

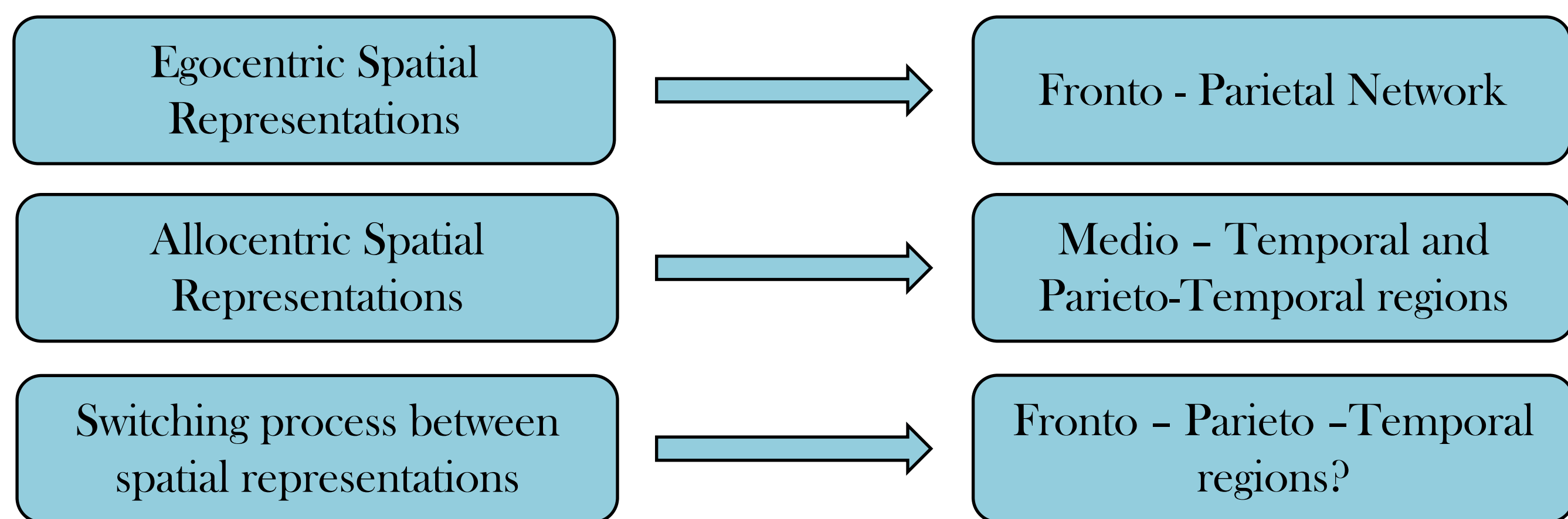
1. BACKGROUND

Spatial information are represented in memory with respect to **egocentric** (body-to-object) and **allocentric** (object-to-object) **frames of reference** (FoRs), respectively supported by **fronto-parietal** and **medio-temporal regions** [1-7]. Due to the natural complexity of the spatial environments, a cooperation between between egocentric and allocentric spatial representations is needed.

This entails that **egocentric and allocentric FoRs switch between them**, and such spatial switching process is supposed to be supported by **posteromedial structures** (PCC - RSC) and **Locus Coeruleus Prefrontal Cortex Noradrenaline System** (LCNA - PFC) [8-10].

2. RESEARCH QUESTION

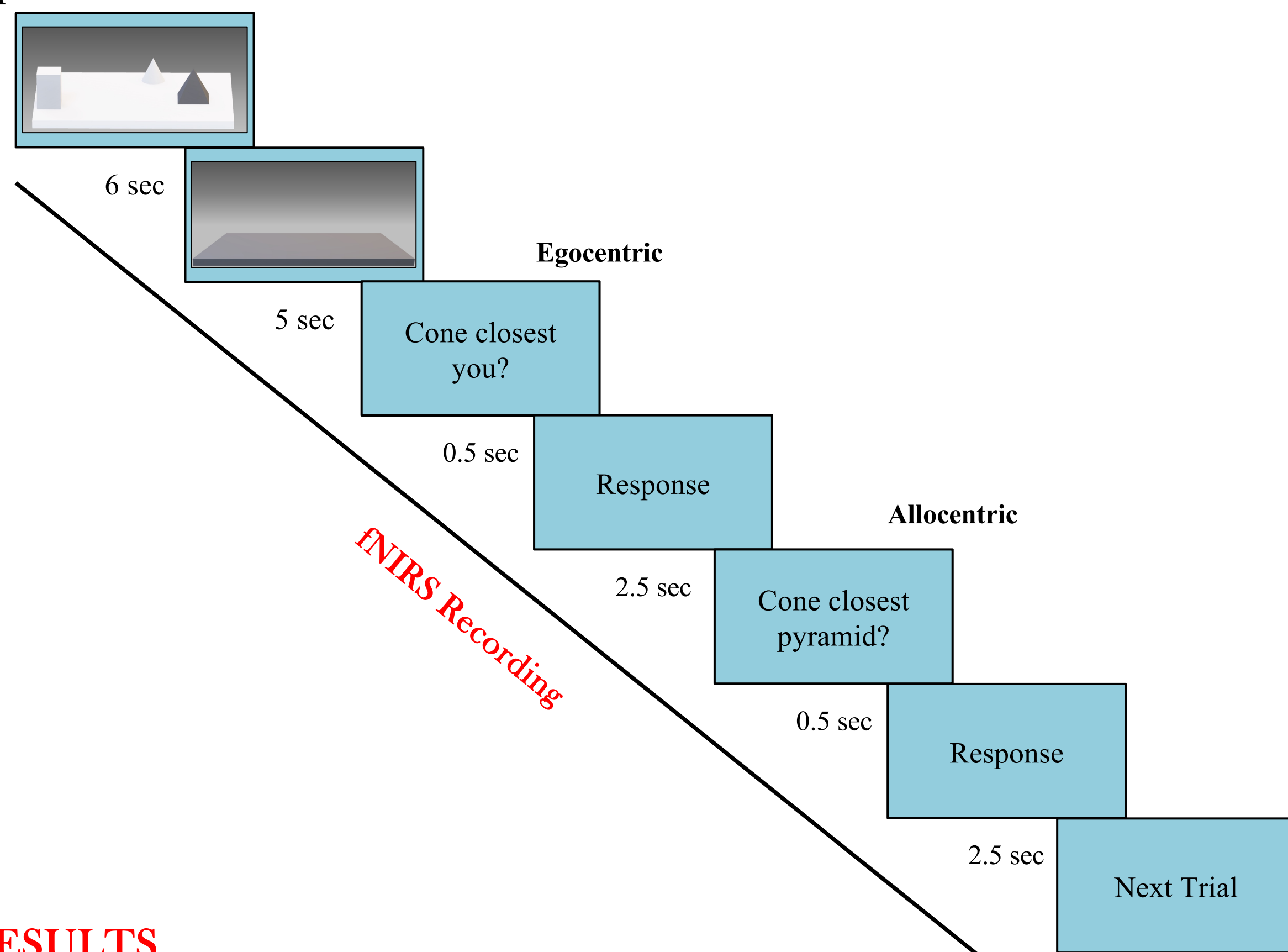
Despite such visuo-spatial process is pivotal in our daily life activities, **to date it is unclear which cortical regions are mainly involved in spatial switching processes**.



3. METHOD

- **Participants:** 38 (27 females) aged 18-35 (M = 22.86, SD = 4.08)
- **Stimuli:** Ego-Allo Switching Task [10]
- **Procedure and Task:** participants memorized triads of geometrical objects, then provided two consecutive spatial judgments of relative distance about memorized stimuli in an egocentric and allocentric reference frames in switching (from Ego-to-Allo, from Allo-to-Ego) and non-switching (Ego-Ego, Allo-Allo) conditions.

- **Experimental Flow:**



4. RESULTS

- The **Ego-Allo > Baseline** contrast revealed greater concentrations of HbO in the SFG, MFG and IFG, in SPL, IPL, finally in STG, MTG.
- The **Allo-Ego > Baseline** contrast revealed greater concentrations of HbO in SFG, MFG, IFG.
- The **Ego-Allo > EgoEgo** contrast greater concentrations of HbO in SGF, MFG, IFG, SPL, STG and greater concentrations of HbR in IPL, SMG and ANG.
- The **Allo-Allo > Allo-Ego** contrast revealed greater concentrations of HbO in SFG.

7. CONCLUSIONS

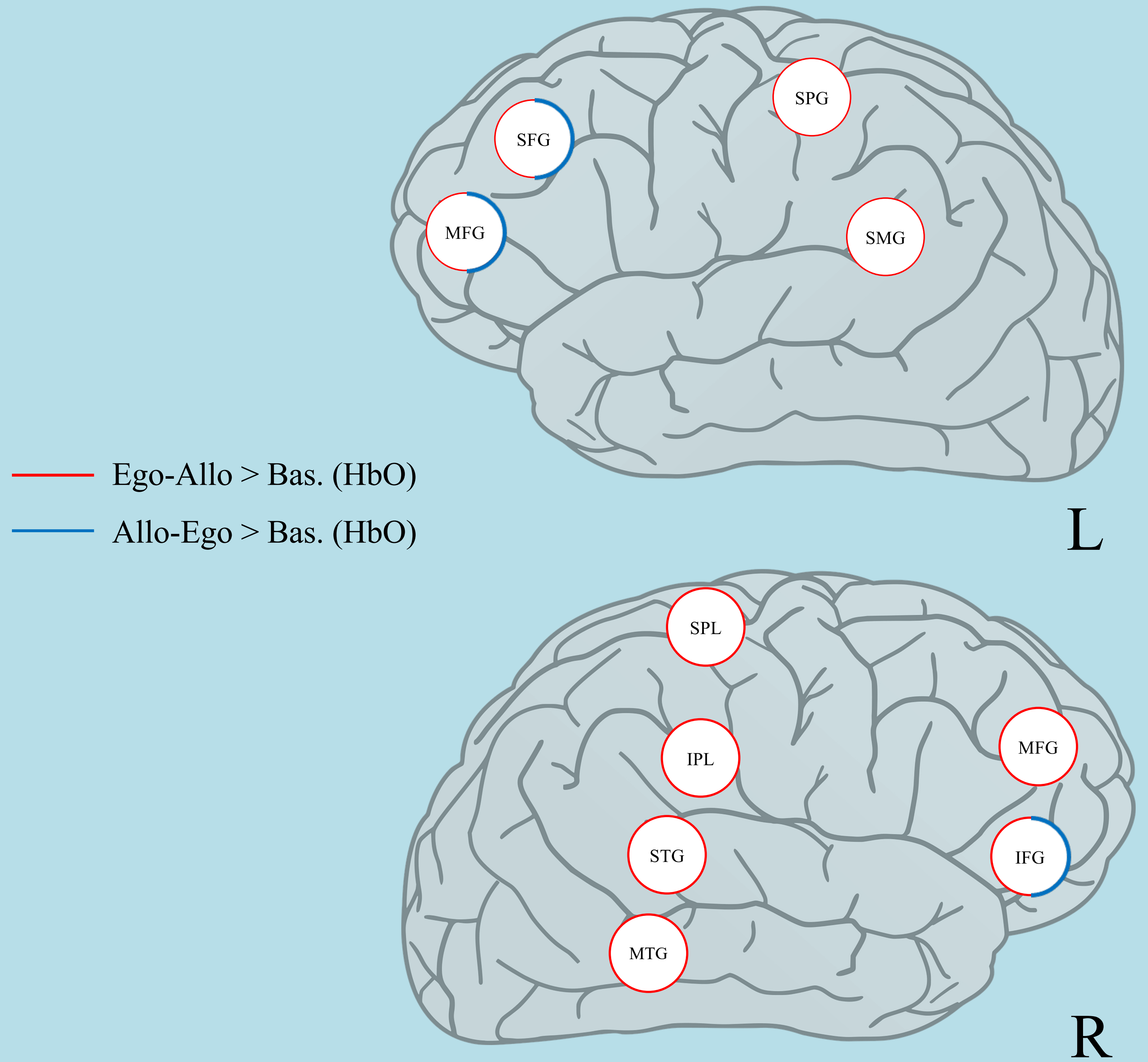
The results show the concurrent activation of **fronto-parietal regions**, where **body-centred** representations are stored, and **parieto-temporal regions**, where **object-centred** representations are stored instead, in line with the 'two-systems model' [8, 13]. Furthermore, the activation of the **temporo-parietal junction** emerged, suggesting a crucial role of this brain region in the **translation processes between body-centred and object-centred spatial representations**.

REFERENCES

- [1] Galati, G., Pelle, G., Berthoz, A., & Committeri, G. (2010). Multiple reference frames used by the human brain for spatial perception and memory. *Experimental brain research*, 206(2), 109-120.
- [2] McNamara, T. P. (2002, May). How are the locations of objects in the environment represented in memory?. In *International conference on spatial cognition* (pp. 174-191). Springer, Berlin, Heidelberg.
- [3] Committeri, G., Galati, G., Paradis, A. L., Pizzamiglio, L., Berthoz, A., & LeBihan, D. (2004). Reference frames for spatial cognition: different brain areas are involved in viewer-, object-, and landmark-centered judgments about object location. *Journal of cognitive neuroscience*, 16(9), 1517-1535.
- [4] Zachle, T., Jordán, K., Wüstenberg, T., Baudewig, J., Dechent, P., & Mast, F. W. (2007). The neural basis of the egocentric and allocentric spatial frame of reference. *Brain research*, 1137, 92-103.
- [5] Chen, Y., Momen, S., Byrne, P., Yan, X., Henriques, D. Y., & Crawford, J. D. (2014). Allocentric versus egocentric representation of remembered reach targets in human cortex. *Journal of Neuroscience*, 34(37), 12515-12526.
- [6] Ruotolo, F., Ruggiero, G., Baenckers, M., Iachini, T., Van der Ham, I. J. M., Fracasso, A., & Postma, A. (2019). Neural correlates of egocentric and allocentric frames of reference combined with metric and non-metric spatial relations. *Neuroscience*, 409, 235-252.

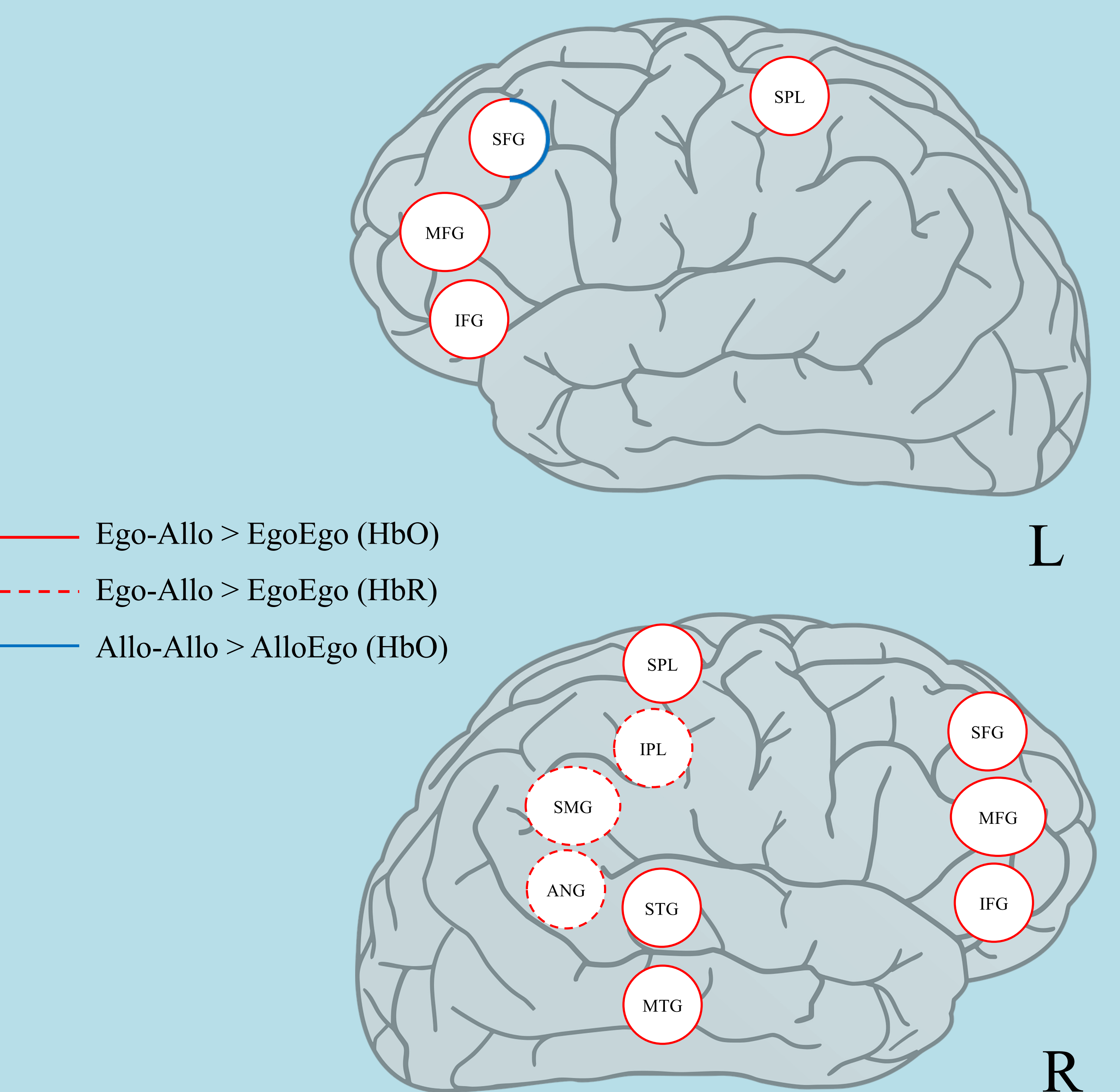
Switching Vs. Baseline

At least $p < 0.05$, FDR Corrected^[11]



Switching Vs. Non-Switching

At least $p < 0.05$, FDR Corrected^[11]



LEGEND

SFG = Superior Frontal Gyrus; MFG = Middle Frontal Gyrus; IFG = Inferior Frontal Gyrus; SPL = Superior Parietal Lobule; IPL = Inferior Parietal Lobule; SMG = Supramarginal Gyrus; ANG = Angular Gyrus; STG = Superior Temporal Gyrus; MTG = Middle Temporal Gyrus.

- [7] Derbie, A. Y., Chau, B., Lam, B., Fang, Y. H., Ting, K. H., Wong, C. Y., Tao, J., Chen, L., & Chan, C. C. (2021). Cortical hemodynamic response associated with spatial coding: a near-infrared spectroscopy study. *Brain Topography*, 34(2), 207-220.
- [8] Burgess, N. (2006). Spatial memory: how egocentric and allocentric combine. *Trends in cognitive sciences*, 10(12), 551-557.
- [9] Harris, M. A., Wiener, J. M., & Wolbers, T. (2012). Aging specifically impairs switching to an allocentric navigational strategy. *Frontiers in aging neuroscience*, 4, 29.
- [10] Ruggiero, G., Iavarone, A., & Iachini, T. (2018). Allocentric to egocentric spatial switching: Impairment in mCI and Alzheimer's Disease patients?. *Current Alzheimer Research*, 15(3), 229-236.
- [11] Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal statistical society: series B (Methodological)*, 57(1), 289-300.
- [13] Byrne, P., Becker, S., & Burgess, N. (2007). Remembering the past and imagining the future: a neural model of spatial memory and imagery. *Psychological review*, 114(2), 340.