“Follow your rhythms: MEG spectral fingerprints differentiate evidence accumulation from saccadic motor preparation in perceptual decision-making”

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Studies on primates demonstrated that the decision process relies on an integrative mechanism of evidence accumulation implemented in the same areas devoted to execution of the action response [1].

These studies inspired several investigations on decision-making in the human brain, but only few studies have attempted to describe the human neural correlates of this mechanism [2]. Here we aimed at describing a human homologue of the decision variable and its frequency specific signature by exploiting magnetoencephalographic (MEG) recordings from sixteen subjects performing a continuous version of the classical Random Dot Motion task [3]. Participants were instructed to monitor a cloud of incoherently moving dots for seamless intermittent targets defined by 1.9s periods of coherent motion (coherency level equal to 30% - easy, 60% -medium, 90% - hard) and were asked to indicate through a spatially-direct saccadic eye movement the prevalent direction of motion in the leftward or rightward direction.

A 3x2 ANOVA confirmed a main effect of evidence on both detection accuracy and reaction time between the three conditions. Sensor-level and source-level time-frequency (TF) analysis were then performed to identify channel clusters which show power modulations associated with the decision process and cortical activity modulations onset, respectively. Finally a cluster-based permutation test was used to assess the contrast between time-varying modulations in the easy and hard conditions, then a paired-sample t-test was used to assess slope differences between the two conditions.

Our results showed an alpha band event-related desynchronization (ERD), localized in a region of the posterior parietal cortex, consistent with the definition of a human homologue of the monkey LIP area.
We also found that the slope of this alpha-band ERD significantly scales across the different sensory evidence levels, suggesting that it represents the human counterpart of the evidence-accumulation process described in monkeys.
Moreover, in the same areas, a beta power modulation was observed, with a functional role conceivably related to specific mechanism of motor preparation.
Overall, our results suggest that although the decision-making process and the planning of action execution occurs in the same areas, in accordance with the foundational findings that support an intentional account of decision-making, it exploits two different frequency specific mechanisms with different functional roles.

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