

TOWARDS QUANTITATIVE FUNCTIONAL BRAIN MAPPING: THE SPATIAL ACCURACY OF ARTERIAL SPIN LABELLING

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BACKGROUND

- BOLD is widely used in research and clinic to map functional cortex. However, BOLD is an indirect measure of neuronal activity and its specificity can be biased by draining veins and especially in case of altered neurovascular coupling (i.e. in neuro-patients) [1].
- Arterial Spin Labelling (ASL) is an alternative non-invasive imaging technique that allows for a direct and quantitative measurement of the cerebral blood flow [2]. Although ASL may locate more directly and more precisely the neuronal activity, it is still only occasionally used in functional mapping.

AIM

- To validate the spatial specificity of ASL in functional modality (*fASL*) compared to BOLD in healthy subjects during the execution of tasks, before the application in the neurological population and application in the clinical routine.

METHODS

- 26 healthy subjects: [18-60] years old; 18 F.
- 1st session → MRI:
 - Structural T1 (4 echoes mprage)
 - Dual echo pseudocontinuous ASL (DE-pcASL) for simultaneous BOLD/ASL
 - Clenching hand task
 - Pneumatic stimulation of thumb
- 2nd session → neuronavigated TMS (**Fig. 1**):
 - Stimulation of the motor area
 - Motor evoked potentials (MEP) measure (thumb and little finger)
 - Spatial assessment on the coordinates of the maximum of activation (MAX) and the center of gravity (CoG)
 - ASL versus BOLD
 - ASL/BOLD versus TMS

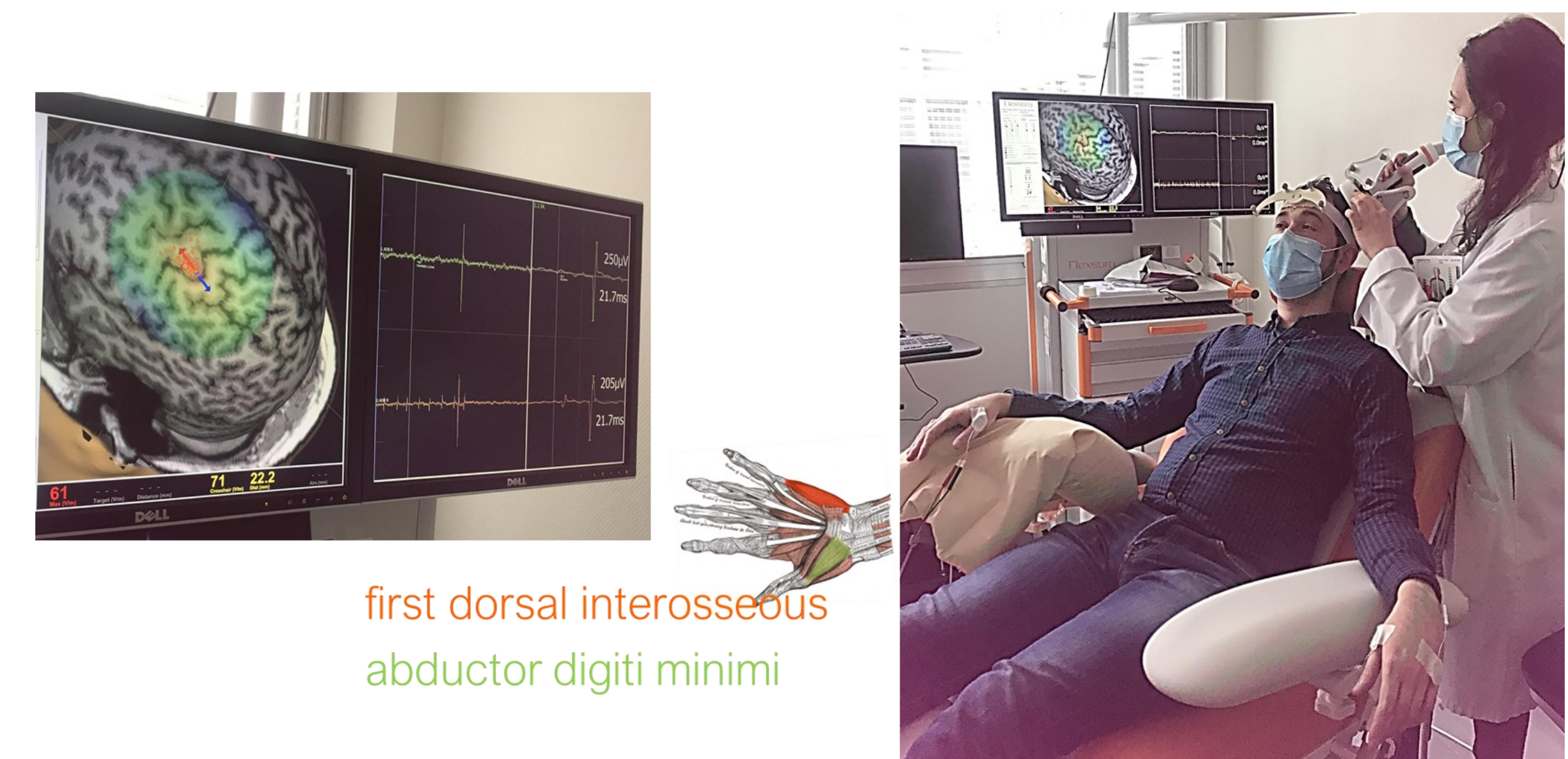


Fig. 1: TMS session. The hand area (Ω region in the pre-central sulcus) is mapped by using TMS stimulation (105% of the measured subject's specific motor threshold). Significant activations are defined according to the MEP amplitude measured for the thumb and the little finger, during the stimulation.

RESULTS

- In clenching hand task:
 - The Euclidean distance between *fASL* and BOLD ranged between 10.1 mm and 16.6 mm, as in literature [4].
 - In respect to BOLD, across subjects and along each brain direction (**Fig 2**), *fASL* localized significantly: *i*) more lateral ($p < 0.05$); *ii*) more anterior ($p < 0.05$); *iii*) more inferior ($p < 0.001$)
- Similar results were observed at group-level under pneumatic stimulation (**Fig 3**).
- fASL* resulted more adjacent than BOLD to TMS, with a significant shift ($p < 0.001$) along the inferior-to-superior direction (**Fig 4**).

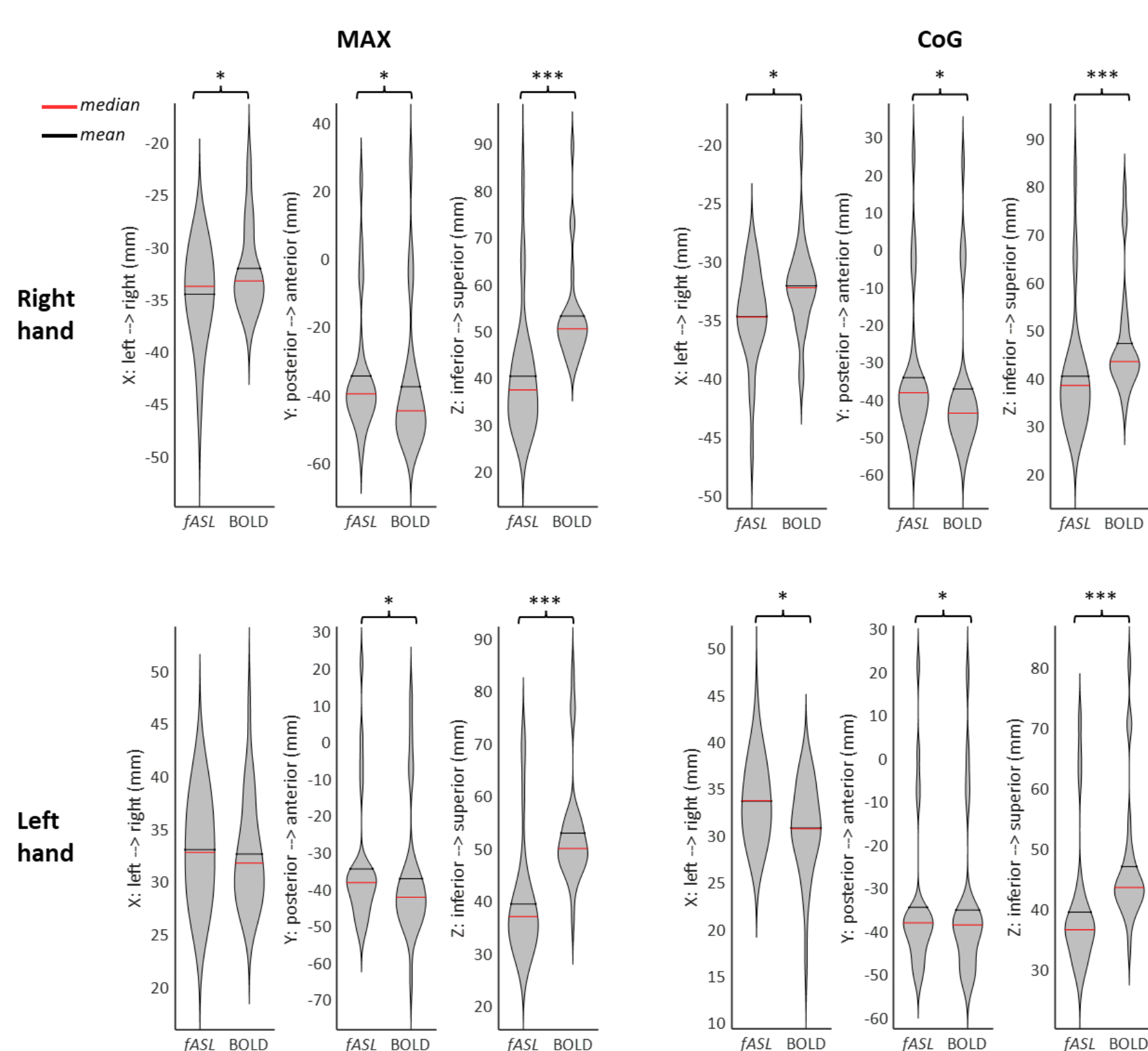


Fig. 2: fASL versus BOLD across anatomical coordinates. Violin plots represent the localization across all brain direction of MAX and CoG obtained from ASL and BOLD activation maps during clenching hand task. *: $p < 0.05$; ***: $p < 0.001$. MAX: global maximum of activation; CoG: Center-of-Gravity.

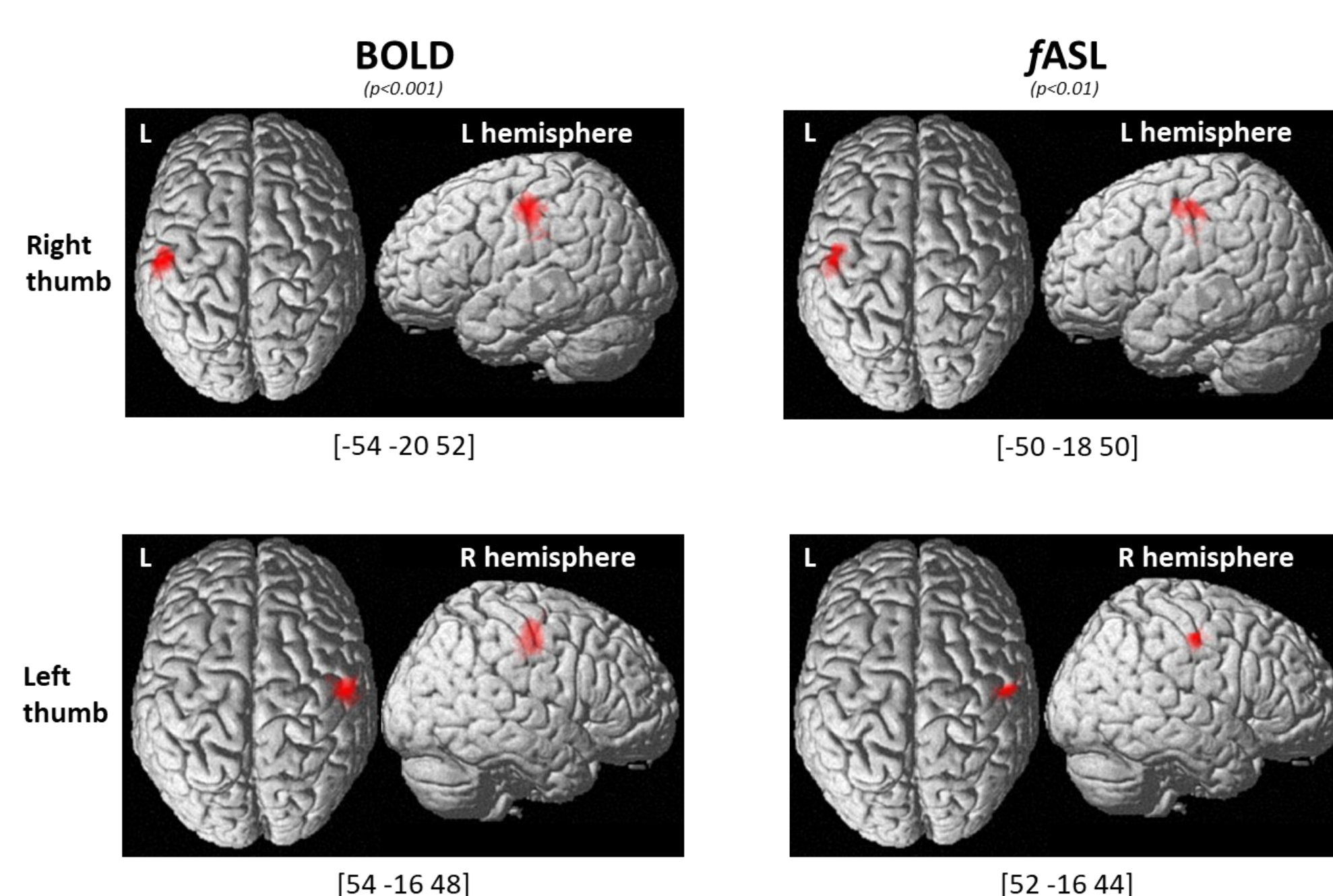


Fig. 3: Results of pneumatic stimulation. Activations at group level are shown for the BOLD and *fASL* for right (top row) and left (bottom row) and right thumb. The locations of the global maximum of activation are specified in MNI coordinates.

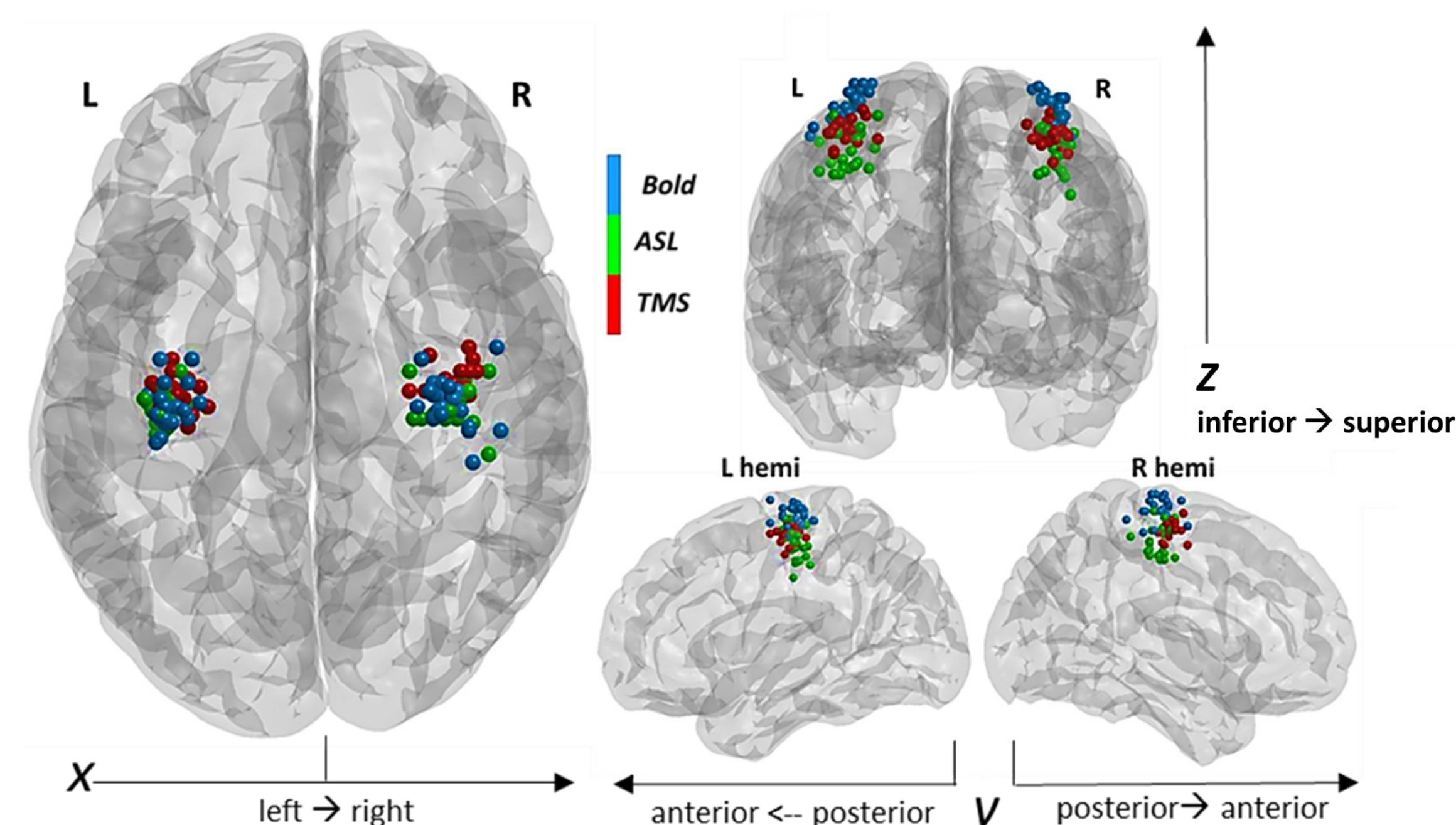


Fig. 4: CoGs on MNI template. For each healthy participant, blue and green spheres are positioned on the MNI coordinates of the CoG for BOLD and *fASL* activations during the clenching motor task of each hand. The red spheres corresponds to the MNI coordinates of the points with the highest motor evoked potential during TMS for each hand.

CONCLUSION

- Systematic shift between *fASL* and BOLD activation.
- Better spatial specificity of *fASL* in respect to BOLD for targeting the regional neuronal excitability.
- fASL* might improve the special accuracy of presurgical localization of eloquent cortex.

References

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