



Dynamics of connectomes: neuronal
network sensory selectivity is
contingent upon presented stimuli

Stéphane Molotchnikoff

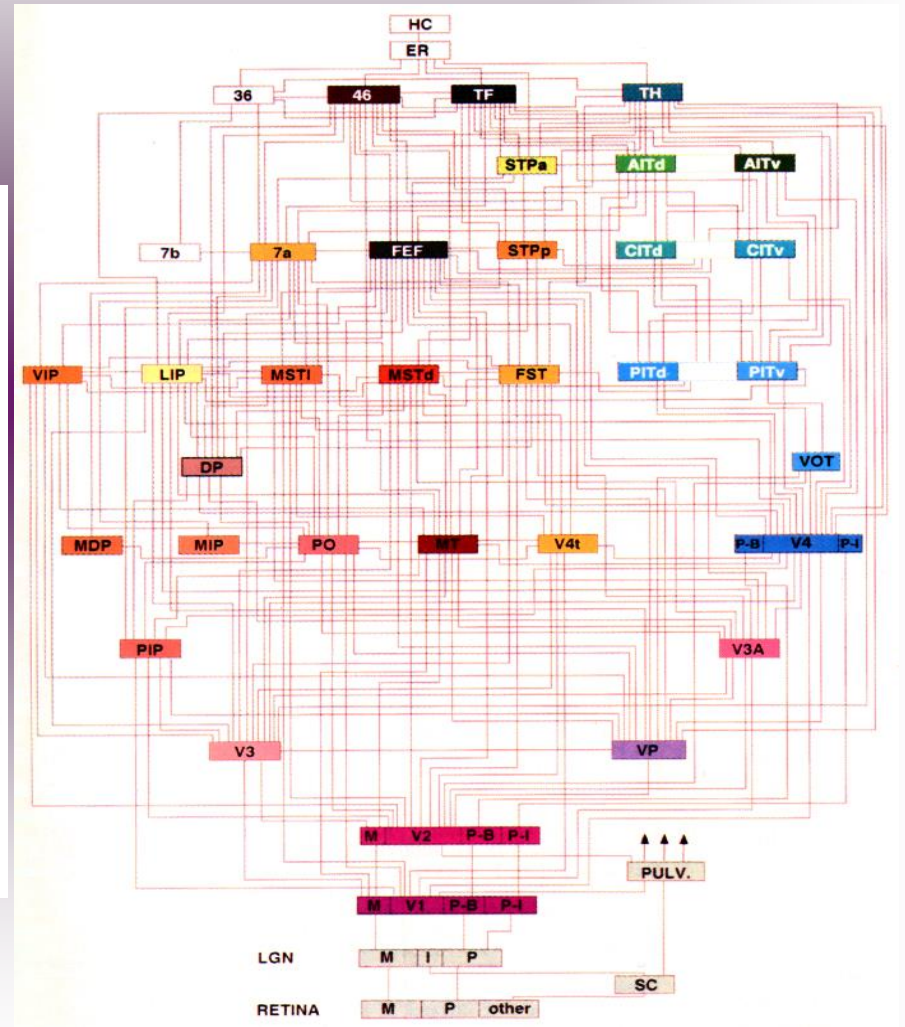
Dépt. Sciences Biologiques

Université de Montréal

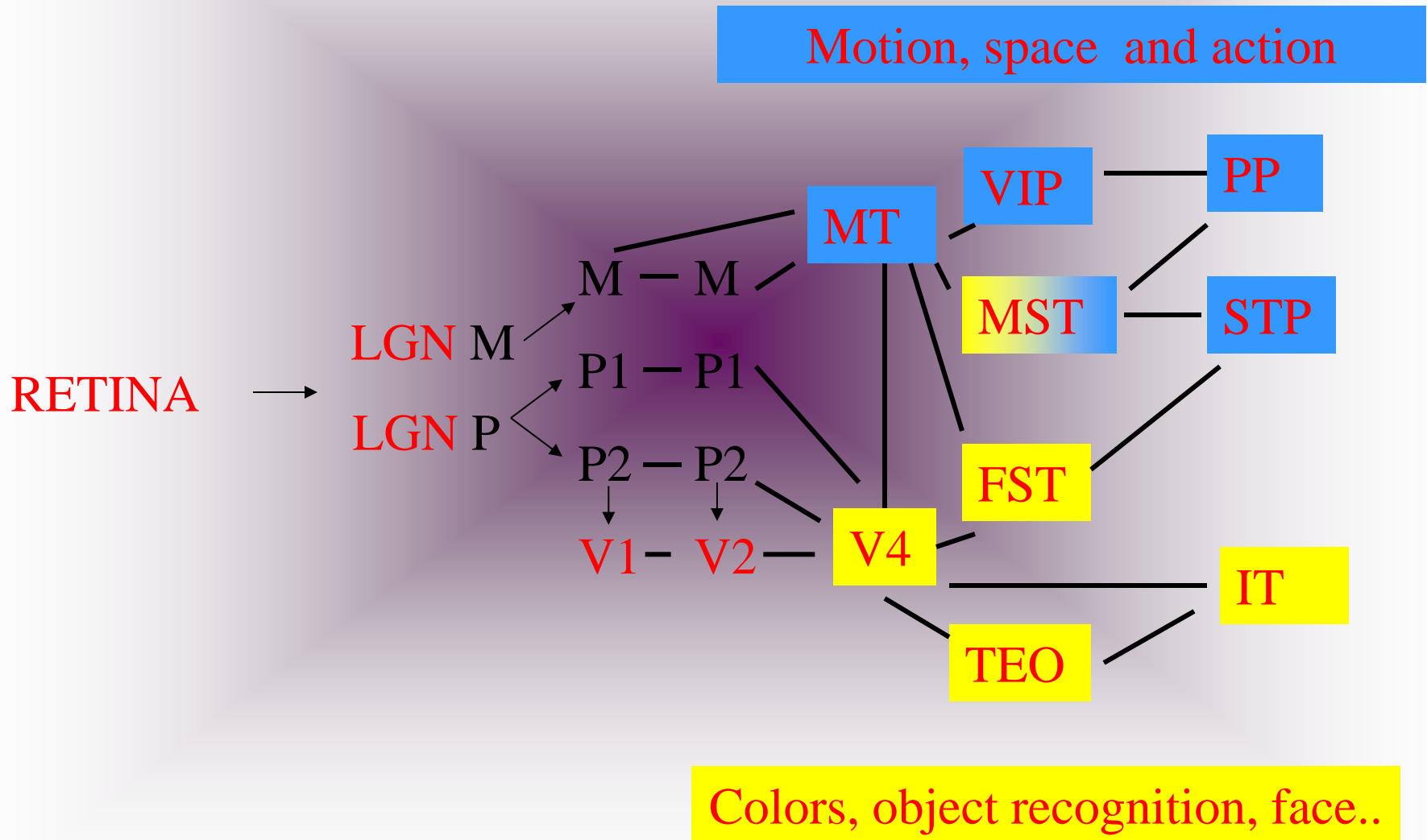
Dépt Génie Électrique et Génie Informatique

Université de Sherbrooke

Canada

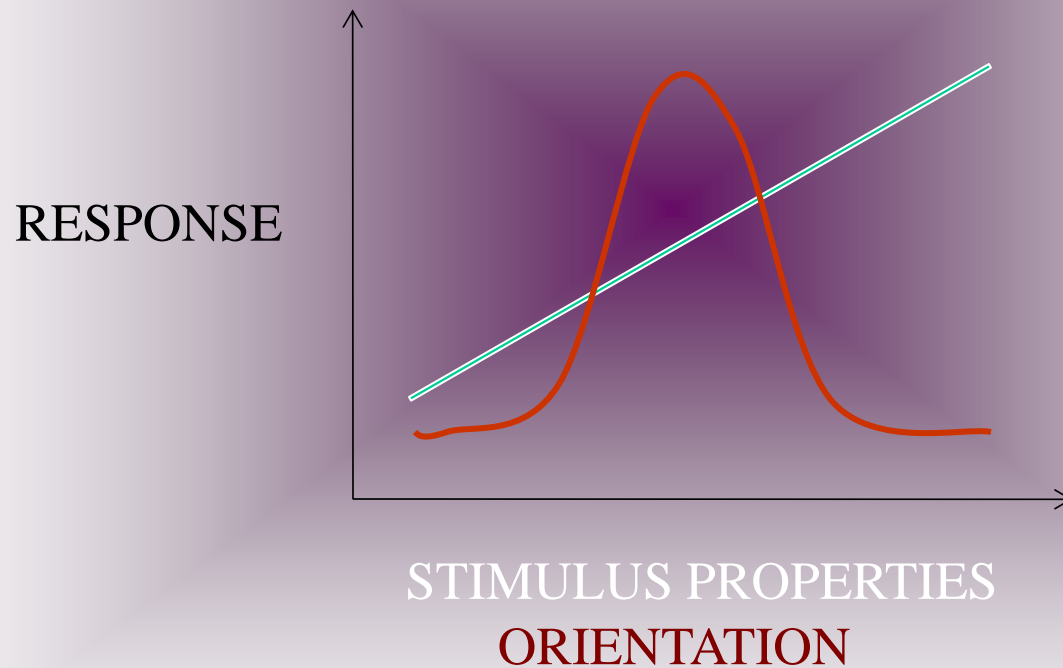
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Hierarchical and parallel processing

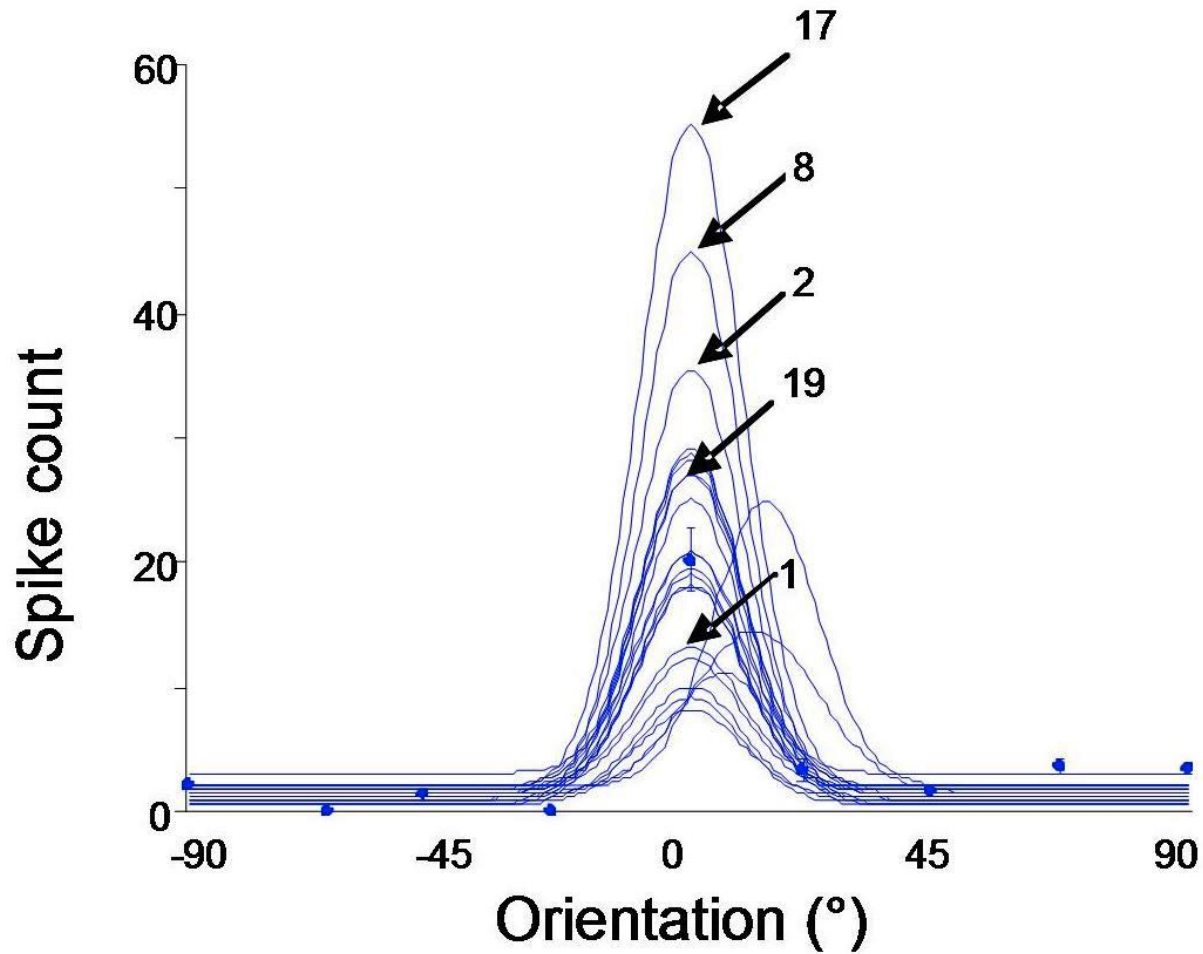


Ambiguities

RATE CODE



Are responses reliable



Are neuronal responses reliable ?

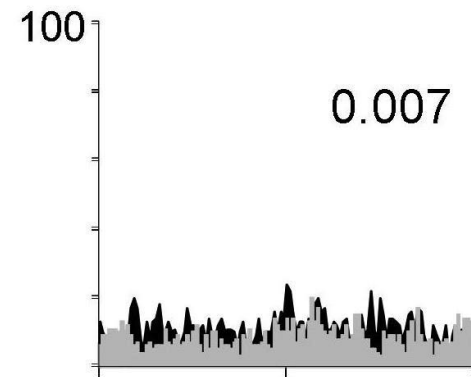
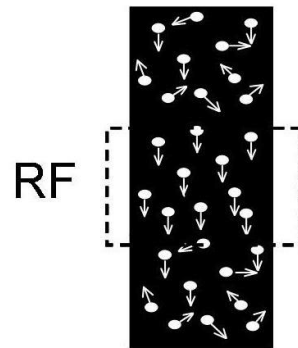
Two Mechanisms

Does brain code with rate code
up to a cardinal cell ?

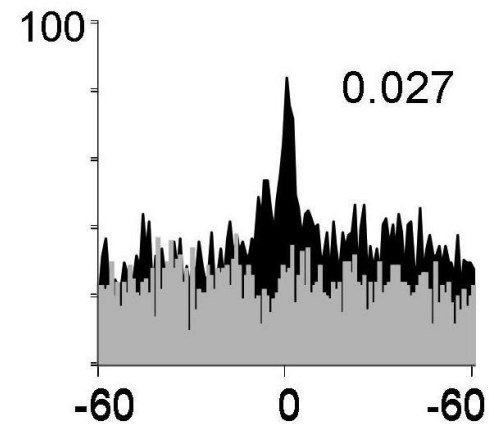
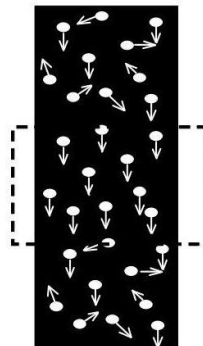
Or

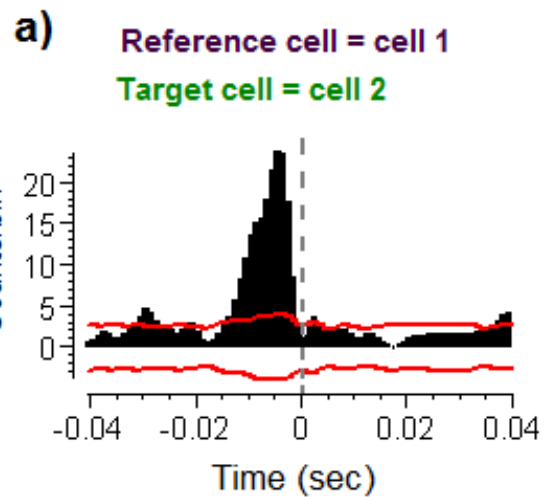
Does brain signal by forming
an encoding assembly?

Surr. coher. 12%



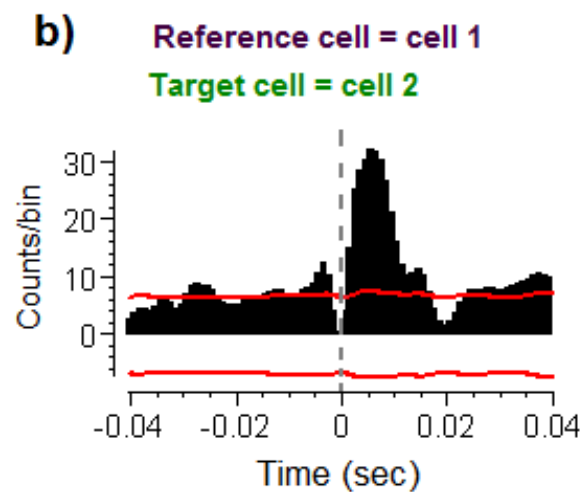
Surr. coher. 25%





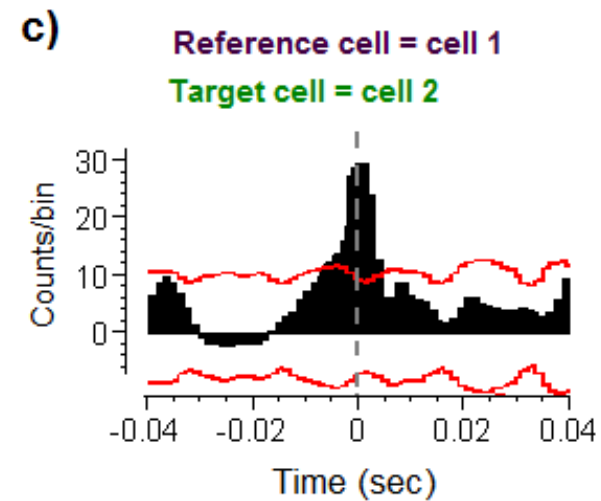
Target projects on reference

Cell 2 \Rightarrow Cell 1



Reference projects on target

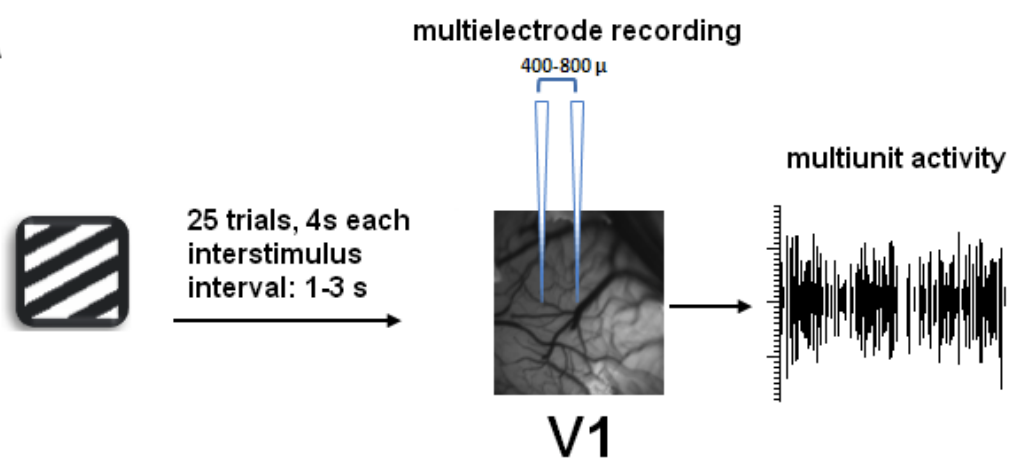
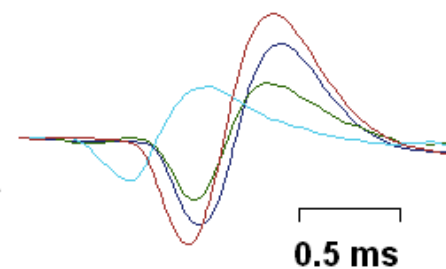
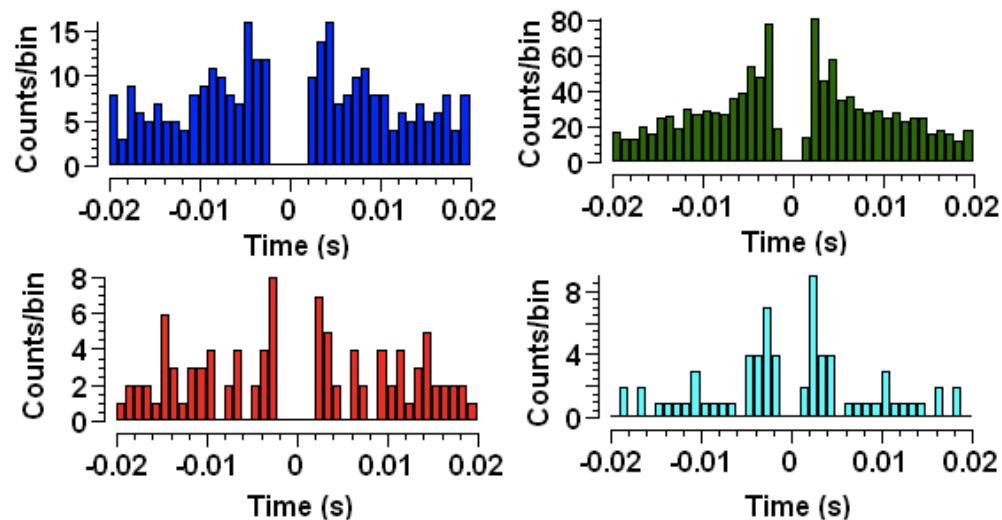
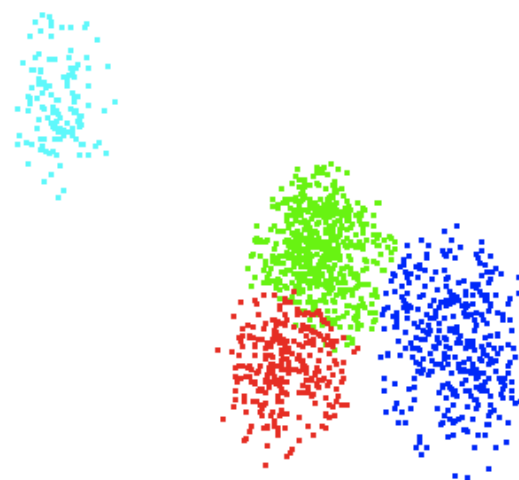
Cell 1 \Rightarrow Cell 2

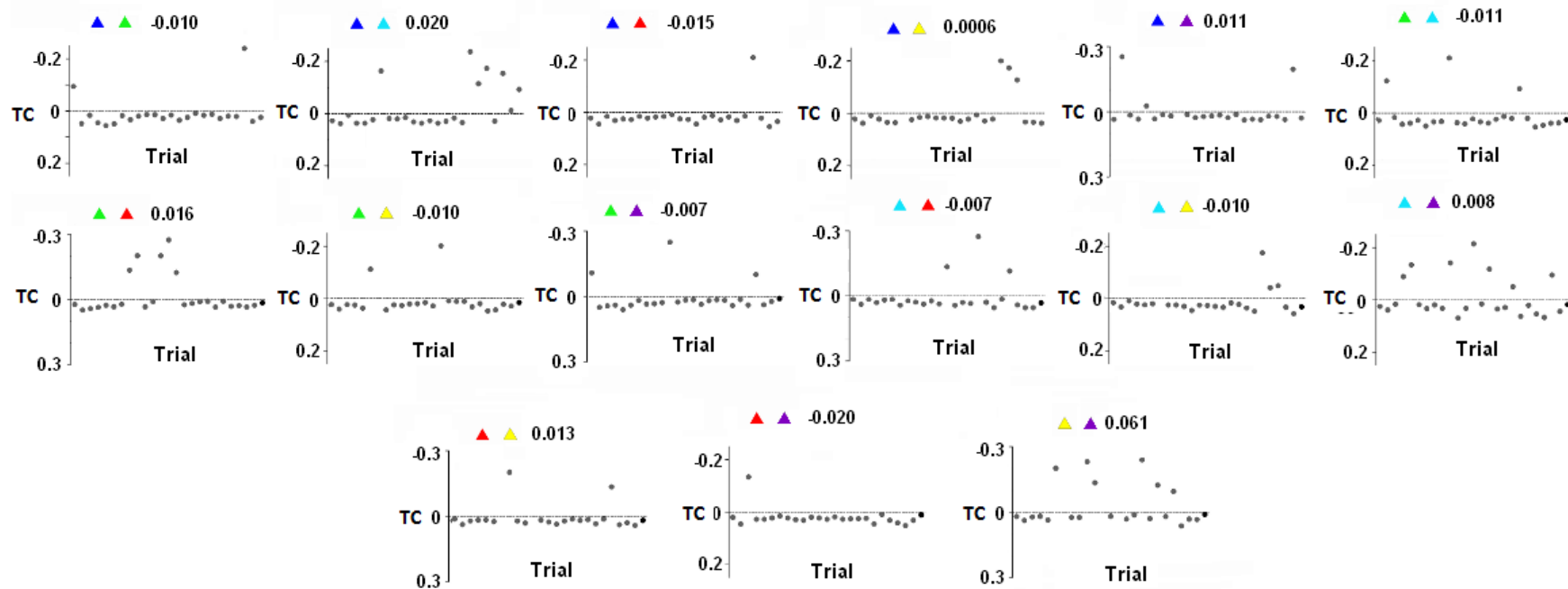
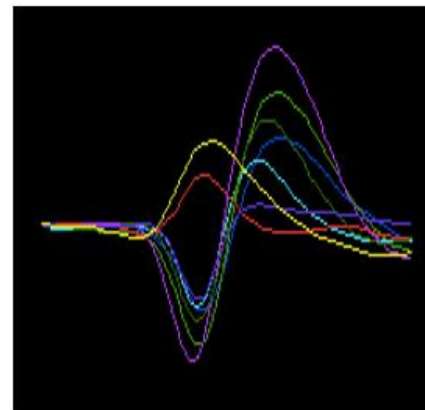
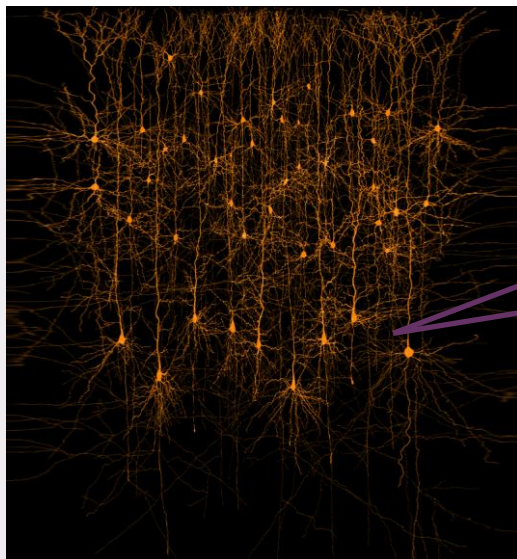


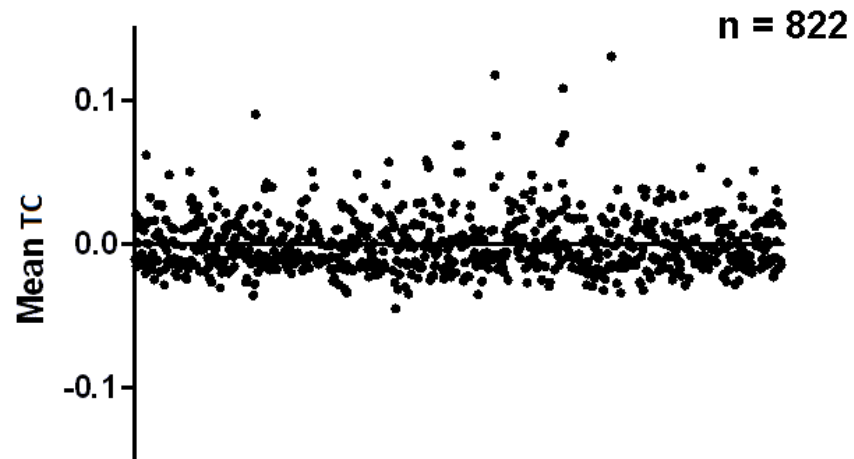
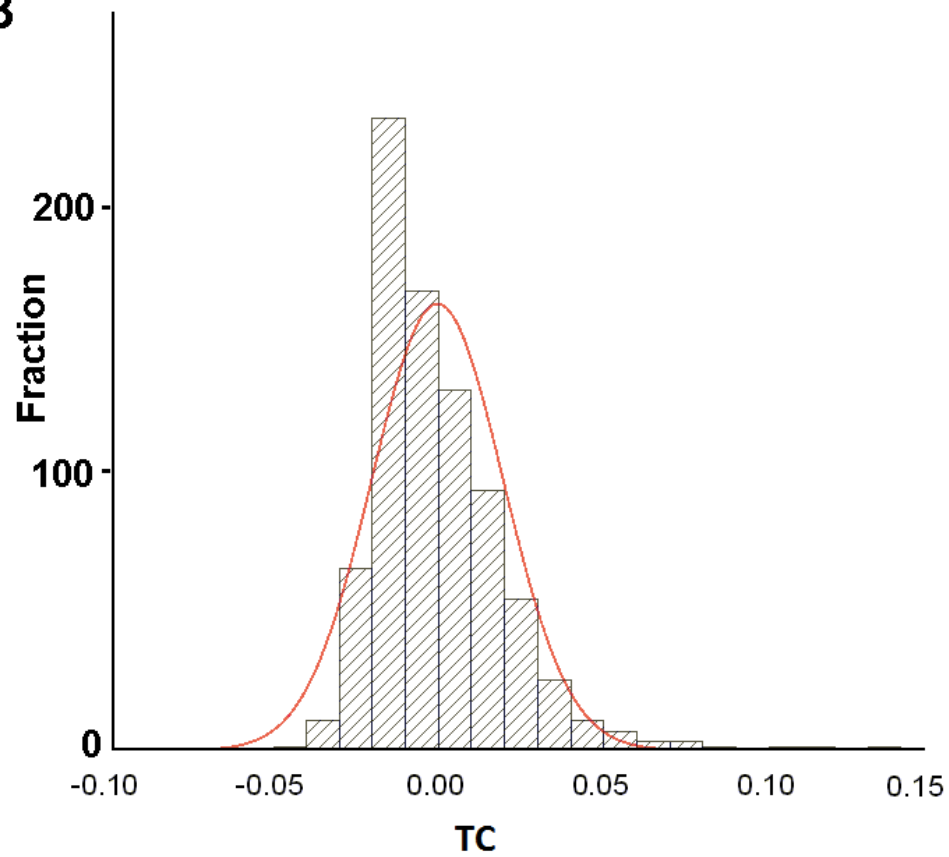
Common input

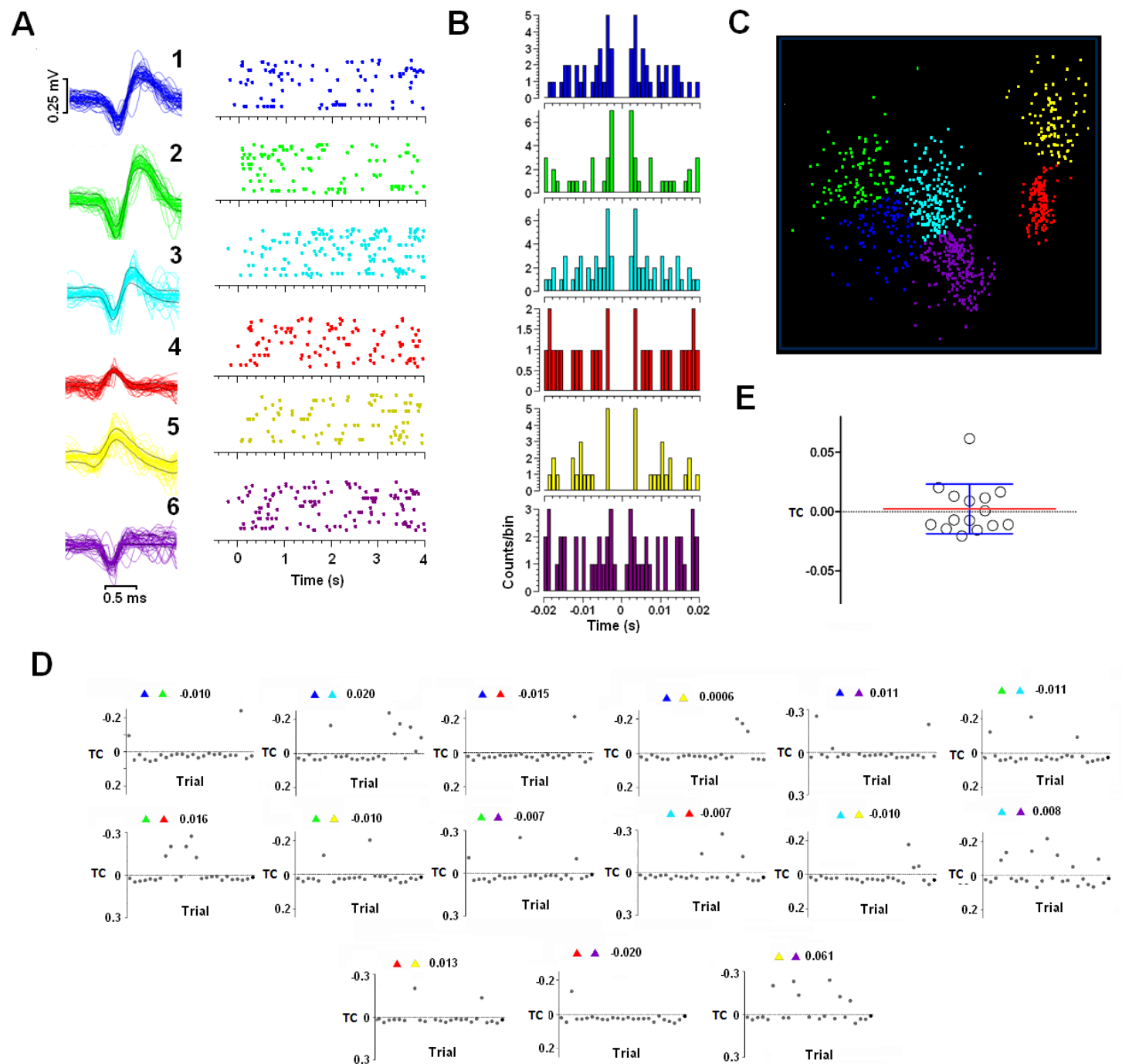


$$PC = N^s / N^t$$

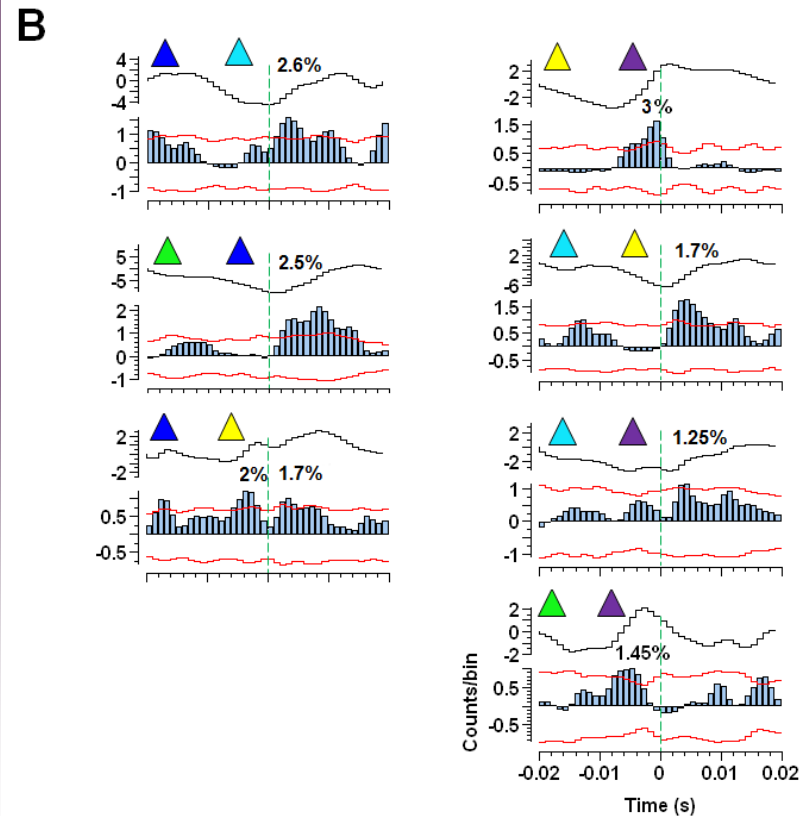
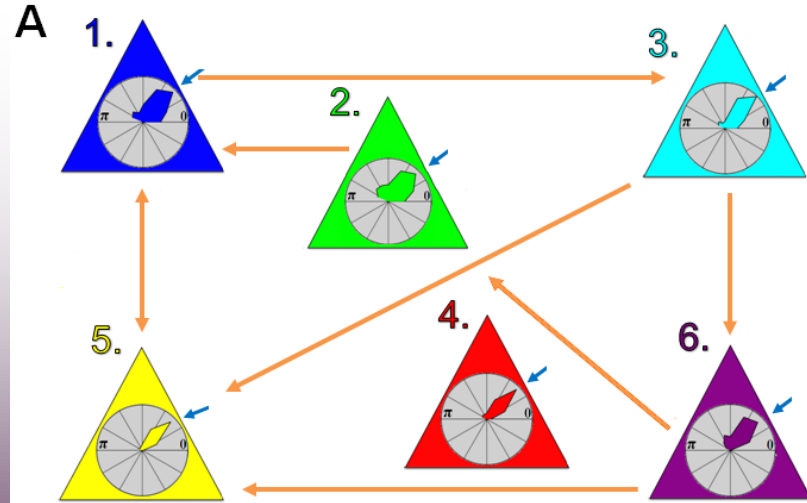
A**B****C****D**



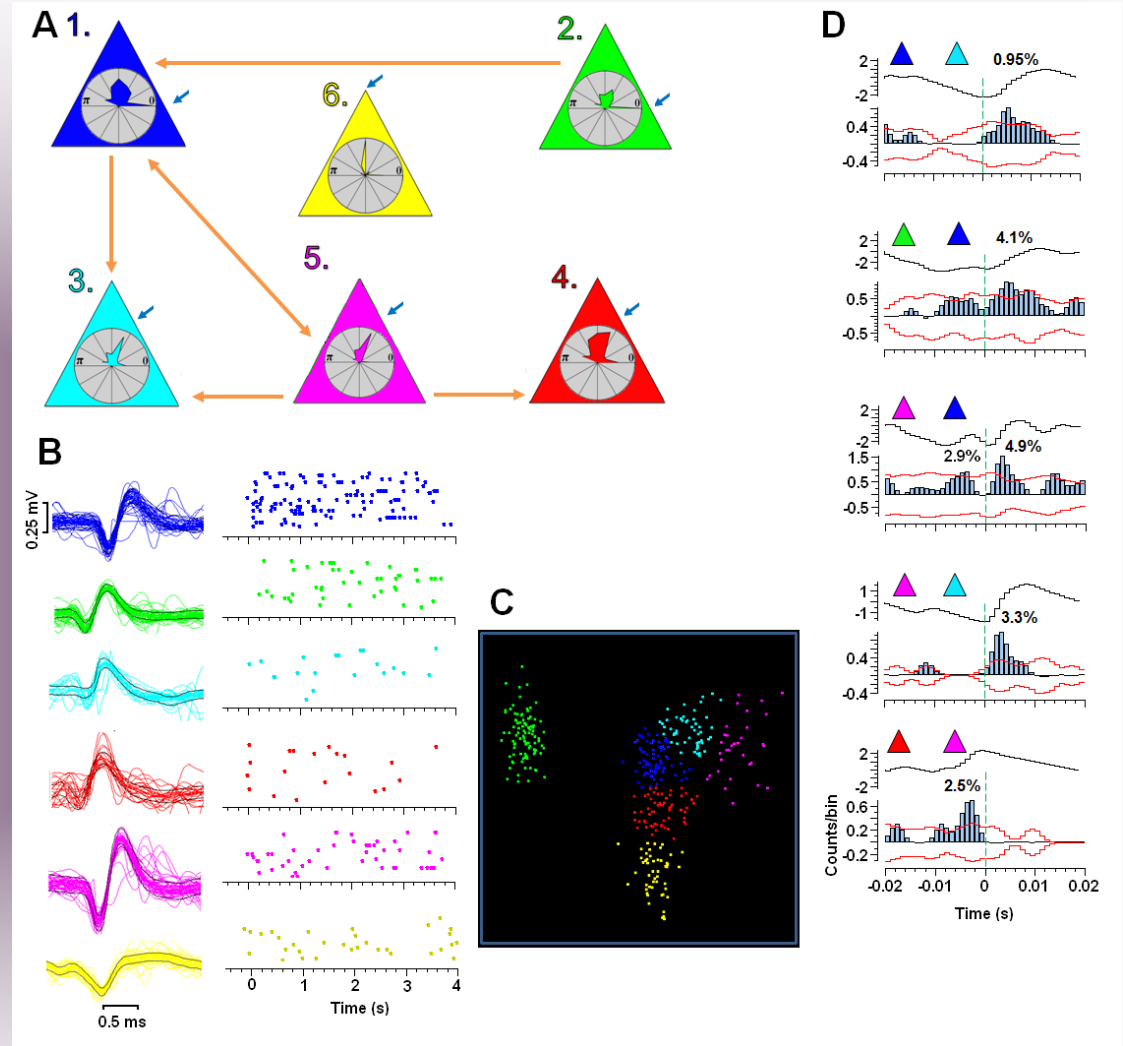
A**B**



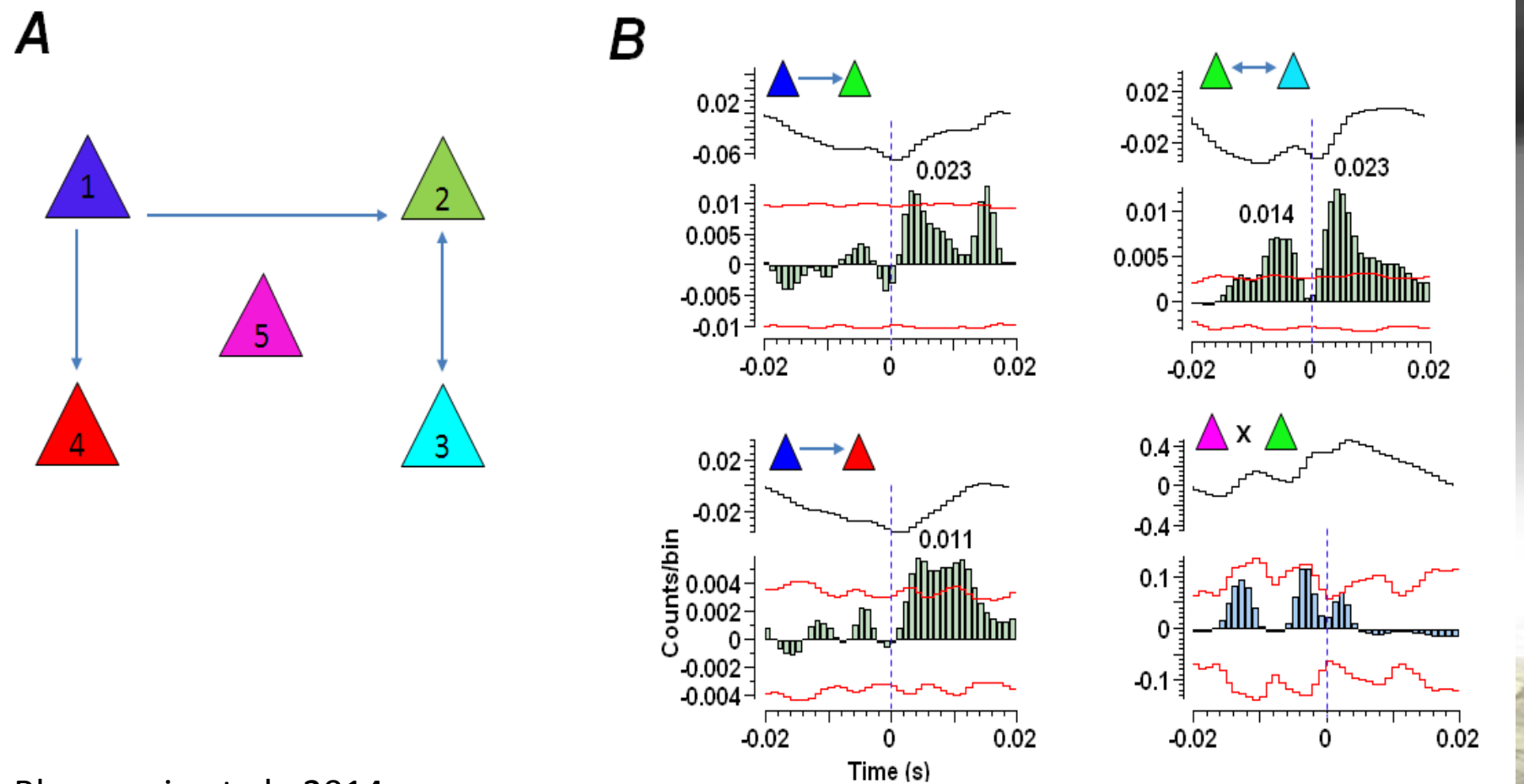
All cells have about the same preferred orientation



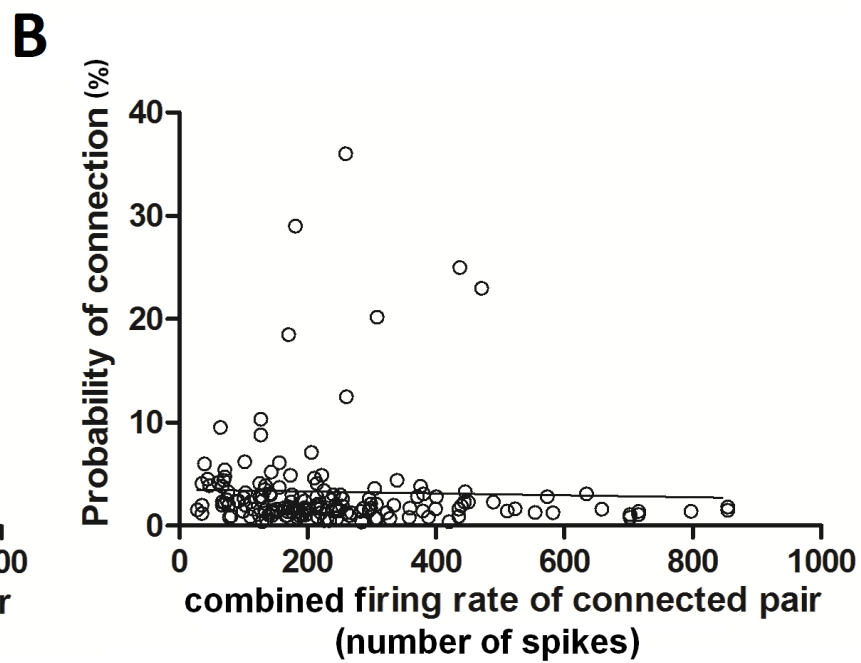
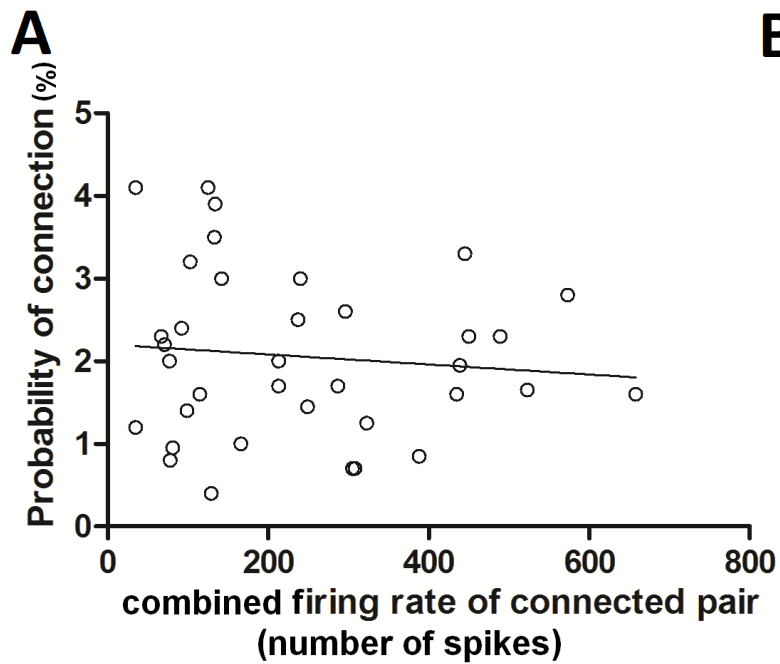
Cells have
different
orientations

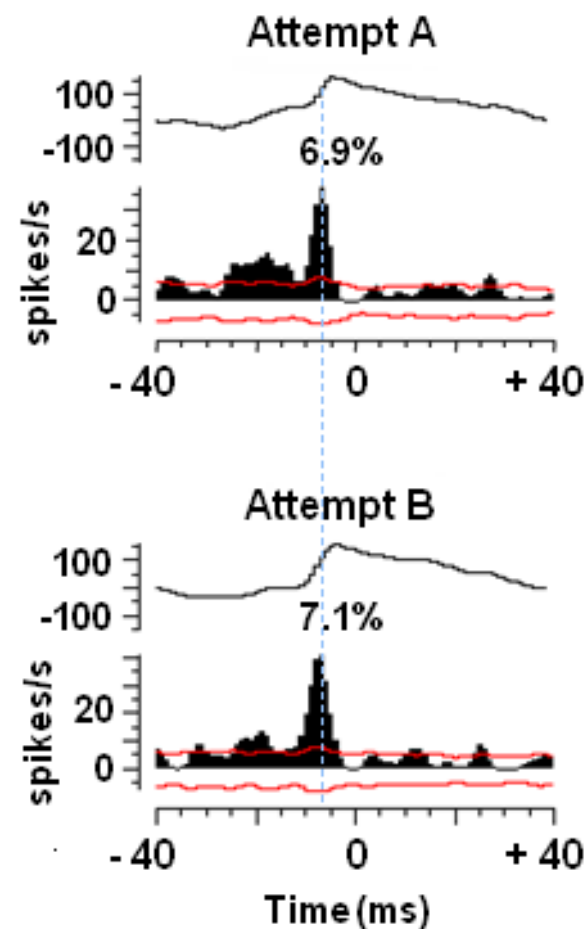
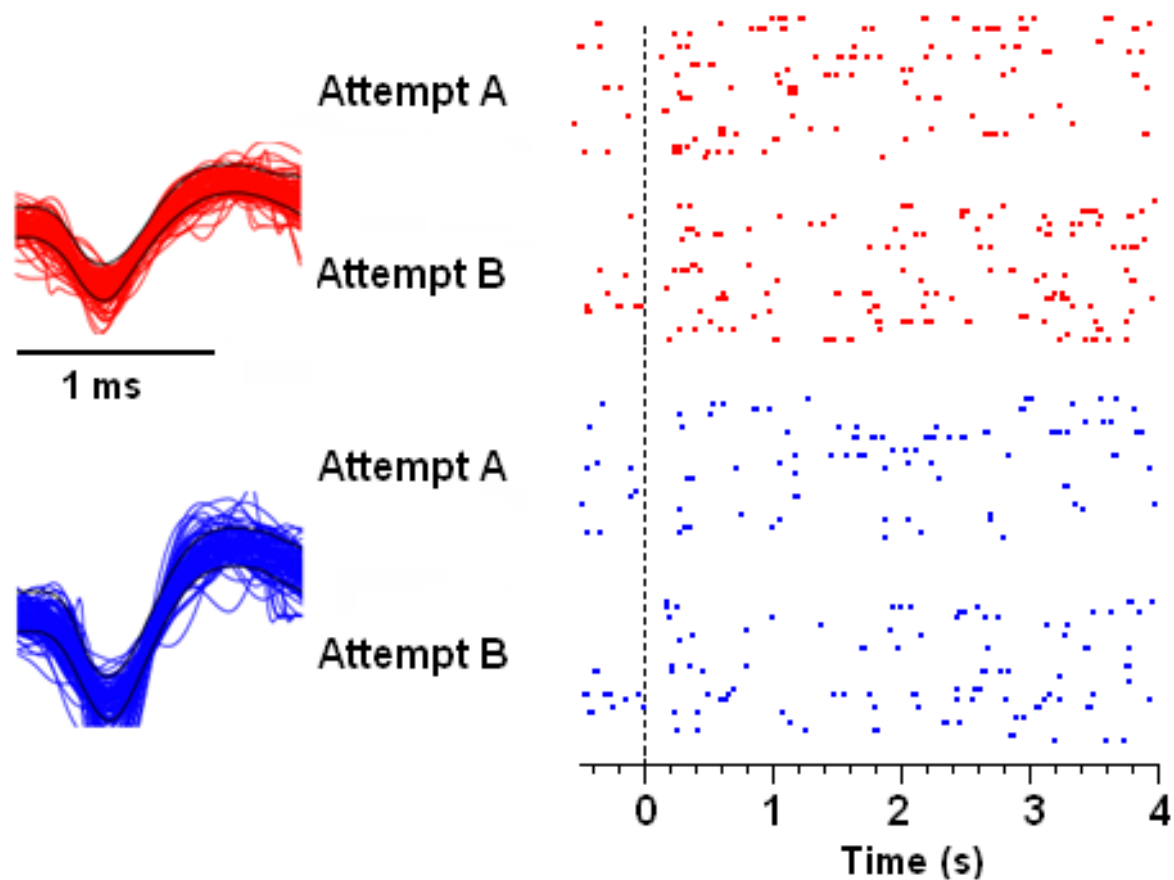


Another example of functional network

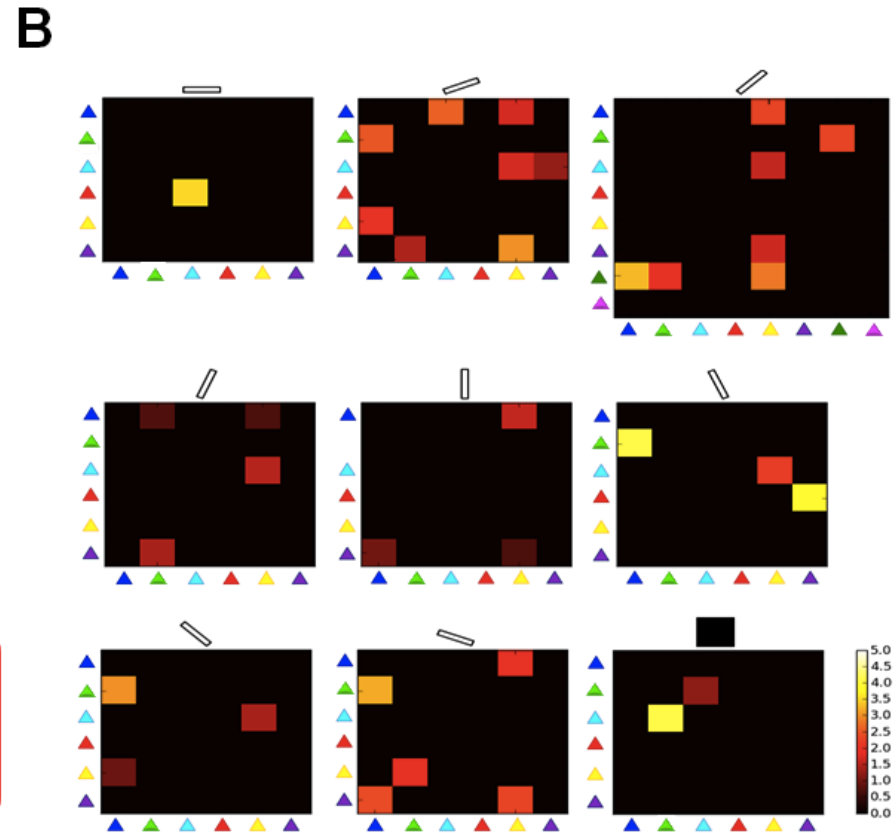
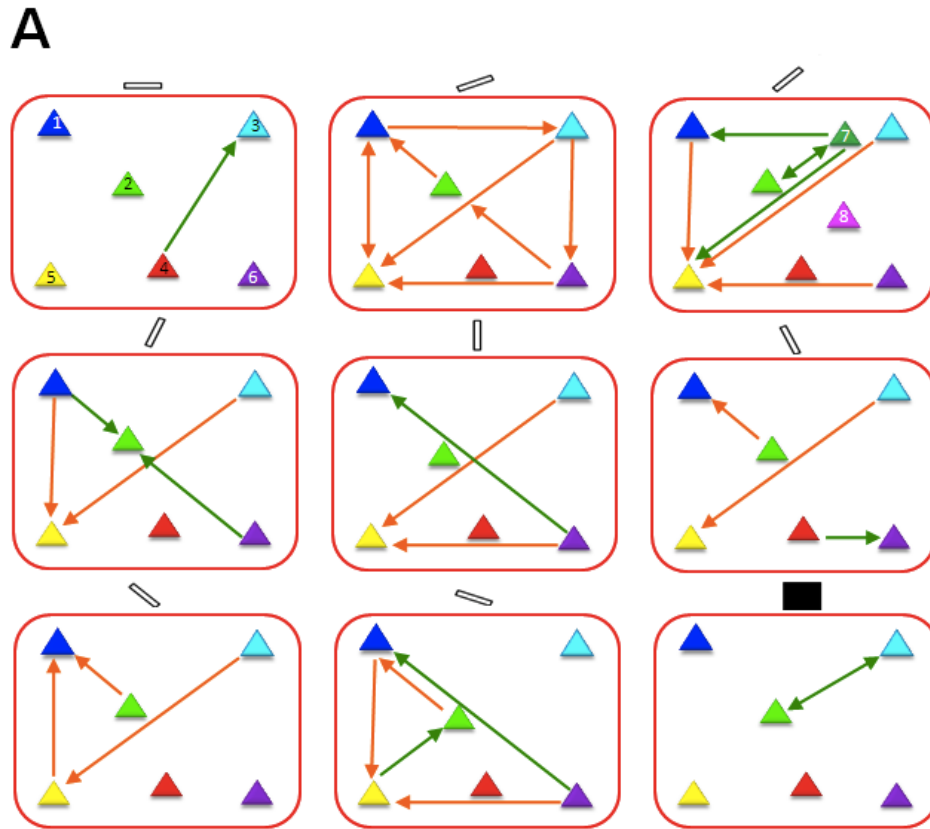


Bhamauria et al., 2014

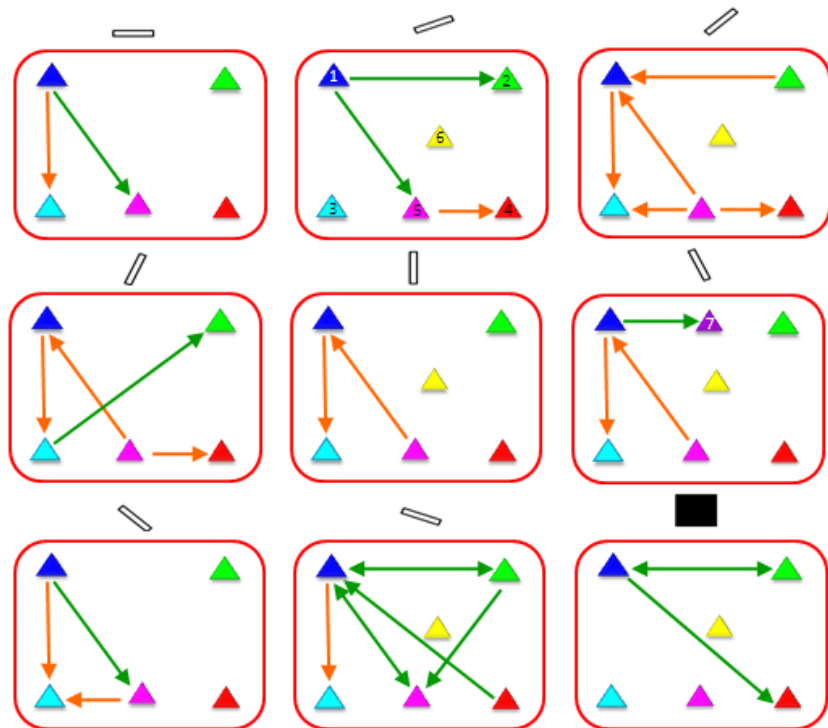




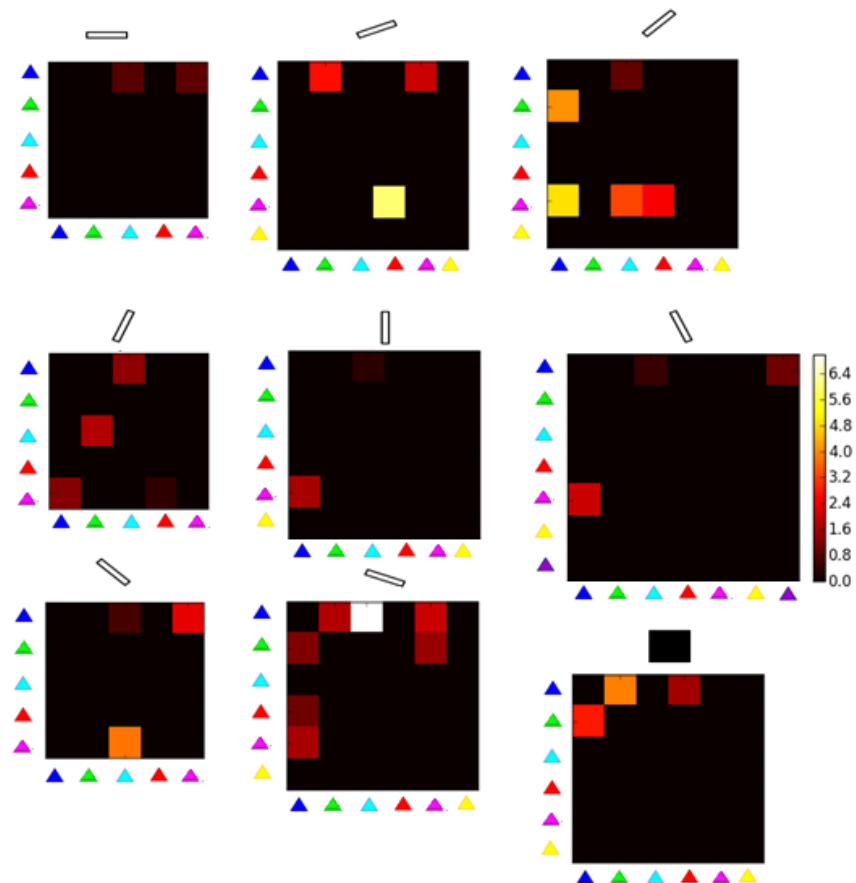
Strength of connections related to orientation



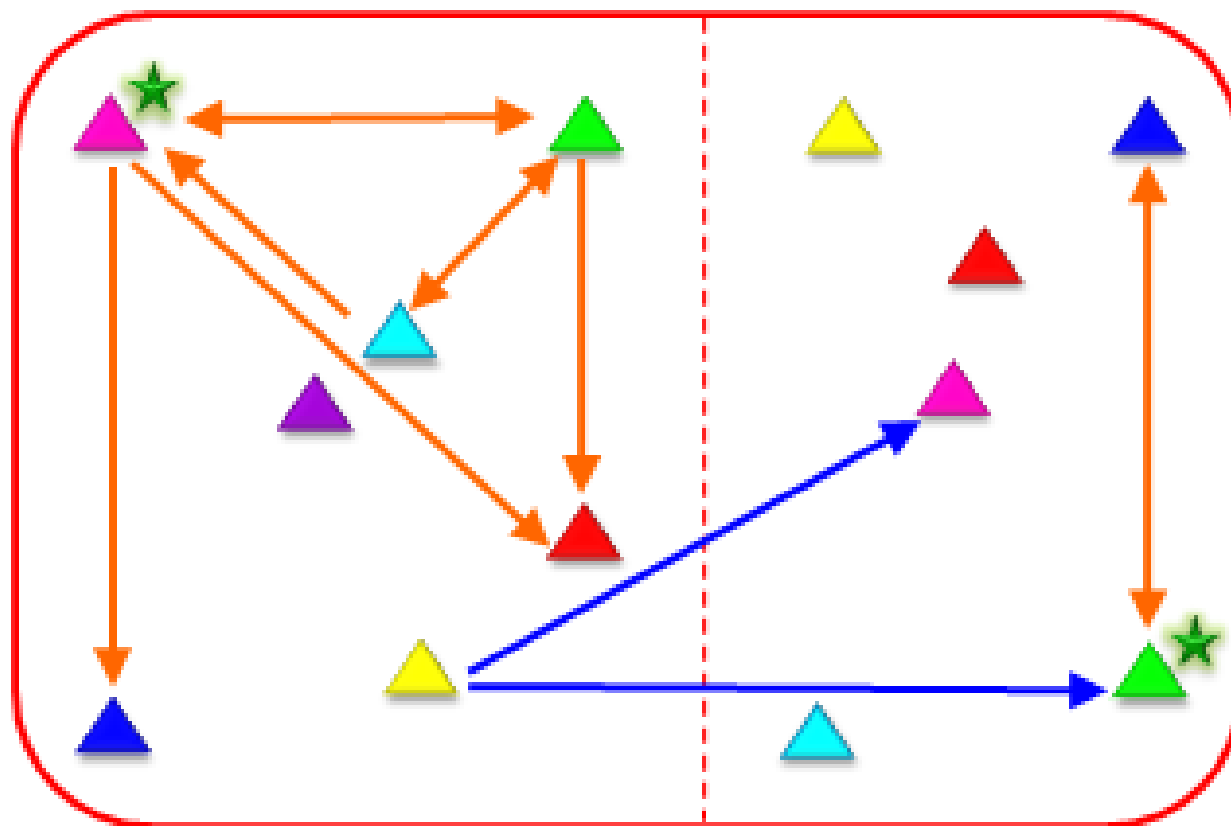
A

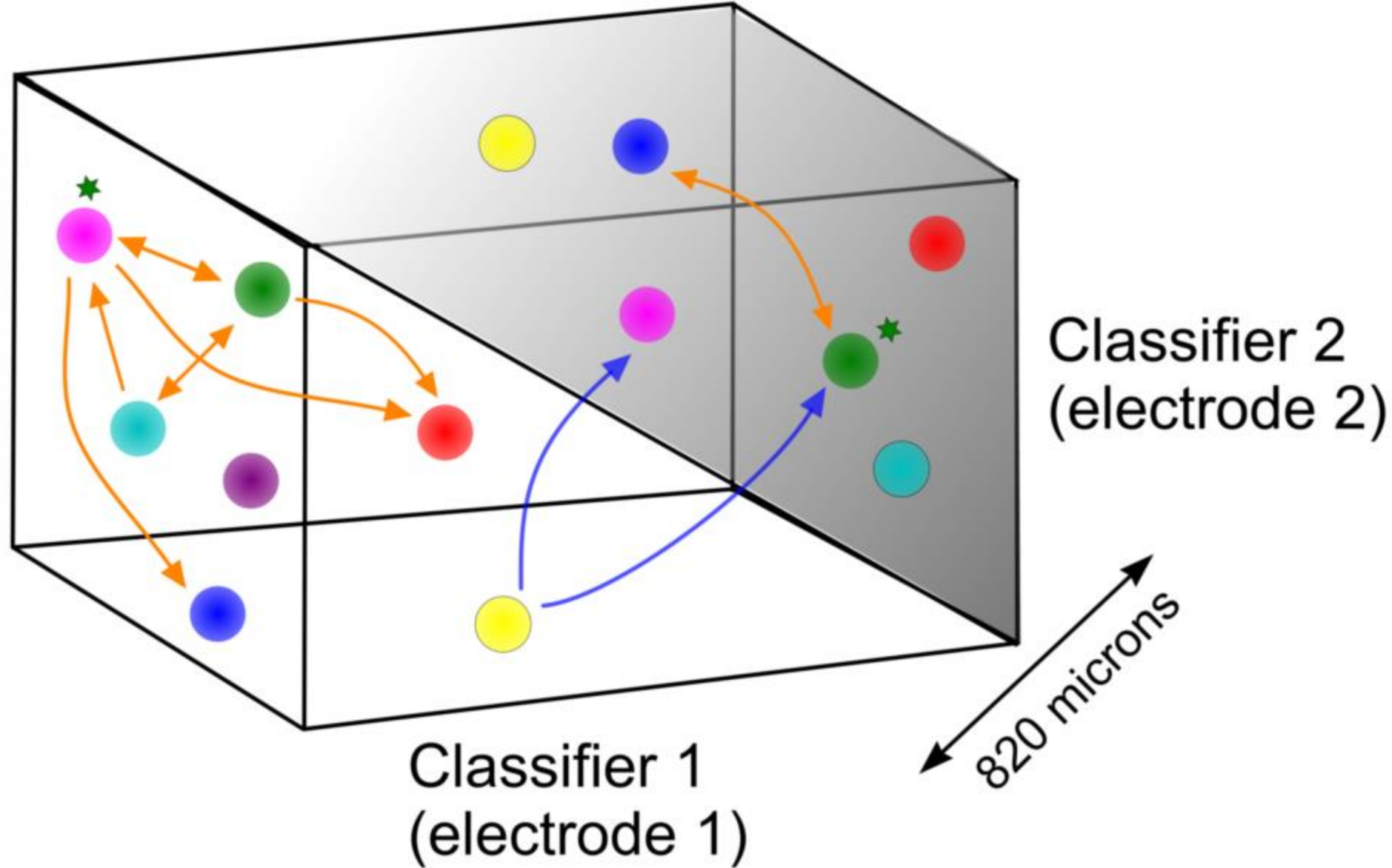


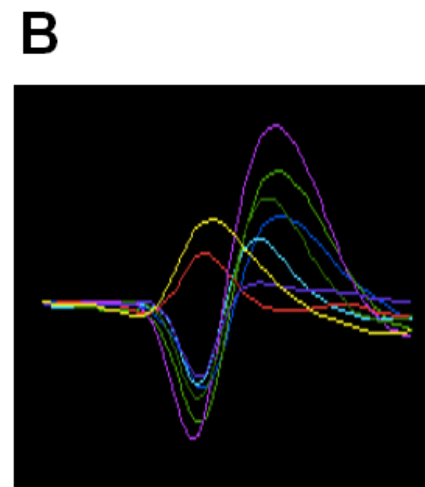
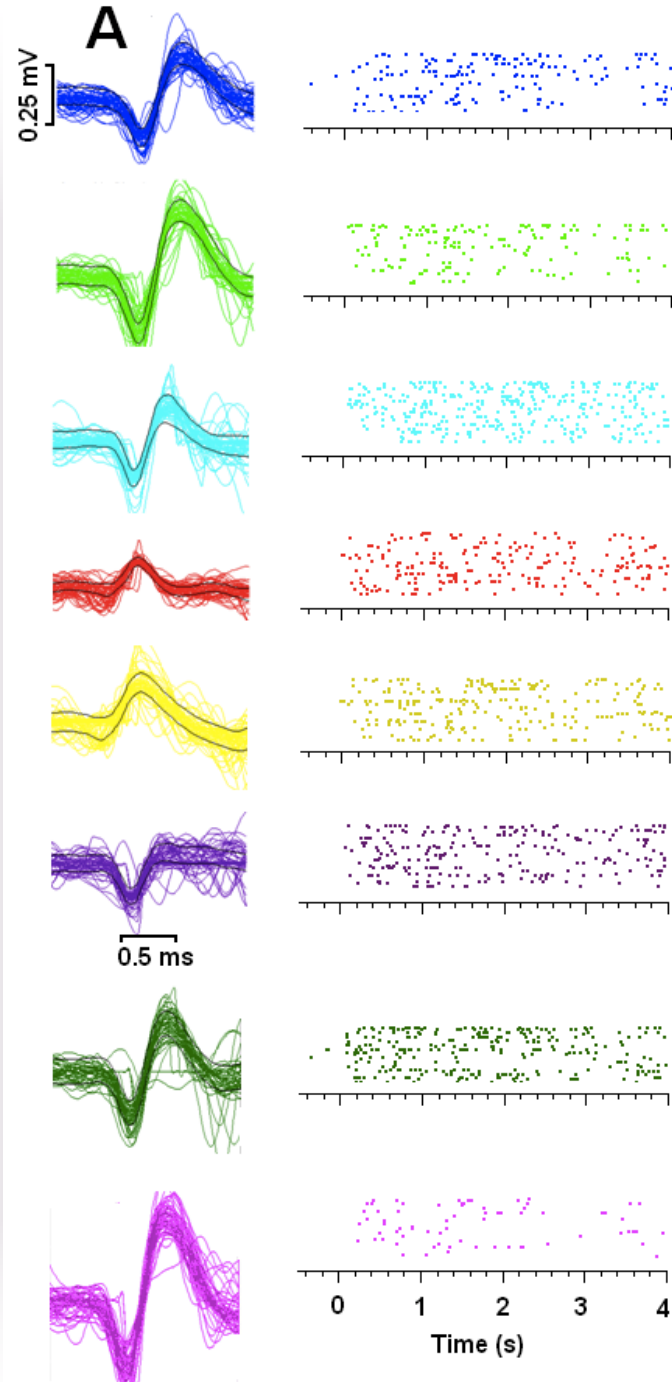
B

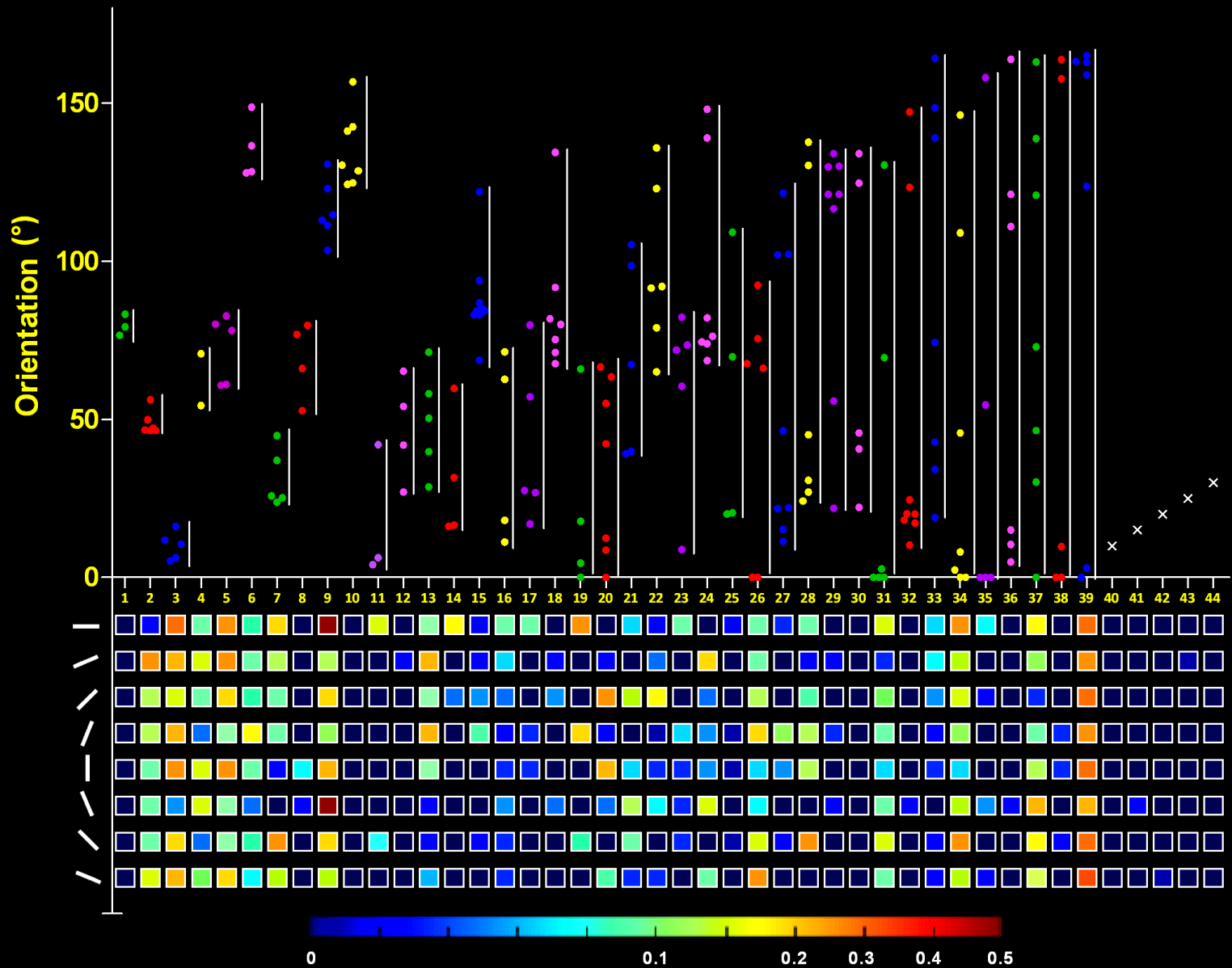


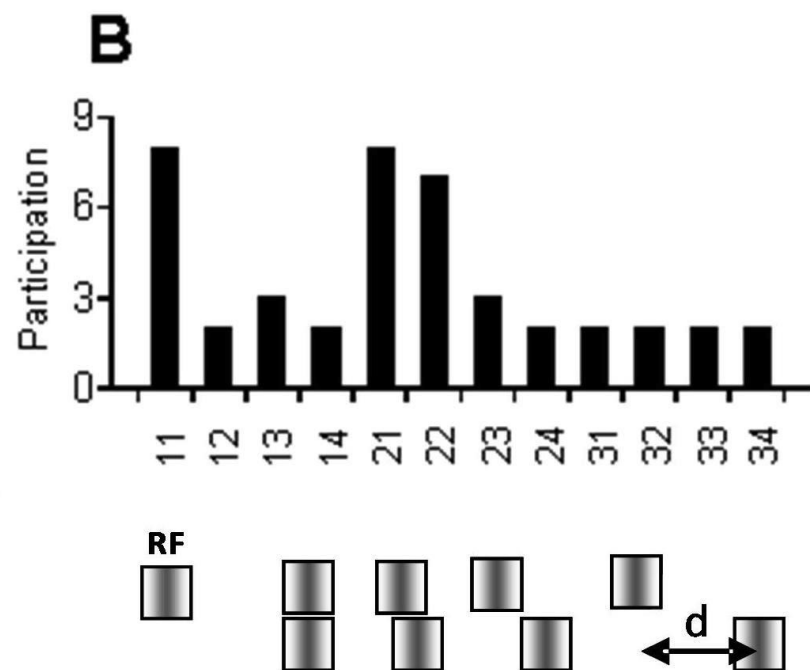
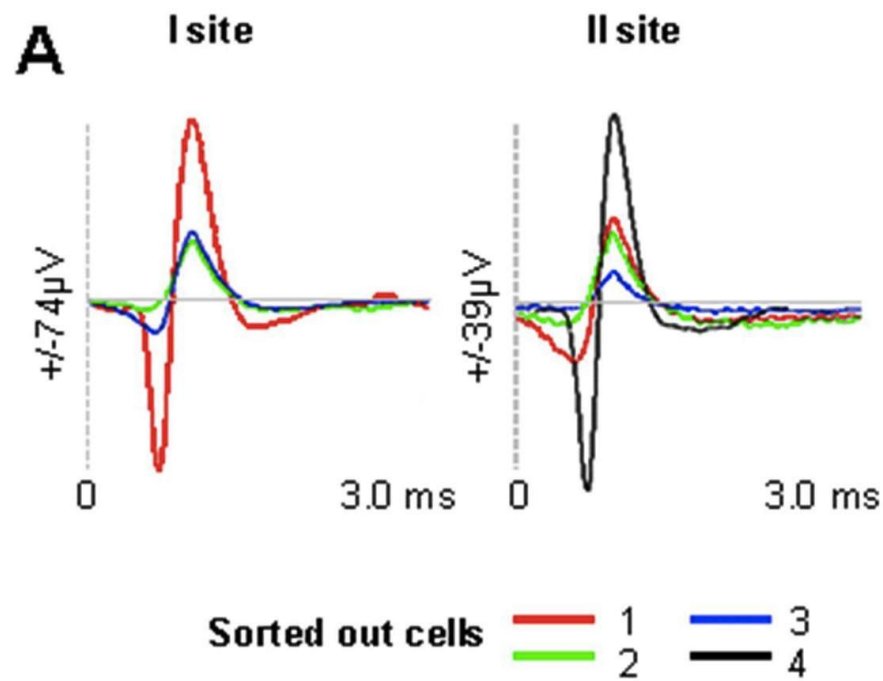
Electrode 1 $\xleftrightarrow{820\ \mu}$ Electrode 2

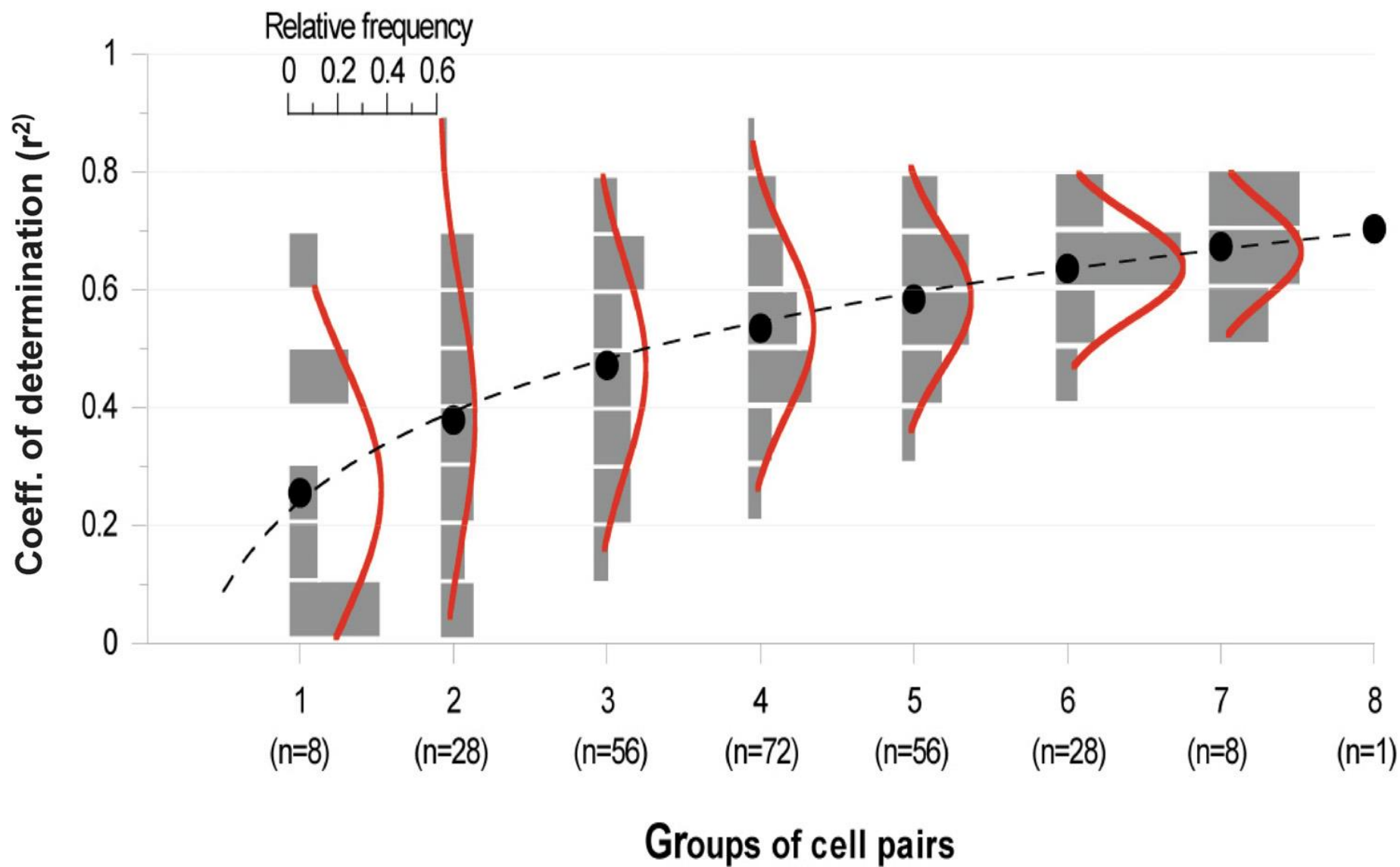


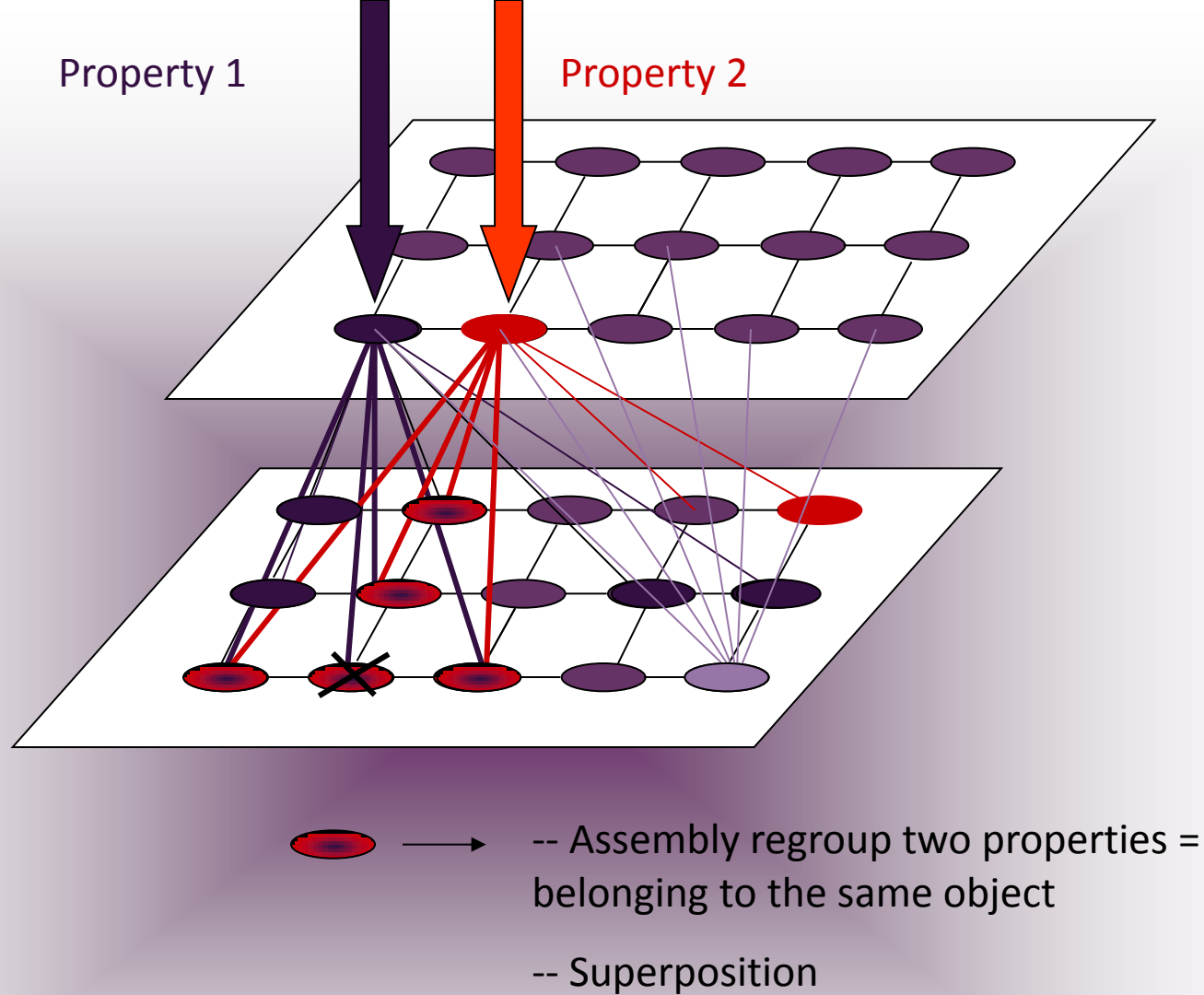












Two cells sharing similar properties may function distinctly.



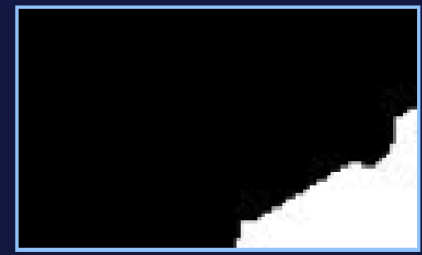
T1



T2



T3



T4

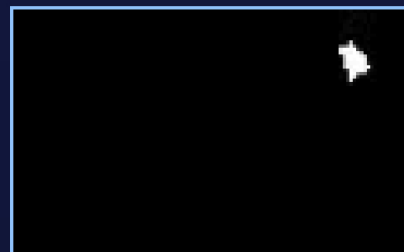
(a)



T5

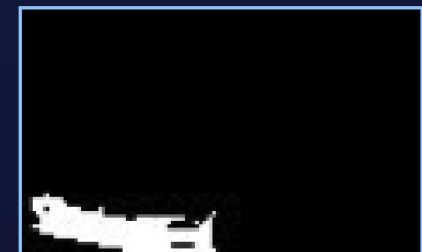


T6



T7

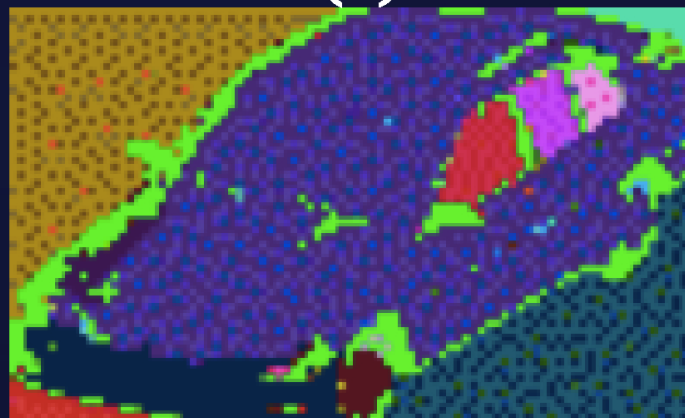
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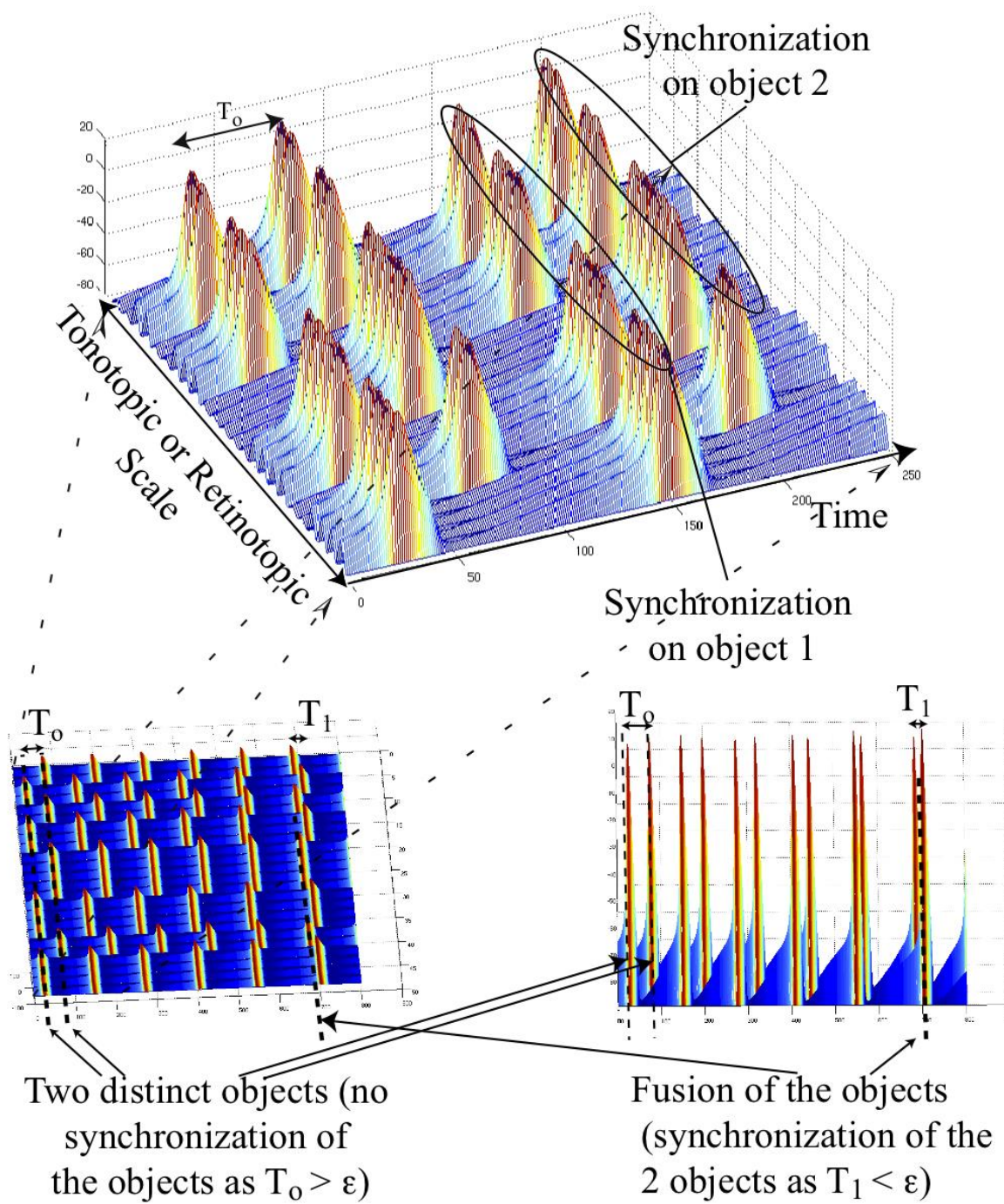


Tn



(b)

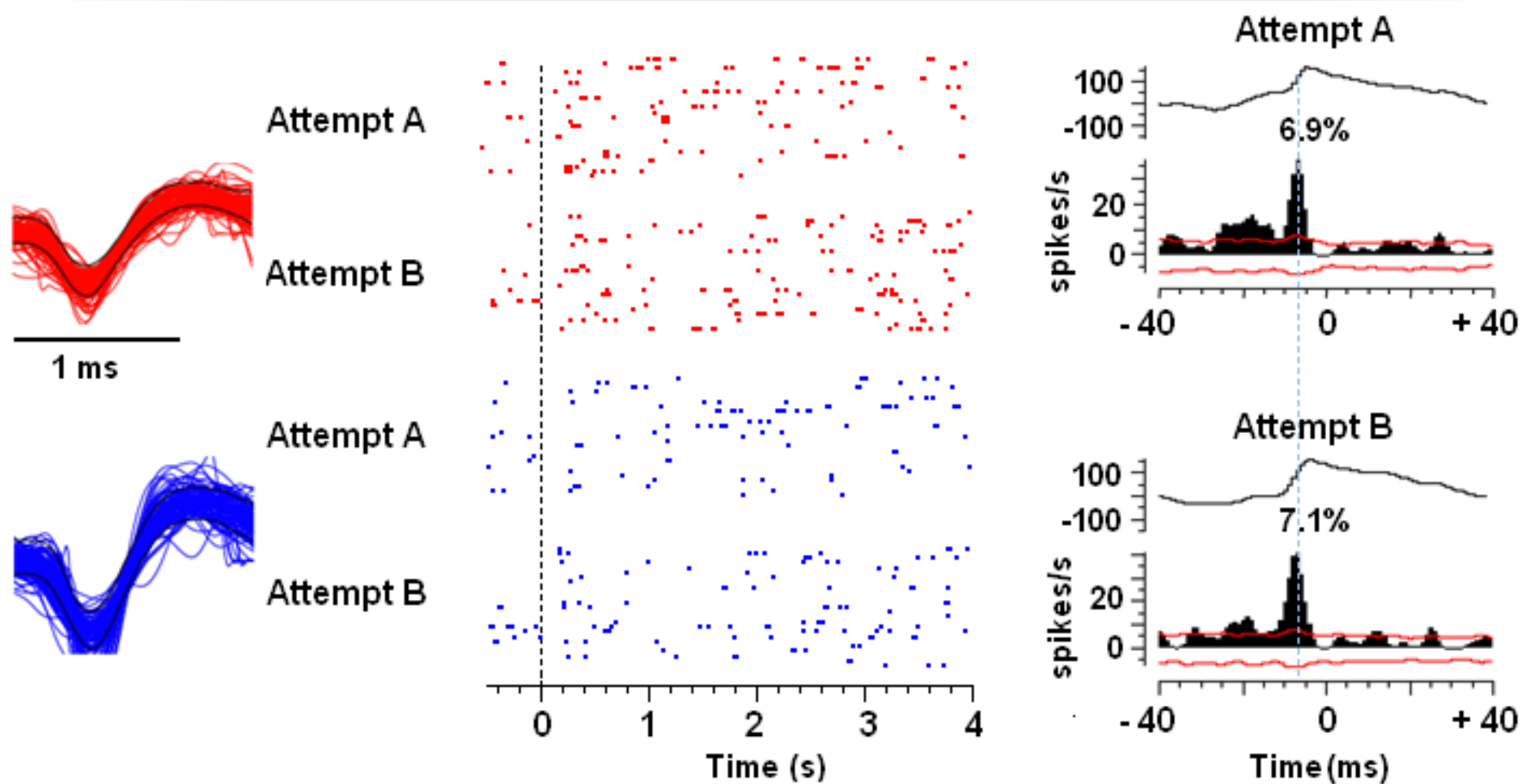


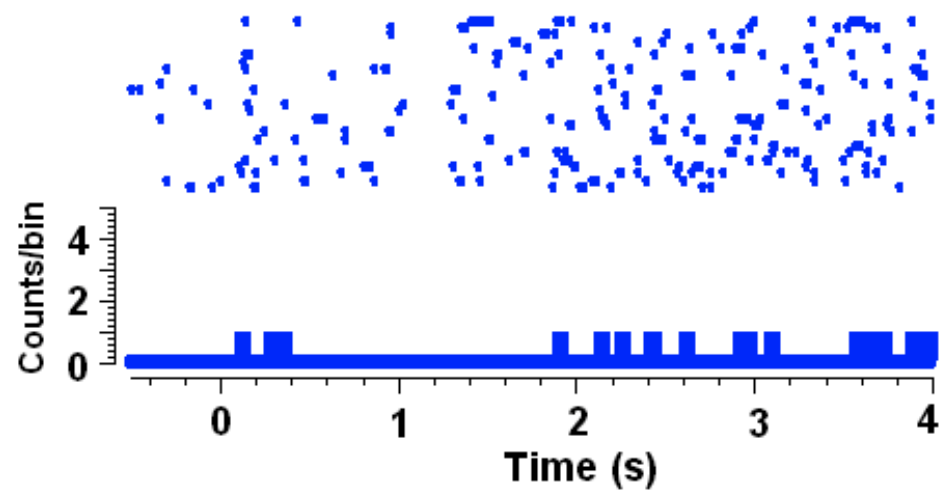
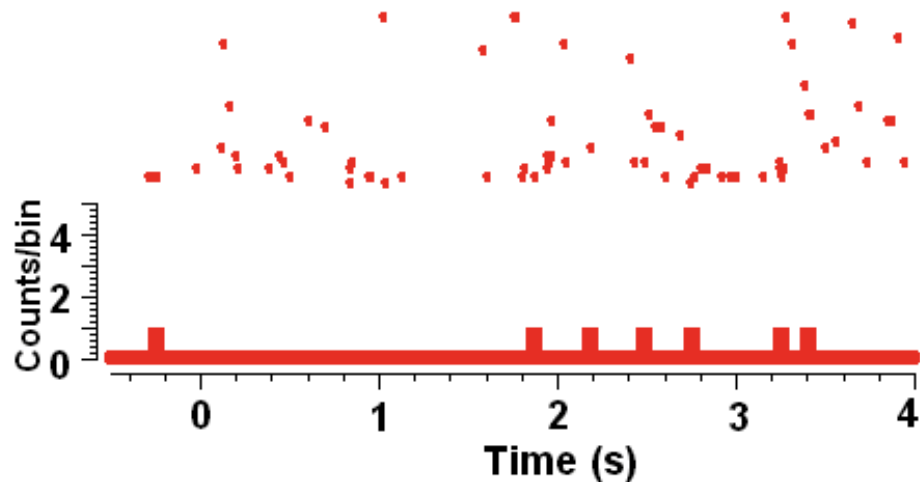
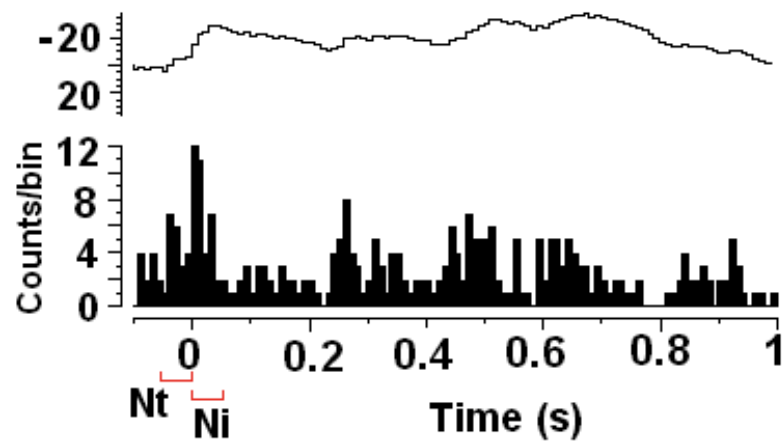
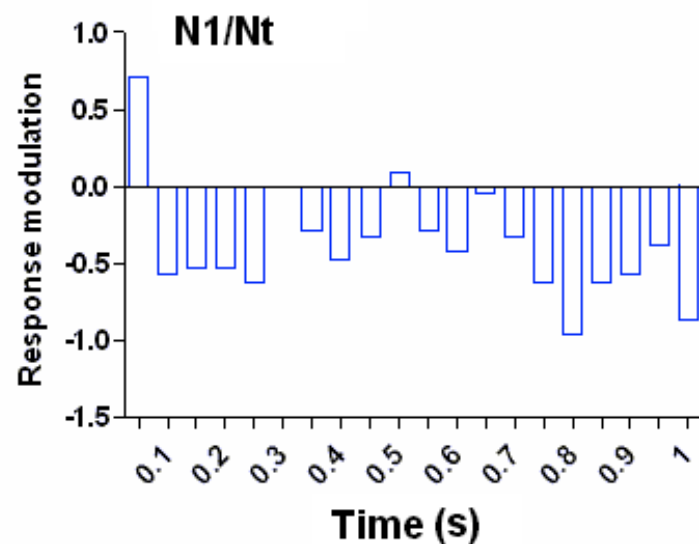


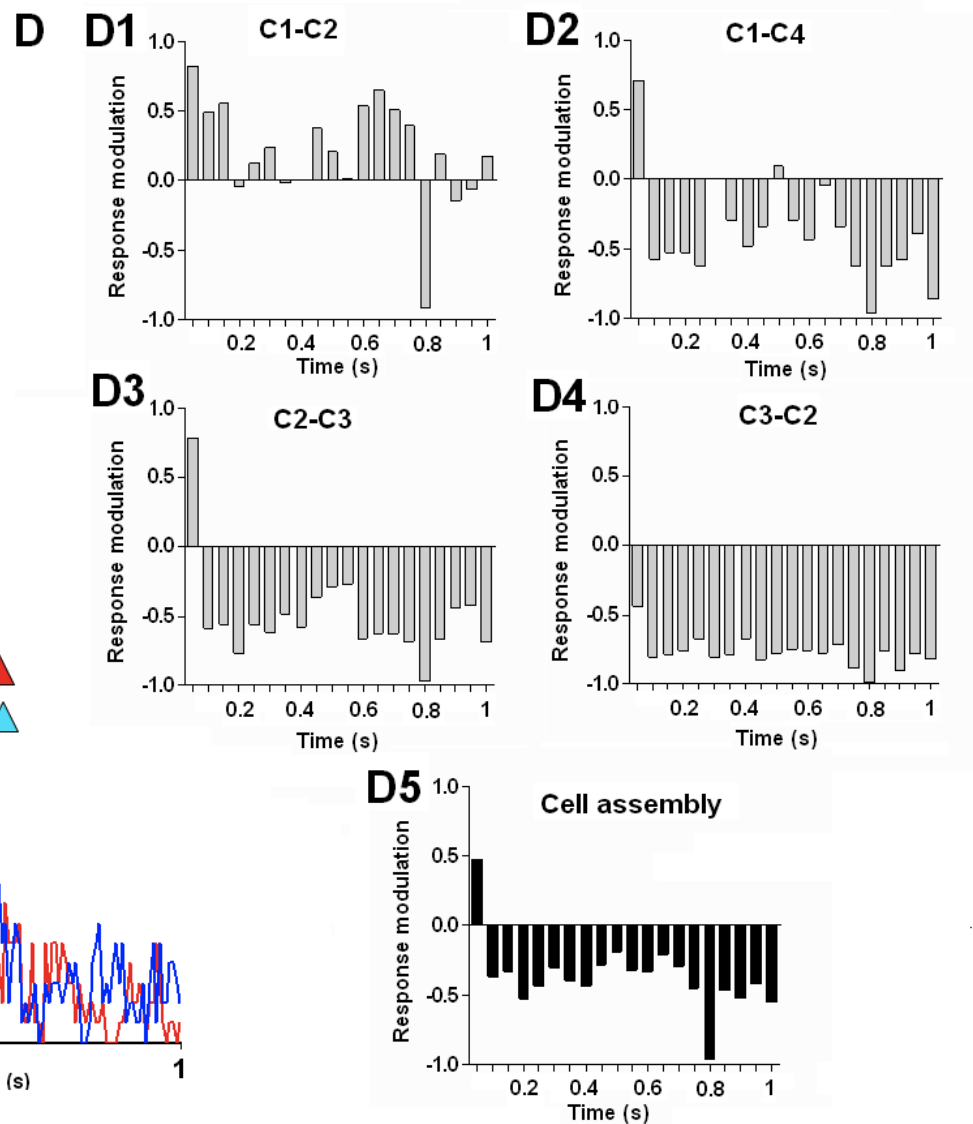
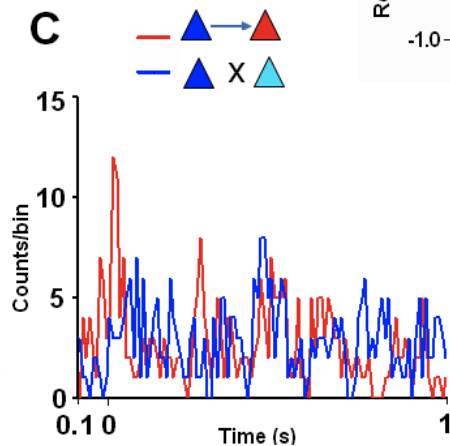
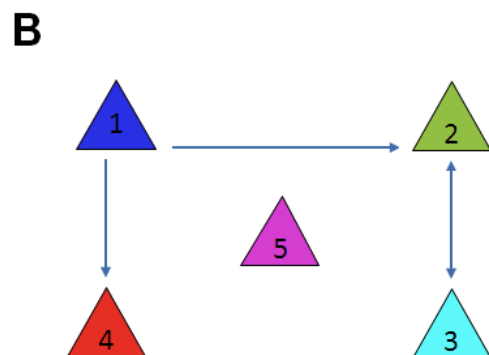
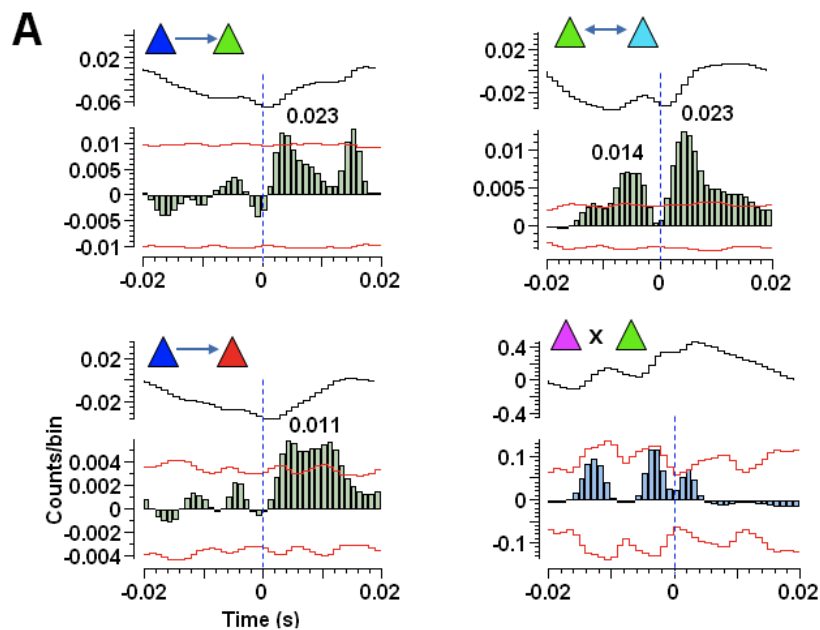
Advantage of neuronal assembly:

Saliency of selected cells

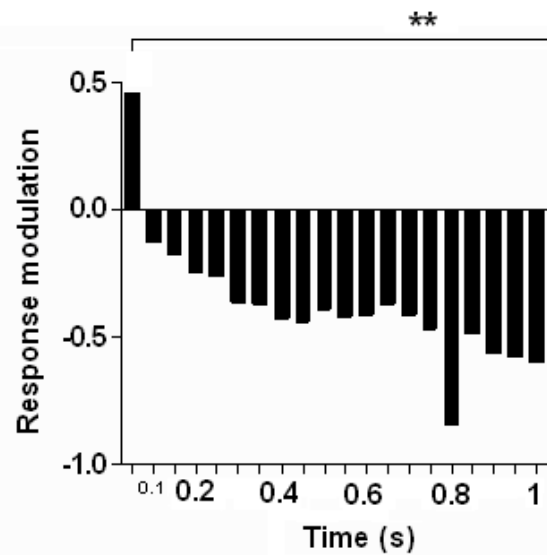
Less variability



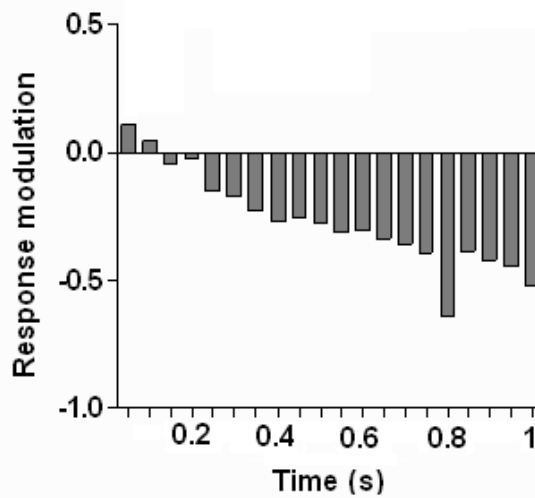
A**B****C****D**



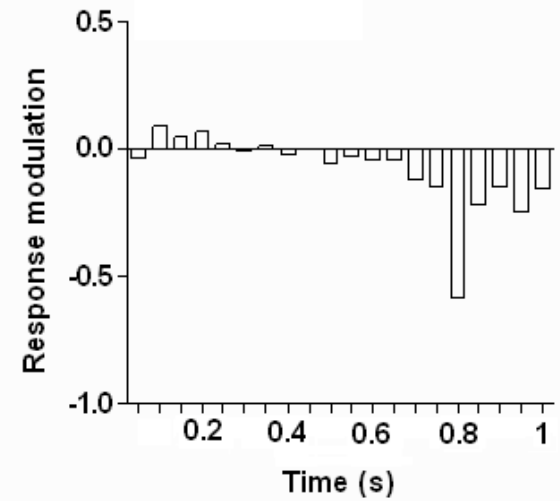
A Connected Cell-pairs

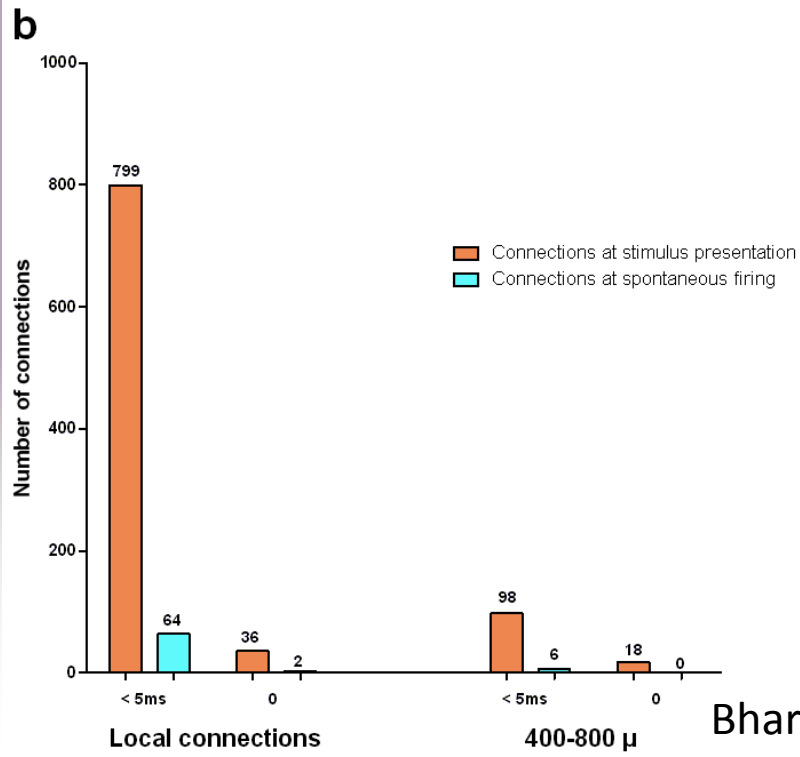
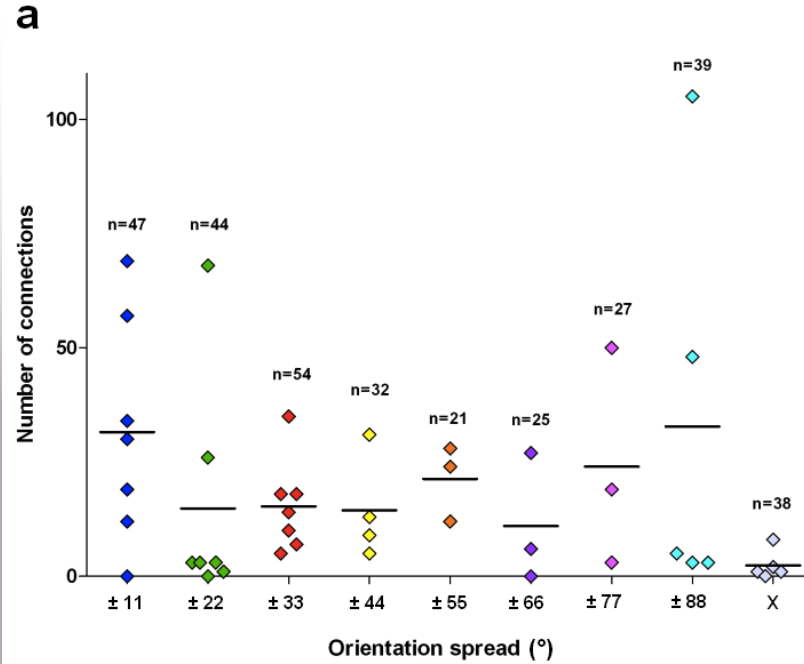


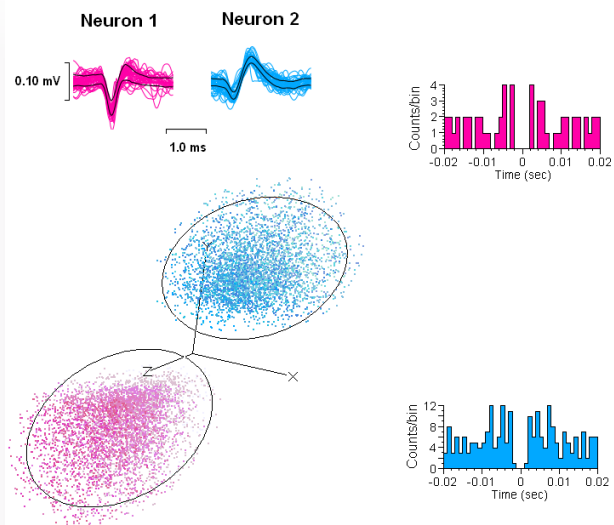
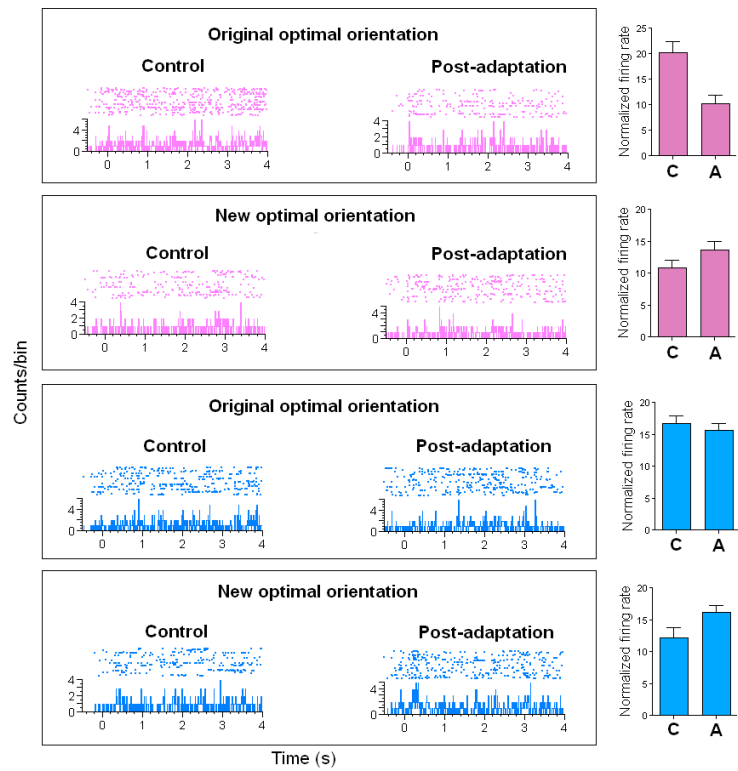
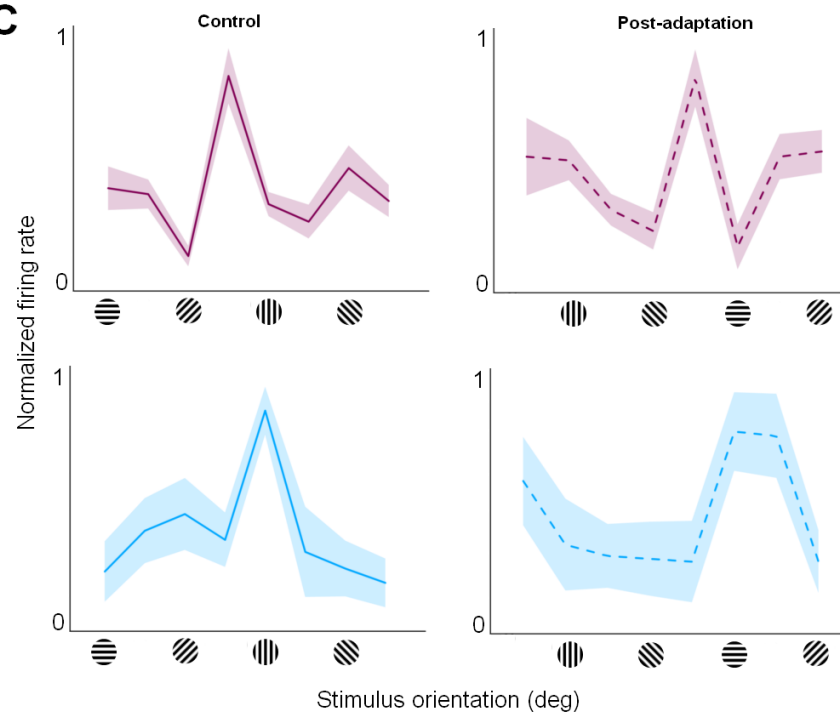
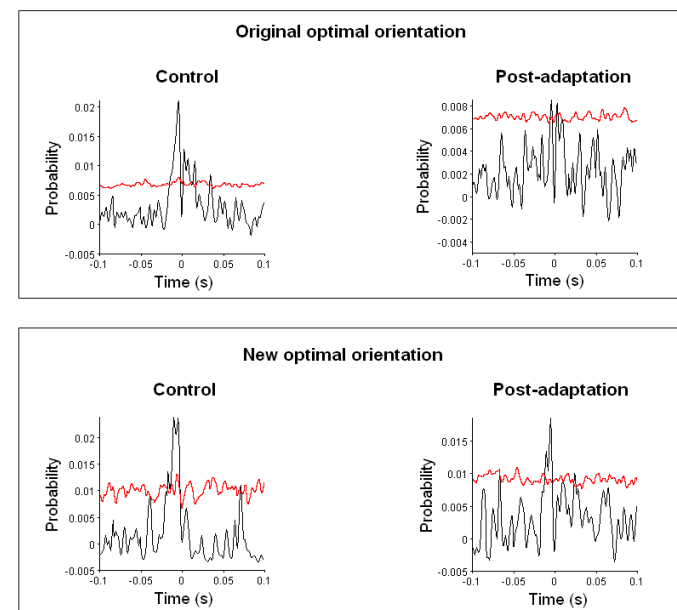
B Unconnected Cell-pairs



C Untuned Cell-pairs

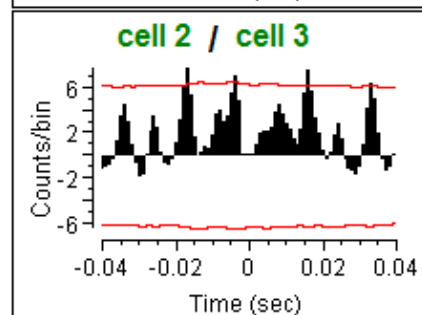
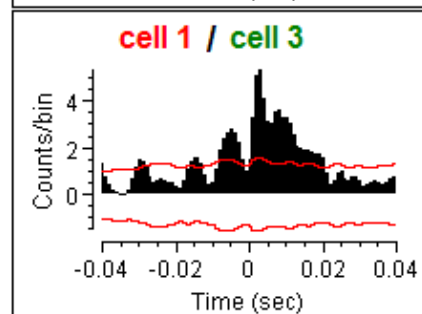
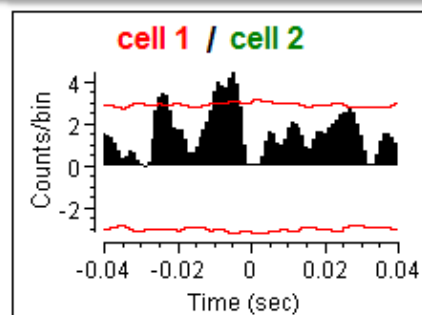
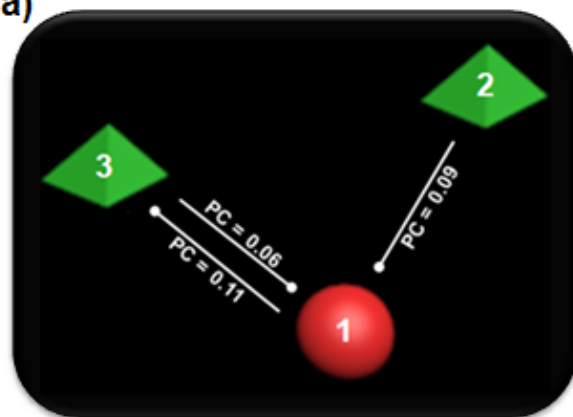




A**B****C****D**

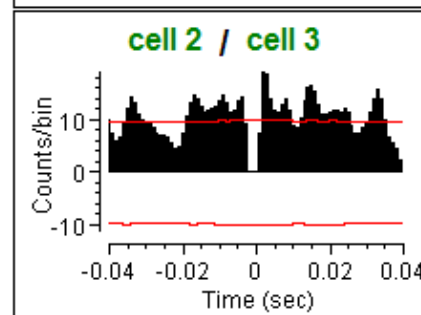
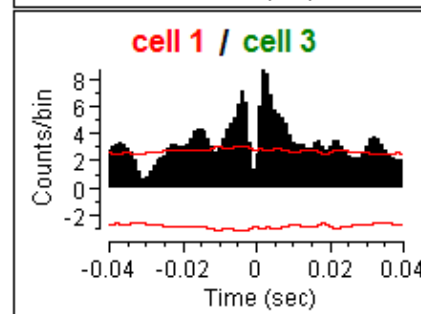
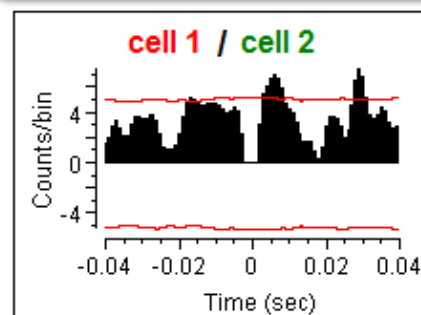
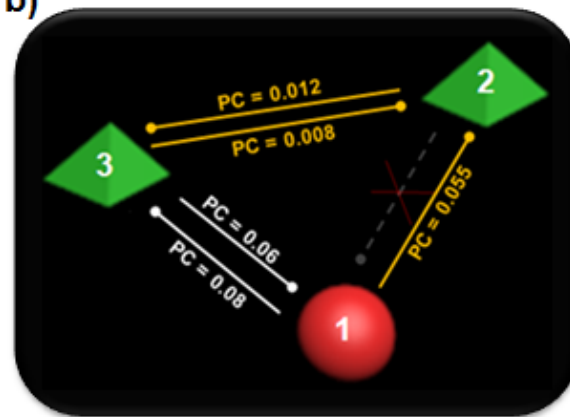
Before adaptation

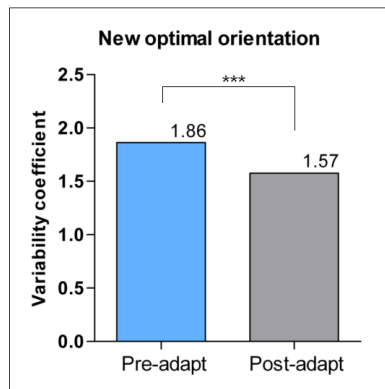
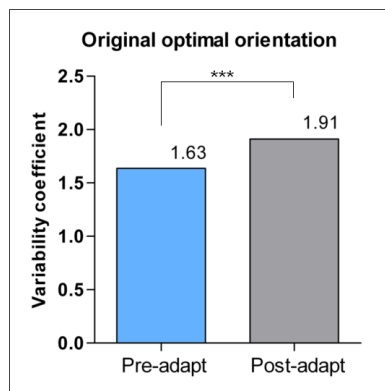
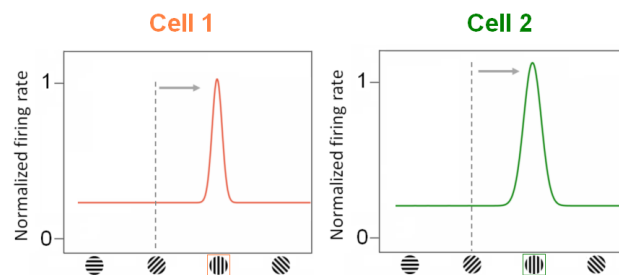
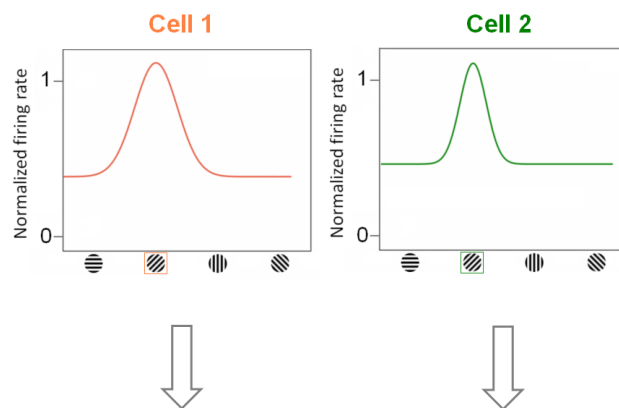
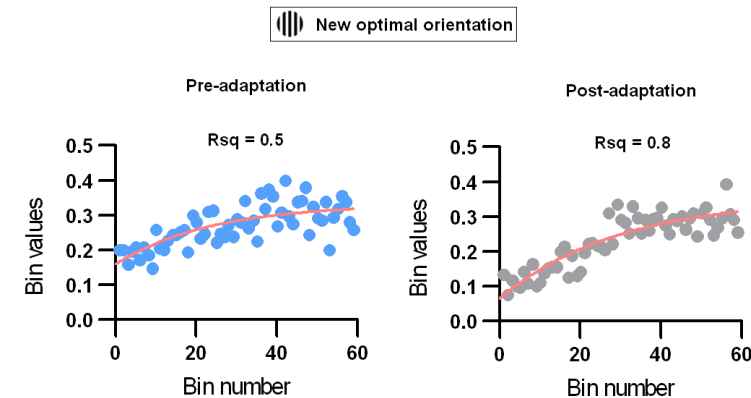
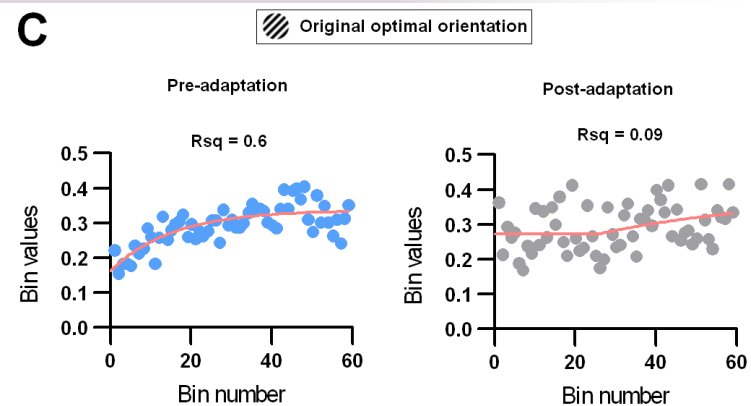
a)

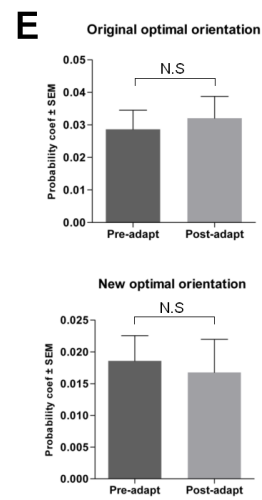
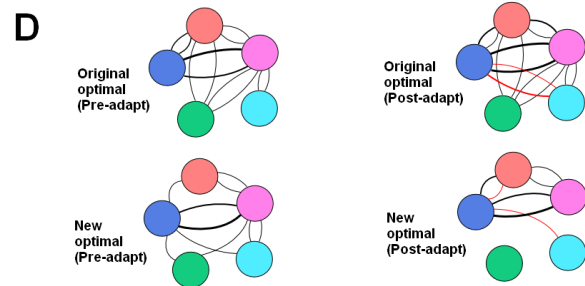
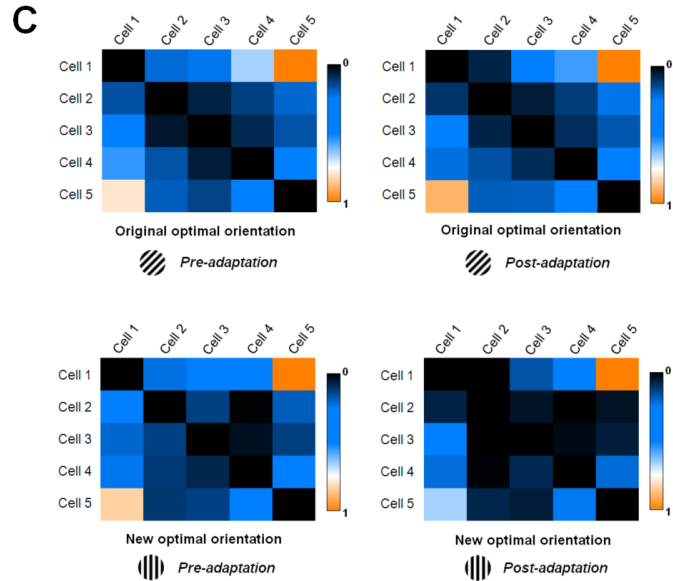
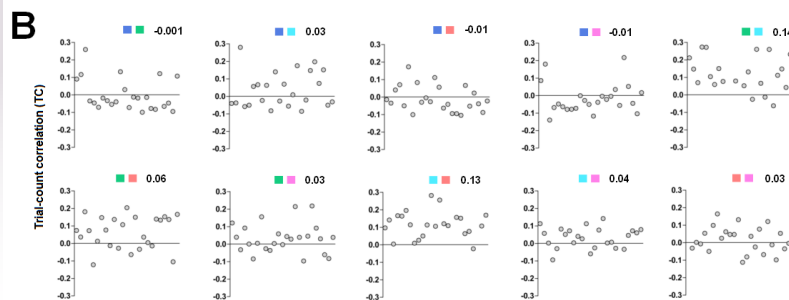
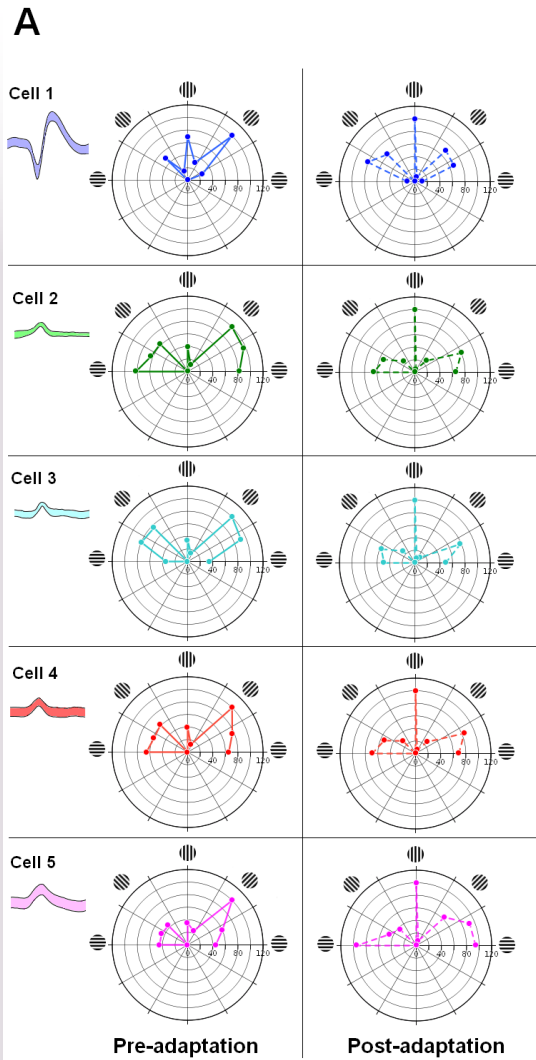


After adaptation

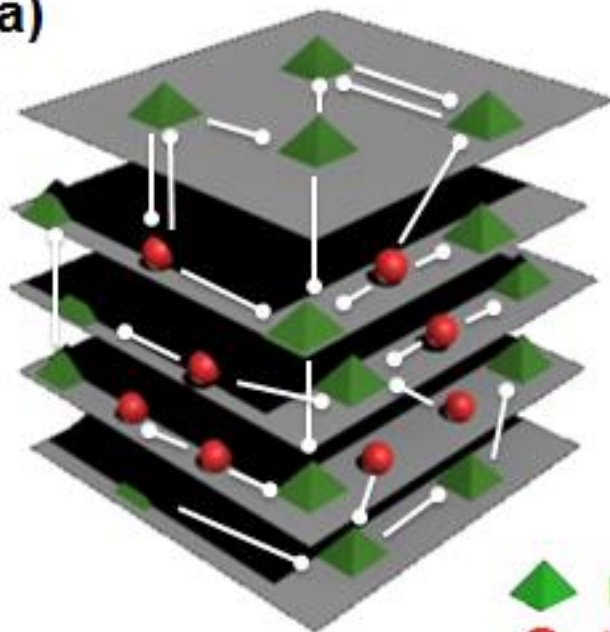
b)



A**B****C**

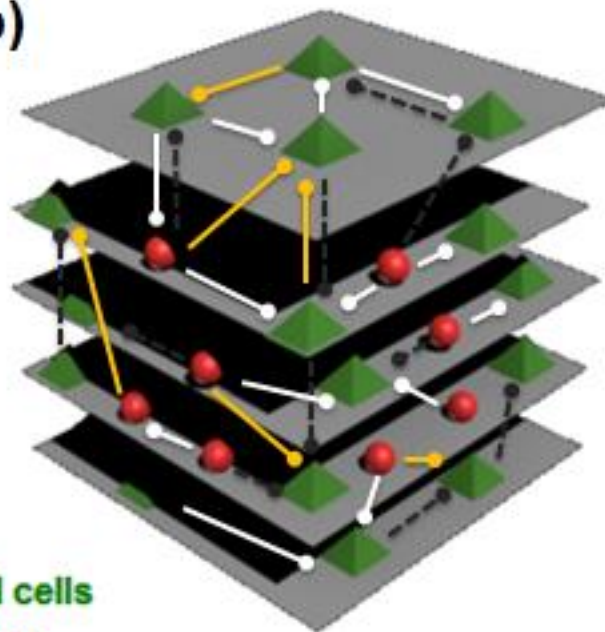


a)



Network before adaptation

b)



Network after adaptation

Conclusions

- Cortical neurons coordinate their activity in an assembly to encode a stimulus.
- Functionally connected neurons exhibit heightened excitability in response to a feature —a neuron facilitates the responsiveness of its companion neuron for 250 ms after it fires an action potential, thereafter, the response declines. This suggests that the cortical network is framed within 250 ms after the onset of the activity of the companion cells in an assembly.
- The augmented excitation for about 250 ms creates a **‘window of opportunity’** for downstream recipient clusters of neurons to encode the stimulus.
- Synergistic influence is more between neurons in assemblies consisting large orientation spread.

Thank you

Acknowledgements to the team



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L. Bachatene



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J.
Jeyabalaratnam

