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Self/Other Referential Processing Following Mindfulness and Loving-Kindness Meditation

Kyle Logie · Paul Frewen

Abstract The immediate outcomes of mindfulness meditation (MM) and loving-kindness meditation (LKM) on experimental measures of explicit and implicit self- and other-referential processing (SRP-ORP) have not been investigated previously. In this study, undergraduate students ($n=104$) were randomized to a single-session practice of MM, LKM, or reading control and completed self-report measures of decentering and positive affect directed toward self and other. Participants also completed an experimental measure of valenced SRP-ORP. Practice of both meditations was associated with increased decentering and positive affect relative to reading control, although self-reported response to MM and LKM did not significantly differ. Following the meditation, whereas participants randomized to MM evidenced an expected self-positivity bias in positive affective response and reaction time during an experimental SRP-ORP task, participants randomized to LKM did not. LKM, as uniquely involving the intentional cultivation of positive emotion toward both self and other, may be associated with a relative normalization of the self-positivity bias. Individual differences in response to SRP-ORP were also examined as a function of traits related to mindfulness and loving-kindness, in addition to as a function of variability in experiential response to MM and LKM. Study limitations and future research directions are also discussed.

Keywords Mindfulness · Loving-kindness · Metta · Meditation · Self-referential processing

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Introduction

Following Northoff et al. (2006), self-referential processing (SRP) refers to responses made to stimuli that are intrinsically related to one's own person, for example, one's name, voice, or visual image (e.g., recognizing oneself in a mirror or photograph), as well as to evaluations made concerning *whether* a stimulus is self-referent or not (e.g., as in trait adjective endorsements and personality surveys). Disturbances in SRP of emotional stimuli frequently accompany mental health problems including distress-based disorders such as anxiety and depression, symptomatic of which include negative ruminations and worry concerning the self and the self in relation with others (Mennin and Fresco 2013). In addition to self-report, studies in cognitive and affective neuroscience consistently find that response within a network of brain regions including the medial prefrontal cortex, anterior and posterior cingulate, and precuneus is engaged during SRP (reviews by Denny, Kober, Wager, and Ochsner, 2012; Northoff et al. 2006). Interestingly, anxiety disorders and depression are associated with abnormalities in neural responding during SRP (review by Lemogne et al. 2012).

By contrast, other-referential processing (ORP) refers to evaluations regarding the applicability of stimuli to other specific or nonspecific people, often provoking social comparisons and evaluation of relatedness relative to self. People generally tend to view themselves more positively in comparison with others, an effect known as the *self-positivity bias* that is positively correlated with individual differences in self-esteem and psychological wellbeing (Mezulis et al. 2004). In arguably the first study to examine the neural correlates of individual differences in self-esteem, Frewen and colleagues found that the dorsomedial prefrontal cortex was activated relative to baseline primarily for positively valenced SRP rather than ORP, and as a function of greater positive affect experienced during positive SRP (Frewen et al. 2013).

However, people's sense of self may not always be purely individualistic; rather, people frequently extend their conception of themselves to include certain individuals or groups (e.g., intimate partners, family, friends, ethnicity, and country) while excluding others, a social psychological process referred to as in-group ("us") versus out-group ("them") bias that may be partially dependent upon emotional processing. For example, Johnson and Fredrickson (2005) found that increasing experiences of positive emotion eliminated the "own-race bias" in face perception, that is, that faces of people from another race are typically considered to look more similar to each other. As such, Johnson and Fredrickson considered whether positive emotions may be associated with a social broadening such that the conception of self is expanded. Consistent with this notion, Wang et al. (2012) found that the more related was another person to one's own self-concept (e.g., one's mother vs. a stranger), the more was one's neural response during ORP mediated by brain regions found to be activated during SRP. Although affective and anxiety disorders have most often been associated with negative SRP (e.g., rumination, worry, and self-criticism; Mennin and Fresco 2013), negative responses to others involving either vulnerability (e.g., social phobia) or hostility (e.g., antisocial personality disorder) can also be a telling sign of mental health problems.

Various forms of meditation practice, including mindfulness meditation and "metta" or "loving-kindness" meditation (e.g., Hofmann et al. 2011), are increasingly recognized within clinical psychology as practices beneficial to mental health and well-being, including via the reduction of negative and improvement of positive SRP and ORP. Mindfulness meditation (MM) is increasingly regarded in contemporary scientific discourse to involve a particular way of paying attention that is open and nonjudgmental, often but not necessarily focused toward the process of one's breathing (e.g., Bishop et al. 2004). MM may allow an individual to become more aware of their thoughts and to observe them in a more decentered and objective way, as opposed to unconsciously identifying with them, perhaps thereby generally reducing negative SRP and ORP. MM as such may be effective in reducing anxiety and depression not necessarily because MM decreases the quantity of negative thoughts but rather because an individual's "relationship towards" her or his thoughts changes (e.g., Frewen et al. 2008), often involving a process of increased subjective detachment between oneself and one's thinking that Fresco et al. (2007) and others label "decentering." Consistent with an effect for MM on SRP, Farb et al. (2007) and Goldin et al. (2009) demonstrated that MM practice resulted in decreased medial and dorsomedial prefrontal and posterior cingulate responses, strongly associated with SRP, during SRP tasks in depressed-anxious and socially anxious persons, respectively, and Goldin et al. found that such changes were accompanied by perceived increases in positive and decreases

in negative adjective self-descriptiveness. Goldin and Gross (2010) also found that socially anxious participants, after an MM intervention, evidenced greater response in brain areas implicated in visual attention as well as within the parahippocampal gyrus during a task requiring them to focus their attention toward their breathing during SRP. These researchers have speculated that one reason MM may be therapeutic for persons with mood and anxiety disorders is through its influence on SRP.

Loving-kindness meditation (LKM), by contrast with MM, involves intentionally associating oneself and others with good will, health, and wellbeing by reciting positive affirmations (e.g., "May I be well…," "May she/he be well…"). Relative to MM, LKM therefore more explicitly involves cultivating positive thoughts and emotions. Fredrickson (2001) argues that the experience of positive emotions increases personal resources, and that this can culminate in human flourishing. More specifically, Fredrickson argues that, whereas negative emotions tend to narrow attentional focus, cognition, and behavioral action, positive emotions broaden such functions, helping to build cognitive and social resources important for mental health and wellbeing. Fredrickson et al. (2008) demonstrated the long-term effect of LKM practices on increasing positive thoughts, overall life satisfaction, and reducing symptoms of depression (Fredrickson et al. 2008). Hutcherson et al. (2008) also established that a single short LKM can be effective in increasing social connection and explicit and implicit positivity toward oneself as well as neutral strangers, demonstrating the potential effect of LKM not only for SRP but also on ORP. Colzato et al. (2012) also compared Buddhist monks, who were well practiced in LKM, to a control group on an experimental "Social Simon" task measuring participants' degree of self-other integration based upon identification with a co-actor. Colzato et al. found that the monks displayed much higher levels of self-other integration than the control group, suggesting that internal representations of "self" may expand to include or overlap more greatly with notions of "other" through the practice of LKM.

Despite the inherent subjective differences between MM and LKM, few studies have directly contrasted the immediate effects of these meditation practices on measures relevant to mental health and wellbeing. Feldman et al. (2010) observed in novice meditators that MM, relative to both LKM and progressive muscle relaxation, was associated with a more frequent experience of repetitive thoughts, a less strong association between repetitive thought frequency and negative affect as a reaction to repetitive thoughts, and greater decentering. In comparison, Brewer et al. (2011) described alterations in brain functions associated with SRP and ORP in adept meditators, although no differences were found between MM and LKM. To our knowledge, despite the clinical significance of internal representations of "self" and

"other" to the development and maintenance of affective and anxiety disorders, and the potential clinical benefit of MM and LKM on such representations, no research studies have directly contrasted the immediate effects of MM and LKM on experimental measures of valenced SRP or ORP.

The current research therefore introduces the study of brief (15 min) sessions of MM and LKM to investigations of valenced SRP and ORP with a particular interest in positive valence. We hypothesized that both the practice of MM and LKM would be associated with positive SRP and ORP relative to reading control as assessed both via self-report questionnaire and experimentally. Contrasting MM with LKM, we tested two alternative hypotheses. The first hypothesis was that LKM would impact SRP and ORP more positively than MM given our impression of LKM as itself more directly and explicitly involving the practice of positive SRP and ORP. The second or alternate hypothesis was that the general self-positivity bias would be less strong following LKM than MM (e.g., Colzato et al. 2012), owing to LKM explicitly involving the practice not only of positive SRP but additionally of positive ORP. Finally, we examined individual differences in response to SRP and ORP in association with mindfulness and loving-kindness related traits as well as self-reported experiential responses to MM and LKM in order to broadly investigate the relevance of mindfulness and loving-kindness for an understanding of SRP and ORP.

Method

Participants

The present sample consisted of 105 (70 female and 35 male) introductory psychology students who participated in the study for partial course credit and were randomized to MM, LKM, or reading control conditions ($n=35$ per group). A single female participant from the reading control group failed to complete all measures and so was excluded, leaving a final sample of 104 participants. Age ranged from 17 to 30, although 93 (88 %) were between 18 and 19 ($M=18.63$, SD$=1.61$). The majority of participants were of European-Caucasian ($n=66$, 63 %) or Asian ($n=30$, 29 %) descent and indicated that they "did not meditate regularly" ($n=90$, 87 %; the remaining participants noted that they either practiced meditation about "once per month" [$n=12$] or "once per week" [$n=3$]). There were no differences between groups with regard to gender, age, ethnicity, or extent of prior meditation experience.

Procedure

Between one and three participants completed the procedure simultaneously per experimental session within a computer lab at the representing institution. Participants were randomized into one of three groups: MM, LKM, or reading control. After completion of informed consent, participants' photographs were taken and standardized, and they completed the following questionnaires, described in the "Measures" section: Depression Anxiety Stress Scale, Neff Self-Compassion Scale, Five-Factor Mindfulness Questionnaire, and an adjective rating survey associated with completion of the Visual-Verbal Self-Other Referential Processing Task. These questionnaires were administered partly in order to ensure that group randomization successfully equated the groups on characteristics associated with meditation practice and trait negative affect at baseline, specifically, measures of trait mindfulness, self-compassion, trait-valenced SRP and ORP, and symptoms of depression, anxiety, and stress. Participants randomized to the reading control group were then given and instructed to read an article describing meditation practice and its potential therapeutic benefits for 15 min, whereas those randomized to MM and LKM practiced these respective meditations.

Participants randomized to the MM group were guided through a simple 15-min eyes-closed breathing meditation based on that described in Frewen et al. (2008, 2010, 2014). In the MM condition, participants were instructed to focus their attention on their breathing process and to return their focus to their breath whenever they noticed their mind wandering. Meditation breath attention scores (MBAS; Frewen et al. 2008, 2010, 2014) were recorded during participants practice of MM as a measure of their ability to focus their attention toward their breath without distraction. Approximately every 3 min during the 15 min MM, the experimenter rang a Tibetan meditation bell; when participants heard the chime, they were instructed to record, via pencil and paper, whether they were focusing on their breath at that moment, by making a simple "tick" mark on the page while keeping their eyes closed.

Participants randomized to the LKM group were instructed to put on headphones and, also with their eyes closed, listen to a guided LKM via computer audio file for approximately 15 min. The particular audio file that was administered is at the time of this writing readily obtainable online (http://www.youtube.com/watch?v=sz7cpV7ERsM). The guided audio file instructed participants to direct positive qualities toward themselves as well as their immediate family members, friends, and eventually to all of humanity.

The rest of the procedure was identical for all participants. A computerized version of the TMS and SOFI questionnaires were administered following MM/LKM/reading in counterbalanced order as a manipulation check that participants randomized to MM or LKM would expectedly experience greater state mindfulness and positive affect referring toward themselves and others than would participants randomized to reading control, as well as to assess potential

differences between the experiences of participants randomized to MM versus LKM. Participants then completed an experimental SRP-ORP task, the Visual-Verbal Self-Other Referential Processing Task, described within the "Measures" section. They were then debriefed and received course credit. The entire study took approximately 1 h to complete.

Measures

In order to assess the association between SRP and ORP and a number of traits and postmeditation states of relevance to the experience of mindfulness and loving-kindness, as well as to assess the efficacy of group randomization to equate groups on these measures at baseline, participants completed a number of self-report measures as detailed below.

Depression Anxiety Stress Scale-21 (Short Form) The Depression Anxiety Stress Scale (DASS; Lovibond and Lovibond 1995) is a 21-item questionnaire designed to measure symptoms of *depression* (e.g., "I felt that life was meaningless," "I couldn't seem to experience any positive feeling at all"), *anxiety* (e.g., "I felt I was close to panic," "I felt scared without any good reason"), and *stress* (e.g., "I found it hard to wind down," "I tended to over-react to situations") levels over the past 2 weeks.

Self Compassion Scale (Short Form) The short-form of the Self Compassion Scale (SCS-SF; Neff 2003; Raes et al. 2011) is comprised of 12-items that measure overall compassion towards oneself (e.g., "I try to be understanding and patient towards those aspects of my personality I don't like," "When I'm going through a very hard time, I give myself the caring and tenderness I need").

Five-Factor Mindfulness Questionnaire The Five Factor Mindfulness Questionnaire (FFMQ, Baer et al. 2006) measures five psychological traits that are conceptually related to mindfulness as follows: (1) *acting with awareness* (e.g., "When I do things, my mind wanders off and I'm easily distracted" [*reverse scored*]), (2) *non-reactivity* (e.g., "I perceive my feelings and emotions without having to react to them"), (3) *observing* (e.g., "When I'm walking, I deliberately notice the sensations of my body moving"), (4) *describing* (e.g., "I'm good at finding words to describe my feelings"), and (5) *nonjudging* (e.g., "I criticize myself for having irrational or inappropriate emotions" [*reverse scored*]). There are a total of 39 items.

Toronto Mindfulness Scale (Short Form) The Toronto Mindfulness Scale (TMS; Lau et al. 2006) is a 13-item state questionnaire measuring the "decentering" and "curiosity" aspects of mindfulness as an immediate response to

meditation. The *decentering* subscale is intended to measure "awareness of one's experience with some distance and disidentification rather than being carried away by one's thoughts and feelings" (Lau et al. 2006; p. 1452) and include items such as "I experienced myself as separate from my changing thoughts and feelings" and "I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are." The *curiosity* subscale is intended to measure "awareness of present moment experience with a quality of curiosity" (Lau et al. 2006; p. 1452) and includes as exemplar items "I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings, or sensations" and "I was curious to see what my mind was up to from moment to moment."

Self-Other Four Immeasurables The Self-Other Four Immeasurables questionnaire (SOFI; Kraus and Sears 2009) is a 16-item questionnaire that measures the experience of positive versus negative qualities referring to self and others. Each item is a positive or negative adjective, specifically: "friendly," "joyful," "accepting," and "compassionate" (all positive terms), and "hateful," "angry," "cruel," and "mean" (all negative terms). The instructional set was modified for the present study such that participants rated the extent to which each adjective described the way they felt towards themselves and others (separate ratings) at the present moment, rather than over the past week (the latter as per regular instructions), on a five-point Likert scale. For the purposes of analysis, response to the SOFI was scored via four subscales distinguishing the factors *reference* (2: self vs. other) and *valence* (2: positive vs. negative words).

The Visual and Verbal Self/Other Referential Processing Task The Visual and Verbal Self/Other Referential Processing Task (VV-SORP-T) was developed by Frewen and Lundberg (Frewen and Lundberg 2012; Frewen et al. 2013) and instructions followed these previously published procedures. Completion of the VV-SORP-T yields four dependent measures (1: adjective endorsement, 2: negative affect [NA], 3: positive affect [PA], and 4: reaction time [RT]) for each of the four experimental conditions (1: self-negative [S-N], 2: self-positive [S-P], 3: other-negative [O-N], and 4: other-positive [O-P]).

Before completing the "experimental" aspect of the task, participants simply read ten positive and ten negative words (based on social and achievement themes; e.g., "rejected," "abandoned," "worthless," and "failure") and rated how much each word described themselves as well as (separately) a generic "other" person (a typical stranger they might meet in everyday life) on a scale from 0 ("not at all") to 10 ("completely"). For the experimental procedure, a photograph of the

participant displaying a neutral expression (as taken as if for a passport photograph) was acquired with a 7.2 mega-pixel camera. This photo was uploaded to a computer and standardized to match the size and background color of neutral-expression photographs of actors comprising the *NimStim* database (Tottenham et al. 2009). During different trials of the task, participants viewed a series of photographs either of themselves or a stranger taken from the *NimStim* database (matched for gender and general appearance) interspersed between the same words used in the adjective rating survey, blocked by valence. Each block lasted 45 s in length and contained five similarly valenced words, with the procedure first entailing the presentation of a fixation cross for 12 s (between blocks), followed by the word "self" or "other" (appearing 3 s) to alert the participant to the *Reference* condition of the upcoming block, followed by five pictures and five words, interspersed, each lasting 3 s, being either their self-photograph or that of a stranger, and being either a series of positive or negative adjectives, the same as those evaluated for self-referential or other-referential endorsement.

While the photos were presented, participants were instructed to internally rehearse the phrase "I am" (for self stimuli) or "s/he is" (for photographs of the stranger) and then to press a response key with either their index or middle finger (counterbalanced). As noted, after presentation of the photograph, either a positive or negative word was presented and participants were instructed to read the word silently and to press the response key again after doing so. Although participants' reaction time (RT) was recorded and served as a dependent measure, they were instructed that their button-pressing represented a passive measure of behavioral response to ensure that they were engaged in the task (i.e., participants were *not* correspondingly instructed to concern themselves with needing to press response buttons as fast as possible as is commonly conducted in cognitive psychology experiments). Participants were, however, instructed to "notice how they feel" throughout the task for subsequent report. As such, after completing the experimental aspect of the procedure, a post-task affect rating questionnaire was completed, requiring participants to rate how strongly (from 0 to 100 %) they experienced descriptors of either positive affect (PA) (e.g., "happy") or negative affect (NA) (e.g., "sad" and "fear-anxiety") during each of the four task-block combinations (i.e., self/other crossed by positive/negative words).

Data Analysis

Adjective endorsement and affect ratings (positive vs. negative) were averaged across trials specific to the four experimental conditions of the VV-SORP-T: self-positive (S-P), self-negative (S-N), other-positive (O-P), and other-negative (O-N). Reaction time (RT) was analyzed separately and excluded from analysis, following established procedures

(Frewen and Lundberg 2012), if the participant failed to respond to more than 10 % (>8 responses) of the trials in any one run, or more than 5 % (>12 responses) of the trials overall. RT data was also only submitted to statistical analysis if a participant's grand mean RT was within ±2 SD of the group grand mean. By these constraints, RT data was available for statistical analysis for 67 participants.

Results

Sample Characteristics Prerandomization

Table 1 reports descriptive and inferential statistics referring to participants' responses to the FFMQ, SCS, and DASS-21 before randomization. Participants randomized to MM, LKM, and reading-control did not differ significantly on any measure prerandomization ($p>.10$) excepting that the MM group scored higher on FFMQ-observing when compared with both the LKM group, $t(68)=2.67$, $p=.01$ (two-tailed), and the reading control group, $t(68)=2.17$, $p=.03$ (two-tailed). There was also a trend for the MM group to score higher on FFMQ-describing when compared with the LKM group specifically, $t(68)=1.80$, $p=.08$ (two-tailed).

Immediate Subjective Effects of MM and LKM

Table 2 reports descriptive and inferential statistics referring to participants' responses to the TMS and SOFI. As would be expected, participants randomized to reading control reported less TMS decentering than those randomized to MM, $t(67)= 3.99$, $p<.001$ (two-tailed), or LKM, $t(67)=4.64$, $p<.001$; less positive qualities as referring to self on the SOFI than those randomized to MM, $t(67)=1.65$, $p=.05$, or LKM, $t(67)=2.68$, $p<.01$; and less positive qualities as referring to others on the SOFI than those randomized to MM, $t(67)=1.74$, $p=.04$, or LKM, $t(67)=2.40$, $p<.01$. However, there were no significant group differences between the MM and LKM groups on any TMS or SOFI subscale. These results remained significant after controlling for FFMQ-observing scores.

VV-SORP-T: Group Comparisons

Following established approaches (Frewen and Lundberg 2012), the VV-SORP-T was analyzed in a $3\times2\times2$ split-plot repeated measures MANOVA with one between-group factor (MM/LKM/control), two within-group factors (*Reference*: SRP-vs-ORP and *Valence*: Positive-vs-Negative), and four dependent measures (adjective ratings, PA, NA, and RT). Please see Table 3 for descriptive statistics obtained. Across groups, main effects and interactions implicating *Reference* and *Valence* on PA and NA for the most part replicated

Table 1 Descriptive statistics and group comparisons referring to traits relevant to mindfulness and loving-kindness

Survey	Subscale	MM		LKM		Control		ANOVA		
		M	SD	M	SD	M	SD	$F(2,101)$	p	η^2
DASS	Depression	4.89	4.23	4.32	3.47	4.94	4.53	0.24	.79	<.01
	Anxiety	4.17	2.75	4.03	3.75	4.15	3.17	0.19	.98	<.01
	Stress	6.69	3.92	6.79	4.04	6.71	4.71	0.01	.99	<.01
FFMQ	Observing	27.17[a]	4.87	24.53[b]	4.06	24.59[b]	5.04	3.61	.03	.07
	Describing	16.37	3.59	14.97	3.33	16.88	4.05	2.48	.09	.05
	Act with awareness	23.69	6.31	23.56	6.00	22.50	6.12	0.38	.68	<.01
	Nonjudging	25.06	6.64	23.15	5.78	23.41	5.43	0.91	.41	.02
	Nonreactivity	20.77	3.32	19.38	4.78	19.91	4.14	1.00	.37	.02
SCS	Self-compassion	35.34	7.63	33.76	8.13	33.38	6.90	0.65	.52	.01

DASS Depression Anxiety Stress Scales, *FFMQ* Five Facet Mindfulness Questionnaire, *SCS* Self Compassion Scale. Means with differing superscripts ([a, b]) differ significantly (p<.05, two-tailed)

Frewen and Lundberg's (2012) prior findings, including that participants on average experienced greater PA during S-P than O-P, $t(103)=5.22$, $p<.001$, $d'=.51$, and greater NA during S-N than O-N, $t(103)=5.40$, $p<.001$, $d'=.53$. However, previous findings that endorsements of positive adjectives should be higher for self than for others, as per the self-positivity bias, failed to reach statistical significance in the present sample, $t(103)=1.30$, $p=.10$, $d'=.13$. In addition, overall, participants endorsed negative adjectives *higher* for self than for others within the present sample, $t(103)=2.26$, $p=.03$ (two-tailed), $d'=.22$, the opposite of prior results. Prior findings for self-related trials to be associated with longer RT when compared with other-related trials were also replicated (Frewen and Lundberg 2012). However, in the present sample, participants took *longer* overall to press buttons for negative trials than positive trials, the opposite of prior findings.

Table 3 reports observations regarding VV-SORP-T referring to the effects of group randomization. There were neither significant main effects for group, nor interactions of group with valence, for any dependent measure of the VV-SORP-T. However, PA ratings differed by group in interaction with *Reference* (Self-vs-Other), $F(2, 101)=3.08$, $p<.05$, $\eta^2=.06$.

This effect was reduced only trivially after covarying for group differences in FFMQ-observing, $F(2, 100)=2.91$, $p=.06$, $\eta^2=.06$. Referring to RT, there was only a trend observed for a three-way interaction (group × reference × valence), $F(2, 64)=2.50$, $p=.09$, $\eta^2=.07$. The significance of this effect was reduced upon covarying for group differences in FFMQ-observing, $F(2, 62)=2.04$, $p=.14$, $\eta^2=.06$. The results of post hoc tests of these interactions are illustrated in Figs. 1 and 2.

Figure 1 shows the results of group comparisons for PA ratings for SRP and ORP trials across valence. Comparing PA ratings for SRP trials (S-P and S-N) between groups, there was a trend for participants randomized to LKM to report *lower* PA than those randomized to MM, $t(68)=1.56$, $p=.06$, or reading control, $t(67)=1.58$, $p=.06$; in comparison, the MM and reading control groups did not differ, $t(67)=0.06$, $p=.95$. Follow-up analyses also confirmed that the size of the difference between PA ratings for SRP versus ORP trials differed significantly between the LKM ($M=2.56$, SD=16.23) and MM groups ($M=12.26$, SD=14.48), $t(68)=2.63$, $p=.01$. However, neither the LKM nor MM groups differed significantly from controls on this difference score.

Table 2 Descriptive statistics and group comparisons referring to mindfulness, loving-kindness, and state response to meditation

Survey	Subscale	MM		LKM		Control		ANOVA		
		M	SD	M	SD	M	SD	$F(2,101)$	p	η^2
TMS	Decentering	21.43[a]	3.73	22.51[a]	4.52	17.35[b]	4.72	13.52	<.001	.21
	Curiosity	18.80	4.29	19.63	5.09	17.56	6.24	1.35	.26	.03
SOFI	S-P	13.69[a]	2.77	14.51[a]	3.03	12.50[b]	3.20	3.91	.02	.07
	O-P	15.31[a]	2.48	15.83[a]	2.59	14.03[b]	3.57	3.47	.04	.06
	S-N	6.20	2.84	6.03	2.68	7.24	2.98	1.82	.17	.04
	O-N	5.29	2.19	5.60	2.40	6.53	2.39	2.65	.08	.05

TMS Toronto Mindfulness Scale, *SOFI* Self Other Immeasureables Inventory, *MM* Mindfulness Meditation, *LKM* Loving-kindness Meditation, *S-P* self positive, *O-P* other positive, *S-N* self-negative, *O-N* other negative. Means with differing superscripts ([a, b]) differ significantly (p<.05, two-tailed)

Table 3 Descriptive statistics and group comparisons between conditions of the VV-SORP-T

DV	Block	MM		LKM		Control		ANOVA			
		M	SD	M	SD	M	SD	Effect	F	p	η^2
Survey	S-P	69.77	17.39	68.43	17.18	69.56	14.74	Group	1.99	.14	.04
	O-P	68.67	11.25	65.46	15.13	67.12	15.47	GxR	0.29	.75	.01
	S-N	20.26	20.55	15.86	13.60	19.59	19.00	GxV	0.03	.98	<.01
	O-N	16.43	14.86	13.86	13.29	14.68	12.60	GxRxV	0.17	.85	<.01
PA	S-P	59.43	28.67	53.40	33.87	64.53	30.30	Group	0.63	.54	.01
	O-P	43.43	33.54	45.09	31.91	48.79	28.61	GxR	3.08	<.05	.06
	S-N	22.17	26.52	13.14	23.64	17.59	26.14	GxV	0.25	.78	.01
	O-N	13.66	22.63	16.29	29.14	17.21	27.17	GxRxV	0.42	.66	.01
NA	S-P	10.34	14.16	10.49	20.06	9.21	14.24	Group	0.04	.96	<.01
	O-P	9.03	13.47	12.66	19.47	10.98	11.22	GxR	2.02	.14	.04
	S-N	36.51	20.04	33.62	26.17	37.21	22.81	GxV	0.10	.91	<.01
	O-N	24.47	20.85	27.29	23.15	23.92	21.04	GxRxV	0.45	.64	.01
RT	S-P	864	378	823	262	898	359	Group	11.32	.001	.15
	O-P	792	300	803	311	811	285	GxR	0.28	.76	.01
	S-N	916	320	944	363	914	400	GxV	0.40	.67	.01
	O-N	842	278	856	345	915	341	GxRxV	2.50	.09	.07

$n=104$ for analyses of survey scores, PA, and NA, and $n=67$ for analyses of RT. *PA* positive affect, *NA* negative affect, *RT* reaction time, *G* group, *R* reference, *V* valence, *MM* mindfulness meditation, *LKM* loving-kindness meditation, *S-P* self positive, *O-P* other positive, *S-N* self-negative, *O-N* other negative

Referring to RT, the trend toward a three-way interaction was followed up with planned contrasts regarding SRP versus ORP for trials of positive valence within and across groups. Group comparisons were found to be nonsignificant. However, the significance of within-group comparisons concerning the effect of *Reference* varied by group. Figure 2 depicts the results for the contrast of SRP with ORP for trials of positive valence. Whereas participants randomly assigned to MM ($t[24]=2.16$, $p=.02$, $d'=.43$) and reading control ($t[18]=3.16$, $p<.01$, $d'=.73$) evidenced the expected effect of slower RT during SRP than ORP, this effect was not observed within those randomized to LKM, $t(22)=0.58$, $p=.57$, $d'=.12$. However, follow-up group comparisons of the difference

between RT for S-P versus O-P trials failed to reach significance.

VV-SORP-T: Correlations with Traits and States Related to Mindfulness and Loving-Kindness

Correlations between individual differences in affective responses during SRP and ORP with traits relating to mindfulness (FFMQ) and self-compassion (SCS) (see Table 4, top), and with self-reported mindfulness (TMS) and positive and negative qualities directed to self and other (SOFI) as an immediate response to meditation (see Table 4, bottom), were examined in participants who were randomized to either MM
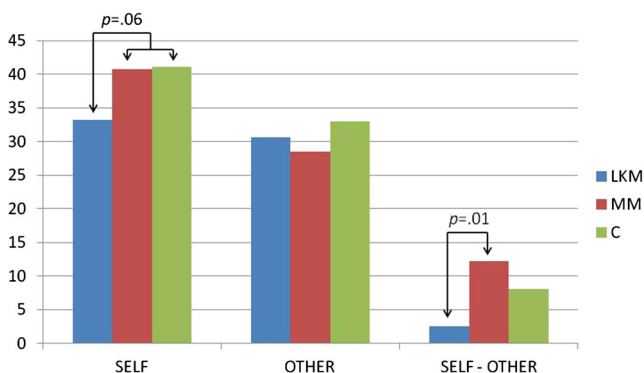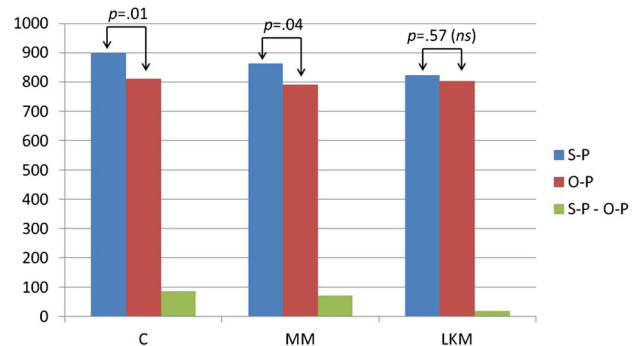

Fig. 1 PA ratings: group × reference

Fig. 2 RT ratings: group × reference × valence

Table 4 Correlations between affective response to the VV-SORP-T and traits and states related to mindfulness and loving-kindness

	Negative affect				Positive affect			
	S-N	S-P	O-N	O-P	S-N	S-P	O-N	O-P
Traits								
FFMQ-observing	*.24	−.04	.09	−.01	.06	−.02	.04	−.20
FFMQ-describing	.03	−.09	−.16	−.07	.04	−.13	−.09	−.17
FFMQ-act with awareness	*−.24	*−.42	*−.26	*−.24	−.21	−.05	−.10	−.03
FFMQ-nonjudging	*−.31	−.23	−.19	−.16	−.06	−.05	−.04	.02
FFMQ-nonreactivity	−.23	−.08	−.06	−.14	.05	−.02	−.08	−.03
SCS-self-compassion	*−.42	−.21	−.23	*−.26	−.05	−.21	−.14	−.10
States								
TMS-curiosity	.09	*.34	.14	.17	*.32	.19	*.26	.09
TMS-decentering	.14	.01	.19	.05	.00	.17	.05	.03
SOFI–SP	−.02	*−.26	−.01	−.19	−.11	.17	.01	.06
SOFI–OP	−.11	−.19	.06	−.17	.01	.13	.10	.18
SOFI–SN	.13	*.38	.11	*.35	*.32	.00	.17	*−.24
SOFI–ON	.08	.13	.18	.14	−.02	.02	.07	−.13

FFMQ Five Facet Mindfulness Questionnaire, *SCS* Self Compassion Scale, *TMS* Toronto Mindfulness Scale, *SOFI* Self Other Immeasureables Inventory, *S-P* self positive, *O-P* other positive, *S-N* self-negative, *O-N* other negative

*$p < .05$ (two-tailed)

or LKM. It was determined that *acting with awareness*, *nonjudging*, and *self-compassion* were variably negatively associated with the experience of negative affect during both SRP and ORP. Interestingly, mindful *observing*, by contrast, was positively associated with negative affect experienced during negative SRP.

Referring to states measured immediately following meditation practice, mindful *curiosity* experienced during the practice of meditation was positively associated with *negative* affect experienced during positive SRP, and positive affect experienced during *negative* SRP and ORP. In comparison, negative qualities directed to self on the SOFI were positively associated with negative affect experienced during both positive SRP and ORP, positive affect experienced during negative SRP, and negatively associated with positive affect experienced during positive ORP.

Discussion

The present study investigated the immediate effects of single, brief sessions of MM and LKM in comparison with reading control on valenced SRP and ORP as assessed experimentally, with a particular interest in examining positive SRP and ORP. Individual differences in traits related to mindfulness and loving-kindness, and immediate responses to MM and LKM, were also examined in association with individual differences in SRP and ORP.

As measured by self-report questionnaires, both MM and LKM were associated with increasing decentering and positive emotion as directed towards self and others, relative to reading control, with no apparent specificity between meditation type. In comparison, as assessed using an experimental measure of valenced SRP-ORP, neither MM nor LKM were found to increase positive SRP or ORP relative to reading control, which contrasts with our first hypothesis. Specifically, participants randomized to MM evidenced the expected self-positivity bias favoring increasing experience of positive affect during trials associating positivity with the self in comparison with a stranger, as was the case for those randomized to reading-control. However, consistent with our second hypothesis, this self-positivity bias was reduced in participants randomized to LKM. Moreover, individuals randomized to MM continued to show the expected lengthening of response times for positive-valence trials involving SRP versus ORP that was observed in the reading control group. In contrast, this effect was reduced to null within participants randomized to LKM.

Given that individuals randomized to MM did not differ from reading control in their pattern of responses to the VV-SORP-T, it seems more reasonable to interpret the overall pattern of results as reflecting the influence of LKM rather than MM per se. One interpretation of this pattern of results is that LKM, as uniquely involving the intentional cultivation of positive emotion toward both self and others, may be associated with a relative "rebalancing" or equalization of positive associations referring to self versus others. However, we were

surprised to find that this effect was primarily brought about by a relative *reduction* in positive affect experienced during SRP following LKM, as opposed to a relative heightening of positive affect experienced during ORP. Whether such an effect would be maintained with repeated practice of LKM, and its adaptiveness relative to the self-positivity bias, are clear questions for future research. In the present study, LKM may have heightened the sensitivity of a certain number of participants who would normally refrain from endorsing adjectives such as being "supported," "cared for," and well "loved" as self-descriptive, thereby increasing their experience of distress during the VV-SORP-T during S-P trials. Bearing on such an experience, Neff and others have brought to researchers' attention the conceptual distinction between general self-esteem and the construct of self-compassion, the latter involving not only being kind and respectful towards oneself but also being mindfully aware not only of one's positive but also of one's negative qualities with sensitivity and care (Neff 2003, 2011; Neff and Vonk 2007; Leary et al. 2007). Future research might examine whether guided meditations that directly seek to cultivate self- and other-compassion, rather than only to increase positive affect and self-esteem per se, are better able to reduce negative affect potentially experienced during experimentally evoked negative as well as positive SRP and ORP.

In addition to group level effects, we investigated the associations between individual differences in valenced SRP and ORP and traits and states relevant to mindfulness and loving-kindness. Supporting the relevance of an understanding of SRP and ORP to the constructs of mindfulness and loving-kindness, mindful acting with awareness, nonjudging, and self-compassion were associated primarily with a reduction in negative affect experienced during SRP and ORP. By contrast, the experience of directed negative qualities toward self after meditation practice, as assessed by the SOFI, tended to be associated with a seemingly maladaptive profile of SRP and ORP on the VV-SORP-T, specifically, involving increasing *negative* affect experienced during *positive* SRP, and increasing *positive* affect experienced during *negative* SRP and ORP. It is perhaps less surprising that participants who attributed more negative qualities to themselves (i.e., "hateful," "angry," "cruel," and "mean") following meditation practice would also be those more likely to report experiencing low positive affect during positive SRP (e.g., on the VV-SORP-T, rehearsing "I am… loved"), or even increasing positive affect during *negative* ORP (e.g., rehearsing "You are…worthless"). Whether such findings signal a form of affective or interpersonal disturbance will require further study.

However, it was also interesting to note that participants who reported increasing mindful curiosity, as assessed by the TMS, reported a generally similar pattern of findings to those who attributed a greater number of negative qualities to themselves following the meditations on the SOFI. It may be that participants who were more curious during meditation practice were similarly

more open and reflective toward statements such as "I am… worthless"; such findings suggest that encouraging the mindful stance of decentering, rather than curiosity, may be more protective against experiences of distress during experimentally evoked negative SRP. Moreover, participants reporting higher mindful "observing" traits were more likely to experience negative affect during negative SRP; these findings are consistent with Baer and colleagues' findings that the observing trait may not be associated with healthy self-regulation and wellbeing within novice meditators (Baer et al. 2006, 2008).

We conclude that the practice of different kinds of meditation, and encouraging the development of certain traits related to mindfulness and loving-kindness, may influence SRP and ORP in the direction of increased health, wellbeing, and adaptation. Nevertheless, the present study has several limitations. Participants were mostly Caucasian or Asian female undergraduates aged 17 or 18; the generalizability of the present results to persons of a more diverse demographic is unknown. In particular, studies of adept meditators and clinical samples are needed. Sample sizes were small, particularly for the analyses of reaction times in response to the VV-SORP-T that may have been specific to the meditation groups. Moreover, the randomization procedure unfortunately failed to equate groups on all variables of potential significance to task performance (i.e., trait mindful observing). Additionally, some prior findings concerning the self-positivity bias in adjective endorsement were not replicated in the present sample relative to participants studied by Frewen and Lundberg (2012) and Frewen et al. (2013); the reason for these differing results may somehow relate to the fact that the present study was carried out within the context of a research project investigating meditation. The VV-SORP-T is also a relatively new methodology and its construct validity as an experimental measure of valenced SRP and ORP requires further study; in particular, it may be more sensitive to trait aspects of valenced SRP and ORP that are less amenable to change following only a single meditation sitting. In addition, whereas participants randomized to MM were periodically interrupted in order for them to self-monitor their attentional state, that is, as per the procedure for calculating meditation breath attention scores (e.g., Frewen et al. 2008, 2010, 2014), no similar assessment was undertaken for LKM or reading control, introducing a possible source of bias. Clearly, more experimental research is needed before the effects of MM and LKM on SRP and ORP are fully understood.

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