Correcting age-dependent BOLD signal change for vascular contributions using resting state fluctuation of amplitude in large-scale datasets

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Background

The impact of ageing on the vasculature can have significant effect on the fMRI signal. Therefore, fMRI studies in ageing should include an estimate of vascular reactivity for each subject. Standard approaches that adjust for vasculature changes (e.g. breathholding and hypercapnia) may be difficult for older adults to perform and impractical to implement in large-scale cohort studies. A task-free alternative such as resting state fluctuation amplitude (RSFA) can be implemented to account for age-dependent alterations in the vasculature1.

Using 250 population-representative healthy adults (aged 20-85) from the Cambridge Centre for Ageing and Neuroscience (www.cam-can.com), we applied the RSFA scaling approach to correct for age-related vascular contributions in fMRI-BOLD signal during an audio-visual cued motor task (AV-task).

Methods

- RSFA maps follow the spatial pattern of vascular reactivity maps from other “calibrating” approaches1. In addition, the RSFA ICA did not resemble resting state network ICA, suggesting that it is unlikely to be related to neural variance.
- Age-related decreases of RSFA were observed in frontal orbital, cuneus, precuneus, posterior cingulate, posterior parietal cortex, and dorso-lateral prefrontal cortex.
- Age-related decrease of BOLD signal change in response to sensory stimulation was minimised by RSFA-correction of the task-induced BOLD signal. The data suggests that the observed pattern of activation in the uncorrected signal might be associated with vascular reactivity changes in ageing.

Whole-group AV-task response

Both whole-brain and roi-analysis showed sensitivity in identifying primary visual, motor and auditory cortices in response to av-task stimulation.

Ageing effects in AV-task (Whole-brain analysis)

Scaling task-induced BOLD response with RSFA reduces the extend of ageing effects in primary visual, auditory and motor cortices.

Summary

- RSFA maps follow the spatial pattern of vascular reactivity maps from other “calibrating” approaches1. In addition, the RSFA ICA did not resemble resting state network ICA, suggesting that it is unlikely to be related to neural variance.
- Age-related decreases of RSFA were observed in frontal orbital, cuneus, precuneus, posterior cingulate, posterior parietal cortex, and dorso-lateral prefrontal cortex.
- Age-related decrease of BOLD signal change in response to sensory stimulation was minimised by RSFA-correction of the task-induced BOLD signal. The data suggests that the observed pattern of activation in the uncorrected signal might be associated with vascular reactivity changes in ageing.

Conclusion and Future work

- RSFA can be used as an estimate of vascular reactivity for correction of non-neural contribution in task-specific fMRI-BOLD signal. This can be particularly useful in large-scale neuroimaging studies of ageing, where alternative measures of vascular reactivity can be impractical.
- Validation of RSFA is necessary for confirming the assumptions that resting state fluctuations/variability are induced by the vascular properties of brain tissue and does not reflect neural variance.