PNM

Perception and Neuroarchitectural Mapping Group

by Kristian Sandberg

The Perception and Neuroarchitectural Mapping Group focuses on basic as well as clinical research. The starting point has been basic perceptual consciousness research – which still is a primary focus point – but the group has subsequently branched into other aspects of cognitive neuroscience and is planning to increase its clinical efforts in the coming years. Much of the work takes place within the SkuldNet consciousness consortium and EU COST Action CA18106 (The Neural Architecture of Consciousness), which are respectively directed and chaired by group leader Kristian Sandberg. In the context of these two constructs, the group conducts large-scale studies linking MRI-based estimates of neural architecture to individual differences in conscious perception/memory as well as more general cognitive phenomena like intelligence and personality.

Over the last years, the group has collected genetic material, 1 hour of MRI and around 10 hours of behavioural data from a total of 300 participants locally in Aarhus, and data has been collected from another 400 participants at two other consortium sites. An important part of the reasoning behind conducting large-scale studies is that the number of statistical tests that can be made within a dataset increases exponentially as a function of sample size whereas the number of comparisons you need to make when adding more experiments increases linearly. It is thus substantially more efficient in terms of costs and labour to conduct many experiments simultaneously with one large sample. The study is designed so that each site has enough power to conduct multiple experiments in isolation as well as a number of experiments that are run across multiple sites for which even larger sample sizes are particularly useful.

Large datasets do not only have adequate power to examine many behavioural/cognitive phenomena, but also to relate them to multiple brain characteristics. MRI provides a time-efficient, non-invasive method for examining these brain characteristics. We use a range of different sequences. The results of our current pipelines are shown in Figure 1, which also illustrates how they in combination form a complex data structure that we call a neuroarchitectural map. This structure is currently being related to a range of behavioural variables using multivariate approaches such as canonical correlation analysis (CCA) (see Figure 1). This work will continue to form the bulk of the work of the Perception and Neuroarchitectural mapping group over the next years.

Although the group spends the majority of its time on neuroarchitectural mapping at the moment, it is not its sole focus, and over the two last years, the group has published a broad range of articles on topics such as perceptions, consciousness and metacognition. For example, the group has published a method for estimating metacognitive capacity based on awareness/confidence ratings (S. B. Kristensen et al., 2020). They have also published an MEG experiment on the temporal context effect illusion (Zhou et al., 2020). Related to neuroarchitectural mapping, the group/consortium has contributed to a large-scale effort to examine frequency drift in MR spectroscopy (Hui et al., 2021), and the group has used modelling of fMRI data to show that the receptive fields of neuronal populations in early visual cortex behave as bandpass filters (D. G. Kristensen & Sandberg, 2021). Finally, the group has continued its work with experimental and theoretical consciousness studies (Del Pin et al., 2020, 2021; Overgaard & Sandberg, 2021) as well as experimental and theoretical transcranial magnetic stimulation (TMS) studies (Hobot et al., 2020, 2021).

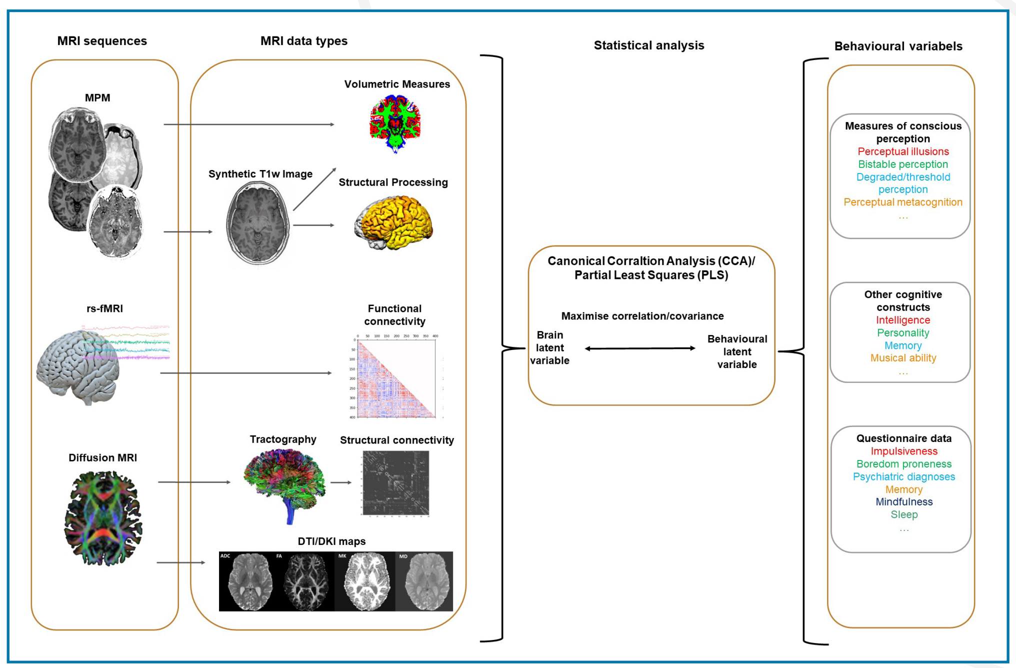

Figure 1
Neuroarchitectural mapping. Schematic of a key subset of MRI processing pipelines used in the SkuldNet consortium and COST Action CA18106 leading to multimodal neuroarchitectural maps. The maps are related to behavioural data using advanced statistical methods such as CCA/PLS.

NEW FACES at CFIN

Dunja Paunovic is a PhD candidate in psychology at the University of Belgrade, Serbia. Her involvement in EU COST action The Neural Architecture of Consciousness brought her to CFIN.

Her research interest is focused on human memory processes. Specifically, on isolating neurophysiological markers of mechanisms that lead to successful encoding and retrieval.

For her thesis she is exploring the possibility of varying the impact of non-invasive brain stimulation on memory performance by tailoring the frequency of stimulation protocols to individual brain rhythms obtained from EEG recordings.

At CFIN, she is working on MRI-based neuroarchitectural mapping of memory under Kristian Sandberg's supervision. While her main focus is on exploring the neural underpinnings of associative and implicit memory, Dunja is also taking part in behavioral assessment of various types of conscious perception and the metacognition of memory.

Daniel Tchemerinsky Konieczny is our new research year student, supervised by Kristian Sandberg. He has completed his bachelor's degree in Medicine at Aarhus University. During his master studies, he completed an internship at CFIN and afterwards continued to write his master thesis before starting this research year.

His research interests revolve mainly around human consciousness. Already during his master studies, Daniel has co-written an article with his supervisors at CFIN on the relationship between the subjective importance of olfaction and measured olfactory skill. Currently, he is responsible for combining DWI and MPM MRI data for advanced brain segmentation within the COST Action the Neural Architecture of Consciousness. He will subsequently use machine learning to relate subjective aspects of olfaction and audition to a range a brain characteristics obtained from MRI data.

In the future, he aspires to become a neurologist and provide CFIN with clinical linkage to consciousness research.

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