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Frontal Electroencephalographic Asymmetry Associated With Positive Emotion Is Produced by Very Brief Meditation Training

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Meditation training changes the brain. Recent reports suggest that 70 or more hours of standardized training in mindfulness meditation across 8 weeks shifts electroencephalographic (EEG) asymmetry toward a pattern associated with positive emotion (Davidson et al., 2003) and increases gray matter in the left hippocampus (Hölzel et al., 2010). Such training is dwarfed by the 10,000 or more hours accumulated by expert Buddhist practitioners (Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004), but it likely represents a daunting commitment to many people. We examined whether frontal EEG asymmetry could be generated by a more accessible amount of meditation training.

Method

Following the study's approval by the University of Wisconsin–Stout's institutional review board, 29 right-handed nonmeditators participated in return for meditation instruction. Twenty-six individuals completed the study; 21 (6 men, 15 women; mean age = 24.52 years, range = 18 to 73 years) provided EEG data before and after a 5-week meditation training period.

Before random assignment to condition, participants completed an 18-min protocol consisting of oral completion of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), 15 min of attempted focused-attention meditation according to provided instructions ("relax with your eyes closed, and focus on the flow of your breath at the tip of your nose; if a random thought arises, acknowledge the thought and then simply let it go by gently bringing your attention back to the flow of your breath"), a second PANAS completion, and 1 min of nonmeditative rest. Participants were then randomly assigned to the meditation training (MT; n = 11) or waiting-list (WL; n = 10) group. MT participants were told that nine 30-min sessions of meditation instruction were available to them and were encouraged to attend as many sessions as possible.

Two instructors, one with 3 years' meditation practice and 4 months' instruction experience, and another with 14 years' meditation practice and 5 years' instruction experience, each taught a section of meditation instruction; they followed the same curriculum, and MT participants were encouraged to attend either section to maximize the instruction received. Sessions began with 5 to 10 min of education, followed by practice in focused-attention meditation that progressed in length from 5-min to 20-min intervals across the 5-week training period. Sessions concluded with an opportunity for participants to discuss their meditation experiences. MT participants were also encouraged to practice independently. WL participants were informed that they would be offered identical instruction after the study's conclusion. At the end of the 5-week training period, participants completed the previously described 18-min protocol a second time.

EEG activity was recorded continuously for each participant during both 18-min protocols. A 64-channel EEG system and Net Station 4.2 software (both from Electrical Geodesics, Eugene, OR) were used to record EEG activity from nine-site montages for left (sites 10–16, 18, and 19) and right (sites 2, 5, 51, 53, and 56–60) frontal regions. EEG was sampled at 250 Hz (0.3- to 35-Hz band-pass filter) and vertex-referenced. Impedances were kept below 60 kΩ. Participants were instructed to keep their eyes closed during the protocols, and time-locked video recordings of participants' faces aided identification of movement artifacts. Researchers blind to group assignment identified artifact-free 30-s epochs corresponding to 14 time

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points across the 18-min protocols. The frequency spectrum for each epoch was calculated with a 1-s window using Welch's (1967) method. Alpha-band (8–12 Hz) power was averaged for each montage to calculate frontal EEG asymmetry (ln(right alpha) – ln(left alpha)) for each participant during each protocol. Higher values indicate a greater proportion of activity in the left frontal region, a pattern associated with positive, approach-oriented emotional states (Coan & Allen, 2004).

Results

MT and WL participants did not differ in frontal EEG asymmetry before training, paired $t(13) = 0.16$, $r = -.01$, $p = .88$, $d = 0.06$ (see Fig. 1). During training, MT participants attended an average of 6.73 (SD = 1.35, range = 4−8) instruction sessions and reported engaging in independent 15-min intervals of meditation an average of 2.24 (SD = 1.01, range = 1−5) times per week. MT participants averaged 6 hr 13 min of

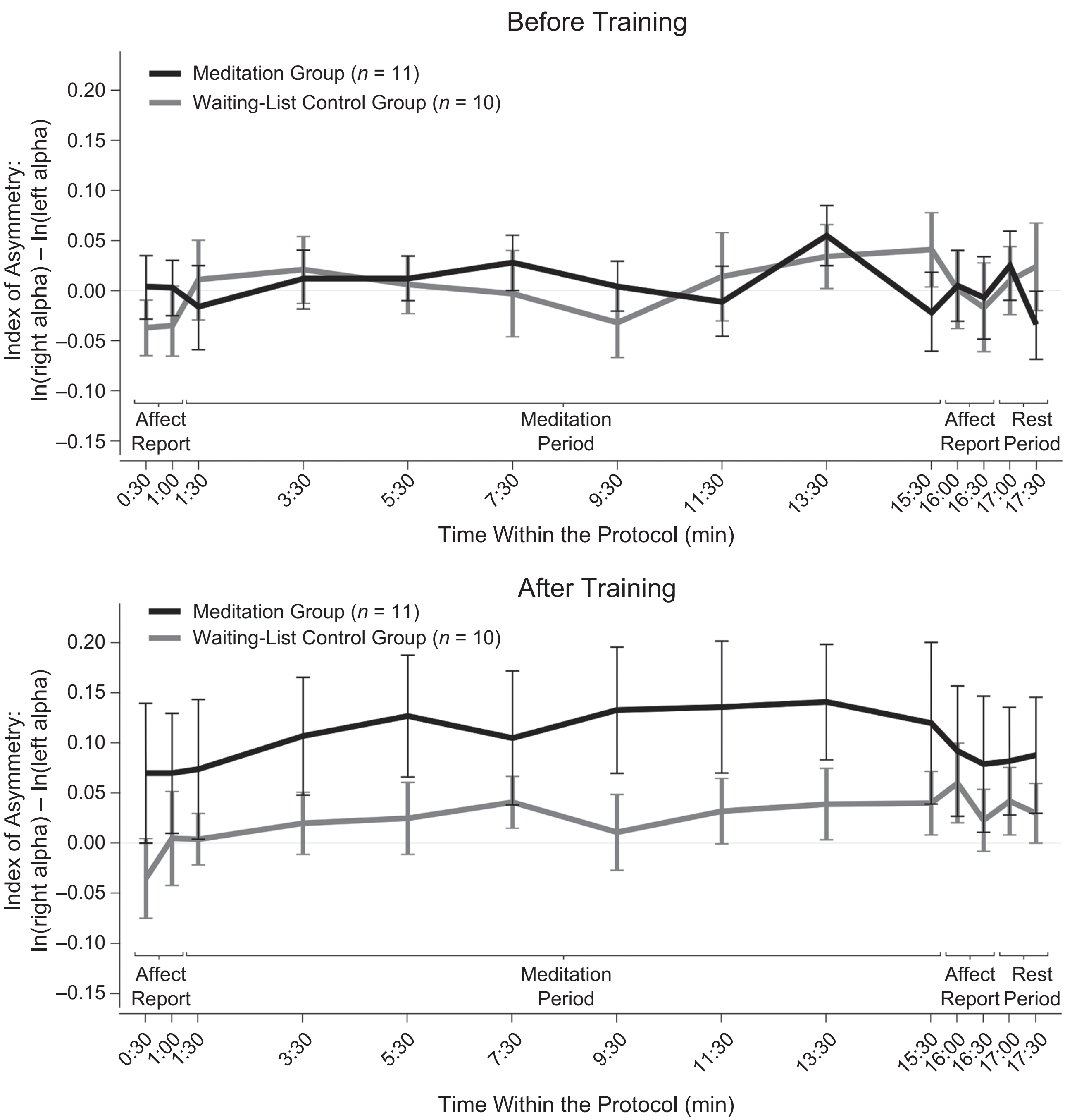

Fig. 1. Mean frontal electroencephalographic (EEG) asymmetry (±1 *SE*) in the meditation and waiting-list groups. Results are shown separately for the beginning of the study and the end of the study, after participants in the meditation-training group had undergone a 5-week period of meditation training.

training (SD = 1 hr 35 min, range = 3 hr 15 min to 9 hr 8 min) across the 5 weeks. After training, MT participants had significantly greater leftward shift in frontal EEG asymmetry than WL participants did across all time points, paired $t(13) = 10.80$, $r = .40$, $p < .001$, $d = 3.18$ (see Fig. 1).

Across all participants, both positive and negative affect declined significantly (ps < .001) in response to attempted meditation both before and after the training period, but no significant between-groups differences were observed (ps ≥ .20).

Discussion

With training, focused-attention meditation shifts frontal EEG asymmetry toward a pattern associated with positive, approach-oriented emotions. Further, this shift does not require hundreds or even dozens of hours of practice. Individual MT participants in this study averaged only 5 to 16 min of active training (i.e., instruction, independent practice) per day across 5 weeks, but still exhibited a strong change in EEG asymmetry compared with the WL group. Our results suggest that the benefits of meditation may be more accessible than was previously believed. However, this study does not indicate if such asymmetry is pervasive or is limited to the time of meditation and the brief intervals that immediately surround it. Also, this study did not find a between-groups difference in affect corresponding to the EEG asymmetry; this lack of a significant difference may be attributable to low statistical power. It is also possible that the influence of EEG asymmetry on affect depends on specific social contexts, such as perceived rejection (Koslov, Mendes, Pajtas, & Pizzagalli, 2011).

We suggest two explanations for the increase in EEG asymmetry that emerged after so little training. First, our MT participants were able to decide when to practice, and for how long; this flexibility allowed them to determine for themselves when they would be most receptive to meditation, and choosing advantageous times may have heightened the efficacy of the meditation. Second, the small amount of active practice participants reported may have enabled a larger amount of passive practice to occur spontaneously, without a conscious decision to meditate; such passive practice may have strengthened the effects of meditation. This latter explanation is consistent with reports from some MT participants that they occasionally found themselves focusing their attention in the way they had been taught, even without having set out to do so.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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