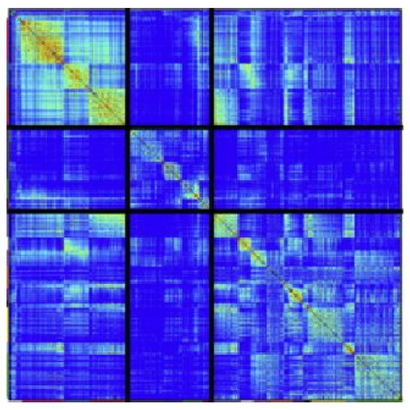
Long-term meditation and meditation-related **traits** increase the **connectivity** between **functional networks**

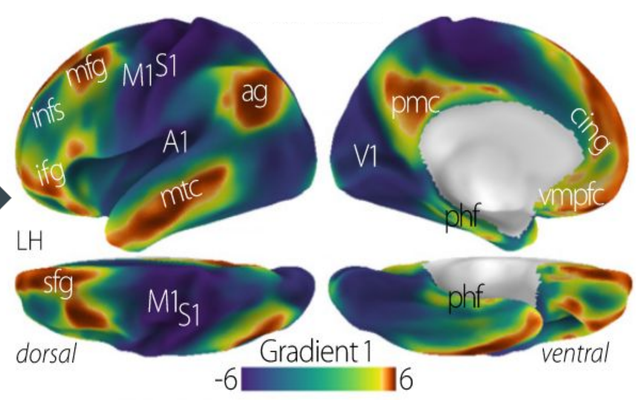
Methods

Functional connectivity

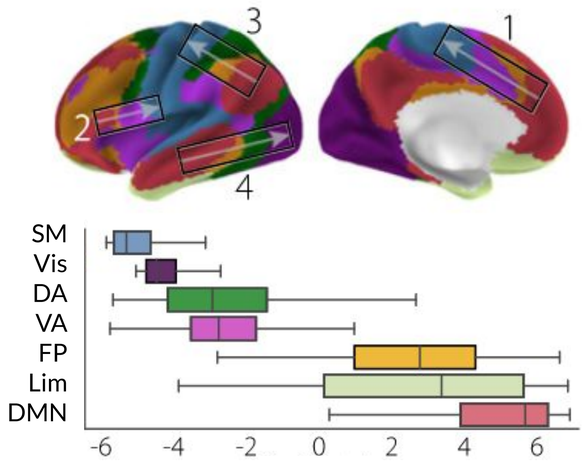


Margulies et al., 2016, PNAS

Principal Gradient of diffusion embedding

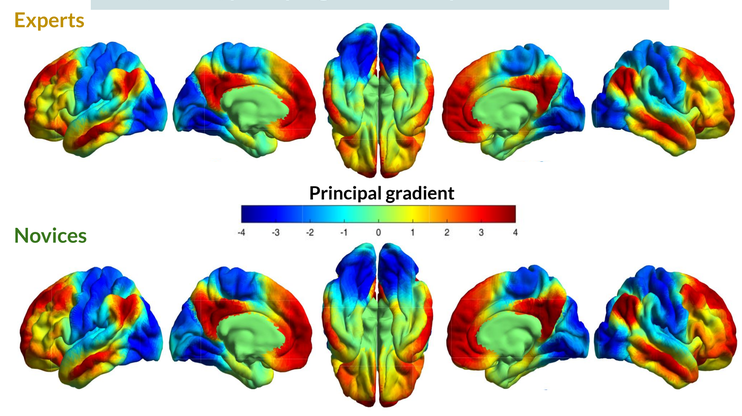


Community-based profile

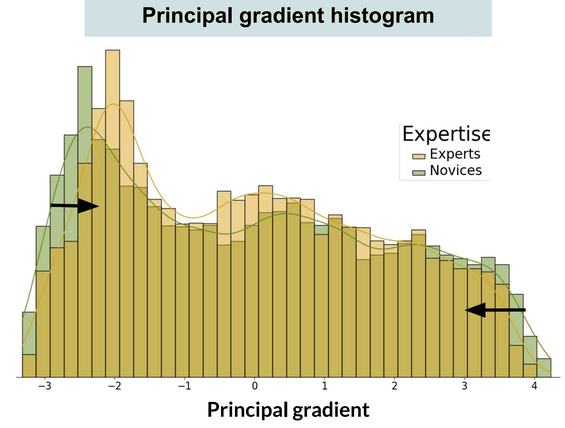


Traits-level analysis

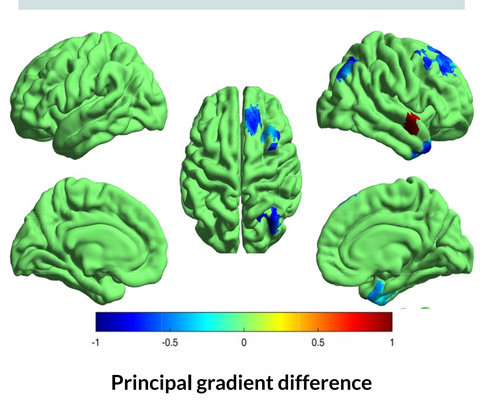
(OP+RS) principal gradient in experts and novices



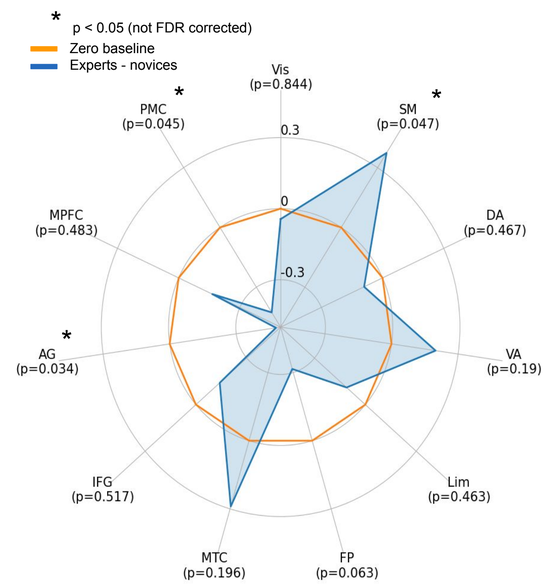
Principal gradient histogram



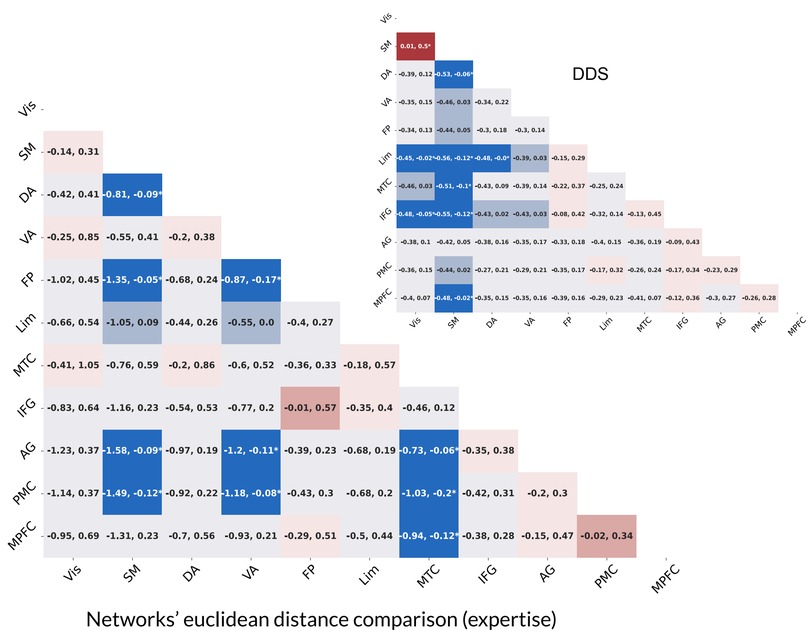
Surface-based analysis (Exp vs Nov)



Community-based profile anlysis

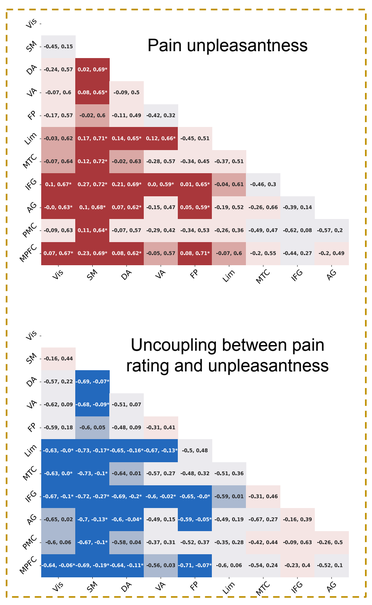


Euclidean distance analysis and their correlation with traits scores



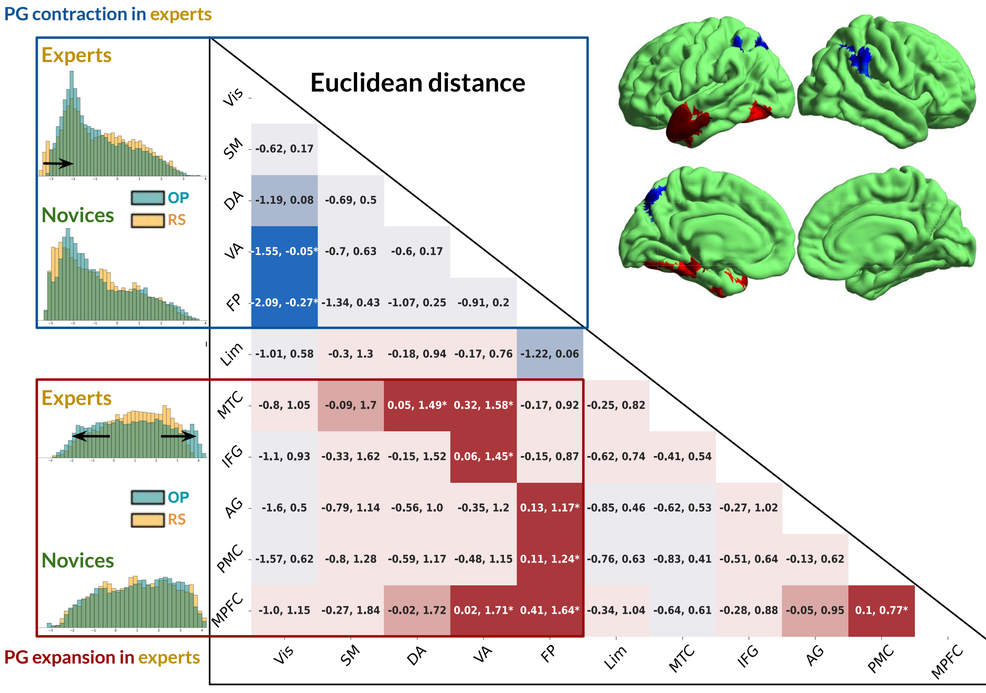
Networks' euclidean distance comparison (expertise)

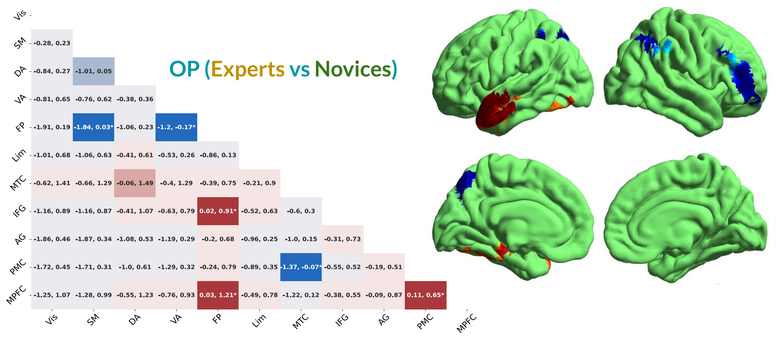
Experts

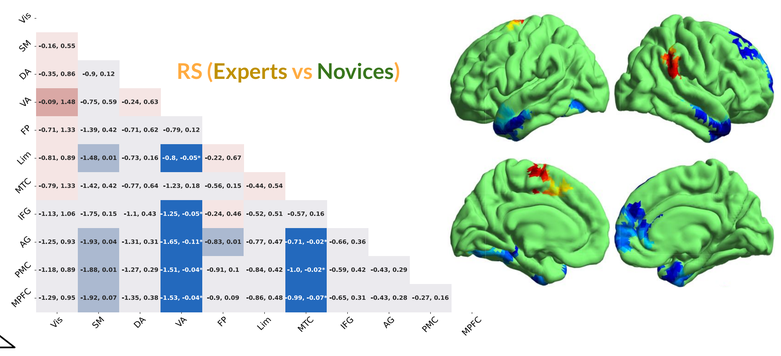


Interaction-level analysis

Interaction: Expertise x State







Mindfulness meditation state and traits modulate the brain gradient connectome in expert and novice meditators

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Background

Mindfulness meditation practice has been associated with specific functional relationships between central executive network (CEN), salience network (SN), and default mode network (DMN), but also the sensory perceptual cortices on which they exert top-down modulation. Yet, lack of homogeneity in these studies' samples, small sample size, and a focus on a few ROIs led to disparate findings in the field.

Objective

We used a recent method to study the whole brain connectivity within a functional space called diffusion embedding which we applied on a uniquely large dataset of 28 highly trained experts (>10,000 hours of formal practice in life), and 47 matched novices.

Methods

Using diffusion embedding, we reduced participants' functional connectivity matrix into several gradient components. We focused on the first component, termed the principal gradient (PG).

Open presence (OP) and resting state (RS) PG were averaged for the traits-level analysis, while they were subtracted for the interaction-level analysis.

Gradient component scores were statistically compared between experts and controls using surface-based linear models implemented in SurfStat (FWE<0.5).

The brain was parcellated using Yeo 7 networks atlas (Yeo et al., 2011, Journal of Neuropsychology). The default-mode-network (DMN) was further parcelated into its five key regions.

Within the framework of diffusion embedding, two networks should be closer to each other within the PG if they are more connected to each other. Thus, in order to interpret the previous differences, we computed the euclidean distance between networks and compared them between experts and controls using bootstrap mean difference tests (not corrected). We computed bootstrapped Pearson partial-correlations (not corrected) within the whole group between Drexel defusion scale (DDS) scores and euclidean distances, while controlling for the group effect. The same method was applied for pain unpleasantness ratings and uncoupling scores, only applied to the experts' group and controlled for the pain intensity rating (Zorn et al., 2020, EJP),

Conclusion

Using an exploratory approach, the group-level analysis shows that globally, long-term meditation practice increases the connectivity between the SM, FP, VA and the DMN (AG, MTC, PMC). We also show that DDS and uncoupling scores correlate with an increased connectivity with some of these networks.

The interaction-level analysis shows that experts differs from controls both in OP and RS. Mainly, experts' DMN was more connected to itself and to the VA during RS when compared with controls, while it was more disconnected during OP. We think that this reflect the capacity of experts to engage and disengage their mind from thoughts. Finally, depending on the contrast and the instructions given during the scanning session, we show that the DMN connectivity of experts decrease or increase. Thus, these results may provide the beginning of an explanation regarding the disparate findings in the field, as they may also come from the instructions provided to the participants.

Still these results should be taken carefully, as the analysis is exploratory and euclidean distance analyses and the correlation tests did not survived multiple comparison correction.

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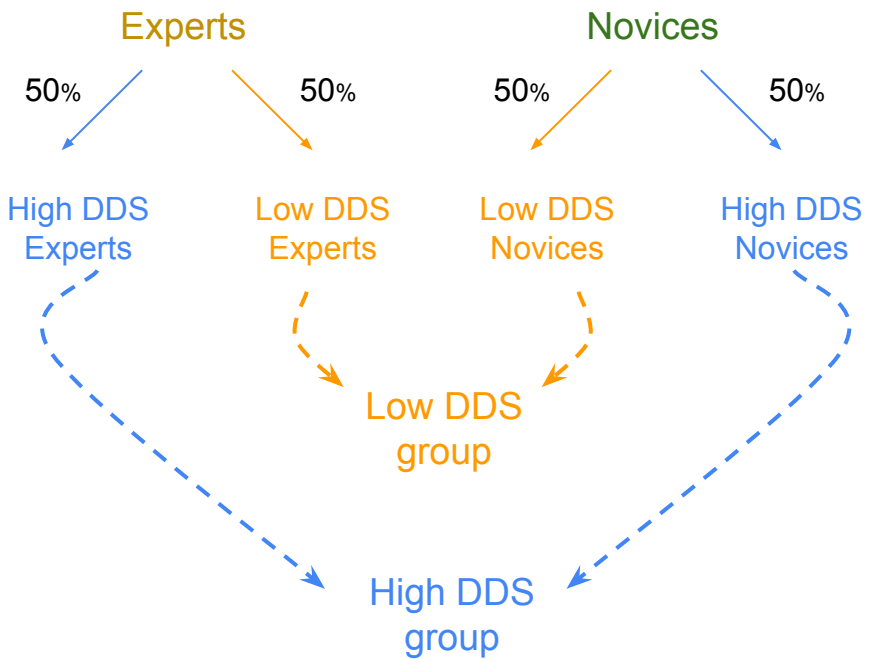
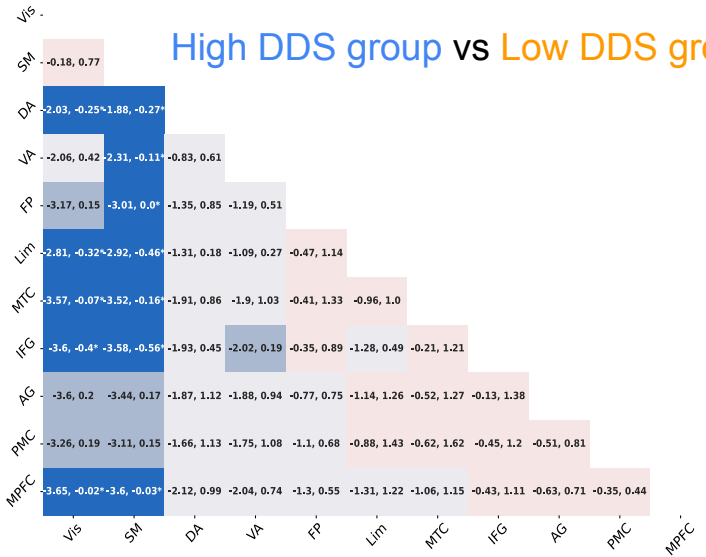
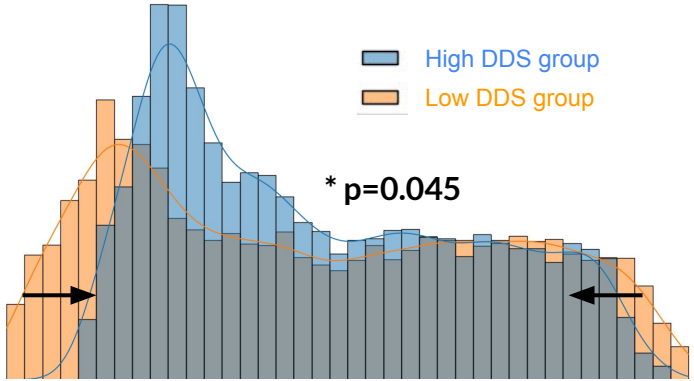
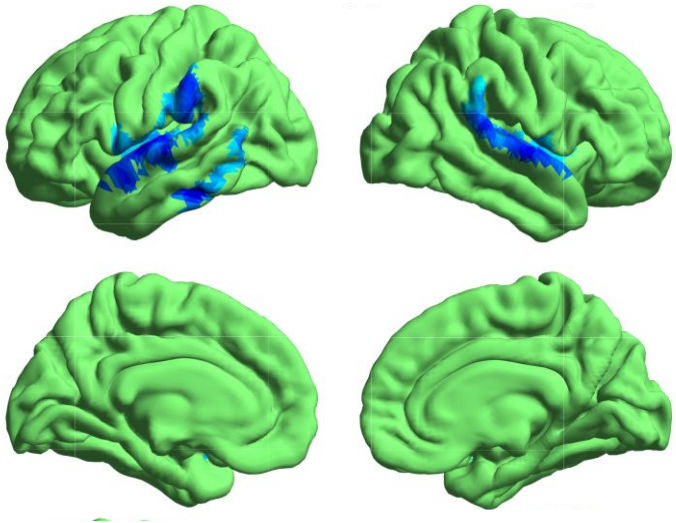




Networks' euclidean distance comparison (trait)



Principal gradient histogram



Surface-based analysis (OP vs RS)

Networks' euclidean distance comparison (states)