Meditation, Cognitive Flexibility, and Emotion Regulation: A Test of Technique

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Most people have felt as if their emotions got the best of them at some point in their lives. During these moments, it can feel impossible to shift one's attention from the emotionally charged experience to de-escalate. The ability to shift attention is a key aspect of cognitive flexibility and has a significant impact on our capacity to regulate our emotions. In fact, it has been found that tolerance for negative emotional states and emotion regulation are positively correlated with cognitive flexibility (Arici-Ozcan et al., 2019). Furthermore, psychological studies have focused on ways to enhance cognitive and emotional processes because the impairment of these processes is central to many psychiatric disorders (Gu et al., 2015; Millan et al., 2012; Koole, 2009). One useful method that has been identified by these studies is meditation, as meditation has been found to increase connectivity between neural networks associated with emotion and attentional processes (Froeliger et al., 2012). Clinical studies show support for the use of meditation and a component of meditation, mindfulness, for chronic pain treatment, personality disorders, attention disorders, and various disorders of emotions (Hofmann et al., 2011; Marchand, 2013; Rubia, 2009; Sedlmeier et al., 2012). Many clinical therapeutic approaches have a basis in mindfulness practices, for example, mindfulness-based cognitive therapy (Segal & Walsh, 2016), dialectical behavior therapy (Linehan, 1987), acceptance and commitment therapy (Hayes & Wilson, 1994), and mindfulness-based stress reduction program (MBSR) (Kabat-Zinn et al., 1985; Moore & Malinowski, 2009). However, it is not clear how these therapeutic techniques lead to benefits for cognitive and emotional processes. Thus, the current study will attempt to gain insight into the relationship between meditation techniques, cognitive flexibility, and emotional regulation.

Although it is unclear which meditation techniques produce the cognitive and emotional benefits of mindfulness-based therapeutic approaches, several studies have concluded that meditation has positive effects on the regulation of attention and emotions (Chambers et al., 2007; Jha et al., 2007), cognitive flexibility (Moore & Malinowski, 2009), memory (Jha et al., 2010), and overall well-being (Wallace & Shapiro, 2006). However, these studies did not utilize a specific meditation technique and the length of meditation exposure varied. Chambers et al. (2007) compared the results of participants after a 10-day intensive mindfulness retreat to a meditation naïve group. Moore and Malinowski (2009) compared Buddhist meditators that had completed at least one, 6-week mindfulness meditation retreat, to a meditation naïve control group. Jha et al. (2010) included two military cohorts and provided 8 weeks of mindfulness training to one of the cohorts. Wallace and Shapiro (2006) primarily came to their conclusions based on correlations between general meditation practice and well-being. Jha et al. (2007) compared participants from an 8-week MBSR cohort to individuals from a 4-week intensive mindfulness retreat. While Jha et al. (2007) did not explicitly state the meditation type, one could argue that focused attention meditation (FAM) and open monitoring meditation (OMM) were included as FAM and OMM are considered foundational to the mindfulness-based stress reduction program (Khoury et al., 2015). While these studies conclude that meditation and mindfulness are beneficial for emotion regulation and cognitive control, they do not clearly define which meditation technique was used. This is an important consideration as Sedlmeier et al. (2012) found that different meditation techniques yield variable effects on cognitive and emotional processes. In summation, there are various benefits found with meditation, but it is unclear what produces the benefit or what type of benefit is generated because the authors either do not report the type of meditation or the studies use multiple different meditation techniques. It

is also unclear how much meditation is needed to produce benefits as many studies vary in the length of time spent meditating. Therefore, consideration of various meditation techniques and durations is necessary.

FAM, OMM, and loving-kindness meditation (LKM) are among some of the most frequently utilized styles. In fact, FAM is often considered the starting foundation for many other types of meditation practice. This style of meditation involves an extended focus on a single tangible or physical object, such as one's breath. The FAM practitioner must actively bring awareness to mind wandering and reorient their attention (Lippelt et al., 2014). As the goal of FAM is to increase attentional control and reduce emotional reactivity, advanced practitioners of FAM can maintain a state of hyperfocus with little effort. OMM is typically the next step in meditation practice after FAM practice has been established. Worth noting, there is little difference between OMM and FAM; the object of attention in FAM is something tangible or physical, and the object of attention in OMM is that which rises to one's awareness (Lippelt et al., 2014; Yordanova et al., 2020). Thus, OMM involves constant monitoring of mental states and reorienting to a state of active monitoring. Another type of meditation, loving-kindness meditation (LKM), is an easy transition for advanced OMM practitioners as the constant awareness of one's mental state is an integral component of LKM. A typical LKM session involves mentally extending love and compassion to oneself, then a loved one, a stranger, and finally, to an "unlikeable" other. During LKM, practitioners are encouraged to reassess negative feelings such as hatred and anger and reorient to feelings of compassion and kindness. Thus, LKM focuses on socio-affective capacities by mentally extending thoughts of kindness and goodwill to others, while FAM and OMM focus on attention regulation.

While FAM, OMM, and LKM practices differ in the object of attention, some studies have identified neural activation patterns common to all three styles. For example, a comparison of FAM, OMM, and LKM on measures of EEG oscillatory synchronization patterns indicated all three types of meditation shared a consistent connectivity pattern during meditation (Yordanova et al., 2020). All three meditation types had a bilateral increase in delta oscillations, a left hemisphere increase in theta oscillations, and a right hemisphere increase in fast alpha oscillations (Yordanova et al., 2020). Theta and alpha oscillations have been associated with "working memory engagement and inhibition of task-irrelevant cortical regions" (Spironelli & Angrilli, 2010, p. 259). Interestingly, delta waves are typically only seen in healthy adults during deep stages of sleep and are considered indicative of brain damage or psychiatric disease when active during wakefulness (Spironelli & Angrilli, 2010). Thus, increased delta activity during FAM, OMM, and LKM practice may indicate the induction of a deep-sleep-like state while one practices meditation. Of note, the participants in this study all had approximately 20,000 hours of meditative practice, therefore these findings may only be typical for advanced FAM, OMM, or LKM practitioners. However, Yordanova et al. (2020) conclude the specific EEG patterns identified are indicative of heightened attention and awareness of one's experiences (meta-cognition). Overall, this indicates that there are similar connectivity patterns that occur with various types of meditation. However, while imaging studies provide insight into brain activity and neural connections, they cannot indicate if, and to what degree, cognitive or emotional processes may be impacted by the imaged activity. Moreover, research into the impact of LKM and FAM on cognitive and emotional processes is lacking. One study found reduced cognitive flexibility with FAM (Wolff & Beste, 2020), and another found moderate effects on emotional processes with LKM (Hofmann et al., 2015). However, the interpretation of Hofmann

et al. (2015) is limited as it was uncontrolled and only included subjects with mood disorders. No studies of FAM and measures of emotion regulation were identified nor were studies of LKM and cognitive flexibility. Thus, a comparison of LKM and FAM on measures of cognitive flexibility and emotion regulation is needed to provide insight into the various findings of imaging studies.

Adding to the neural activity overlap of meditation styles, some studies have found that meditation also appears to activate specific neural networks. For example, a study of long-term LKM practitioners identified via structural MRI that LKM practitioners had thicker fronto-insular cortices than meditation naïve controls (Engen et al., 2018). Furthermore, fMRI indicated that LKM activates fronto-insular regions bilaterally, and this activation pattern partially overlapped with the identified increases in the thickness of these regions in those that meditated (Engen et al., 2018). It is suggested that the overlap between fronto-insular thickness increases and activation may provide support for meditation-mediated neuroplasticity, which may enhance cognitive flexibility due to increased connectivity in fronto-insular regions. To support this theory, FAM has been found to increase gray matter in the insular and frontal cortices (Lenhart et al., 2020). Important to note, Engen et al. (2018) included a relatively small cohort size with only 17 LKM practitioners. Additionally, all the practitioners in the LKM study had meditated for an estimated total of 40,000 hours, practiced for an average of 30 years, and attended multiple intensive meditation retreats (Engen et al., 2018). The duration and hours of LKM practiced by the cohort limit the generalizability of the findings. Interestingly, while the FAM study also had a relatively small cohort size of 27 participants, all participants were meditation novices and practiced for only 7 weeks before alterations in the insular and prefrontal regions were found (Lenhart et al., 2020). Therefore, these findings may indicate benefits of

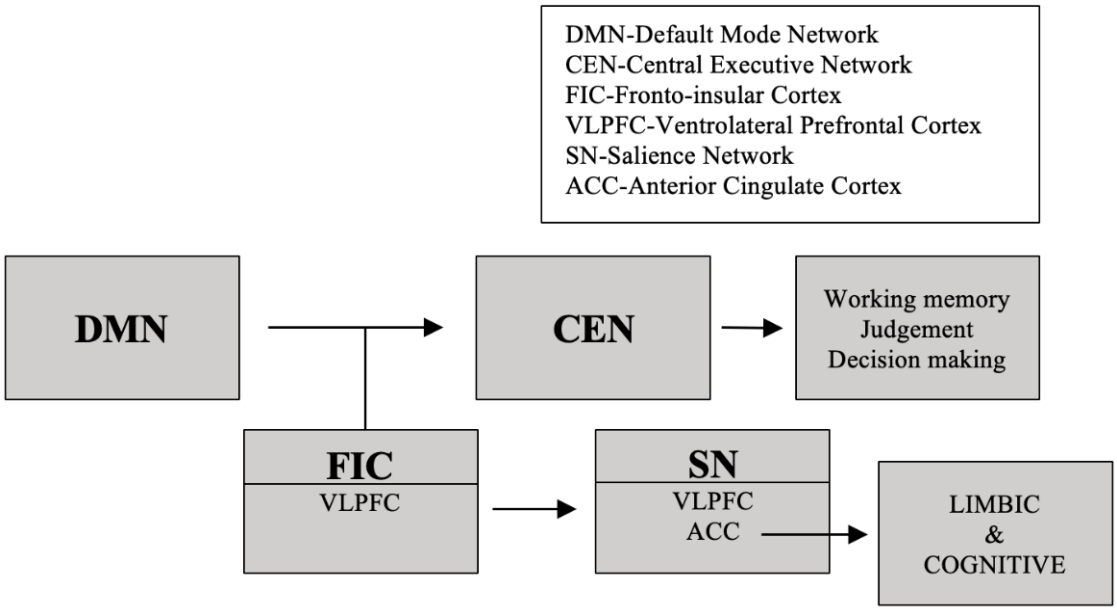
meditation are possible within a relatively short period regardless of previous meditation experience. Nevertheless, both studies indicate that LKM and FAM increase the activation of prefrontal and insular regions. Moreover, the activation of these regions likely influences emotion regulation and cognitive flexibility due to their association with these processes.

Emotion and attention regulation, and thus cognitive flexibility, are two primary functions of the fronto-insular cortex. Moreover, the fronto-insular cortex appears to initiate the switch to the central executive network from the default mode network during cognitively demanding tasks (Sridharan et al., 2008). The default mode network includes the ventromedial prefrontal cortex and posterior cingulate cortex and is active when individuals are not focused on the outside world (Sridharan et al., 2008). The central executive network consists of the dorsolateral prefrontal cortex and posterior parietal cortex and is critical not only for working memory functions but for judgment and decision-making as well (Sridharan et al., 2008). This explains the increase in theta and alpha oscillations during meditation found by Yordanova et al. (2020), as these waves are associated with working memory. The fronto-insular cortex contains the ventrolateral prefrontal cortex (VLPFC) and is a key node of the salience network, which directs our attention to cognitive and emotional stimuli deemed important. The VLPFC has a well-established connection with affect regulation, particularly when cognitive reappraisal is necessary to divulge alternative meanings of emotional stimuli (Engen et al., 2018). Additionally, the salience network includes the anterior cingulate cortex (ACC), which has connections with the limbic (emotional) system and the prefrontal cortex (cognitive system) (Stevens et al., 2011). Thus, cognitively demanding tasks, like meditation, activate the network responsible for directing our attention to important cognitive and emotional stimuli (the fronto-insular cortex of

the salience network), which then activates the network responsible for making judgments and decisions (the central executive network) based on those stimuli (Fig. 1).

Figure 1

Neural Networks Activated by Meditation



Note. The FIC mediates the shift from the DMN to CEN. The VLPFC is part of the FIC and SN. The ACC is connected to the limbic and cognitive systems.

The functions of these neural networks, combined with the thickness increases in the fronto-insular cortex of long-time meditators, indicate the ability to switch between networks is augmented by meditation. Moreover, an increased ability to switch between networks likely improves emotional regulation through greater cognitive flexibility. However, a review of FAM, OMM, and LKM by Lippelt et al. (2014) indicates that distinguishing these meditation types in any meaningful way on measures of emotion and cognition is lacking. Furthermore, while FAM and LKM have similar neural activation patterns, these meditation types differ in technique, which is expected to influence the effect on cognitive and emotional processes based on the

findings of Sedlmeier et al. (2012) that found variable effects dependent on meditation technique. Therefore, differences in the degree to which cognitive and emotional processes are affected by meditation are expected and will vary depending on the technique used.

While it is currently unclear how meditation style influences psychological outcomes, each one has a different technique that may aid in distinguishing which style yields the most benefit. For example, LKM has a focus on socio-affective skills, which are processes of the anterior insula and the ACC (Engen et al., 2018). Moreover, von Economo neurons (VEN) are a unique cell type found only within the insular and cingulate cortices and are currently only known to exist in "humans, great apes, elephants, and some cetaceans," all highly social animals with large brains (Gogolla, 2017, p. R580). While Sridharan et al. (2008) suggest these neurons allow the salience network to mediate the switch from the default mode network to the central executive network, the specific function of these neurons is not clear. Other research indicates that VENs may be central to fostering social connections and socio-affective skills (Gogolla, 2017). In support of this, VEN numbers are greatly reduced in individuals with neuropsychiatric disorders that involve impaired social functions, like frontotemporal dementia and early-onset schizophrenia (Santos et al., 2011). Research also suggests that VEN numbers are abnormal in those with autism, a disorder characterized by impaired social skills (Santos et al., 2011). Additional support for the role of VENs in socio-affective processes comes from the conclusion that insular activity is increased with LKM which, as mentioned previously, has a particular focus on cultivating socio-affective skills. Overall, it appears the insula and ACC have a direct impact on attention shifting, which is the basis of cognitive flexibility. These studies also indicate the insula and ACC have a direct impact on socio-affective and emotional processes that are likely mediated by VENs. Therefore, as FAM and LKM meditation activate the fronto-insular

cortex, both emotion regulation and cognitive flexibility should be directly influenced by meditation practice. However, increases in fronto-insular activity are likely not as great with FAM due to the cultivation of an inflexible attentional state. Furthermore, considering the likely role of VENs in socio-affective and emotional processes and attention shifting, greater increases in these processes with LKM are expected when compared to FAM.

Although FAM is found to increase gray matter, and thus connectivity, in fronto-insular regions, FAM appears to promote persistent cognitive stability that is not conducive to cognitive flexibility (Wolff & Beste, 2020). For example, on a measure of task switching Wolff and Beste (2020) found switch costs increased with a single 15-minute guided FAM session. Switch costs "reflect processing time when responses are to be switched" (Wolff & Beste, 2020, p. 1484). This may be explained by the basic principle of FAM to focus on a single object and reduce mind-wandering. Wolff and Beste (2020) explain that attention to extraneous stimuli is necessary to evaluate the importance of those stimuli and orient to them when necessary. Thus, FAM shields other cognitive processes from information outside the current focus and reduces cognitive flexibility. Interestingly, Stevens et al. (2011) found that amygdala activity was increased by the suppression of thoughts. As suppression of thoughts is central to FAM, and the amygdala is part of the limbic system, one could tentatively conclude that FAM would decrease emotion regulation. Conversely, Stevens et al. (2011) found that amygdala activity decreased with reappraisal, distraction, and distancing. As the reappraisal of feelings towards others is a central component of LKM, emotion regulation is expected to increase by LKM. However, as mentioned previously, there is not currently any research that compares these meditation types on measures of both cognitive flexibility and emotion regulation.

This study aims to fill the gap in comparative meditation research, and thus will compare FAM and LKM on cognitive flexibility and emotion regulation measures. As previously mentioned, FAM and OMM differ only in the object of attention during practice. Therefore, OMM will not be included here as this study aims to compare divergent forms of meditation. Furthermore, the studies discussed previously involved cohorts of advanced meditation practitioners (Yordanova et al., 2020), or prescribed meditation practice for at least 10 days (Chambers et al., 2007) and up to 8 weeks (Jha et al., 2010). To date, very little research exists examining the short-term effects of meditation. In fact, only one study of short-term effects from either FAM or LKM was identified. In that study, 11 of 19 participants had reduced cognitive flexibility after a single, 15-minute smartphone app-guided FAM meditation (Wolff & Beste, 2020). Based on these findings, it was expected that a short-term meditation task, such as a 10-minute video-guided meditation, may have some effect. Three other studies of short-term meditation were identified but the meditation was either OMM (Lin et al., 2020) or a generalized breath awareness meditation (Wu et al., 2019; Basso et al., 2019). Lin et al. (2020) did not find any measurable effect on emotion regulation after a brief 20-minute exposure to meditation. In contrast, Wu et al. (2019) and Basso et al. (2019) found improvements in emotion regulation measures after meditation, but both studies included brief (13-15 minute) meditation for at least one week (Wu et al., 2019) and up to 8-weeks (Basso et al., 2019). Therefore, these studies are more long-term compared to the intended meditation exposure in this study. Thus, this study aimed to identify if emotion regulation and cognitive flexibility are affected with a single, 10-minute guided FAM or LKM meditation.

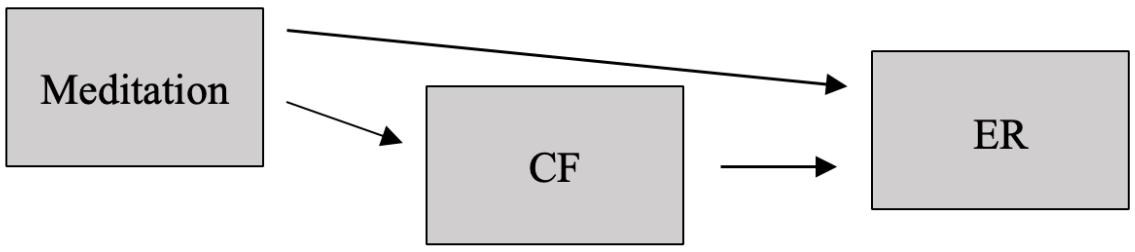
Here, we examined the effects of a single exposure to FAM or LKM on cognitive flexibility and affect regulation tasks in meditation novices. An emotional counting Stroop

(ecStroop) and Wisconsin Card Sort (WCS) task were administered after a 10-minute guided LKM or FAM video. The ecStroop is a "variant of the traditional color-naming Stroop task" with a focus on identifying emotional interference (Brennan et al., 2015, p.1867). Previous studies have used the ecStroop to assess emotion regulation (Brennan et al., 2015; Whalen et al., 2006). However, these studies were specifically examining ACC function relative to the amygdala. As the ACC and amygdala are functionally connected to the fronto-insular cortex, it is assumed that the ecStroop will also apply here. The WCS task was used to assess cognitive flexibility due to the understanding that this task is commonly used to assess this aspect of executive functioning (Meyers et al., 2021). Participants in this study were meditation novices and results were compared to a non-meditation control group on the same measures.

Based on the conclusion that meditation promotes the connectivity of neural regions associated with emotional processes, the first hypothesis of this study is that meditation will have a direct effect on emotion regulation (Fig. 2). Additionally, the studies discussed here demonstrate that meditation has a direct effect on cognitive flexibility. Therefore, the second hypothesis of this study is that meditation will have cognitive flexibility-mediated influences on emotion regulation that differ between LKM and FAM (Fig. 2).

Figure 2

Causal Relationships



Note. Meditation will have a direct effect on emotion regulation (ER) and cognitive flexibility (CF). Meditation will also have an indirect effect on emotion regulation that is meditated by cognitive flexibility.

Methods

Participants

Participants were recruited by contacting psychology professors at Eastern Oregon University (EOU). Participants' professors offered extra credit towards students' overall grade in one course upon completion of this study. Data collection was completed exclusively online; thus, participants were able to access the experiment via a URL link that was provided. Participants were asked to complete this study via Windows laptop or desktop computer with access to the internet and working speakers. Participants were also asked to complete the experiment alone in a quiet, non-disruptive environment, and be proficient in the English language. To ensure confidentiality, participant data was only associated with an ID number. Additionally, informed consent was obtained before data collection. After participants provided their electronic signature on the informed consent they were redirected to a new survey where their data was only associated with an ID number. In total, 114 people completed the informed consent and first half of the study, but only 49 participants completed the task portion, 45 of which were female, aged 18-50 years. Twelve participants were randomly assigned to the control group, 18 to the FAM group, and 19 to the LKM group.

Materials and Instruments

E-prime was used to create a Wisconsin Card Sort and emotional counting Stroop (ecStroop) task to assess cognitive flexibility and emotion regulation. Guided meditation and cartoon videos were administered via a YouTube video embedded in Qualtrics. Both guided

meditation videos displayed a nature photo throughout the entire 10 minutes while a voice directed them to awareness of their breath (Declutter the Mind, 2020) or to mentally extend thoughts of gratitude and wellness to others (Declutter the Mind, 2019). The cartoon video was a 10-minute clip of the movie *Tom and Jerry: Snowman's Land* (WB Kids, 2022). Questionnaires, consent forms, and debriefing were also administered via Qualtrics. The Wisconsin Card Sort task required participants to learn one rule for a response, then shift their response to a new rule after approximately 10 correct responses (see Appendix). The rules for response were the same for all participants but order of sorting rule (shape, color, number of items) was randomized for each participant. The ecStroop task required participants to report the number of words they saw on a screen, regardless of meaning. Participants had trials that occurred in random order and contained neutral words (e.g., chance, owl, cork) or negative emotional words (e.g., alone, broken, crisis) (see Appendix). Participants were also asked questions regarding their current mood state prior to video exposure and task completion.

Design

This study design was between subjects with three levels. Therefore, participants were randomly assigned to one of three groups: FAM, LKM, or no meditation. Participants in all groups completed the same cognitive flexibility and emotional regulation tasks, though the order of tasks presented to participants was randomized. The dependent variables were cognitive flexibility and emotional regulation scores, measured with a WCS and ecStroop task.

Procedure

Before the administration of measures, participants first completed an online informed consent, then a questionnaire that assessed current emotions, previous meditation experience, age, gender, student status, and employment status. Participants assigned to LKM or FAM

followed a self-administered 10-minute video-guided meditation. Participants assigned to the control group watched a 10-minute video of Tom and Jerry cartoons. After video completion, all participants were assigned the Wisconsin Card Sort and ecStroop tasks, both tasks were completed via computer, and the order of tasks was randomized. In total, this study took approximately 35 minutes to complete and concluded with a debriefing.

Data Analysis

Variables for analysis included those in the hypothesized model; meditation was the independent variable, and cognitive flexibility and emotion regulation were the dependent variables (Fig. 2**)**. An ANOVA was conducted to compare the control group, LKM, and FAM groups on the measures of cognitive flexibility and emotion regulation. Further, path analysis was used to analyze the data from this study as well to consider the indirect relationship of meditation on emotion regulation through cognitive flexibility. Path analysis is a form of structural equation modeling that is also viewed as a special case of multiple regression analysis (Lleras, 2005; Suhr, 2008). This statistical method accounts for variation and relationships within the measured variables and does not require the specification of relationships between variables before testing. Thus, all possible relationships are considered and tested between the dependent and independent variables. Furthermore, path analysis can provide insight into any possible latent variables and indirect effects of the independent variable on the dependent variable (Suhr, 2008). The path model was tested with Rstudio version 4.2.3.

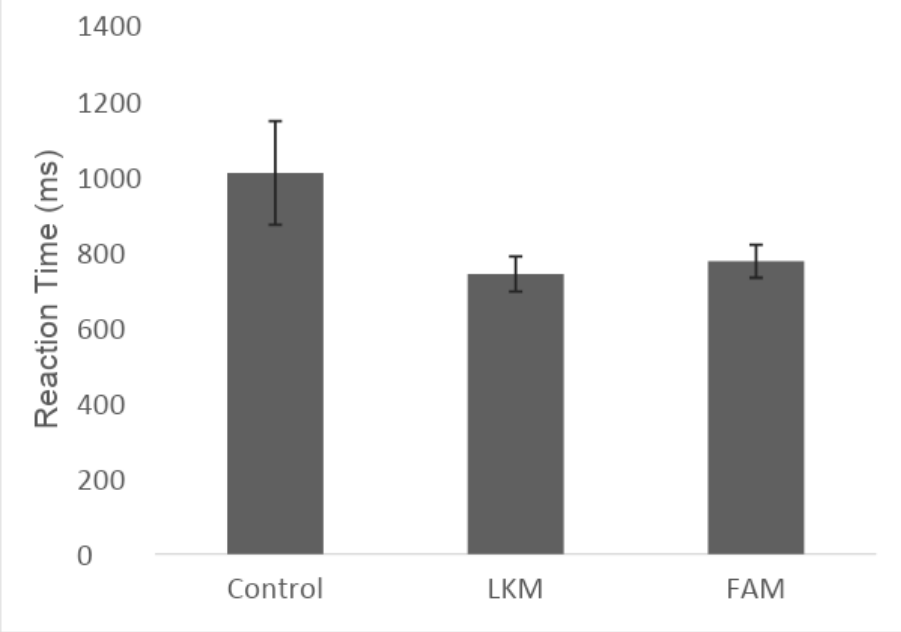
Results

The first hypothesis of this study was that meditation would have a direct effect on emotion regulation and the second hypothesis of this study was that meditation would have cognitive flexibility-mediated influences on emotion regulation that differ between LKM and

FAM (Fig. 2). ANOVA tests were conducted first to examine the effect of meditation type on cognitive flexibility and emotion regulation. The Shapiro-Wilk test indicated that the data was not normal for emotional regulation ($p < .001$), but upon visual inspection of histograms, they did not appear strongly skewed or with outliers. However, Levene's test indicated the variances with the emotion regulation task were not homogenous ($p = .001$), so Welch's ANOVA was used. The results of Welch's ANOVA indicate that the difference between the control, LKM, and FAM groups on the measure of emotional regulation was not significant, ($F(2,46) = 1.66$, $p = .21$; Fig. 3).

Figure 3

ecStroop Results with Standard Error.

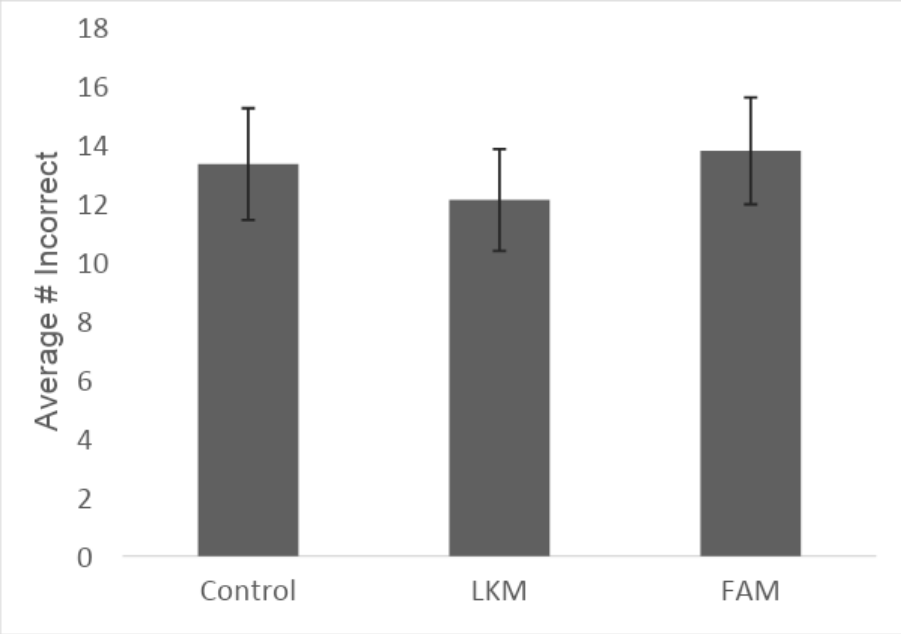


The data was also not normal for the cognitive flexibility task as indicated by the Shapiro-Wilk test ($p = .005$), but also upon visual inspection, did not look strongly skewed or with outliers. Further, variances for the WCS were homogenous as assessed by Levene's test ($p = .68$), so we continued with the one-way ANOVA. The results of this ANOVA indicate that the difference

between the control, LKM, and FAM groups on the measure of cognitive flexibility was not significant ($F(2,46) = 0.25$, $p = .78$; Fig. 4).

Figure 4

WCS Results with Standard Error.



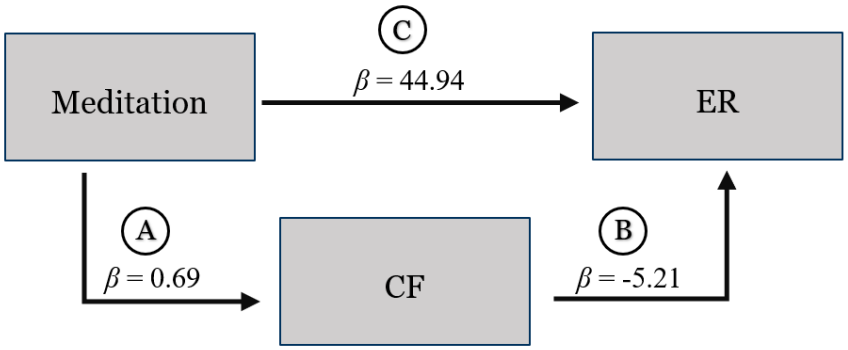
Note. The average number incorrect is out of 30 trials.

A path model was used to test the indirect effect of meditation on emotion regulation via cognitive flexibility (the second hypothesis of this study) and to test for the direct effect of cognitive flexibility on emotion regulation. The first path analysis compared only the meditation groups as the control group was initially excluded. Results indicated that meditation did not have a direct effect on emotional regulation, $\beta(37) = 44.94$, SE = 63.02, $p = .48$, or cognitive flexibility $\beta(37) = 0.69$, SE = 2.50, $p = .78$ (Fig. 5). There was no direct effect of cognitive flexibility on emotion regulation $\beta(37) = -5.21$, SE = 3.86, $p = .18$ (Fig. 5). The indirect effect, tested using the Sobel test and percentile bootstrapping, was not significant $\beta(37) = -3.61$, SE =

17.18, p = .83. A second path analysis was conducted with the meditation groups collapsed into one and the control group was added as there was no significant difference in the ANOVAS and no significant effect in the first path analysis. Results indicated that meditation had a marginally significant effect on emotional regulation $\beta(49)$ = -251.02, SE = 138.55, p = .07, and no effect on cognitive flexibility $\beta(49)$ = -0.41, SE = 2.26, p = .86. There was no direct effect of cognitive flexibility on emotion regulation $\beta(49)$ = -1.11, SE = 4.34, p = .80. The indirect effect, tested using the Sobel test and percentile bootstrapping, was not significant $\beta(49)$ = -0.46, SE = 10.71, p = .97.

Figure 5

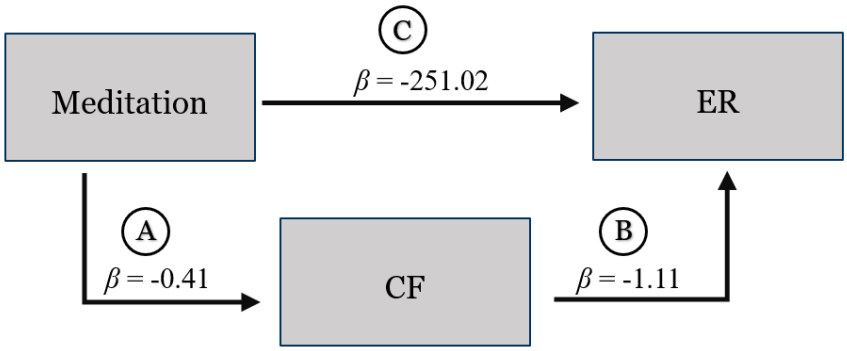
Path analysis results with control group excluded.



Note. Path A – direct effect of meditation on CF, path B – direct effect of CF on ER, path C – direct effect of meditation on ER.

Figure 6

Path analysis results with control group included.



Note. Path A – direct effect of meditation on CF, path B – direct effect of CF on ER, path C – direct effect of meditation on ER.

Discussion

In this study, the effect of two types of brief meditation exposure on cognitive and emotional processes was assessed. Emotion regulation was assessed with an emotional counting stroop task (ecStroop), and cognitive flexibility was assessed with a Wisconsin Card Sort task (WCS). Prior to task completion, participants were randomly assigned to watch 10 minutes of FAM, LKM, or cartoons. Then, participants downloaded and completed the WCS and ecStroop tasks. Based on findings from previous studies, the hypotheses of this study were that meditation would have a direct effect on emotion regulation and on cognitive flexibility.

The results of the current study indicate that there is no variation in cognitive or emotional abilities that is dependent on meditation technique. Further, meditation did not directly impact cognitive flexibility or emotion regulation and there was no effect on emotional regulation mediated by cognitive flexibility. Thus, the results of the current study do not support the hypothesis that meditation will have cognitive flexibility-mediated influences on emotion regulation. This is supported by the study from Basso et al. (2019) that concluded improvements in emotion regulation were a direct result of meditation and not mediated by any cognitive

changes. However, while brief meditation did not significantly impact emotional regulation or cognitive flexibility in the current study, path analysis showed there was a marginally significant effect of the control group versus the meditation group on emotion regulation. Therefore, the results of the current study provide moderate support for the hypothesis that meditation will have a direct effect on emotion regulation. Further, the finding that a brief 10-minute exposure to meditation may yield measurable results coincides with previous research from Wolff and Beste (2020). In that study, 11 of 19 participants had a measurable reduction in cognitive flexibility after a 15-minute guided FAM session. While the results of that study were not in favor of increased cognitive flexibility, the results indicate that a brief, one-time exposure to meditation may have measurable effect.

The failure of the current study to fully support the hypotheses may indicate that there is simply no effect or there was interference by extraneous variables. For example, some participants may have mood or cognitive patterns that result in poor performance on measures of these processes. According to Matt et al. (1992), participants' mood patterns influence the interpretation of stimuli, and thus, the response patterns to emotional tasks. Participants' responses to the current mood assessment may be an additional consideration for future analyses. Further, as this study was completed entirely online, controlling the participants' environment to limit distractions was not possible. Future studies in this subject may aim to conduct in-person studies to eliminate possible distractions and task interference. Additionally, the limited duration of meditation may have also prevented this study from providing support for the hypotheses. While Wolff and Beste (2020) found deleterious effects on cognitive flexibility with a single 15-minute FAM session, this has not been the standard for many meditation studies. For example, Basso et al. (2019) found effect on emotional regulation after 8 weeks of brief (15

minute) daily meditation, but not when participants were assessed after only 4 weeks. Linn et al. (2020) did not find any significant effect after a single 20-minute OMM session, and Wu et al. (2019) found a significant effect with one week of daily meditation. Therefore, it may be that effects of meditation increase in strength with duration of at least one week. Perhaps this is due to variation in mood at the time of meditation and the interference of this variable with the effect of the practice. In other words, participants' mood at the time of meditation likely influences task responses, as explained by Matt et al. (1992). Therefore, when exposed to meditation consistently for at least a week, this interference may not influence emotional and cognitive abilities as significantly as may be the case with a single meditation session. Thus, as mentioned previously, participants' responses to the current mood assessment could be added to a more complex path analysis if there were a larger sample size. Another potential interference with data collection includes the method of task delivery. Only 49 participants completed the entire study out of the 114 participants that completed the survey and watched a video. This indicates that the download of the task files to complete the cognitive flexibility and emotion regulation tasks was likely a barrier to completion for many. Future research may aim to identify a different task delivery software that doesn't require download to make this process more user-friendly.

An additional reason why the current study failed to support the hypothesis is that there may not be enough power to yield significant effect due to the lack of a large enough sample size. Of the 49 participants data files were received for, 19 were assigned to LKM, 18 to FAM, and 12 to cartoons. A larger sample size would likely increase the power and improve the ability to detect significant effects. Additionally, any generalizable conclusions may be difficult to extrapolate from the results as the small sample size consisted only of psychology students and was comprised almost entirely of females (91.84%). Previous research suggests that females

react more strongly than males on measures of emotion and possibly respond differently to mindfulness meditation (Rojiani et al., 2017). It is for this reason that Lin et al. (2020) conducted their study comprised entirely of females. One likely explanation for the differences between the sexes on measures of emotion is that female and male brains are structurally different, as identified with neuroimaging studies. Gur and Gur (2016) explain that female brains have more inter-hemispheric connections, limbic activity, and orbitofrontal volume than male brains and these differences are connected to differences between the sexes in emotion regulation. In other words, the female brain is structurally and functionally conducive to emotion sensitivity. Important to note, these are all generalizations based on imaging studies and there are more differences within the sexes than between. However, these observed differences are a likely explanation for why a majority female meditation study may skew data in favor of meditation.

In summary, the results indicate there was no significant effect of brief meditation on cognitive flexibility and emotion regulation. However, these findings do not rule out the possibility of effects due to extraneous variables, duration of meditation, and limited sample size. Considering the limitations of the current study, the effect of meditation on emotional and cognitive processes warrants further assessment to confirm if there is a significant difference between brief LKM and FAM on these processes. A better understanding of how these practices or stimuli impact our mental capabilities may aid in psychological treatment and personal wellbeing. Researchers may yield a more definitive answer by conducting a similar study in-person, utilizing an alternative software for task delivery, and/or utilizing a larger and more diverse sample size. Overall, this topic is one that is ripe with potential for future studies to advance the science of meditation.

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Appendix
Materials Used

PARTICIPANT CONSENT FORM

Eastern Oregon University

Consent to Participate in Research

Title of Study: A test of meditation style.

Investigator: Ashley Figel
afigel@eou.edu

Faculty Sponsor: Dr. Zoe Johnson-Ulrich
zjohnsonulrich@eou.edu

Brief Description of Procedure:
If you agree to be in this study, you will be asked to do the following:
1. Answer questions about your current mood.
2. Follow a 10-minute video-guided meditation or watch 10 minutes of Tom and Jerry cartoons.
3. Complete two cognitive tasks via your computer.

Your participation in this study will take approximately 35 minutes.

Risks and Benefits: Minimal risk is identified beyond discomfort with disclosing information regarding emotional state or with reading emotionally charged words. Additionally, there is some risk of temporary anxiety and emotional sensitivity after meditation. While risks are minimal, please end the guided meditation if you experience any discomfort.
If needed, and you are an EOU student, there are counseling services available at EOU's Student Health and Counseling Center shc@eou.edu 541-962-3524.
There are also services available through the National Institute of Mental Health at 1-800-273-8255 or text "HELLO" to 741741.
If you have any concerns relating to the experiment, you are encouraged to contact the researchers of this study, or the chair of the IRB committee at athornburg@eou.edu.

You may benefit from participating in this study by receiving extra credit from your professor, if offered. Beyond that, participation in research contributes to growth within the scientific community. We hope that you will also benefit from learning about how research is conducted.

Confidentiality: Your name will not be connected to your results or to your responses on the questionnaire; instead, a number will be used for identification purposes. Information that would make it possible to identify you or any other participant will never be included in any sort of

report. The data will be accessible only to those working on the project. You may request to see the general results of the study when this project is complete.

Compensation (may include course credit): If you are a student, you may be offered extra credit for one course for your participation.

Right to Refuse or Withdraw (include statement of participant withdrawal procedure): Participation in this study requires your voluntary consent and you will not be forced to participate. At any time during this study, you have the right to refuse or withdraw. If you choose to refuse or withdraw, you will not be penalized in any way and all participant information will be deleted.

Consent: Your digital signature below indicates that you have agreed to volunteer as a research subject, that you understand your rights for withdrawal, and that you will notify the investigator in advance if you are unable to participate for any reason.

Please type your name and today's date below:

_____ _____

Date Participant's Signature

Professor's name and the course # you would like to receive extra credit for (ex: PSY 442, Dr. Timmermann):

_____

DEBRIEF FORM

Project title: A test of meditation style.

Thank you for taking part in our research! Now that your contribution has finished, let us explain the rationale behind this work.

We are interested in understanding whether brief, stand-alone self-administered mindfulness exercises have demonstrated an effect on attention and emotional regulation processes. Previous research has shown that brief meditation produces a measurable effect (Wolff & Beste, 2020), and the effect produced varies depending on the technique (Sedlmeier et al., 2012). In this research, we are looking at which type of meditation exercise is most effective in increasing attention and emotion regulation processes, compared to an active control condition. We tested two different types of meditation exercises: focused attention and loving kindness; and we compared attention and emotion regulation task scores of those who did one of these exercises with those of people who were in an active control condition. In the active control condition, participants watched 10 minutes of cartoons that were chosen for the purpose of this study. After completing any of these exercises, participants answered measures of stress levels. We expect to find greater effects on attention and emotion regulation processes for those who participated in meditation exercises than those who were in the active control condition.
If you would like more detailed information on this topic, here are some references you can consult:

Feldman, G., Greeson, J., & Senville, J. (2010). Differential effects of mindful breathing, progressive muscle relaxation, and loving-kindness meditation on decentering and negative reactions to repetitive thoughts. *Behaviour research and therapy*, *48*(10), 1002–1011.

Sedlmeier, P., Eberth, J., Schwarz, M., Zimmermann, D., Haarig, F., Jaeger, S., & Kunze, S. (2012). The psychological effects of meditation: A meta-analysis. Psychological Bulletin, 138(6), 1139–1171. https://doi.org/10.1037/a0028168

Wolff, N., & Beste, C. (2020). Short-term smartphone app–based focused attention meditation diminishes cognitive flexibility. *Journal of Cognitive Neuroscience*, *32*(8), 1484–1496. https://doi.org/10.1162/jocn_a_01564

The information you have provided is confidential. If you feel affected by issues raised by this research and would like to discuss any concerns, or if you have any further questions, please contact Ashley Figel, Department of Psychology, Eastern Oregon University, afigel@eou.edu. Similarly, if you have concerns about the study, you can contact the Institutional Review Board (IRB).

- If you are concerned about anything related to your current mental state and well-being, please get in touch with the Local National Alliance on Mental Illness helpline by calling 1-800-950-6264 or emailing info@nami.org
- If you feel like talking to someone about how you feel right now, you can get help from *EOU's Student Health and Counseling Center: shc@eou.edu 541-962-3524.*

Finally, please don't share this information with other students who may participate in this research. Thank you, again, for your willingness to participate.

Qualtrics Survey Information

Below are the questionnaires used in this study project in order of administration:

Demographics:

How old are you? _____ (provide your age in years)

What is your gender?

1. male
2. female
3. other
4. prefer not to say

Are you a student?

- yes
- no

If no - What is your job?

- Open answer

Meditation experience

Have you meditated in the previous 6 months?

- yes
- no

If yes, approximately how many times have you meditated in the previous 6 months?

- Open answer

Current Mood:

IPIP - 5 NEO Domains - Neuroticism (20-item scale, Goldberg, 1999; Goldberg, Johnson, Eber, Hogan, Ashton, Cloninger & Gough, 2006; IPIP, 2001); retrieved from: https://ipip.ori.org/newNEOKey.htm#Neuroticism

The following page contains phrases describing people's behaviors. Please use the rating scale next to each phrase to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future. Describe yourself as you honestly see yourself, in relation to other people you know of the same sex as you are, and roughly your same age. So that you can describe yourself in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully, and then click the circle that corresponds to the accuracy of the statement.

Participants can answer a 5-points scale (1 = very inaccurate, 2 = Moderately Inaccurate, 3 = Neither Inaccurate nor Accurate, 4 = Moderately Accurate, 5 = Very Accurate)

1. Often feel blue.
2. Dislike myself.
3. Am often down in the dumps.
4. Have frequent mood swings.
5. Panic easily.
6. Am filled with doubts about things.
7. Feel threatened easily.
8. Get stressed out easily.
9. Fear for the worst.
10. Worry about things.
11. Seldom feel blue. - R
12. Feel comfortable with myself. - R
13. Rarely get irritated. - R
14. Am not easily bothered by things. - R
15. Am very pleased with myself. - R
16. Am relaxed most of the time. - R
17. Seldom get mad. - R
18. Am not easily frustrated. - R
19. Remain calm under pressure. - R
20. Rarely lose my composure. - R

For what concerns the scoring weights of the items:

For + keyed items, the scoring weights are: Very Inaccurate = 1, Moderately Inaccurate = 2, Neither Inaccurate nor Accurate = 3, Moderately Accurate = 4, Very Accurate = 5.
For - keyed items (R items), the scoring weights are: Very Inaccurate = 5, Moderately Inaccurate = 4, Neither Inaccurate nor Accurate = 3, Moderately Accurate = 2, Very Accurate = 1. So, R items need to be reverse-coded.

Once numbers are assigned for all the items in the scale, sum all the values to obtain a total scale score.

References

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Recruitment Email/Social Media Ad

Project title: Test of meditation style.

We are conducting research testing different meditation techniques. The research is open to everyone who is 18 or older and fluent in English.
If you agree to take part, you will be asked to complete a 15-20-minute exercise that may or may not involve meditation, then complete two tasks of attention and emotion regulation, and complete a questionnaire about how you feel. The entire study is expected to take about 35-45 minutes.

If you are interested in participating, please contact the researcher at afigel@eou.edu. Please include Meditation Study in the email subject line. The researcher will provide you with instructions for how to complete the study.

Meditation Scripts and URLs

Focused attention meditation:

https://www.youtube.com/watch?v=vBO8QEjANjs

Welcome to a guided meditation for focused attention on Declutter the Mind.
Let's start the practice by finding a comfortable to sit, whether it's on a chair or cushion on the floor.
And sit with your back upright but comfortably.
We want to maintain a posture here that will keep us attentive.
And to start things off with your eyes open take a few big deep breaths.
And now close your eyes.
Allow your breath to return to its natural rhythm.
And without any effort here or changing your breath simply notice how your body breathes.
Notice the air as it passes through your nostrils.
Notice the rise and fall of your body with each inhale and exhale.
Maybe you notice these rising and falling sensations around the chest or stomach.
And whenever you notice that the mind has wandered, simply bring your attention back to the breath.
Part of focused attention and concentration is noticing the mind when it has wandered and bringing it back to the object of focus.
It is less about making a strong effort to be concentrated and more about noticing distractions.
And your mind may get pulled away by thoughts planning feelings noises.
Whatever it is, notice it and then gently bring your mind back to the breath.
And now let's see if we can drill down our focused attention on the breath even more here.
See if you can notice other aspects of the breath.
The phases of each complete breath.
From the inhale to the phase in between, to the exhale.
Notice whether your breath is warm or cool, deep or shallow, and again if your mind wanders, gently bring it back to the breath.
And whenever a distraction arises or you catch yourself lost in thought, instead of judging that thought or thinking about the distraction, simply note it.
So, if it's a noise that took your attention, note it as sound, and then bring your attention back.
If it's worries or planning that is distracting you, note it as thinking and then bring your attention back.
And now simply let go of any attempt to maintain focus and concentration.
Allow the mind to do what it wants for the next few moments.
And now open your eyes.
You've just completed the focused attention practice.
Thanks for sitting and may you have a focused and productive day.

Loving kindness meditation:

https://www.youtube.com/watch?v=yCt6AYI3kHU

Welcome to Declutter the Mind's loving kindness meditation.
So first, find a spot, whether it's a chair or cushion on the floor.
Sit comfortably with your arms resting in your lap and with your eyes open.

Begin to take a few deep breaths.
In through the nose and out through the mouth.
On the next out-breath, gently close your eyes.
Begin to notice physical sensations around you and the physical points of contact.
Notice the weight of your body in the chair or on the floor.
Place your attention on your back against the chair, your feet or legs on the floor, your hands in your lap.
And now begin to bring to mind the image of a person who you know or you've known in your life to be loving and kind to you.
Someone who easily evokes feelings of warmth and love.
It could be a friend you know or used to know.
It could be a partner or your spouse
It could be a family member such as a parent or your child.
Maybe it's a mentor or co-worker.
It can be whoever has been good to you, makes you feel safe or comfortable to be yourself.
Someone who is caring to you and you care a lot about.
If someone doesn't come to mind it can be someone imaginative as well.
It could be the ideal of someone who is extremely caring and loving to you, and perhaps someone who will one day enter your life.
And now when you visualize this person there is no right or wrong way to picture them in your mind's eye.
The easiest way for you to picture them is the way you should picture them.
You could visualize this person sitting in front of you.
You can imagine their face.
You can imagine a moment with them in which it's easier to bring them to mind.
Now that we have this person in mind we're going to imagine sending wishes of well-being to them.
We are going to wish them well, and if it feels right, sing it aloud in your mind to them.
May you be happy.
Picture them now receiving your wishes for them.
Imagine the look on their face or change of their facial expression.
And again, begin saying aloud in your mind to them, may you be alive, engaged, joyful.
May you experience inner peace and ease.
May you be free from suffering.
Again, picture them receiving your wishes.
Imagine how they might feel.
Now you might have your own words and wishes for them.
Feel free to tell them things that resonate with you.
Take some time to do this and if you're not sure you can continue to say in your mind, may you be happy.
Take a moment now to feel how it is to wish these things for them.
Allow yourself to sense the wishes for them emanating from you, connecting you to them.
And begin to notice how it feels inside you as you send these wishes of well-being to this person.
And now begin to imagine this person wishing these same things for you.
Imagine them saying may you be happy, may you be alive, engaged, and joyful.
May you be free from suffering.

Allow those feelings now to wash over you.
Allow the feelings of love and caring to grow in you knowing that there's nothing you have to do to deserve these wishes and feelings.
These are given freely without any conditions
And now to begin to imagine this person in their happiest state they've ever been in.
Imagine all their worries having been solved.
Imagine anything they've ever wanted to achieve or accomplish has been awarded to them.
Imagine all their ailments and issues having been cured.
Just picture them in this state for a few moments.
Picture them in complete joy and bliss.
Picture them the happiest they've ever been in their emotional state.
Picture their face and their expression to this joy.
Imagine the way they would move or act.
Imagine the things they would say, the tone in their voice.
And now begin to wish these things upon yourself.
In your mind begin to say, may I be happy, may I be safe and protected, may I be free and alive, may I be free from suffering.
And again, and finally, say to yourself in your mind, may I be happy.
And now gently return your attention back to the body and back to the physical points of contact.
Again noticing your weight on the floor or chair.
Noticing the legs and feet, arms in the lap, the back against the chair.
And now in your own time, gently open your eyes and notice how you feel.
You've just completed the loving kindness meditation, thanks for sitting, and I'll see you next time.

Cartoons:
https://www.youtube.com/watch?v=aG4CaJuQxQ8

Task Procedures

ecStroop word list

from, Kahan, T. A., & Hely, C. D. (2008). The role of valence and frequency in the emotional Stroop task. *Psychonomic Bulletin & Review*, *15*(5), 956–960. https://doi.org/10.3758/pbr.15.5.956

Words with negative emotional valence:
alone
broken
crisis
dead
death
failure
hell
lie
lost
pressure
sick
dump
foul
loser
maggot
massacre
poison
rat
scar
torture
trash
wasp

Words with neutral emotional valence:
body
chance
coast
hit
hospital
manner
news
patient
ship
truck
wine
coin
cork
doll

hammer
owl
pungent
scissors
swamp
tease
vanity
vest

Wisconsin Card Sort

Description of task:
Participants will first be provided practice trials with the rule of card sort explicitly stated. The rules for sorting cards are shape, number of shapes on the card, or color of shape on the card. After 5 successful practice trials, participants will begin the real trials. In the real trials, participants will not be given the sorting rule but will need to learn this through trial and error. The sorting rule will change rules after 10 successful trials regardless of number of correct responses. Furthermore, the order of sorting rules will be randomized for each participant.