SLAP2
Receptive Field Analysis

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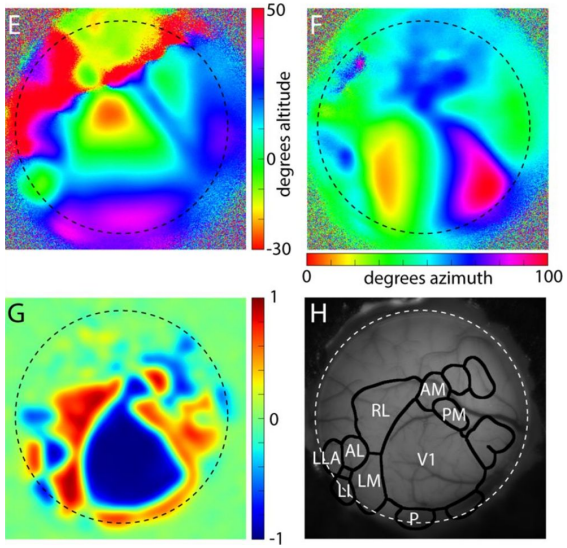
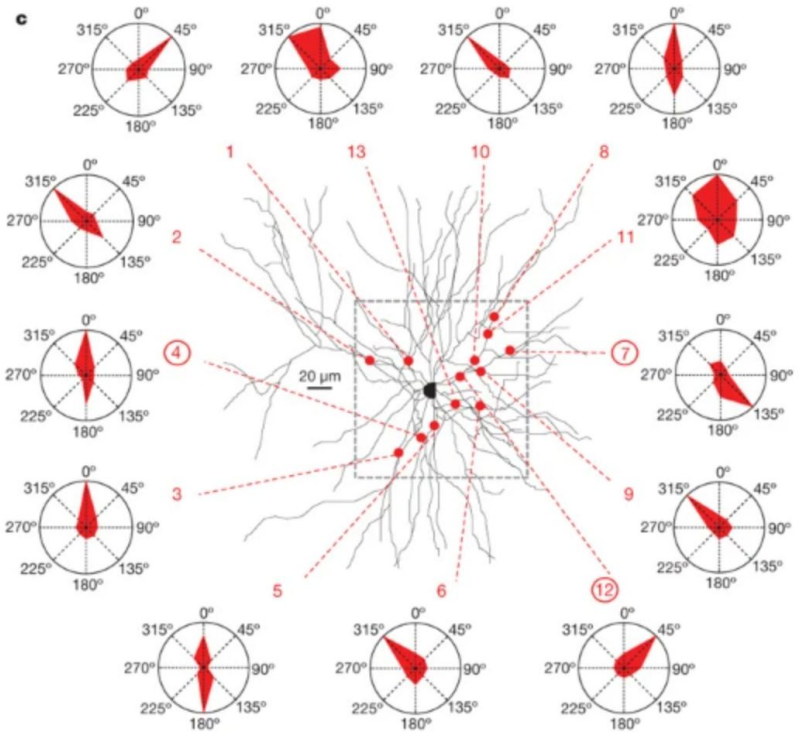
What is known about somatic retinotopy



- At the neuronal population level: smooth azimuth, elevation maps, and non-uniform cortical magnification across visual areas
  - Extends past V1 into higher visual areas
- Individual V1 neurons can have strong RF structure and substantial orientation selectivity, yet no ordered orientation columns between neighbouring cells
- Fu et al. 2024: even a single neuron's receptive field can contain internally heterogeneous tuning structure

Spine-level retinotopy



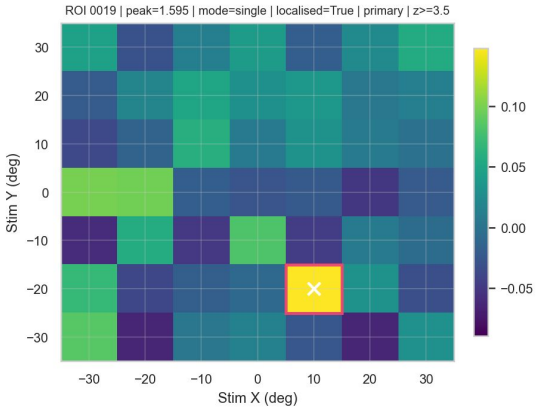
- Mostly Ca imaging
- Jia et al. 2010:
  - Dendrites of layer 2/3 neurons contain local calcium hotspots associated with synaptic input
  - These inputs are functionally diverse even when the soma is strongly orientation-tuned
  - Adjacent dendritic segments can prefer different orientations, therefore somatic selectivity is assembled from a diverse dendritic input pool
- General takeaway: dendritic input is biologically meaningful at fine spatial scale, but the limited field of view of traditional spine imaging methods don't answer **what principle(s) govern dendritic input organisation across larger arbours, multiple compartments, or many neurons**

Subjects

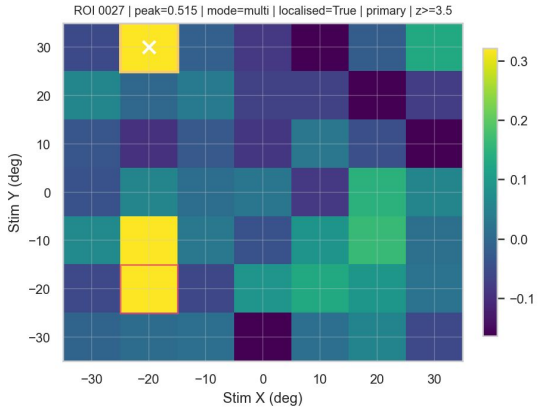
Subject	Genotype	Sessions	ROIs
sub-776270	Excitatory	1	40
sub-794237	Excitatory (iGluSnFR4)	3	559
sub-796630	Excitatory	4	646
sub-801381	Excitatory (iGluSnFR4 + RCaMP3)	3	447
sub-803496	VIP-IRES-Cre	1	52

RF mapping method

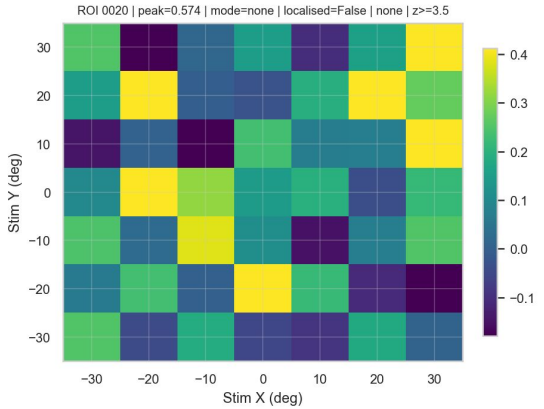
- Precomputed ΔF/F traces
- Per-trial responses z-scored at z≥3.5 relative to the broader pre-stimulus window spanning 5.5-0.5s before onset
- Filtered ROIs:



Single-hotspot

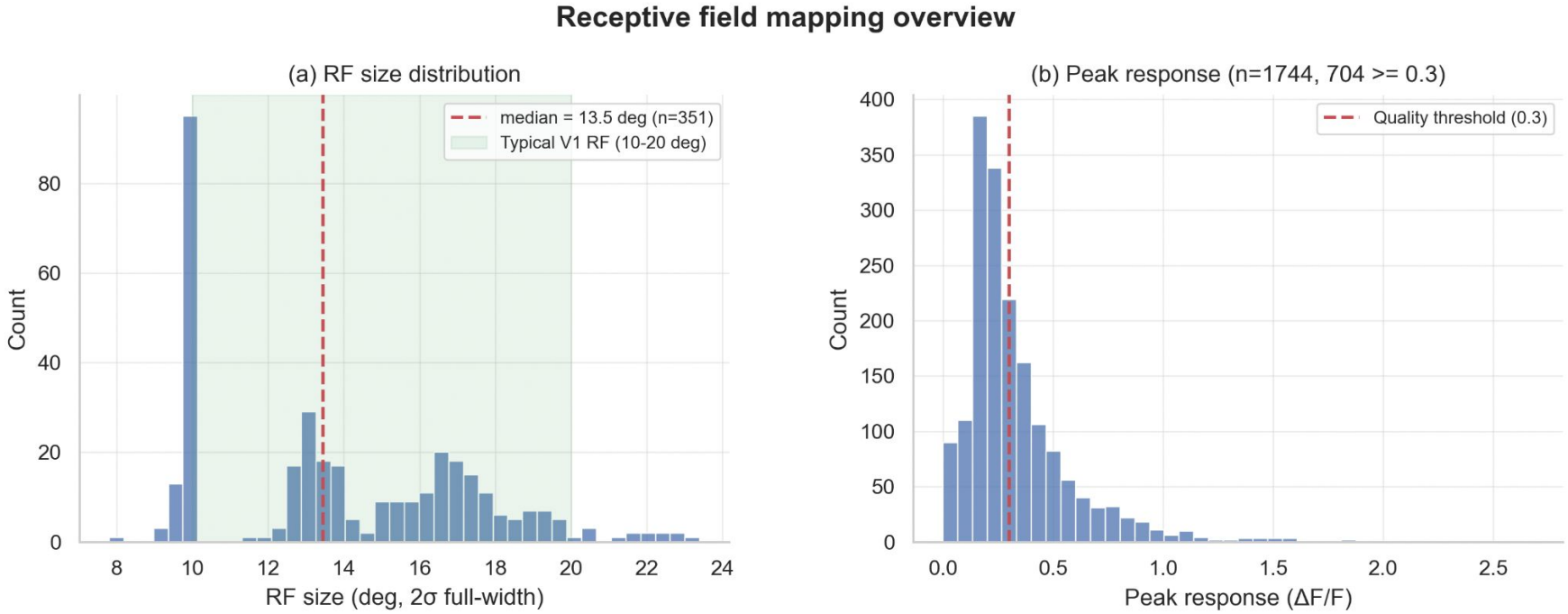


Multi-hotspot



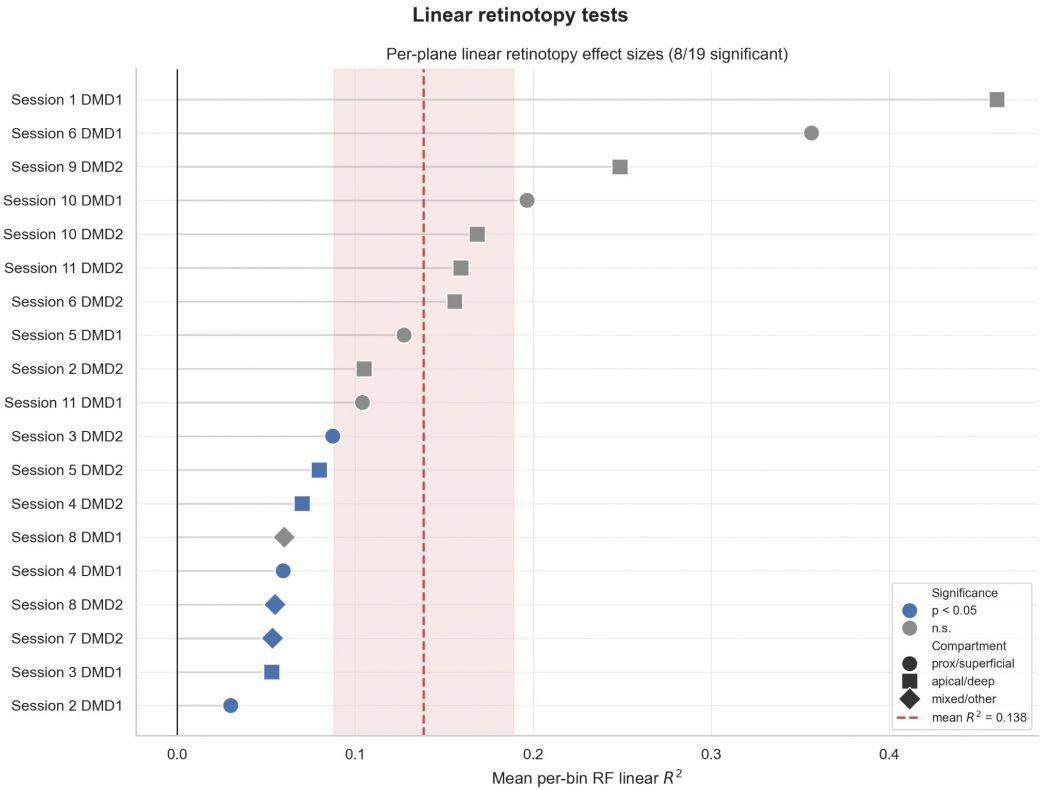
Unlocalised

What is the spatial spread of receptive fields?

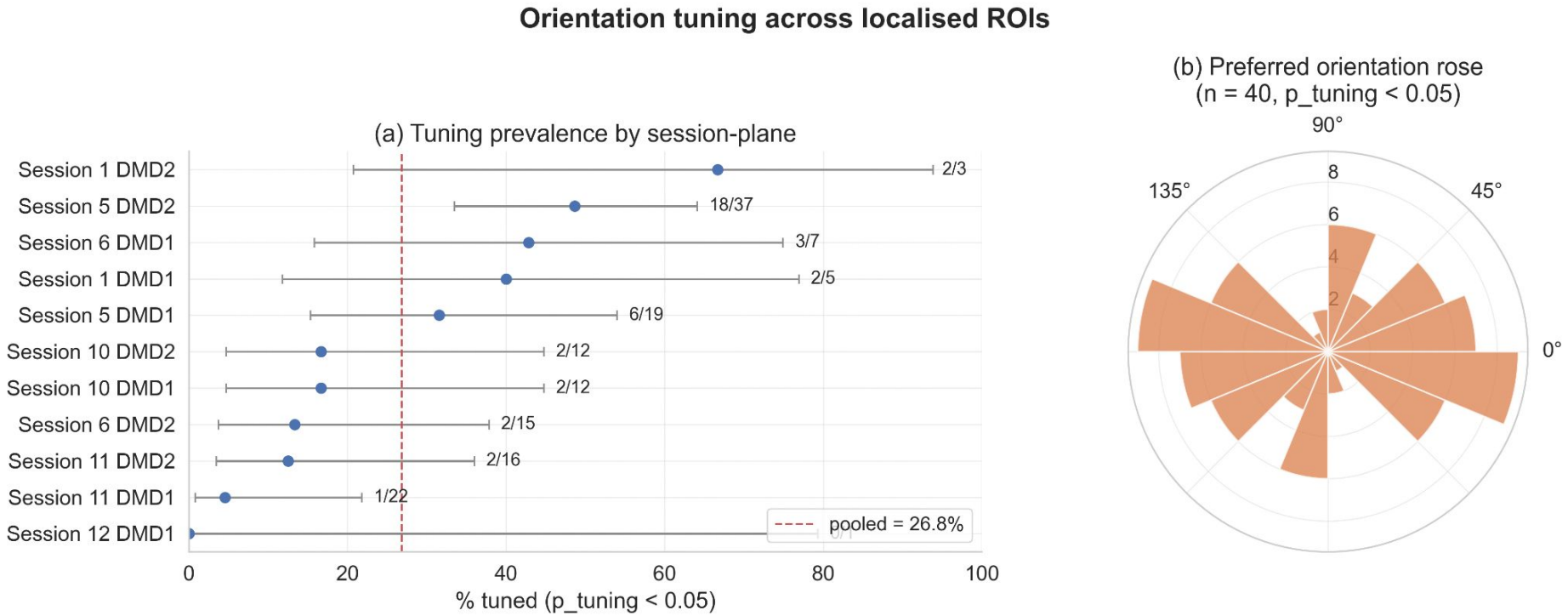


Receptive fields are spatially selective, but highly heterogeneous.

Classical retinotopic gradients across mice and sessions are weak and inconsistent



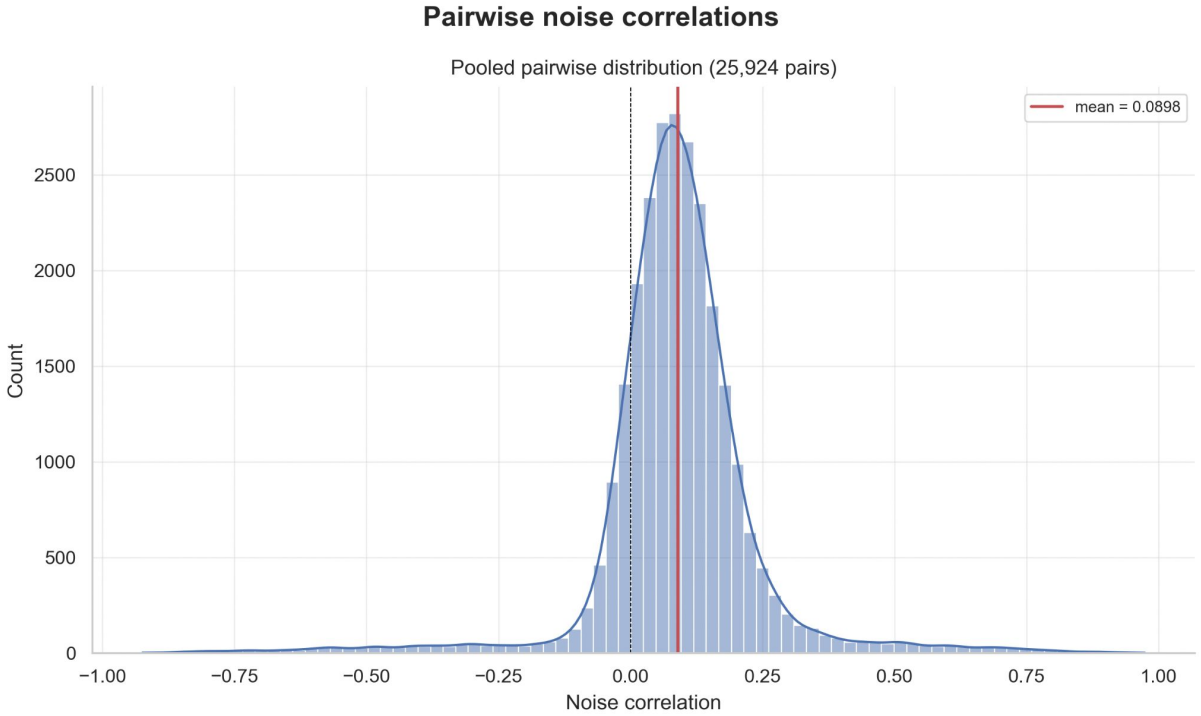
Orientation tuning is moderate, but its relation to receptive field position is underpowered



Noise correlations as indicative of shared synaptic drive

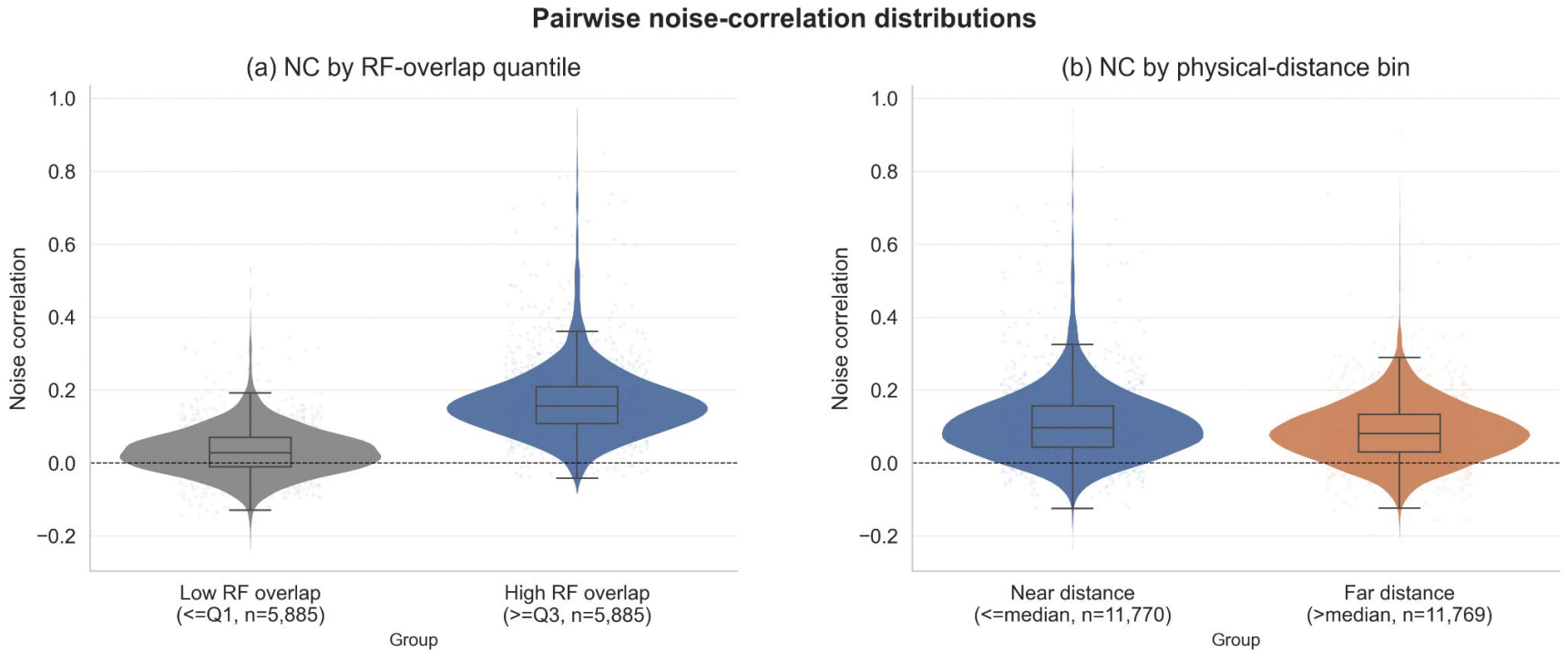
- Trial-to-trial co-variations in neural activity for a given stimulus
- Usually treated as a limiting factor for amount of sensory information encoded by a population of neurons
  - Increases density of coding, greater catastrophic interference of inputs, etc expected to hinder perceptual discrimination
- However, there is a growing body of work indicating noise correlations enhance behavioural readout and are therefore themselves information encoding (Valente et al. 2022)
  - Another indicator of synapse-synapse relations

RF proximity on the dendrite as a baseline

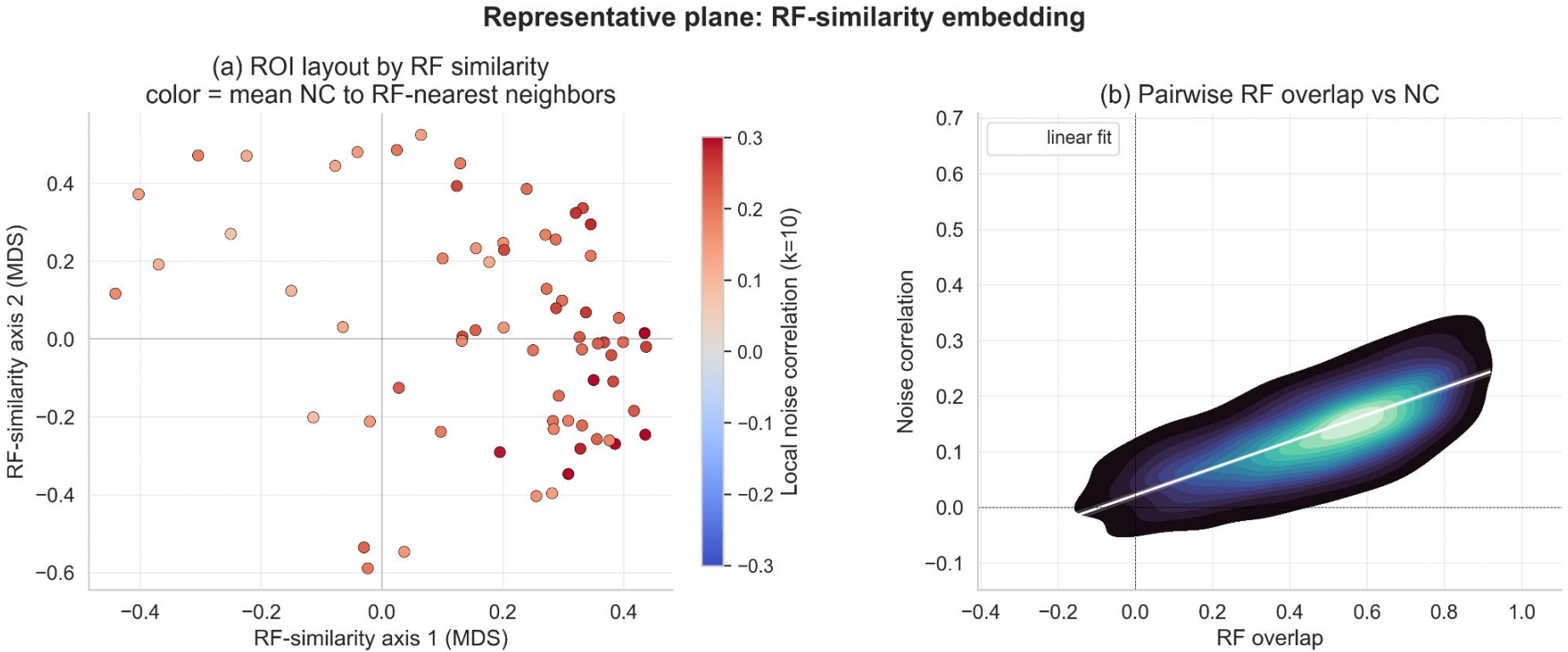


- Pairwise noise correlations across all synapses and mice are strongly positive
- These NCs strongly relate to physical distance (-0.183)

Functional neighbourhoods in RF space vs physical space

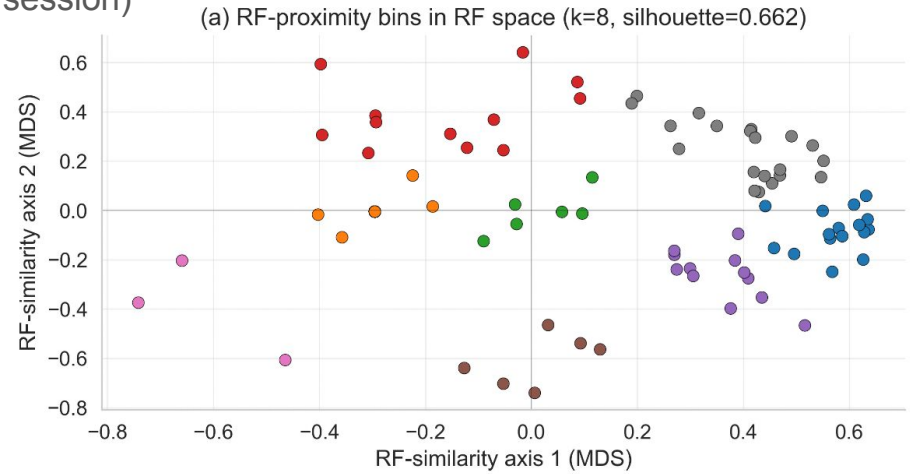


Functional neighbourhoods in RF space (RF similarity)

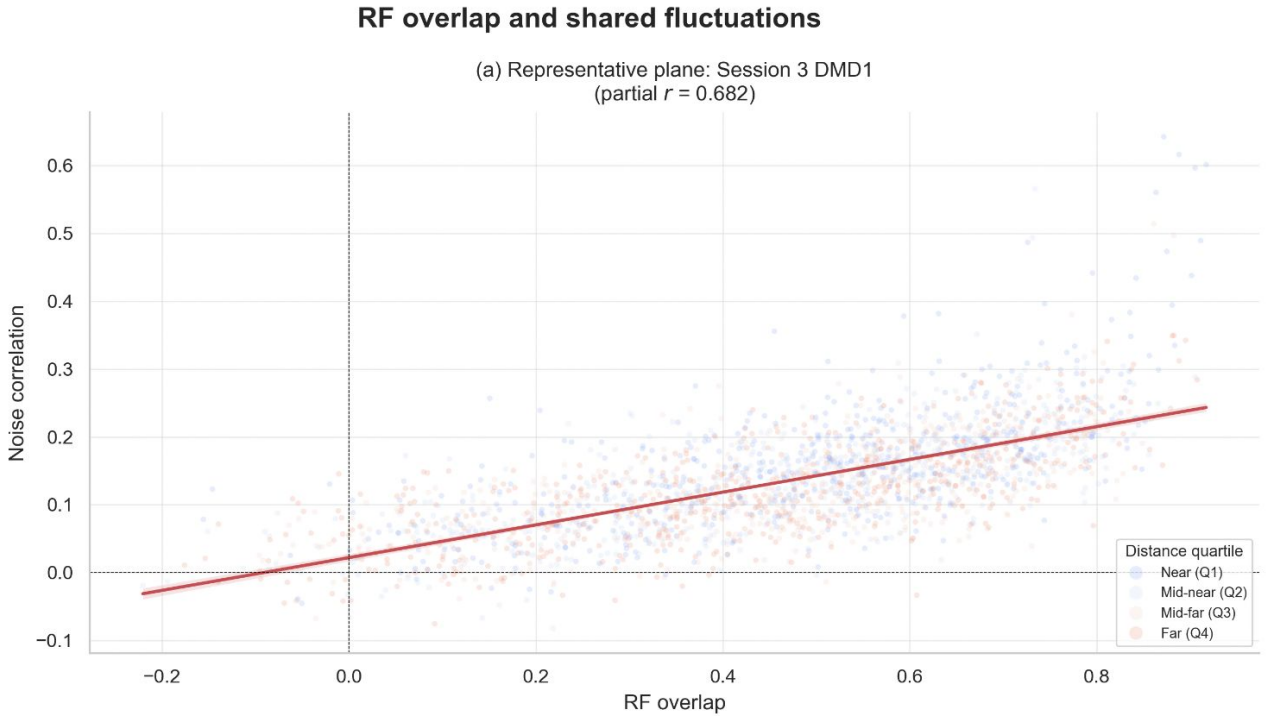


Functional neighbourhoods in RF space (RF similarity)

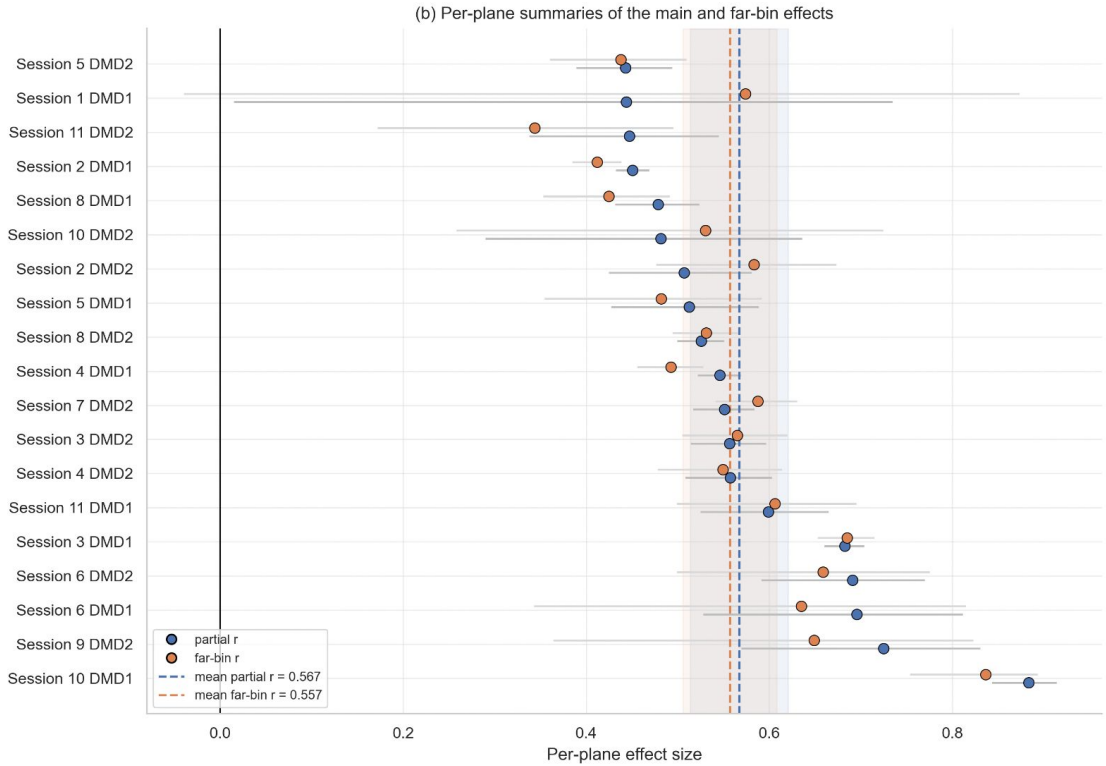
(One session)



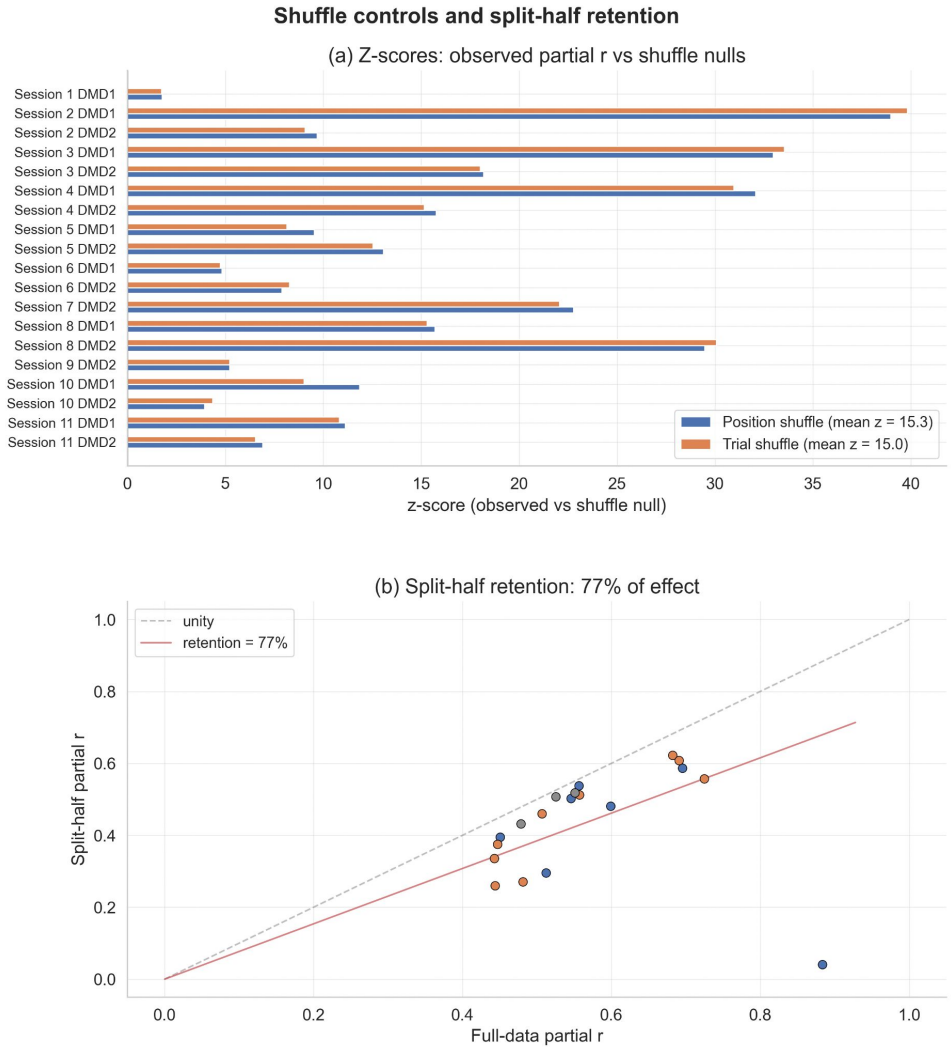
RF overlap-noise correlation relationship (one session)



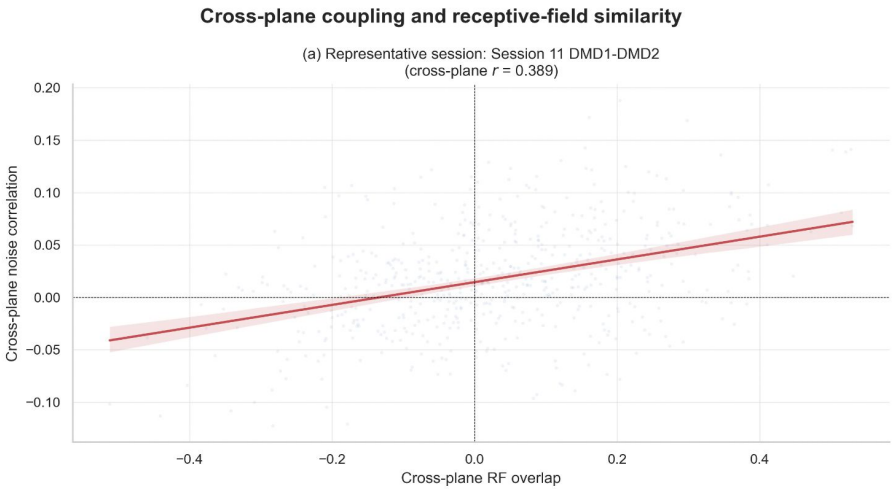
Controlling for physical distance

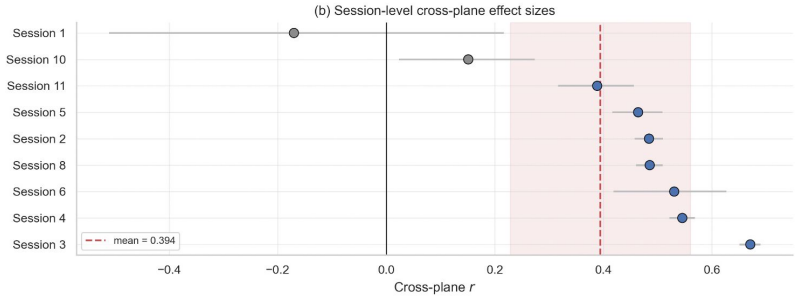


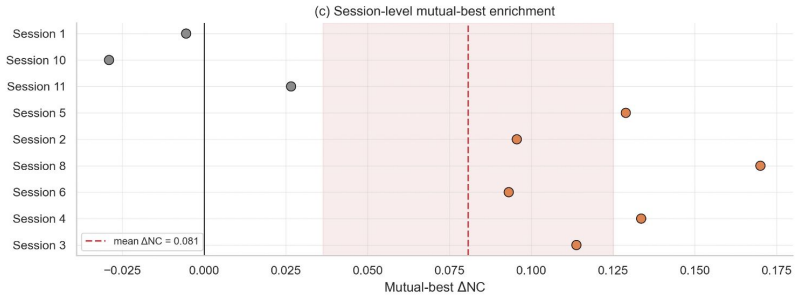
Further validation



RF-matched pairs co-fluctuate across distinct dendritic compartments



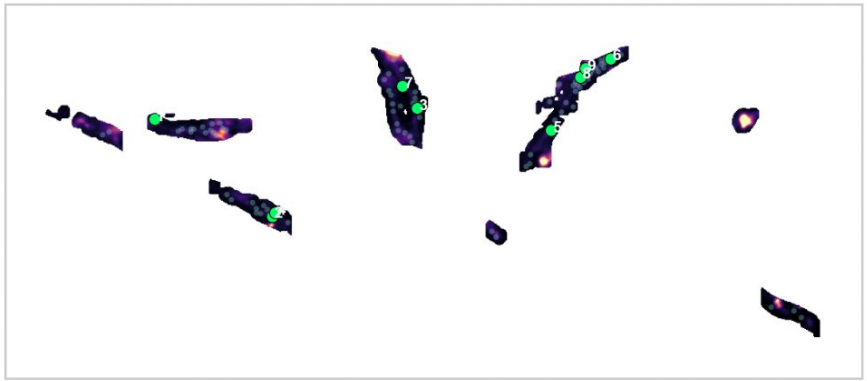




Validating the ROIs themselves

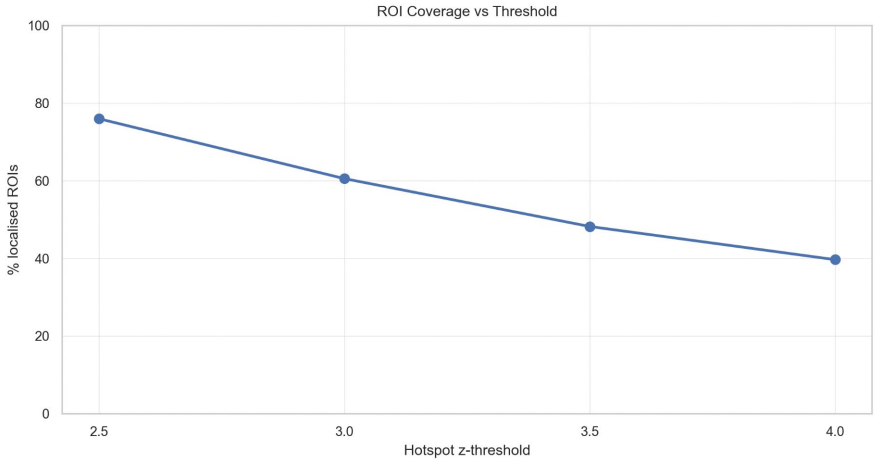
Representative structural overlay

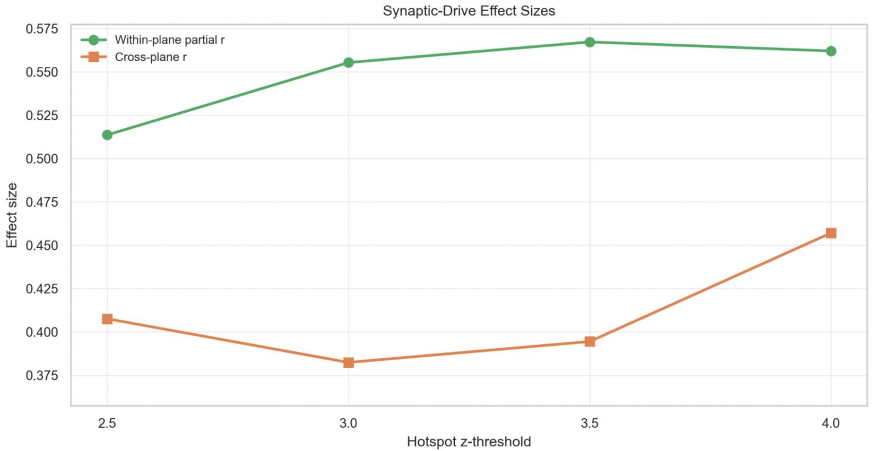
DMD1 mean structural image



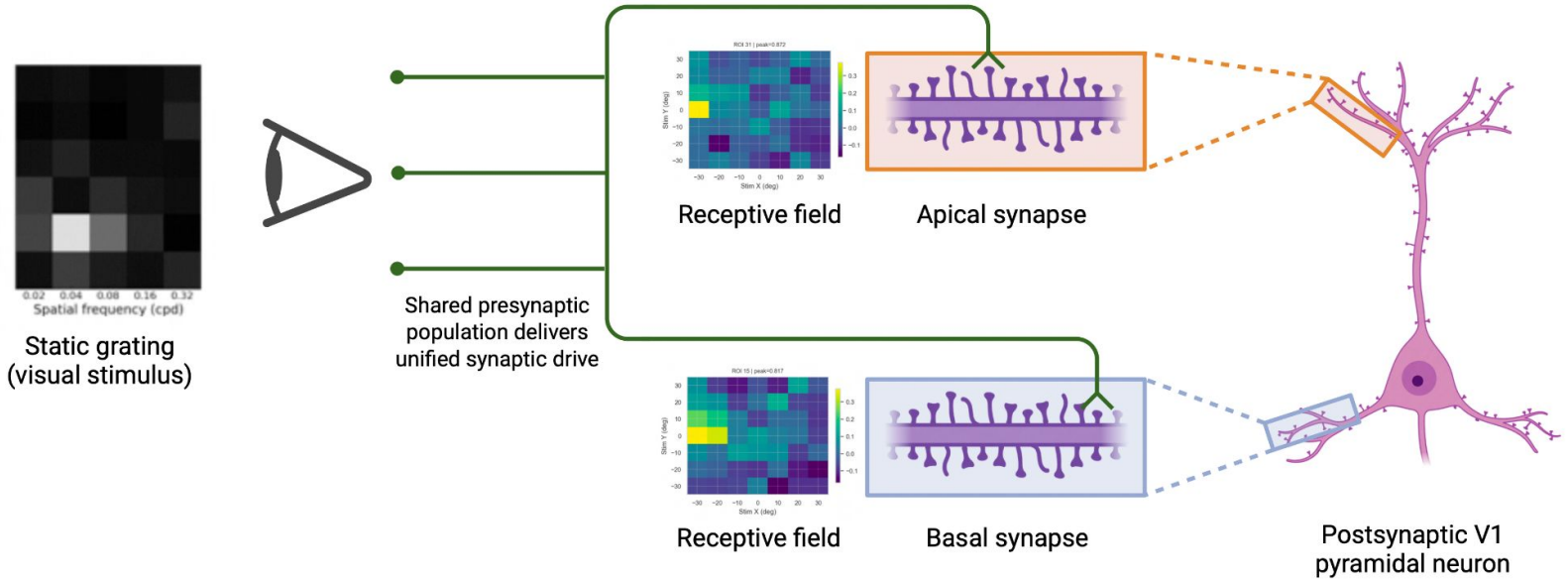
DMD2 mean structural image

RF z-scoring threshold does not confound either the within-plane or cross-plane r





A tentative inference…



Thank you! Any questions?