Meditation-associated change in the functional connectivity of the insula

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Introduction
Most types of meditation include focusing attention on internal events or feelings and inhibiting interference from irrelevant external events. The insular cortex, through a functional connection with the prefrontal cortex and other brain regions, plays a key role in integrating external sensory information with internal bodily state signals and emotional awareness. The purpose of this study was to examine the resting-state functional connectivity of the insula with other brain regions in meditation practitioners and control subjects.

Method

Subjects
» A total of 35 meditators and 33 controls participated.

<table>
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<tr>
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<th>Meditators (N=35)</th>
<th>Controls (N=33)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>25.0±4.3</td>
<td>25.7±3.6</td>
<td>0.131</td>
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<tr>
<td>Sex (M/F)</td>
<td>16/19</td>
<td>22/11</td>
<td>0.094</td>
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<tr>
<td>Duration of meditation practice (month)</td>
<td>39.9</td>
<td></td>
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<tr>
<td>BDI score</td>
<td>2.7±6.3</td>
<td>3.0±4.8</td>
<td>0.818</td>
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<tr>
<td>BAI score</td>
<td>4.4±7.9</td>
<td>3.6±4.2</td>
<td>0.588</td>
</tr>
</tbody>
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Abbreviations: BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory

MR acquisition
» Subjects were instructed to keep their eyes open fixated on a crosshair.
» All data were acquired on 1.5-T scanner (Siemens Avanto).
Interleaved multi-slice echo-planar imaging (EPI) during resting-state:
  - echo time/repetition time = 52/2340 ms, field of view= 220 mm
  - flip angle= 90°, voxel size= 3.44 x 3.44 x 5 mm3
T1 -weighted 3D MPRAE:
  - echo time/repetition time = 4.76/1160 ms, field of view= 230 mm
  - flip angle= 15°, voxel size= 0.45 x 0.45 x 0.9 mm3

Analyses
» The insular cortex was manually defined on the T1-weighted MR image of each subject. (Figure 1)
» The insular cortex was segmented into anterior and posterior subregions using functional connectivity-based parcellation method.
» Permutation test was performed to compare the degree of functional connectivity between groups (P<0.001).

Results
Meditation practitioners showed significantly greater insula-related functional connectivity in the thalamus, caudate, middle frontal gyrus, and superior temporal gyrus than did controls. (Figure 2: red voxels)

Control subjects demonstrated greater functional connectivity with the posterior insula in the parahippocampal gyrus. (Figure 2: blue voxels)

Conclusions
Our findings suggest that the practice of meditation can affect functional changes in regions related to emotional awareness, executive control, and emotional regulation, even when meditation is not being practiced

Figure 1. Left and right insular cortex manually defined on T1-weighted MRI in (A) axial, (B) coronal, and (C) sagittal view

Figure 2. Comparison of the whole-brain functional connectivity maps between meditation practitioners and control subjects in the left anterior insula (A), the left posterior insula (B), the right anterior insula (C), and the right posterior insula (D)

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