arousal positive emotions, SGS sadness in general sense, INE interpersonal negative emotions

hypothesized, but the group \times time interactions were not significant during the meditation for friends (Table 1, rows 2 and 6) or meditation for strangers (Table 3, rows 2 and 6). However, it is notable that the simple effects indicated that the AJM condition significantly decreased interpersonal negative emotions during the meditation for friends, although other conditions also had similar non-significant trends (Table 2, row 6). Furthermore, it appears that the other two conditions, but not the AJM condition, had trends towards increased interpersonal negative emotions during the meditation for strangers (Table 4, row 6).

The hypothesized effects relevant to arousal were also not supported. There is no significant interaction for low arousal positive emotions or overall arousal (Tables 1 and 3, rows 4 and 7). Simple effects indicated that the AJM and Control conditions significantly increased overall arousal with medium effect sizes during the meditation for friends and had a trend towards increased arousal compared with the CM

condition after practice (Table 2, row 7). During the meditation for strangers, the CM and Control conditions decreased low arousal positive emotions and overall arousal at significant or marginally significant levels; however, the effect sizes were lower than medium (Table 4, rows 4 and 7). Furthermore, the Online Resource presented the correlations between the self-reported emotions after practice (Table S1) and the relationships between the covariates and outcomes (Tables S2 and S3). It is notable that the overall arousal and valence were positively correlated (r 's $> .3$, p 's $< .001$), which may be helpful in understanding the results regarding arousal.

Emotional Stroop

The cases with a correction rate less than 90% and an outlier response time (3 SD) were excluded (see Hester et al. 2006), and 83 cases remained for the analysis. The average reaction time of the corrected responses of each group of the word list

Table 2 Simple effects of self-reported emotions in meditation for friends

	Within-group difference			Between-group difference after practice		
	Mean difference (p, η^2)			Mean difference (p, η^2)		
	AJM	CM	Control	AJM–CM	AJM–Control	CM–Control
OFPE	1.94 (<.001, 0.32)	1.47 (<.001, 0.20)	0.87 (.009, 0.08)	0.29 (.510, 0.01)	0.64 (.136, 0.03)	0.35 (.432, 0.01)
SFPE	0.10 (.704, 0.00)	–0.59 (.029, 0.06)	–0.10 (.718, <.01)	1.18 (.011, 0.07)	0.39 (.384, 0.01)	–0.79 (.097, 0.03)
HGS	1.29 (<.001, 0.19)	–0.01 (.979, 0.00)	0.75 (.019, 0.06)	1.87 (<.001, 0.17)	0.34 (.441, 0.01)	–1.52 (.002, 0.11)
LAPE	0.13 (.681, 0.00)	–0.35 (.294, 0.01)	0.18 (0.592, 0.00)	0.87 (.053, 0.04)	0.66 (.133, 0.03)	–0.21 (.644, <.01)
SGS	–0.57 (.065, 0.04)	1.04 (.001, 0.11)	–0.77 (.020, 0.06)	–1.75 (<.001, 0.20)	0.50 (.180, 0.02)	2.26 (<.001, 0.28)
INE	–0.41 (.026, 0.05)	–0.30 (.133, 0.03)	–0.37 (.072, 0.04)	0.18 (.330, 0.01)	0.48 (.009, 0.08)	0.30 (.119, 0.03)
Arousal	1.25 (.001, 0.12)	0.25 (.508, 0.01)	1.26 (.002, 0.11)	0.86 (.053, 0.04)	0.04 (.924, 0.00)	–0.82 (.074, 0.04)
Valence	0.91 (.001, 0.12)	–0.67 (.021, 0.06)	0.48 (.099, 0.03)	1.85 (<.001, 0.21)	0.25 (.51, 0.01)	–1.60 (<.001, 0.16)

Table 3 Descriptive statistics and group \times time interaction for self-reported emotions in meditation for strangers

	corrected marginal means \pm standardized error						Group \times time interaction: $F(p, \eta^2)$. $df = 2, 84$
	AJM Pre	AJM Post	CM Pre	CM Post	Control Pre	Control Post	
OFPE	4.22 \pm 0.33	4.77 \pm 0.31	4.31 \pm 0.31	4.93 \pm 0.32	4.34 \pm 0.34	2.93 \pm 0.33	16.708 (<.001, 0.29)
SFPE	2.37 \pm 0.26	2.16 \pm 0.23	1.48 \pm 0.27	1.66 \pm 0.24	2.40 \pm 0.28	2.00 \pm 0.24	2.365 (.100, 0.05)
HGS	4.33 \pm 0.33	4.44 \pm 0.31	3.84 \pm 0.34	3.27 \pm 0.32	4.36 \pm 0.35	3.29 \pm 0.33	6.317 (.003, 0.13)
LAPE	6.18 \pm 0.34	6.18 \pm 0.35	5.94 \pm 0.35	5.20 \pm 0.36	5.68 \pm 0.35	4.88 \pm 0.37	2.177 (.120, 0.05)
SGS	1.81 \pm 0.17	1.90 \pm 0.28	2.61 \pm 0.18	3.42 \pm 0.29	1.70 \pm 0.18	1.69 \pm 0.29	2.982 (.056, 0.07)
INE	1.53 \pm 0.11	1.52 \pm 0.16	1.41 \pm 0.12	1.69 \pm 0.17	1.16 \pm 0.12	1.42 \pm 0.17	1.184 (.311, 0.03)
Arousal	4.71 \pm 0.28	4.22 \pm 0.29	3.93 \pm 0.29	4.02 \pm 0.30	5.08 \pm 0.30	4.34 \pm 0.31	2.409 (.096, 0.05)
Valence	5.84 \pm 0.21	5.52 \pm 0.26	4.81 \pm 0.21	4.20 \pm 0.27	5.85 \pm 0.22	4.73 \pm 0.27	2.794 (.067, 0.06)

(i.e., positive, negative, and neutral words) was used as the dependent variable in the ANCOVA, with daily measurements as the covariance. As shown in Table 5, the AJM had a significantly longer reaction time in all groups of word lists compared with the Control condition. The AJM condition also had a trend towards a longer reaction time compared with the CM condition, although only neutral words were significantly different. No significant difference was identified between the CM and Control conditions in the word lists. No daily measurements significantly predict the dependent variables.

The differences between the three word lists for each participant were calculated and implemented as dependent variables. The ANCOVA indicated that there was no significant difference between the conditions (Table 5). However, daily appreciative joy measured by the PIB was negatively associated with the differences between the reaction times for emotional words and the reaction times for neutral words ($p = .049$, $\eta^2 = 0.049$ for RT-positive word minus RT-neutral words; $p = .022$, $\eta^2 = .066$ for RT-negative words–RT-neutral words, Table S4 in the Online Resource).

To investigate the relationship between self-reported emotions and the emotional Stroop, multiple regressions were

conducted with the three conditions combined. The results indicated that the self-reported emotions prior to the emotional Stroop (i.e., after practice for friend) did not significantly predict the outcome of the emotional Stroop regardless of whether the daily measurements were controlled for in the multiple regressions.

Discussion

It is hypothesized that both AJM and CM induced more other focused positive emotions compared with the Control condition, and the effect size should be larger in the practice for friends compared with strangers. However, it appears that neutral visualization for a friend is not so “neutral” because it also significantly increases other focused positive emotions. For this reason, the practice for strangers confirmed the medium to large effect sizes, whereas the practice for friends did not have between-group differences. This unexpected result implied that the effects of FIMs for friends on other focused positive emotions predominately originate from natural emotions when an individual recalls his or her friends rather than

Table 4 Simple effects of self-reported emotions in meditation for strangers

	Within-group difference			Between-group difference after practice		
	Mean difference (p, η^2)			Mean difference (p, η^2)		
	AJM	CM	Control	AJM–CM	AJM–Control	CM–Control
OFPE	0.55 (.044, 0.05)	0.62 (.03, 0.06)	−1.41 (<.001, 0.23)	−0.16 (.732, 0.00)	1.85 (<.001, 0.17)	2.00 (<.001, 0.18)
SFPE	−0.21 (.241, 0.02)	0.18 (.325, 0.01)	−0.40 (.039, 0.05)	0.50 (.142, 0.03)	0.16 (.631, 0.00)	−0.34 (.330, 0.01)
HGS	0.12 (.612, 0.00)	−0.57 (.021, 0.06)	−1.07 (<.001, 0.18)	1.17 (.011, 0.07)	1.15 (.011, 0.07)	−0.02 (.963, <0.01)
LAPE	0.00 (.994, 0.00)	−0.74 (.019, 0.06)	−0.80 (.013, 0.07)	0.98 (.061, 0.04)	1.30 (.012, 0.07)	0.32 (.546, <0.01)
SGS	0.10 (.694, 0.00)	0.81 (.002, 0.11)	−0.01 (.976, 0.00)	−1.51 (<.001, 0.14)	0.21 (.599, 0.00)	1.72 (<.001, 0.17)
INE	0.00 (.98, 0.00)	0.28 (.064, 0.04)	0.27 (.087, 0.03)	−0.16 (.492, 0.01)	0.10 (.659, 0.00)	0.27 (.279, 0.01)
Arousal	−0.49 (.059, 0.04)	0.09 (.733, 0.00)	−0.74 (.007, 0.08)	0.21 (.629, 0.00)	−0.12 (.772, 0.00)	−0.33 (.458, 0.01)
Valence	−0.32 (.184, 0.02)	−0.61 (.015, 0.07)	−1.12 (<.001, 0.19)	1.32 (.001, 0.12)	0.79 (.038, 0.05)	−0.53 (.181, 0.02)

Table 5 Between-group differences on emotional Stroop task

	Est. means \pm std. error			Main effect: $F(p, \eta^2)$, $df = 2, 77$	Simple effects: p, η^2		
	AJM ($N = 31$)	CM ($N = 28$)	Control ($N = 24$)		AJM–CM	AJM–Control	CM–Control
Positive	553 \pm 11	532 \pm 11	519 \pm 12	2.353 (.102, 0.06)	.190, 0.02	.037, 0.06	.450, 0.01
Negative	549 \pm 10	521 \pm 11	513 \pm 11	3.307 (.042, 0.08)	.067, 0.04	.018, 0.07	.601, <0.01
Neutral	561 \pm 10	526 \pm 11	512 \pm 12	5.340 (.007, 0.12)	.027, 0.06	.003, 0.11	.413, 0.01
Pos-Neu	-8 \pm 7	6 \pm 7	7 \pm 8	1.328 (.271, 0.03)	.185, 0.02	.159, 0.03	.934, <0.01
Neg-Neu	-12 \pm 7	-4 \pm 7	1 \pm 8	0.771 (.466, 0.02)	.472, 0.01	.224, 0.02	.636, <0.01
Pos-Neg	5 \pm 11	12 \pm 12	-4 \pm 13	0.218 (.804, 0.01)	.694, <0.01	.610, <0.01	.388, 0.01

The data were based on marginal means corrected with covariates. The decimal part was omitted considering the unit here is milliseconds

Pos-Neu reaction time of positive words minus reaction time of neutral words, *Neg-Neu* reaction time of negative words minus reaction time of neutral words, *Pos-Neg* reaction time of positive words minus reaction time of negative words

the special operation of blessing in the FIMs. Notably, previous laboratory-based studies have compared LKM for individuals with close relationships to neutral visualization for strangers (e.g., Hutcherson et al. 2008) or conditions without people (e.g., neutral location, Seppala et al. 2015), which may over-estimate the effect of FIMs by confounding the effects from the imagination of individuals with close relationships. Nevertheless, the results of the practice for strangers supported the effects of FIMs on other focused positive emotions, and the results are consistent with the expectation that AJM and CM do not have substantial differences in this aspect.

The hypothesized differences in happiness and sadness in a general sense between AJM and CM were confirmed because the results of happiness and sadness supported the ideas that AJM induced happiness and CM induced sadness. Furthermore, the overall valence also confirmed that the experience of AJM was considered pleasurable and that the average score of the CM was in the middle of the pleasant–unpleasant continuum. Zeng et al. (2015) proposed two potential factors to explain the different effects on daily positive emotions between the LKM and CM interventions. One factor is the emotional experience during meditations, and the other factor is the components during disclosure in the weekly course that may or may not emphasize personal happiness (Zeng et al. 2015). The current study confirmed the different emotional experiences during meditation, although the difference was between AJM and CM, not LKM. Future studies may attempt to determine the extent to which this factor accounts for the effects on daily emotions of the complete interventions.

It is hypothesized that the AJM condition could generate self-focused positive emotions, such as pride, via empathy. However, the results did not support this hypothesis. It is possible that the participants in the AJM condition focused on the blessing from their position and thus had limited empathy for the emotions of the targets. Another possibility is that the imagined targets in the AJM condition were not imagined as pride for themselves because the introduction of the

AJM condition described the happiness and success but not the pride of the targets. Nevertheless, the current study could not further identify the mechanism of empathy, and future studies may further investigate the involvement of empathy in AJM.

In contrast to the hypothesis that seeing other individuals in happiness or success may induce interpersonal negative emotions, the AJM condition decreased rather than increased the interpersonal negative emotions during the meditation for friends. The other conditions also exhibited similar trends, but a floor effect limited further comparisons between the conditions. During the meditation for strangers, the AJM did not induce a trend towards increased interpersonal negative emotions as demonstrated by the other conditions, which also implied that the AJM may protect participants from interpersonal negative emotions, although it is not clear why the other conditions tend to increase interpersonal negative emotions. Nevertheless, the current findings implied the effect of the AJM on suppressing potential envy. Notably, Buddhism considers envy as the “direct enemy” of appreciative joy and the purpose of the AJM is to change the habitual reaction of envy (Bodhi 2012, p. 90). The hypothesis that the initial practice of AJM would induce envy is based on an assumption that the AJM instructs the imagination of a situation with potential envy and practitioners practice how to reduce this habitual envy with long-term meditation practice. However, the current findings indicated a possibility that AJM may protect against an increase in potential envy, thus implying a different mechanism. Notably, the current study simply involved friends and strangers; thus, future studies may manipulate situations with stronger potential envy, such as other individuals who succeed in a domain that is relevant to an individual’s self-esteem (Salovey and Rodin 1991) or evaluate whether long-term AJM practice may reduce dispositional envy in daily life. It is worth noting that no previous study on FIMs has evaluated the effect on envy to date, although Buddhism claims that reducing envy is the function of AJM (Bodhi 2012, p. 90).

The current study did not identify a significant difference between two FIMs and the Control condition on variables relevant to arousal. It is possible that the neutral visualization also involves active imaginations similar to FIMs, which resulted in similar arousal. Future studies may compare FIMs with meditations with other mental activities, such as concentration meditation that focuses on breath or mindfulness meditation (e.g., Lumma et al. 2015).

In contrast to the idea that FIMs should generate low arousal positive emotions (Kearney et al. 2014), the current study demonstrated that FIMs had effects on middle arousal emotions (i.e., happiness or sadness in a general sense), but the changes in low arousal positive emotions were minimal. This controversy may be explained by the argument presented by Koopmann-Holm et al. (2013) that the observed increase in low arousal positive emotions essentially originates from the value or expectancy on it rather than real change. Moreover, the advantage of the current laboratory-based experiment is that it attempted to avoid expectancy because it did not refer to the practice as “meditation,” which is associated with the impression of calmness (e.g., Lumma et al. 2015).

Additionally, the factors that influenced arousal are essentially unknown, and confounding factors may exist. For example, the current results demonstrated that self-reported arousal was associated with valence. Therefore, it is possible that the sadness in the CM condition made practitioners feel depressed rather than excited, which may explain why the CM condition tended to show lower arousal during the meditation for friends. This possibility is consistent with the argument from Lumma et al. (2015) that physiological arousal may not be well captured by self-report instruments.

Overall, the concern regarding arousal in FIMs has only been initiated in several recent studies (Zeng et al. 2015) and many methodological issues may influence the results (Koopmann-Holm et al. 2013; Lumma et al. 2015). Current findings support the recent arguments that FIMs do not lead to lower arousal (Koopmann-Holm et al. 2013; Lumma et al. 2015), but more studies are required to draw a solid conclusion on arousal.

The differences in emotional valence following the meditation for friends had medium to large effect sizes, but the hypothesized difference following the emotional Stroop task was not supported. The AJM group results were different from the other groups, and daily appreciative joy was associated with the results, but the underlying mechanism is not clear. The pattern of results was not consistent with “mood congruence” as expected. Moreover, the reaction times were not correlated with self-reported emotions in the current study, so it is possible that the emotional Stroop task reflects other factors rather than emotions as previous studies have noted (Gilboa-Schechtman et al. 2000). Currently, no other studies on FIMs have used the emotional Stroop task, and there are few studies on appreciative joy (Zeng et al. 2016). Thus, the foundation is lacking to

hypothesize that other mechanisms are relevant to AJM or appreciative joy. In this case, we cannot provide a good explanation for the current results of the emotional Stroop task. We expect that the meaning of the current data may be explained following additional investigations in the future.

This study provided a comparison between FIMs and also focused on AJM. Both AJM and CM induced pro-social positive emotions and positive attitudes similar to LKM evaluated in previous studies, which reflects the similarity of FIMs in the cultivation of pro-social attitudes. However, AJM and CM also induced unique emotions and the effect sizes may be large in comparison with one another. These results strongly support the ideas that different FIMs should be separated in psychological research not only for the sake of Buddhist traditions (Shonin et al. 2014) but also for their different effects.

The unique emotions, particularly the negative emotions induced by CM, have implications for practice. A better emotional experience (i.e., enhanced positive emotions) is an important reason why FIMs were favored (Zeng et al. 2015). However, it appears that the emotional experience in CM is not necessarily pleasant, at least in the initial period. Of note, a previous study highlighted that compassion comprised an essentially positive affect, whereas empathy for suffering led to a negative affect (Klimecki et al. 2014). For example, when viewing a video of suffering, the application of an empathy skill increases negative affect compared with baseline, but the application of a CM skill induced a positive affect and also reduced the negative affect to the baseline level (Klimecki et al. 2014). We agree that compassion provides a better emotional experience than empathy when an individual must face the suffering of other individuals, but it is also worth noting that CM cannot completely eliminate the negative emotions, even with sufficient training. Thus, if participants seek a better emotional experience, CM may not be the best recommendation because it is associated with an additional negative impact that may be avoided in AJM. Of note, current research is based on one-shot practice, and the difference between complete interventions is more complex and requires empirical investigation. Furthermore, the current study is mainly concerned with emotional experience, but emotional experience is not the only factor in FIMs. Interventions with CM often deliver a value that cultivates compassion for all beings even with an individual’s own suffering (Lutz et al. 2009), and it is possible that the effectiveness of CM in promoting helping behaviors, as confirmed by empirical studies (e.g., Condon et al. 2013), is irreplaceable by other FIMs. Overall, the current study is preliminary and future studies may further investigate the unique effectiveness of different FIMs.

This study also sheds light on the differences between practices for different targets, which comprise another topic that is only addressed in a limited number of studies (e.g., Weng et al. 2013). The current study demonstrated that meditation for friends induced more substantial changes in emotions and a

previous intervention with CM reported the level of difficulty increased in the order of friend, self, and other targets (Weng et al. 2013). However, these findings were not based on a randomized design and thus lack scrupulousness. The point here is that most FIMs used in psychological research have borrowed the structures of FIM training in Buddhism, but whether these structures are optimal remains unknown. Moreover, the current study identified more negative emotions in practice for friends, which was consistent with the suggestion from the Theravada tradition that close friends are not good choices for CM (Sujiva 2007, p. 66). A previous study also demonstrated that LKM for the self may be misinterpreted and practiced as an unhealthy desire for a conditioned goal (Crane et al. 2010), yet some traditions originate from LKM for oneself (Sujiva 2007, p. 18). These examples highlighted the importance of carefully designing FIM interventions in an optimal structure and thus contribute to the best practice.

Limitations

The following limitations are worth noting. First, the orders of the practice for friends and strangers were not counterbalanced. Therefore, the different results of the practices for different targets may be confounded by order effects. Nevertheless, these issues were not major concerns in the current study. Second, the significant findings regarding arousal, interpersonal negative emotions, and emotional Stroops were essentially post hoc findings without corrections for multiple comparisons and, therefore, several findings may not survive a stricter level of significance. Thus, the stability of these findings should be treated with caution and the previous discussion suggested how to better investigate these effects in the future. On the other hand, it is also notable that the findings on other focused positive emotions and emotional valence supported the hypothesis with medium or large effect sizes and higher levels of significance (e.g., $p < .001$). We believe that these findings were reliable and clearly demonstrated the similarities and differences between the FIMs. Thus, the core argument that different FIMs will be differentiated remains. Third, although the pre-recorded instructions captured the psychological operations of traditional FIMs, such one-shot practice with complete beginners in the current study is quite different from real FIM interventions as noted above. Therefore, more studies are required to generalize current findings to FIM interventions in real practice.

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Author Contributions XZ, XL, and FL designed the study; XZ and VC collected and analyzed the data; and XZ and TO collaborated in the

writing of the paper. All authors discussed the findings and reviewed and commented on the manuscript.

Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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