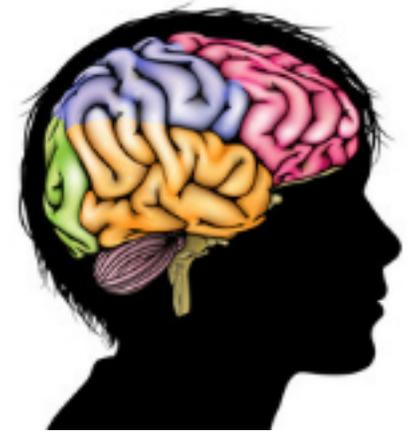


Mindful children have more brain flexibility, imaging study shows

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Meditation involves the processes of focusing attention, recognizing when the mind has wandered off, and re-establishing focus. Neuropsychologists tell us these processes are associated with three large-scale brain networks: a Default Mode Network (DMN) associated with mind-wandering, a Salience and Emotion Network (SEN) associated with present-centered awareness, and a Central Executive Network (CEN) that helps shift, restore, and maintain focus. When two or more networks change activity in a coordinated manner, they are said to be functionally connected.

Positive functional connectivity occurs when two networks increase or decrease activity in tandem. Negative functional connectivity occurs when increased activity in one network is matched by decreased activity in the other. The degree of functional connectivity between networks is usually averaged over time to yield a single measure. The problem with averaged measures is that they give the illusion that the functional connectivity between networks is static, when in fact, it is ever-changing and dynamic.

Marusak et al. [*Behavioral Brain Research*] studied both the average and the dynamic functional connectivity between these brain networks in children, as well as how these networks are related to childrens' self-reported levels of mindfulness and mental health symptoms.

The researchers recruited an economically and racially diverse cohort of 42 children and adolescents (55% female, average age =10 years, age range = 6-17 years). Many of the children were at economic disadvantage and/or at risk for exposure to violence, abuse, and intensive medical treatment.

The participants completed self-report measures of mindfulness (using the Child and Adolescent Mindfulness Measure), anxiety and depression. The majority of participants (65%) exceeded the thresholds on these measures for pathological levels of anxiety and/or depression.

All participants underwent functional magnetic resonance imaging (fMRI) while in a resting state. After imaging, the children were questioned about their present, past, and future-centered thinking as well as self-centered and body-centered thinking while undergoing imaging.

The researchers identified five separate states of dynamic functional connectivity between networks. For example, State 2 was characterized by positive connectivity between the DMN and the CEN, negative connectivity between the SEN and the CEN, and negative connectivity between the DMN and the SEN. In comparison, State 4 was characterized by positive connectivity between all networks, while State 5 was characterized by weak connectivity between all networks.

Higher levels of dispositional mindfulness were significantly associated with lower levels of anxiety ($r = -.49$) and higher levels of present-centered thinking ($r = .36$) during imaging. More mindful children spent significantly less time in State 2 ($r = -.36$) and made a significantly greater number of transitions ($r = .34$) back-and-forth between the five states.

More anxious children, on the other hand, made significantly fewer state transitions ($r = -.54$) and spent a significantly greater time in State 2 ($r = .34$).

Higher levels of present-centered thought were significantly associated with dispositional mindfulness ($r = .36$) and with spending less time in State 2 ($r = -.35$), while past-centered thinking was associated with State 3 ($r = .34$), and self-centered thinking with State 5 ($r = .34$).

These results are consistent with mindful children being better able to redirect attention from mind-wandering and self-referential states to present-centered and/or body-centered states.

This increased flexibility in transitioning between states may reduce anxiety by preventing children from “getting stuck” in rumination. The fact that mindful children spend less time in State 2 makes sense given that State 2 has high levels of Default Mode Network connectivity, a neurological correlate of mind-wandering.

This study is important because it is the first study of mindfulness and dynamic functional connectivity, as well as the first study exploring the neural correlates and mental health benefits of mindfulness disposition in children.

Reference:

Marusak, H. A., Elrahal, F., Peters, C. A., Kundu, P., Lombardo, M. V., Calhoun, V. D., . . . Rabinak, C. A. (2018). Mindfulness and dynamic functional neural connectivity in children and adolescents. *Behavioural Brain Research*.