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Multi-session CVR variability within functional networks

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Within-subject physiological changes over time exhibits high spatial variability, which may impact fMRI network analysis.

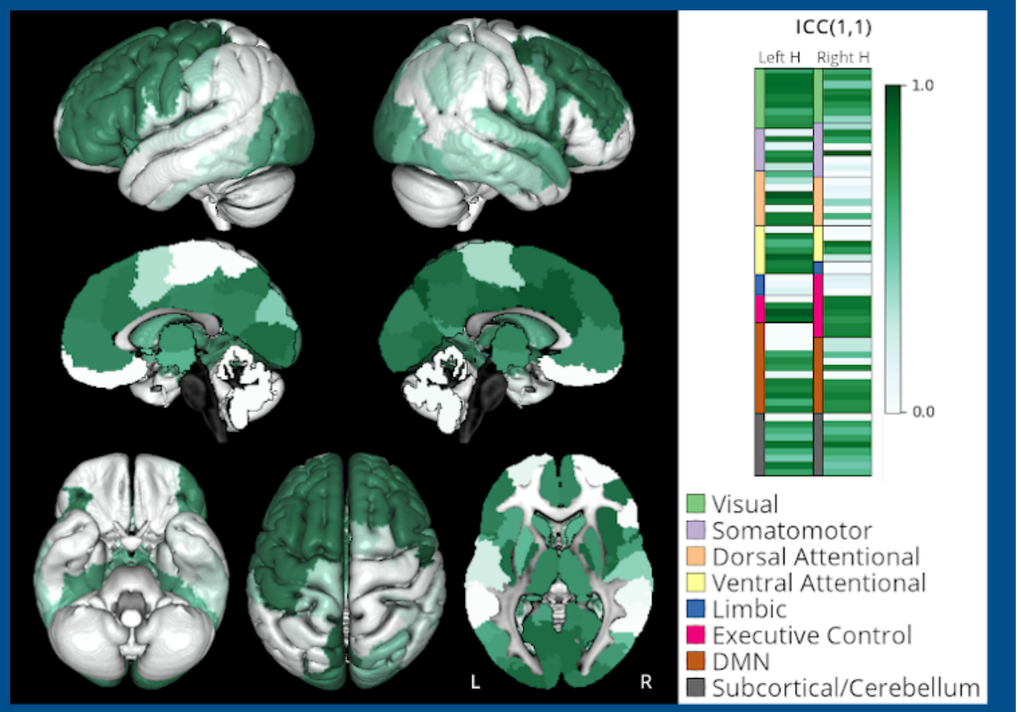

Figure 1. ICC(1,1) of each ROI of the Schaefer atlas. Lower ICC indicates that for each subject the ROI showed less consistent CVR values across sessions, while higher values indicate the opposite. Note the asymmetry of ICC between homologous areas in Somatomotor, Dorsal and Ventral Attentional Networks.

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Background

- BOLD fMRI only indirectly assesses neural activity.
- Vascular effects such as Cerebrovascular Reactivity (CVR) can confound fMRI data interpretation.
- Inter-individual differences in CVR might lead to spurious differences in BOLD fMRI 'activations' that reflect vascular mechanisms rather than metabolic ones.
- CVR variability has been typically attributed to noise or measurement errors, indirectly observed using Intraclass Correlation Coefficient (ICC) [1] to measure reliability.
- CVR has been shown to be very reliable across runs from the same day [2,3] but revealed interesting spatial differences in the long term [4].
- Multi-Echo (ME) BOLD fMRI has been shown to improve reliability and repeatability of CVR, suggesting that an optimal combination (OC) of the multiple echoes reduces spurious noise effects [5].

Results

- Fig. 1 depicts the ICC score of each ROI in the different networks. The limbic system showed the least reliability of CVR between sessions, while primary areas such as the visual network show the highest reliability. Several homologous areas in the somatomotor and attentional networks showed different reliability across sessions.
- Such differences might result in variable subject specificity of 'activations' induced by vascular effects.
- Fig. 2 shows five session of CVR and the intrasubject Coefficient of Variation for a representative subject. The CoV maps demonstrate subtle spatial variability.

Bibliography

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Methods

- 5 subjects underwent 5 sessions scheduled at an interval of 7 days at the same time of the day.
- A BH task adapted from [2] was administered at each session while collecting ME-fMRI data. CO2 levels were measured using a nasal cannula with gas analyzer (ADInstruments) and BIOPAC MP150 system. A T1-w image was collected during each session. The parameters can be found in the website version.
- fMRI data preprocessing and CVR estimation followed the steps described in [6].
- An atlas for each subject was obtained by merging the Schaefer 2018 atlas [7] (100 regions) with the cerebellum and subcortical parcellation of the Destrieux 2010 atlas [8] (18 subcortical and cerebellar regions), projected on each subject's T1 with FreeSurfer and registered to their functional space.
- The average CVR for each ROI was extracted, then ICC(1,1) was used to compute the reliability of each ROI independently [1].
- Within-subject Coefficient of Variation maps were computed across the 5 sessions (Fig. 2).

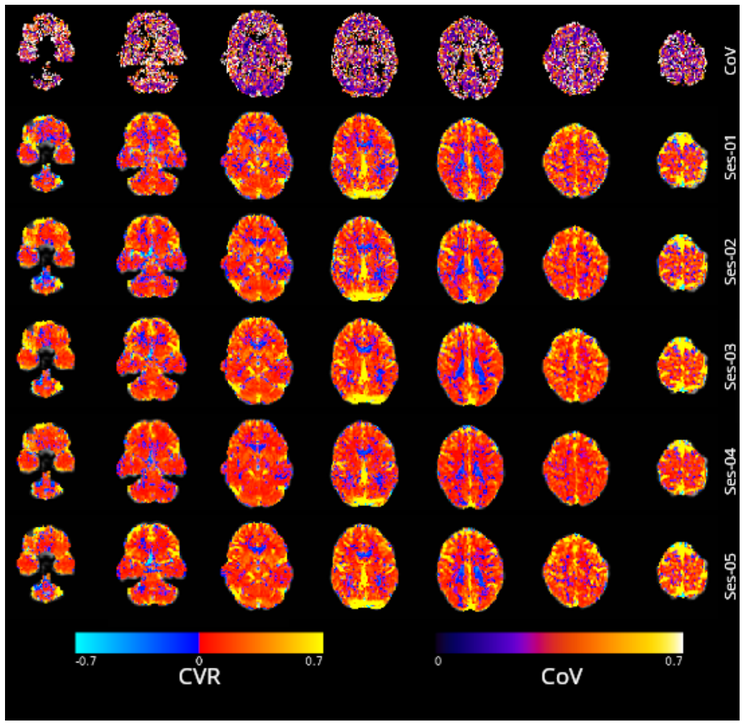

Figure 2. Coefficient of Variation and CVR maps of five sessions for a representative subject.