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The role of cortical waves in shaping the dynamic processing of visual information

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Since the pioneering work of the Hubel and Wiesel, our understanding of visual processing has been dominated by the feed-forward hierarchical approach. Accordingly, low-level visual information (such as position and orientation) is extracted locally within stationary receptive fields and is rapidly cascaded to downstream areas to encode more complex features. As a consequence, the knowledge we have about the visual system mostly relies on results obtained stimuli presented within a stationary aperture, hereby focusing on a steady-state and piecewise information confined to the receptive field.

However, using mesoscopic recording recording tools (voltage-sensitive dye imaging, multi-electrode array) in the awake monkey, we demonstrated that any local stationary stimulus is, in itself, generating non-stationary waves that are propagating within retinotopic maps. Importantly, similar waves are also frequently occurring spontaneously. What can be the functional advantage of such spontaneous or evoked cortical waves in processing visual information? I will argue in this presentation that it can help shaping and structuring the representation of non-stationary stimuli such as object moving along a trajectory. Using a combination of different experimental and computational approaches, I will show that non-linear interactions between feedforward and cortico-cortical propagation of activity can shapes the population response to represents unambiguously and anticipate the motion trajectory of an object. The role of these waves in structuring the framework for predictive computation will be discussed.