Tomas Knapen, PhD

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Personal statement

My research develops mechanistic, model-based approaches for human neuroimaging. I focus on intensive, precision, and ultra-high-field paradigms to characterize how structured representational maps in the human brain support perception, action, social cognition, and self-modeling. My lab has recently discovered vicarious body maps that tile the human brain, bridging vision and touch (Hedger, Naselaris, Kay, Knapen, Nature 2025), by leveraging >750 hours of 7T fMRI. I have also authored the field's recent opinion piece on intensive human neuroimaging (Kupers, Knapen, Merriam, Kay, Trends in Neurosciences 2024). I am thus well aware of the promises and pitfalls of both the use and the production of precision fMRI dataset.

My current portfolio aligns directly with the Digital Brain Project's goals along three converging strands.

Open-source precision-fMRI tooling. I lead *Popylar*, a 2024 Netherlands eScience Center Open eScience Call award (kicked off 2025) that builds the next-generation, unified, community-supported open-source package for population receptive field modeling in human neuroimaging, in partnership with the eScience Center's research software engineers. Popylar provides the consortium with a production-grade, validated pipeline for the encoding-model analyses on which precision fMRI rests.

Active intensive 7T acquisition. I run the Meta-supported *Arrow-Of-Time (AOT) 7T* dataset on the Spinoza Centre's Philips 7T Achieva. AOT is a deep video dataset modeled in approach after NSD, the standard in the field. AOT adds not just dynamic visual stimulation, but also manipulates the direction of video playback to induce world-model based prediction errors. We intend to develop this dataset into an AI benchmark for world-model violations. Meta has already chosen to fund my group to produce intensive 7T data: the acquisition stack, custom preprocessing and analysis pipelines, eye-tracking integration, and stimulus delivery code are already operational. The proposed Digital Brain Project work is distinct in scope but builds on this operational pipeline.

fMRI-MEG fusion. I have co-developed novel methods for forward-model derived fMRI-MEG fusion, which multiplicatively combines the spatial precision of UHF fMRI with the temporal precision of MEG (Eickhoff et al., bioRxiv 2025.05.12.653426).

These three pillars make me well placed to contribute precision-multimodal data to the Digital Brain Project, with embodiment — anchored in the vicarious body-map findings — as the scientific spine.

Education & training

- Postdoctoral Fellow, Cognitive Neuroscience, Université Paris Descartes, 2010
- PhD, Experimental Physics, Utrecht University, 2007
- MSc, Theoretical Biology, University of Amsterdam, 2002

Positions

- Principal Investigator / Group Leader, Vrije Universiteit Amsterdam — Faculty of Behavioural and Movement Sciences (Cognitive Psychology), 2013 – present
- Senior researcher, Spinoza Centre for Neuroimaging, Royal Netherlands Academy of Arts and Sciences (KNAW), 2017 – present
- Affiliated, Netherlands Institute for Neuroscience (NIN, KNAW), 2019 – present

Current and recent funding

Popylar: popularizing population receptive field modeling in neuroimaging. Netherlands eScience Center, Open eScience Call 2024 (kicked off 2025). Lead applicant. Develops the next-generation unified open-source pRF modeling package in partnership with eScience Center research software engineers, replacing the fragmented current tooling and providing community-supported precision-fMRI infrastructure.

Action-Observation Test (AOT) 7T dataset. Meta-supported, ongoing. PI; collaboration with Jean-Rémi King's group at Meta. Intensive 7T naturalistic-video acquisition on the Spinoza Centre's Philips 7T Achieva. Operational pipeline for stimulus delivery, BIDS, eye tracking, and analysis. Disclosed in §3 and §7 of the present application.

Stanford precision-fMRI collaboration. Ongoing collaboration with the Poldrack lab (Stanford) on individual-specific precision neuroimaging of learning-related plasticity. Brings the Amsterdam 7T and Stanford precision-fMRI programs into methodological alignment.

Prior major grants (selected). NWO (Dutch Research Council) VIDI grant; NWO Open Competition; eScience Center fellowship and follow-on projects on prfpy / pRF tooling; collaborative grants in the Spinoza Centre 7T program.

Contributions to science (selected, past 5 years)

1) Methodological authorship in intensive and precision human neuroimaging.

I co-authored the opinion piece that lays out the principles of intensive human neuroimaging — "design well, scan more, optimize quality, share better" — and have contributed empirical demonstrations of mechanistic 7T mapping at laminar and columnar scales.

- Kupers, E. R., Knapen, T., Merriam, E. P. & Kay, K. N. Principles of intensive human neuroimaging. Trends in Neurosciences 47, 100–112 (2024).
- Hollander, G. de, van der Zwaag, W., Qian, C., Zhang, P. & Knapen, T. Ultra-high field fMRI reveals origins of feedforward and feedback activity within laminae of human ocular dominance columns. NeuroImage 228, 117683 (2021).

2) Vicarious body maps and topographic organization beyond classical sensory cortex.

My group has extended topographic-mapping logic into non-classical territories, culminating in the discovery of vicarious body maps that bridge vision and touch across the dorsolateral visual system. This work is the direct scientific predecessor of the proposed Digital Brain Project arm.

- Hedger, N., Naselaris, T., Kay, K. & Knapen, T. Vicarious body maps bridge vision and touch in the human brain. Nature (2025). doi:10.1038/s41586-025-09796-0.
- Knapen, T. Topographic connectivity reveals task-dependent retinotopic processing throughout the human brain. PNAS 118, e2017032118 (2021).
- Groen, I. I. A., Dekker, T. M., Knapen, T. & Silson, E. H. Visuospatial coding as ubiquitous scaffolding for human cognition. Trends in Cognitive Sciences 26, 81–96 (2022). doi:10.1016/j.tics.2021.10.011.

3) fMRI–MEG fusion and computational models of contextual computation.

I contributed to the recently published forward-modeling approach that bridges fMRI spatial resolution with MEG millisecond temporal resolution (Eickhoff et al., 2025; Dumoulin lab, with Hillebrand and the PI as middle-author contributors) — the methodological foundation of the multimodal arm in this proposal — and have led work on divisive normalization, chemoarchitecture, and pharmacological perturbation of contextual computations in human visual cortex.

- Eickhoff, K., Hillebrand, A., Knapen, T., de Jong, M. C. & Dumoulin, S. O. Non-invasive mapping of the temporal processing hierarchy in the human visual cortex. bioRxiv 2025.05.12.653426 (2025).
- Aqil, M., de Hollander, G., Vreugdenhil, N., Knapen, T. & Dumoulin, S. O. Psilocybin alters visual contextual computations. Nature Communications 16, 10271 (2025).
- Aqil, M., Knapen, T. & Dumoulin, S. O. Computational model links normalization to chemoarchitecture in the human visual system. Science Advances 10, eadj6102 (2024).
- Aqil, M., Knapen, T. & Dumoulin, S. O. Divisive normalization unifies disparate response signatures throughout the human visual hierarchy. PNAS 118, e2108713118 (2021).

4) Behavioral and physiological readouts; intensive-7T-adjacent infrastructure.

Pupillometry, eye-movement analyses, and behavioral dissociations relevant to the eye-tracking arm of the Digital Brain Project proposal.

- Brascamp, J., de Hollander, G., Wertheimer, M. D., DePew, A. N. & Knapen, T. Separable pupillary signatures of perception and action during perceptual multistability. eLife 10, e66161 (2021).

Open-source tools, data, and standards

- Popylar (in development, 2025–): next-generation, community-supported open-source package for pRF modeling in human neuroimaging. eScience Center–partnered.
- pRFtime (Eickhoff et al., 2025; github.com/kateic/pRFtime): Python toolbox for spatiotemporal forward modeling of brain signals — the implementation accompanying the Eickhoff et al. fMRI–MEG fusion preprint, co-authored by the PI.
- Nideconv (2020): python toolbox for impulse response fitting of neural signals. Incorporates heriarchical Bayesian estimation of response shapes. Has been used in fMRI and pupil dilation domains.
- prfpy (Aqil & Knapen, 2023; maintained): Python package for pRF fitting, widely used in the precision-fMRI community.

- AOT 7T naturalistic-video dataset (in active acquisition; Meta-supported): intensive naturalistic-video brain dataset on the Spinoza Achieva, scheduled for BIDS-compliant open release.
- Vicarious body-map atlas from Hedger et al. 2025 (Nature): publicly available.

Selected service and recent invited roles

- Reviewer for Nature, Science, Nature Neuroscience, Nature Human Behavior, NeuroImage, eLife, PNAS, Journal of Neuroscience, Cerebral Cortex, Current Biology, Trends in Cognitive Sciences.
- Co-organizer of intensive-7T methods workshops; invited speaker on precision fMRI and vicarious body maps at international meetings.
- Editorial / consortium involvement: member of the prfpy / Popylar community; collaborator in the Spinoza Centre 7T consortium; collaborator in the Meta Brain & AI research network (AOT).

Training and mentoring

Trained postdocs, PhD students, and master's students working on intensive 7T fMRI, pRF modeling, vicarious body maps, divisive normalization, pupillometry, and naturalistic-stimulus paradigms. Several mentees have moved to faculty positions or leading postdoctoral roles in the US, UK, Switzerland, France, and the Netherlands.