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The developmental emergence of reliable cortical representations

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The fundamental structure of cortical networks arises early in development prior to the onset of sensory experience. However, how endogenously generated networks respond to the onset of sensory experience, and how they form mature sensory representations with experience remains unclear. Here we examine this 'nature-nurture transform'at the single trial level using chronic in vivo calcium imaging in ferret visual cortex. At eye opening, visual stimulation evokes robust patterns of modular cortical network activity that are highly variable within and across trials, severely limiting stimulus discriminability. These initial stimulus-evoked modular patterns are distinct from spontaneous network activity patterns present prior to and at the time of eye opening. Within a week of normal visual experience, cortical networks develop low-dimensional, highly-reliable stimulus representations that correspond with reorganized patterns of spontaneous activity. Using a computational model, we propose that reliable visual representations derive from the alignment of feedforward and recurrent cortical networks shaped by novel patterns of visually-driven activity.

Presenter: TRÄGENAP, Sigrid (Frankfurt Institute for Advanced Studies)

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