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ORIGINAL ARTICLE

Mantra Meditation Suppression of Default Mode Beyond an Active Task: a Pilot Study

Rozalyn Simon[1,2] · **Johan Pihlsgård**[2] · **Ulrika Berglind**[2] · **Birgitta Söderfeldt**[3] · **Maria Engström**[1,2]

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Abstract Within the field of neuroimaging, the discovery of a constellation of brain regions silently active when we are "resting" has provided a new view into the elusive effects of meditative practice. This network, called the default mode network (DMN), has been shown by functional neuroimaging to be active when an individual is at rest. Meta-analyses of the fMRI neurocorrelates of meditation have shown that across diverse practices, the most common general effect appears to be modulation of regions within the DMN. The specific practice of mantra meditation is a form of task-positive concentration. These kinds of task-positive activities are regarded by many to be an anti-correlate of DMN activity, thereby in theory, reducing activations within the DMN as concentration on a particular task increases. Yet previous studies on mantra meditation using language tasks as controls have reported only activations, not *deactivations* within the DMN. A study by Berkovich-Ohana showed that word repetition as control task could mask some of the effects of mantra, which may explain why previous studies using language repetition as control task failed to find significant DMN *deactivations* during mantra meditation. To investigate these differences, we analyzed mantra meditation using a finger-tapping control task which required a minimal amount of focused attention, yet enough to reduce blood flow to the major hubs of the DMN and minimally reduce network activity. Using a finger-tapping control thus modifies the research question: Can a brief course of this kind be shown to modulate DMN activations during mantra practice *beyond* that of a minimally active/non-language finger-tapping control condition; and if so, can we see a training effect over time? Our results show that over a 2-week period of Kundalini yoga/meditation, participants successfully decreased activations within subregions of the DMN, namely the pregenual anterior cingulate cortex (PACC) and the precuneus, during mantra meditation with trends toward decreased activation in the posterior cingulate cortex (PCC) as well. These decreased activations were significant despite use of a finger-tapping control task known to deactivate these regions, indicating that mantra practice suppresses activation in these DMN regions *beyond* the active control task. These results emphasize the importance of the choice of control task and provide insight into the "mantra effect." Here, we show that training in mantra meditation, like other practices such as focused attention and open monitoring, also has a suppressive effect on activity within the DMN.

Keywords Meditation · Mantra · Attention · Default mode network · Anterior cingulate cortex · Posterior cingulate cortex · Precuneus · Functional magnetic resonance imaging (fMRI) · Deactivation · Kundalini yoga

✉ Maria Engström
maria.engstrom@liu.se

[1] Center for Medical Image Science and Visualization, Linköping University, SE-581 85 Linköping, Sweden

[2] Department of Medical and Health Sciences, Linköping University, SE-581 85 Linköping, Sweden

[3] Department of Clinical Science and Education, Karolinska Institutet, SE-171 77 Stockholm, Sweden

Introduction

For those who have not practiced meditation, sitting quietly with closed eyes may appear to be a form of disengagement. Despite appearances, a majority of meditative practices employ very specific techniques to *engage* and train the mind and body (Manna et al. 2010). Western categorization of these techniques, based on their objective aims, has resulted in the subgrouping of practices

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across traditions such as: focused attention (FA), open monitoring (OM), loving kindness (LM), and mantra (MR) (Lutz et al. 2008b; Fox et al. 2016). A combination of these and other methods are often practiced in a single sitting. Meta-analysis of the neurocorrelates of meditation have shown that across these diverse practices and varied years of experience, the most common effect appears to be modulation of a network of brain regions called the default mode network (DMN) (Tomasino et al., 2012, 2014; Fox et al. 2014; Simon and Engström 2015; Josipovic 2014; Josipovic et al. 2012). The DMN is a constellation of brain regions silently active when we are passive, which has provided a new view into the elusive nature of meditative practice. The main hubs of the DMN network are the precuneus, the posterior cingulate cortex (PCC), the medial prefrontal cortex (mPFC), and the left and right inferior parietal cortices (Raichle et al. 2000; Buckner et al. 2008). During periods of rest, anterior and posterior subnetworks within the DMN display heterogeneous anti-correlations with other resting state networks (Chen et al. 2017; Josipovic et al. 2012). Whereas in fMRI experiments where task-conditions are compared to rest, activity in the DMN has been shown to fluctuate in response to goal-directed behavior (Biswal et al. 1995; Shulman et al. 1997; Fox and Raichle 2007; Beaty et al. 2017; Seli et al. 2016). Depending on the type of task being investigated, regions of the DMN have been shown to relatively *deactivate* upon active engagement of task-positive networks (TPN) (Sheline et al. 2009; Fox et al. 2005; Kelly et al. 2008; Gusnard et al. 2001; Sonuga-Barke and Castellanos 2007). This anti-correlatory relationship with subregions of the DMN has significance in cognition, as the degree of DMN deactivation has been shown to be an indicator of task performance (Kelly et al. 2008).

Although DMN activity has been associated with mental activities such as creative problem solving and artistic talent, it has also been implicated in potentially problematic cognition such as deficient attention (Weissman et al. 2006; Mason et al. 2007), self-reflective thoughts (Qin and Northoff 2011; Gusnard et al. 2001), and depressive rumination (Sheline et al. 2009, 2010), thereby warranting investigation into the modulation of activity within this network for psychological and cognitive benefits (Greicius 2008; Buckner and Carroll 2007; Killingsworth and Gilbert 2010). Studies investigating the psychological changes associated with meditation practice report such enhancements as increased ability to focus, improved self-regulation, reduced mind wandering, and fewer self-reflective ruminations—all DMN-related processes (Garrison et al. 2015), (Hodgins and Adair 2010; Zeidan et al. 2010; Tang et al. 2007, 2014; Moore and Malinowski 2009; Mrazek et al. 2013; Garrison et al. 2015).

Despite efforts, the neurocognitive mechanisms behind these changes associated with meditation practice remain unclear. Here, we investigate the subcategory of mantra meditation through a novice course in the Sikh style of Kundalini yoga in the lineage of Yogi Bhajan. Mantra meditation can be described as the repetition, silent or audible, of a word or phrase as the "object" of meditative attention. Through repetition, the object is maintained as the meditator's focus, with the aim of calming the mind and focusing the attention (Dahl et al. 2015). The implementation of mantra though can vary quite broadly depending on the connotation of the word or the devotion and experience of the meditator. Depending on the practice and personal context, mantra could be considered an instrument of thought, mind protection, a song of praise, a prayer, or even a sacred incantation. In our case, in a brief course taught to secular novice participants, mantra has fewer of these religious associations and greater similarity to an "instrument of thought" or as a general form of focused attention with a linguistic component (Fox et al. 2016).

Mantra has recently been classified by Dahl et al. as a form of focused attentional meditation with the aim of "manipulating the orientation and aperture of attention, to monitor, detect, and disengage from distractors, and to reorient attention toward a chosen object" (Dahl et al. 2015). Despite the logical categorization of mantra with other attention practices such as FA or OM which have been shown to reduce DMN activity, meta-analysis summarizing the neurocorrelates of mantra has not shown reduced activation of the DMN, which would help justify this grouping in terms of neuroimaging (Fox et al. 2016; Tomasino et al. 2012). Potential explanations for this difference regarding DMN suppression might be that these early mantra studies, investigated mostly experienced meditators, reported only *activations*, and all used language tasks as control conditions (Lazar et al. 2000; Engström et al. 2010; Davanger et al. 2010).

Notably, a recent study by Berkovich-Ohana investigated the "mantra effect" by having participants who were not meditators, chant the neutral word "echad," or "one" in Hebrew (Berkovich-Ohana et al. 2015). They compared this word repetition task to either a period of silent rest or a verbal fluency task. Their main finding was that word repetition alone suppressed major hubs of the DMN when compared to rest. This study showed that word repetition control tasks are very similar to mantra and could thereby potentially mask some of the cognitive effects of mantra, which may explain why previous studies using language controls failed to report significant DMN *deactivations* during mantra meditation.

To investigate this question concerning the influence of control condition, we analyzed previously collected data in the subcategory of mantra meditation, a mind-body practice which includes attention to breath, the physical training of yoga, and mantra meditation (Taylor et al. 2010; Gard et al. 2014; Kerr et al. 2013). Though the practice of Kundalini yoga meditation includes exercise, group training, and many other variables which confound the isolation of the specific effects of meditation alone, the purpose initially motivating this pilot study was to investigate if a brief course of this kind could be employed to modulate functional activity in novice meditators during mantra recitation. Rather than a language control task, this study used a slow-paced finger-tapping control task, shown to reduce blood flow to the precuneus, the ACC, and the PCC (Mazoyer et al. 2001; Joliot et al. 1999; Zang et al. 2004).

In light of the Berkovich-Ohana findings, herein, we evaluated this mantra pilot data in terms of DMN modulation by asking: Can a brief course of this kind be shown to modulate DMN activations during mantra practice *beyond* that of a minimally-active/non-language finger-tapping control condition; and if so, can we see a training effect over time?

Materials and Methods

Participants

Nine right-handed female subjects (ages 23–50 years, mean age 31 years) participated in a Sikh-style Kundalini yoga course in the lineage of Yogi Bhajan. None of the participants had previous experience of meditation except one participant that had tried relaxation meditation twice. One participant could not complete the Kundalini yoga course and results are thus reported for the remaining eight participants.

Each participant completed a questionnaire with general health questions, including questions about current medication, prior or current neurological and psychiatric disease, and head/neck trauma. One participant medicated with serotonin receptor reuptake inhibitors (SSRI). None of the other participants declared that they had any prior or current health issues that could affect the results. The Ethical Review Board in Linköping, Sweden, approved the study, and written informed consent was obtained from each participant.

Procedure

The participants took part in six Kundalini yoga sessions during 2 weeks with three sessions each week. Each session lasted 90 min, starting with yoga exercises and finishing with a mantra meditation. The mantra meditation lasted 11 min each class and included placing the left and right hands over the heart repeating the "sat nam" mantra. During the yoga and meditation sessions, the participants were instructed to observe sensations in body and mind, including thoughts and feelings that might occur. The participants were also instructed to integrate the breathing with the different yoga positions and mentally keep the focus on the "3rd eye," which according to Kundalini yoga tradition is located in the forehead between the eyes.

The participants were scanned with fMRI on the weekends before the start of the Kundalini yoga course, after the first week, and after the final Kundalini session. The participants were scanned subsequently during the day of scanning.

Study Design

The study consisted of three fMRI sessions: (1) baseline before Kundalini yoga course start, (2) after the first week, i.e., after three yoga and meditation training sessions, and (3) after 2 weeks, i.e., after six training sessions. The fMRI paradigm consisted of two meditation blocks and two low-level attention finger-tapping (control condition) blocks. Each block lasted 120 s giving a total scan time of 8 min.

During the meditation blocks, the participants were told to meditate according to the instructions during the course, which included observations of sensations in body and mind and keeping the focus on the "3rd eye" (see above). During the low-level attention finger-tapping control condition, the participants were instructed to perform slow-paced right hand button presses using a four-button key pad (LUMItouch, Photon Control Inc., Burnaby, BC, Canada). The pacing was given by a tone (frequency = 1324 Hz, duration = 0.2 s) given every 2nd second. Instructions to start the different blocks were given audibly by a tone followed by either a directive to *meditate* or to *work*.

Data Acquisition

The fMRI images were acquired on a Philips Achieva 1.5-T scanner using a PRESTO-SENSE sequence sensitive for blood oxygen level-dependent (BOLD) contrast with following parameters: repetition time (TR) = 1.10 s, echo time (TE) = 40 ms, resolution $3 \times 3 \times 3\text{mm}^3$, slice thickness = 3 mm with no gap, number of slices = 31, and image acquisition orientation = axial.

Image Analysis

Preprocessing

The fMRI images of each participant were pre-processed and analyzed using the general linear model (GLM) implemented in SPM5 (Wellcome Department of Imaging Neuroscience, University College, London, UK). All fMRI images were realigned to correct for movement during scanning. Thereafter, the images were normalized to the MNI (Montreal Neurological Institute) echo planar imaging (EPI) template included in the SPM5 package, and finally smoothed applying an 8-mm Gaussian kernel to reduce noise and ameliorate intersubject differences in anatomical location of cerebral structures. The hemodynamic response function implemented in SPM5 was used as a model for the BOLD response in the GLM analysis. In addition, a high pass filter with a cut-off period of 128 s was used to remove low frequency signals. Both the meditation blocks and the control blocks were modeled explicitly.

Statistical Analysis of Main Effects

In order to test our primary hypotheses concerning DMN deactivation, we chose anatomical regions of interest (ROIs) shown by Berkovich-Ohana et al. to be suppressed during word repetition. In accordance with their results, statistical analyses were performed on DMN midline regions of interest using small-volume correction in the precuneus, ACC, and PCC. The ROIs were obtained from the Automated Anatomical Labeling (AAL) atlas (Tzourio-Mazoyer et al. 2002).The localization of the ROIs is shown in Fig. 1d. Image data for each participant was analyzed applying a meditation versus finger-tapping control condition contrast. The resulting contrast images from all three sessions were included in a full-factorial ANOVA of non-independent data in SPM12 and subsequently analyzed for main effects of Mantra. Before small-volume correction, we used a preliminary threshold of uncorrected, $p = 0.001$. A threshold of $p = 0.05$ corrected for multiple comparisons using family wise error (FWE) was used for significance testing.

Statistical Analysis of Training Effects

In order to test our secondary hypothesis concerning training effects in the ROIs, comparisons were performed by repeated measures of ANOVA in the Graph Pad Prism 5 (GraphPad Software Inc., San Diego, CA, USA). Here, brain activation was estimated from beta values obtained from the "meditation < control" contrast images from each subject and each session. The beta values were extracted from spheres with radius 5 mm applied at the most significant voxels in the full-factorial ANOVA. Post hoc analyses of meditation-induced differences in the DMN were performed using one-tailed paired *t* tests.

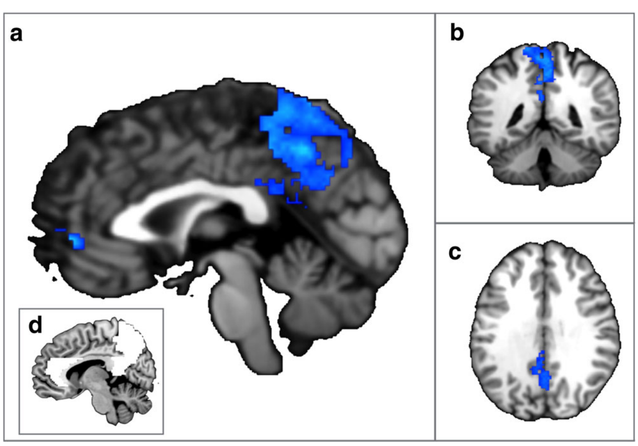

Fig. 1 Deactivation in the default mode network during meditation. Visualization of default mode midline structures that were more deactivated during meditation compared to finger-tapping control condition in **a** sagittal, **b** coronal, and **c** axial orientation. The statistical image was threshold at the uncorrected $p = 0.001$ used for initial analysis. **d** The anatomical ROI masks of the precuneus, the anterior, and the posterior cingulate cortex that were used in the statistical analysis

Results

Our results showed that over a 2-week period Kundalini yoga/meditation course the participants exhibited decreased activations within subregions of the DMN, specifically the precuneus, pregenual ACC (PACC), and the PCC, during mantra meditation when compared to a low-level attention finger-tapping control task (Table 1). The precuneus, $p_{FWE} < 0.001$, MNI coordinates [−8–64 64], number of voxels (#) = 3141; ACC, $p_{FWE} = 0.002$, [2 46 4], # = 130, and PCC, $p_{FWE} = 0.011$, [0–44 28], # = 160 were significantly more deactivated during meditation compared to the control condition (Fig. 1). Deactivation in the precuneus was observed during both the meditation and the low attention control condition, $p_{FWE} < 0.001$ after a small-volume correction in the region of interest. Significant deactivation in the ACC was observed in PACC in BA 32. Significant deactivation within the PCC was seen along the DMN midline. There were no observed activations when comparing mantra to the finger-tapping control.

Training Effects

We observed significant training effects in both the precuneus and ACC. In the precuneus, there was a continuous decrease in activity from the first baseline scan to the last scan acquired after a 2-week intensive yoga and meditation training, $F_{2,7} = 15.48$, $p < 0.001$. Median beta values were −0.34, −0.51, and −1.30 for scans 1–3, respectively. Paired *t* tests showed that the difference between scans 1 and 2 was significant, $p = 0.025$, as well as the difference between scans 2 and 3, $p = 0.006$ (Fig. 2, left).

Also in the PACC, we noted a significant training effect, $F_{2,7} = 10.25$, $p = 0.002$. The paired *t* tests showed that only the difference between the first and second scans was significant, $p = 0.005$, whereas the difference between scans 2 and 3 was not significant, $p = 0.278$ (Fig. 2, middle). The median beta values in the ACC were 0.19, −0.77, and −0.92. Note, in the

Table 1 Deactivations in midline regions of the DMN during mantra meditation

Region	MNI coordinates	BA	p_{FWE}
L precuneus	−8, −64, 64	BA 7	<0.001
R PACC	2, 46, 4	BA 32	=0.002
M PCC	0, −44, 28	BA 31	=0.011

PACC pregenual anterior cingulate cortex, *PCC* posterior cingulate cortex, *L* left, *R* right, *M* medial

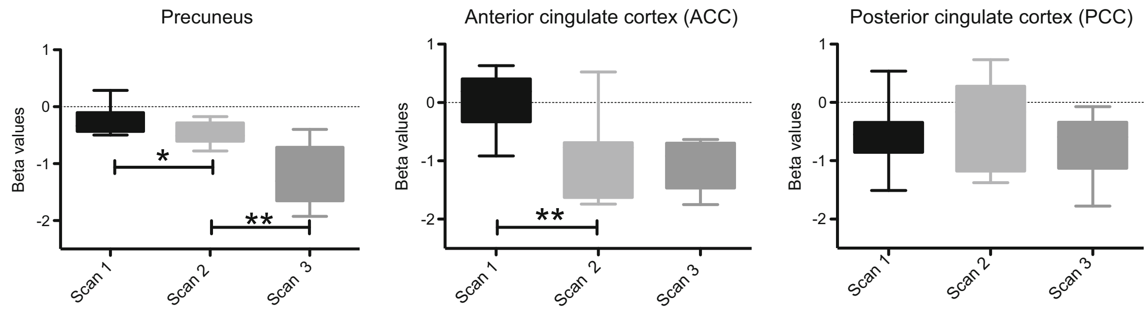

Fig. 2 Training effects of mantra meditation. The median, 25–75 percentiles, and maximum-minimum of beta values of deactivation during meditation compared with the finger-tapping control condition in the precuneus, the anterior cingulate cortex, and the posterior cingulate cortex.*$p < 0.05$, **$p < 0.01$

baseline scan (scan 1) acquired before yoga and meditation training, the median beta values were positive. On the other hand, after 2 weeks of intensive training (scan 3), all beta values in the ACC were negative. We did not observe any significant training effects in the PCC (Fig. 2, right).

Discussion

Our results show that over a 2-week period of the Kundalini yoga/meditation course participants exhibited decreased activations within subregions of the DMN, specifically the precuneus, the PACC, and the PCC, during mantra meditation. Decreased activations were significant despite the use of a control task known to deactivate these regions (Mazoyer et al. 2001; Joliot et al. 1999; Zang et al. 2004), indicating that mantra suppresses activation in major hubs of the DMN *beyond* an active finger-tapping control task. We also observed training effects over three scans in both the precuneus and the PACC, but not in the PCC.

DMN and the "Mantra Effect"

The most significant reductions found in this study were in BA 7 of the precuneus. Similarly, Berkovich-Ohana et al. investigating the "mantra effect," reported deactivation in BA 7 of both the left and right precuneus during "meaningless" word repetition when compared to rest (Berkovich-Ohana et al. 2015). These findings may help to explain why previous studies have not reported DMN deactivations during Mantra practice: regional deactivation associated with the language control tasks may have masked DMN-related neurocorrelates of the mantra effect. Berkovich-Ohana also found that when comparing word repetition to rest, participants reported a significant decrease in "thoughts" and "sensations." These results from simple word repetition align with aims underlying Kundalini practices for the treatment of nervous disorders "to create a silent and stable mind–toward a state of thoughtlessness" leaving room for further investigation (Shannahoff-Khalsa 2004).

During mantra meditation, we also found significant deactivation in the PACC, which lies on the border of the mPFC and is considered by Buckner to be a part of the mPFC/ACC region of the DMN (Buckner et al. 2008). In agreement with our results, previous fMRI studies concerning the neurocorrelates of mantra meditation have also shown reduced activation in the ACC when compared to language and finger touching tasks. Kalyani et al. investigated experienced yoga instructors and found ACC deactivation when comparing the audible chanting of "OM" to "SSSSSS" (Gangadhar et al. 2011). Wang et al. compared two types of "sat nam" mantra meditation in experienced meditators, one with finger touching, and the other with a focus on relaxation and the breath (Wang et al. 2011). When comparing the finger touching and the breathing mantra meditation, they likewise found, among other regions, reduced mPFC/ACC activations. When they compared subjective ratings of "connectedness" and "depth" of meditation, they found that these measures increased with decreasing mPFC/ACC activity. They concluded that relaxation and focus on the breath, as opposed to the focused attention of finger tapping while performing mantra, allows for a more passive meditative experience and requires less engagement of prefrontal regions.

Similar to these previous mantra studies, our results reveal deactivations in main hubs of the DMN during mantra recitation and highlight the importance of the choice of control task in unmasking DMN suppression during the "mantra effect." Our results indicate that mantra may well indeed be categorized within the class of focused attention practices as Dahl et al. suggest, not just in terms of the objectives of the practice but also in terms of the DMN-related neurocorrelates—again, depending on the choice of control task (Dahl et al. 2015).

DMN and Self-Referential Processes

The precuneus and the ACC have been associated with self-related processes and perspective taking, especially in conjunction with activation in other regions of the DMN (Cavanna 2006; Qin and Northoff 2011). A review associating self-related processes to the midline structures of the DMN found that among "self," "familiar," and "other" conditions, ACC activation was more closely associated with "self-related" processes than the PCC or the mPFC. The authors propose that ACC activation in association with DMN activity points toward a higher prevalence of self-related thoughts during mind wandering activities (Qin and Northoff 2011).

Thereby, reduced DMN activity in regions associated with subjective experience and self-referential processing, such as the PCC and the ACC, is thought to allow for more objective present-centered awareness, reducing judgment and self-referential valuation (Ives-Deliperi et al. 2011). Dissociating "self" from evaluation of the external world has the potential to greatly diffuse emotional associations and thereby help to diminish reactivity (Farb et al. 2007, 2010; Buckner and Carroll 2007). Our results showing reduced activations of DMN midline regions could thereby indicate a decrease in emotional reactivity and self-referential processing following the aims of Kundalini practice (Shannahoff-Khalsa 2004; Bhajan 2000).

DMN and Cognitive Enhancement

The PCC is widely considered one of the main hubs of the DMN to the extent that it has been used as representative of DMN activity in real-time feedback studies (Garrison et al. 2013; Brewer and Garrison 2014). PCC activity has been associated with disruption of attention, mind wandering, and craving (Brewer et al. 2013). In contrast, meditative deactivation of the PCC is associated with enhanced present-centered awareness, reduced mind wandering, "effortless-doing," and improvements in attention and working memory (Brewer et al. 2011; Garrison et al. 2013, 2015; Pagnoni and Cekic 2007). PCC deactivation is commonly reported in association with meditative practice in FA and OM studies but less so for mantra meditation (Fox et al. 2016, Tomasino et al. 2012). Here, we show that Kundalini mantra practice in novices does indeed reduce PCC activity in a training-dependent manner, similar to other forms of focused attention meditation, but that these results are likely dependent upon the choice of control task.

In healthy individuals, fMRI studies have shown that activity in the DMN is anti-correlated with goal-oriented or TPNs (Fox et al. 2005; Kelly et al. 2008). On the other hand, abnormal DMN activity such as competitive, antagonistic DMN activation during TPN activity has been associated with psychological disorders such as anxiety (Zhao et al. 2007), depression (Sheline et al. 2009), autism spectrum disorders (Assaf et al. 2010), and attention deficit hyperactivity disorder (ADHD) (Sonuga-Barke and Castellanos 2007; Uddin et al. 2008) just to name a few. Sonuga-Barke and Castellanos proposed a relationship between the DMN and the TPN called the default interference hypothesis which associates DMN activity with self-referential, intrinsic processing while its anti-correlate, TPN activity, is associated with extrinsic, task-positive attentional modes (Sonuga-Barke and Castellanos 2007). They proposed a threshold of DMN interference activity, above which, the DMN distracts from the proper attention required to successfully perform a specific task.

In terms of meditative training, there is significant evidence that meditation helps to improve attentional control and working memory (Lutz et al. 2008a; Hasenkamp et al. 2012; Hasenkamp and Barsalou 2012; MacLean et al. 2010; Tang et al. 2007; Mrazek et al. 2013; Pagnoni and Cekic 2007) potentially via the mechanism of increased anti-correlations between intrinsic and extrinsic networks (Josipovic et al. 2012). In particular, clinical applications of Kundalini meditation have been proposed as a therapy for learning disabilities such as ADHD, via improvements in focus and sensory feedback (Shannahoff-Khalsa 2004). In line then with the aims of Kundalini practice, meditative reductions in DMN-related activity, as shown here during Mantra recitation, may function via the mechanism of reduced competitive interferences between intrinsic, DMN-related cognitive processes and extrinsic TPN processes. In addition, although our results suggest that mantra training may be more effective at reducing activations in the DMN than a simple finger-tapping task, it should be noted that agreement between the Berkovich-Ohana study and results presented here indicate that word repetition *alone* might be enough to deactivate regions within the DMN, providing freedom from distracting thoughts and sensations.

Limitations

This study has several limitations. First, the data was collected over 10 years ago during a time when the importance of a resting state scan and first-person reporting were not well understood. In addition, the data was collected on a 1.5-T scanner on a group of only eight participants, thus limiting the quality of further analysis. Finally, the inability to separate the effects of yoga training from the mantra recitation, the short time allotted for mantra practice *in* the scanner, and the small number of participants are clear limitations for both analysis and interpretation. Despite these limitations, this study *does* show the importance of the choice of control conditions and helps to advise future studies which aim to elucidate the mechanisms and effects of meditative practice on brain function and behavior.

Conclusions/Future Directions

In accordance with previous meta-analysis (Tomasino et al. 2012; Fox et al. 2016) on focused attentional practices, we show that mantra meditation as well reduces activity within the precuneus, PACC, and PCC of the DMN. Based on these similar neurocorrelates with other focused attention practices, we agree that mantra might be considered a form of attention practice as Dahl et al. suggest (Dahl et al. 2015). Early training in focused attention practices emphasizes the development of attention and awareness, often resulting in reduced self-referential thoughts and emotional reactivity, which are processes related to reduction in DMN activity. Here, we report significant reductions in DMN activity following only brief periods of meditative training. These changes merit further investigation of both the long- and short-term outcomes of meditation and yoga training in comparison with other tasks. Although we have demonstrated that Kundalini mantra training reduces DMN activations relative to a finger-tapping task, there remains a need for evidence to distinguish mantra practice from word recitation. These results still beg the question: What are the objective and subjective differences between cognitive attentional training and meditation?

In the future, comparing the dynamic connectivity between participants using a simple cognitive "mind instrument" and those engaged in "mind protecting" mantra might provide additional clues to further categorization within the subgroup of mantra. Here, a deeper understanding of connectivity to other regions outside the DMN, as well as first-person reporting, might shed more light on the similarities and differences between mantra and other attentional practices.

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Compliance with Ethical Standards The Ethical Review Board in Linköping, Sweden, approved the study, and written informed consent was obtained from each participant.

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