22 JUNE 2023, 3:00 p.m.
AULA T2-CLA
(Via Venezia 16, Padova)

PNC SEMINARS

A talk by Ben Harvey (Utrecht University)

REVEALING MECHANISMS OF SENSORY AND COGNITIVE PROCESSING WITH ULTRA-HIGH FIELD fMRI

Ultra-high field MRI (at 7T or more) gives exceptionally clear measurement of the structure and responses of the human brain. This excellent signal-to-noise ratio (SNR) is often used to image brain structure and function at very high resolution. However, at more conventional resolutions (between 1.5 and 2 mm), 7T fMRI allows us to characterize neural responses in much greater detail than 3T fMRI for several reasons. First, the spread of the 7T BOLD signal is far smaller than at 3T, giving a far more spatially specific signal even at the same nominal resolution. Second, this high SNR lets us record responses to many stimuli and tasks in the same experiment, and so capture all these responses with a single response model that reveals the detailed response properties of responsive neural populations. Finally, this high SNR allows us to see relatively weak signals, where there may be relatively small changes between conditions or relatively few responsive neurons in each voxel.

Here I will discuss how we have taken advantage of these new possibilities to reveal the neurophysiology of human sensory and cognitive processing in unprecedented detail. In sensory processing, we have shown how visual spatial receptive fields change when we pay attention at different locations. In cognitive processing, we have revealed the fine-scale spatial structure of responses to physical quantities (numerosity, object size and event timing), showing that topographic map structures emerge in sensory and cognitive processing alike. And we have shown how these quantity-selective responses in cognitive processing are derived from responses in early sensory areas by testing the predictions of different neural response functions. Together, these new possibilities allow us to move fMRI away from localizing responsive areas, instead revealing the response functions of the neurons involved and the computational mechanisms by which these responses arise.

<u>Biography</u>

Ben Harvey is an Associate Professor at Utrecht University. Ben's research aims to characterize sensory and cognitive systems in the human brain, the neural responses and computations within these systems, and how these are affected by sensory stimulus characteristics and attention. His approach combines development and application of cutting edge neuroimaging approaches with computational modeling and behavioral experiments. Following his PhD at Oxford, Ben's postdoctoral research began by investigating the early visual system as a model of neural processing, extending approaches for studying neural response properties from invasive neurophysiological studies to non-invasive neuroimaging (ultra-high field functional MRI). This has allowed application of neural response models to the human brain, clinical disorders and understanding human perception. Working in Utrecht (Netherlands), he has applied these methods widely to characterize neural interactions, binocular visual integration, visual attention, oscillatory electrical brain activity, and fine-scale functional connectivity. Ben's recent work has focused on applying the same methods to investigate neural responses underlying cognition in the human association cortex. He thereby aims to characterize increasingly advanced cognitive functions that are absent or very different in animal models of the brain. He began by showing that object number and size processing share many properties with early sensory processing. In 2015 Ben started his own research group to extend this work. His current work focuses on neural responses to event timing in different sensory modalities, relationships between processing of different quantities, and how responses to quantities are derived from early sensory responses. This work has been supported since 2017 by a Vidi grant from the Netherlands Organization for Scientific Research (NWO).

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