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Investigating an optimal duration of acquisition in resting-state ASL

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Introduction:

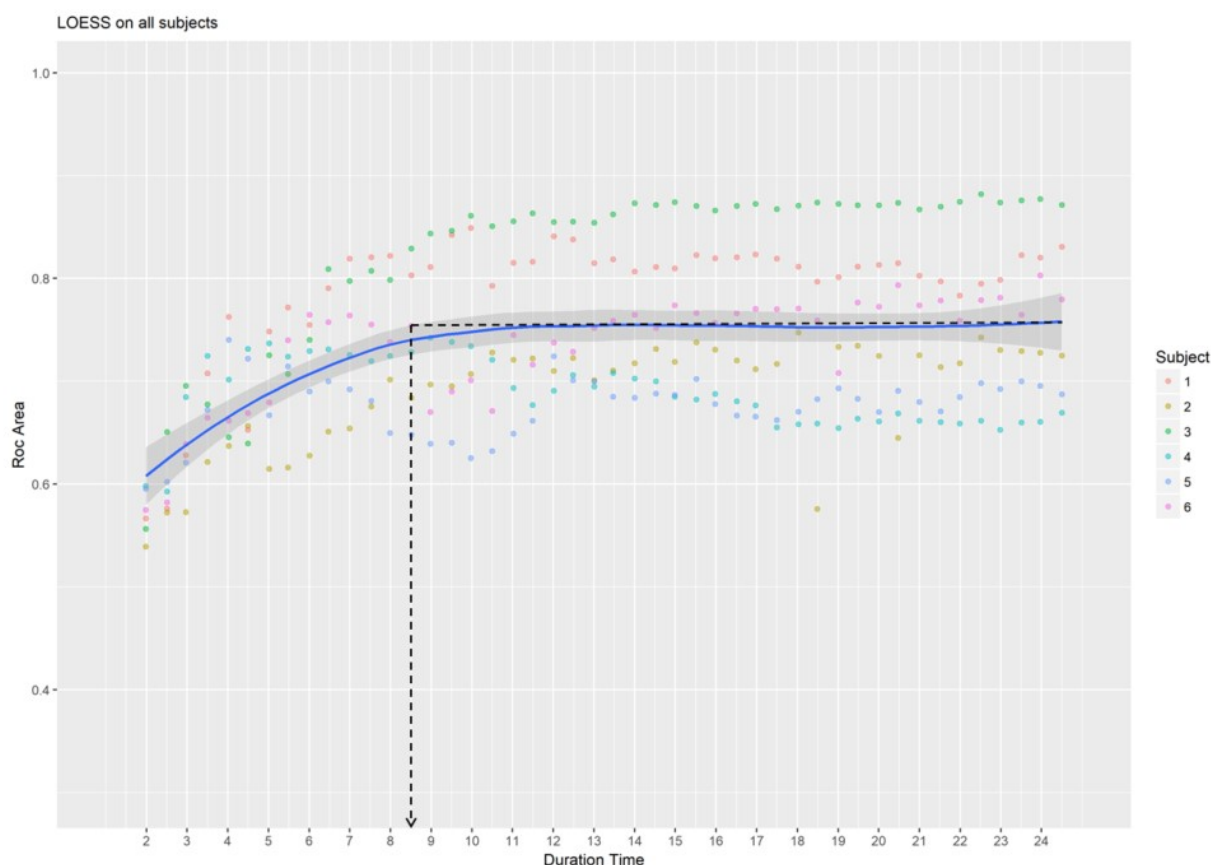
Resting-state Arterial Spin Labeling (rs-ASL) usage in clinical daily practice and academic research remains confidential compared to resting-state BOLD. Despite having a lower signal-to-noise ratio compared to BOLD, ASL MRI allows to quantify cerebral blood flow (CBF) under some assumptions. This leads to significant clinical subject scaled application as CBF can be considered as a biomarker in common neuropathology. A critical parameter when setting up a resting-state sequence is the duration of the acquisition (DOA). While deeply impacting clinical implementation and quality of functional representation, only few papers works on providing an optimal DOA. In this work, we study the evolution of the overall quality of rs-ASL as a function of the DOA. To this end, we consider subject self-Default Mode Network (DMN), and model DMN quality course over time compared to a gold standard DMN. Under the assumption that quality of the DMN can define quite-well the rs-ASL one, we would eventually pave the way on DOA influence for rs-ASL.

Methods:

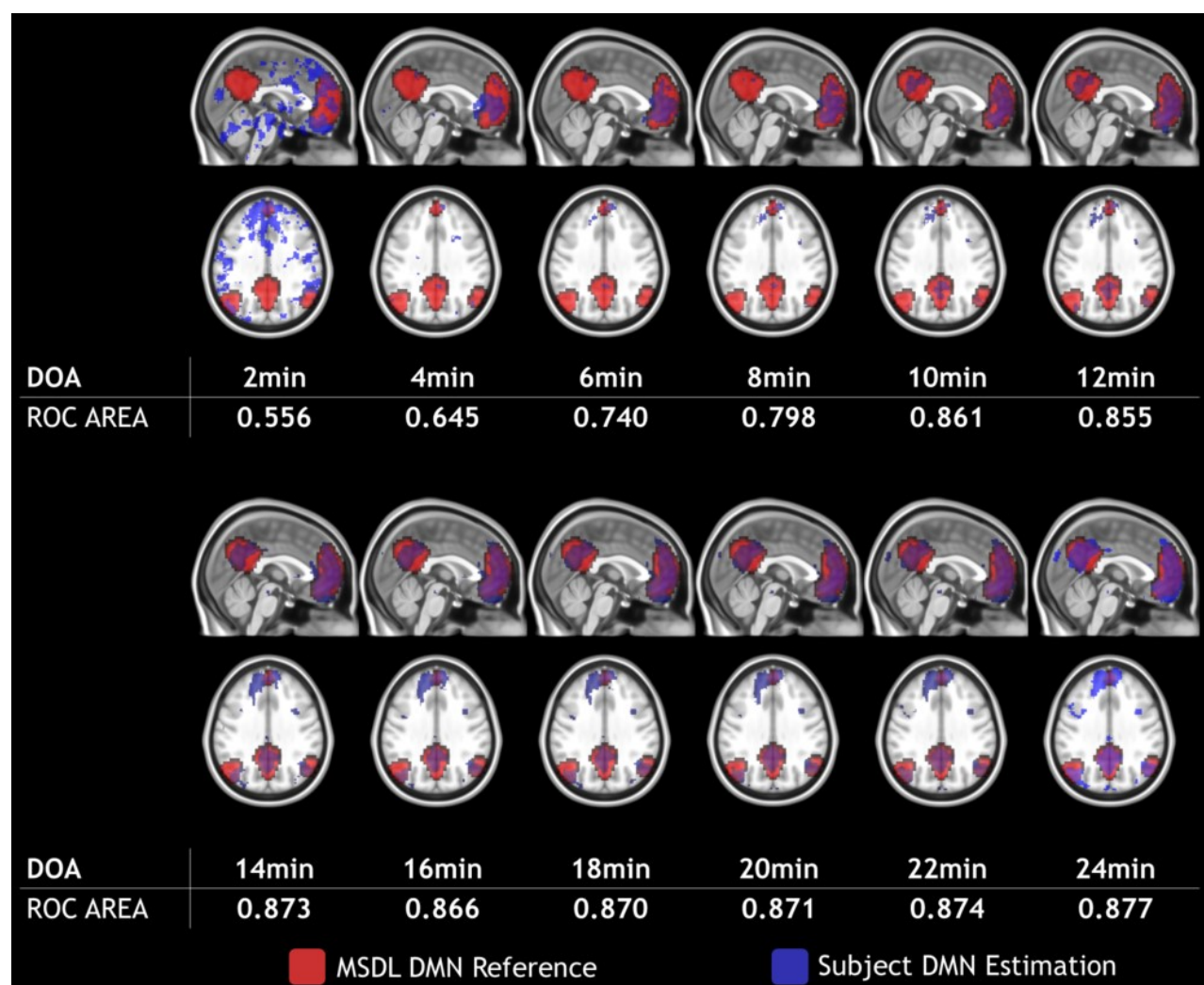
We consider a dataset of 6 healthy subjects who volunteered for a 24min30s (420 volumes) rs-ASL acquisition. Each rs-ASL time series is split into 46 parts of increasing durations from 2min to 24min30 with 30s step. As we want to work as close as an investigator would typically experienced, we use standard preprocessing methods (Chen et al. 2015). Since we work at a subject-scaled level (i.e. considering not group built DMN) and apply the same process for all the 6x46 subacquisitions, we rely on Seed-Based Analysis (SBA). Using the canonical estimator of linear correlation, we build the correlation maps for each subject and each DOA, resulting in a total of 276 maps. To investigate evolution of the DMN over DOA we need a DMN gold-standard. As an independent reference from our dataset, we choose the DMN from the resting-state functional areas atlas (MSDL) proposed by(Varoquaux et al. 2011). To avoid the DMN shape variability induced by a statistical test (risk, multiple comparisons correction), we compute the ROC area between each correlation map and the MSDL DMN. Overall, 276 ROC area scores are computed in order to model the evolution of the quality of the DMN depending on the DOA. Since we do not need extrapolation after 24min30s, neither an exact formula as no theoretical model exists, we use the well-suited local non-parametric regression LOESS with two degrees local polynomials and a 0.8 span.

Results:

Figure 1 shows LOESS modelling of ROC area scores depending on the DOA with some illustrations in Figure 2 of DMN evolution over time (1% FWER corrected statistically tested correlation maps). LOESS suggests that ROC areas increase from 2min to 11min with a rapidly decreasing speed after 8min. After 12min LOESS becomes stable. The same trend is globally followed by all subjects. Considering the 95% confidence area of the modelling, LOESS is on average not significantly different from its maximum between 8min30s and 24min30. On figure 2, at 2min, only false positive noise seems to be represented. Afterwards, three steps seem to appear. First, between 4min and 8min only the frontal component of the DMN is getting detected better and better. Secondly, after 8min and before 12min frontal part is well detected while lateral and posterior components start to appear. Finally after 14min, longer DOA seems irrelevant as DMN is well detected and stable. LOESS stabilization stage matches quite-well with the one DMN representation suggest after 14min.



•Computed LOESS curve of ROC area for all subject. Grey area is the 95% confidence area of the curve. Black lines show the maximum of LOESS curve and the non-significant difference interval.



·Subject 3 DMN evolution (in blue) over DOA in MNI152 space along with MSDL DMN (in red)

Conclusions:

In this work we exhibit a global tendency of stabilization of the DMN depending on the ASL duration of the acquisition. Still assuming the definition of quality of rs-fASL acquisition by its functional area representation, other resting-state networks should be investigated with different scoring methods to confirm the tendency. Sequence influence should also be discussed since ASL parameters (TR, PLD) can have a critical influence on functional area representation.

Imaging Methods:

Non-BOLD fMRI ¹

Modeling and Analysis Methods:

Task-Independent and Resting-State Analysis ²

Keywords:

Other - Arterial Spin Labeling

^{1/2}Indicates the priority used for review