Wave computations and non linearities in a general model of V1

JC series on Online Dynamical Decision in V1

2021/09/27

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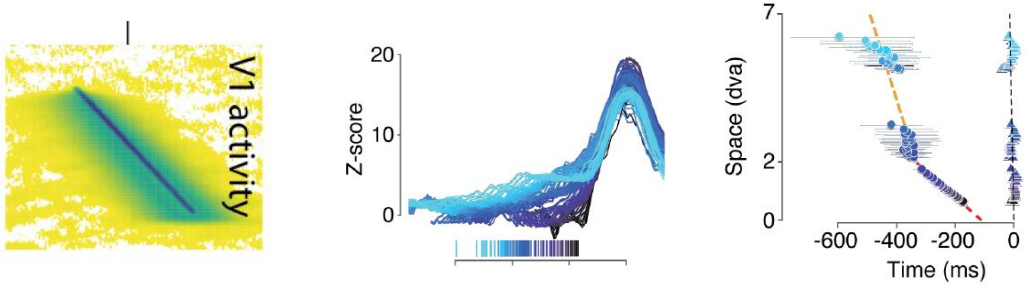

Benvenuti et al 2020, Anticipatory responses along motion trajectories in awake monkey area V1

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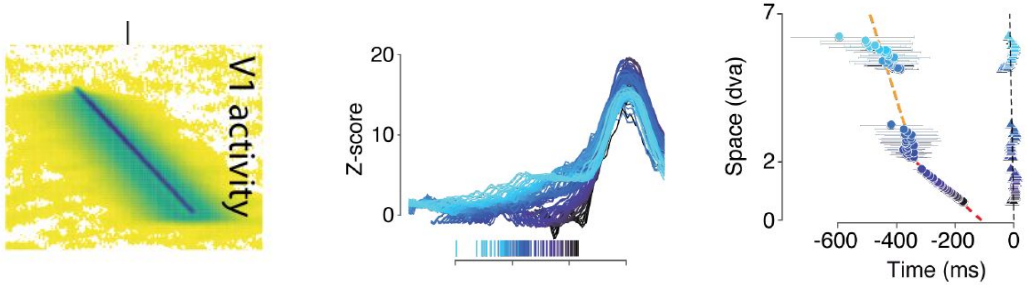

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How do waves make a neural anticipation?

Content

- 1D SNNs general model of V1 which generates cortical **waves**

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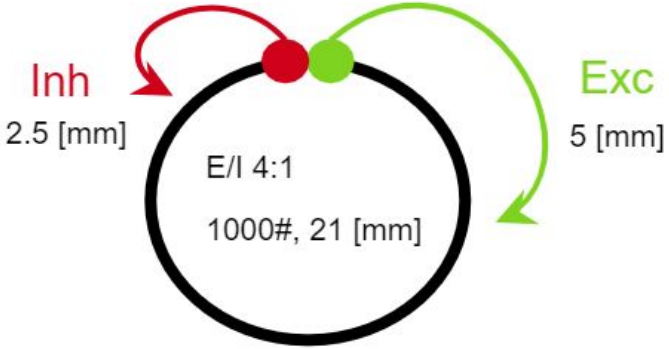
- 1D SNNs general model of V1 which generates cortical **waves**

<u>Topic results about:</u>

- Traveling wave **velocities** shape the wake profile on the cortical topography
- **Fast** waves determine an incremental neural preactivation on brain topography (anticipation)
- Cortical waves interactions are results of **neural non linearities**

1D V1 SNNs general model (Bernstein 2021)



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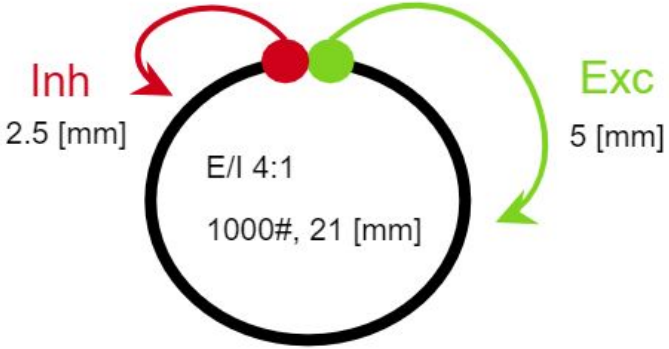
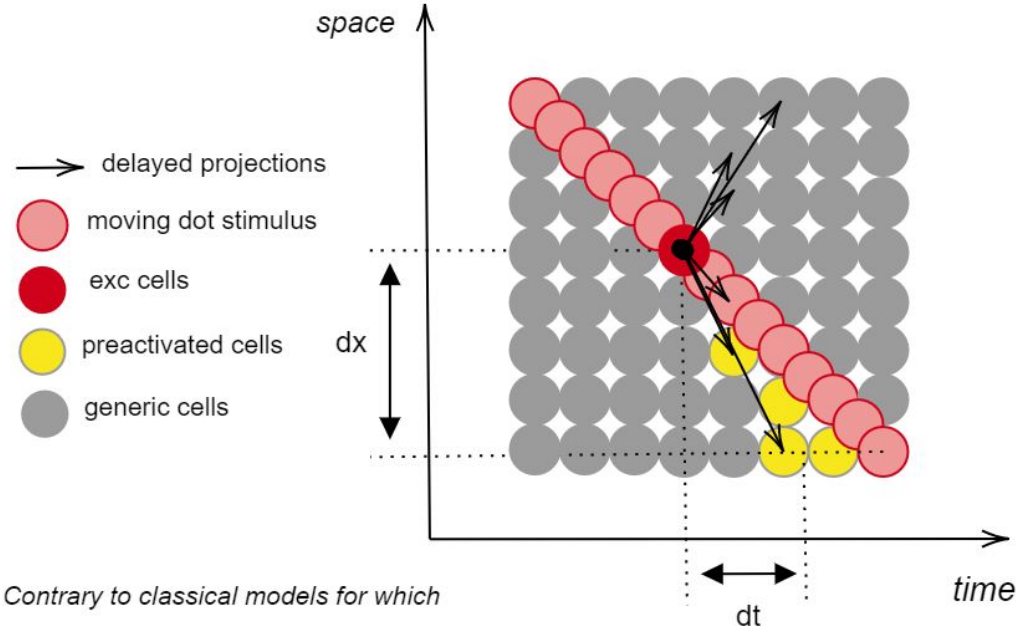
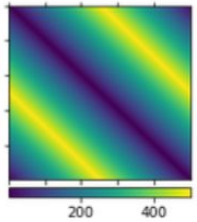




distance based delay [ms]



Contrary to classical models for which the delay is constant, realistic connections exhibit a distance-dependent delay.

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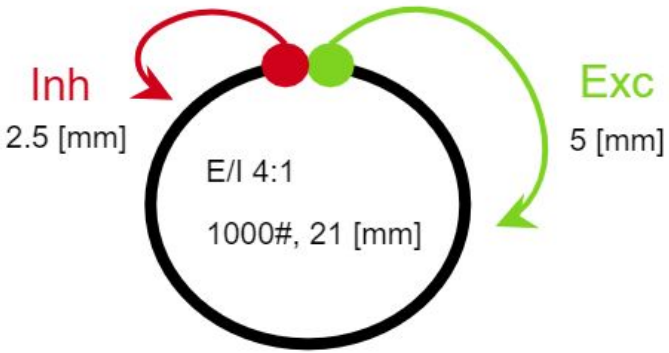

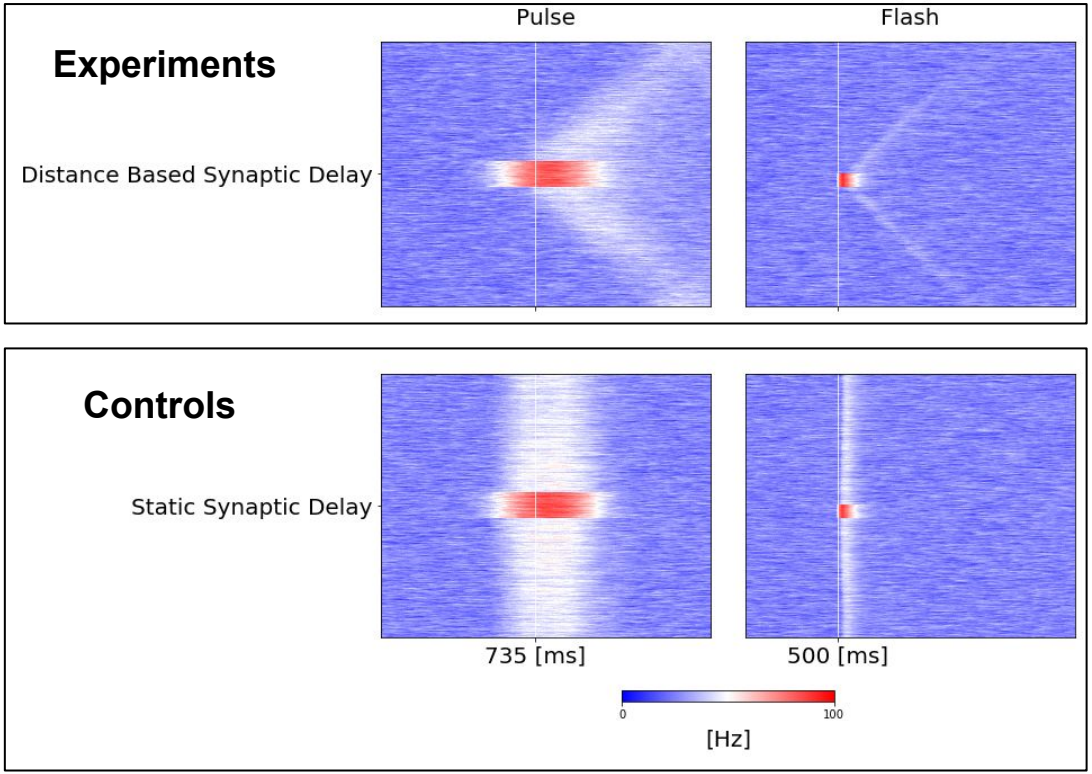

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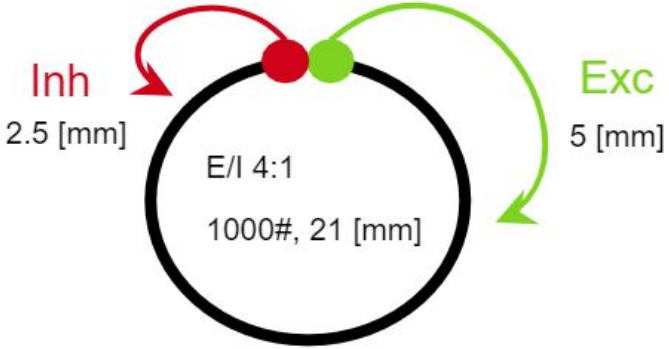
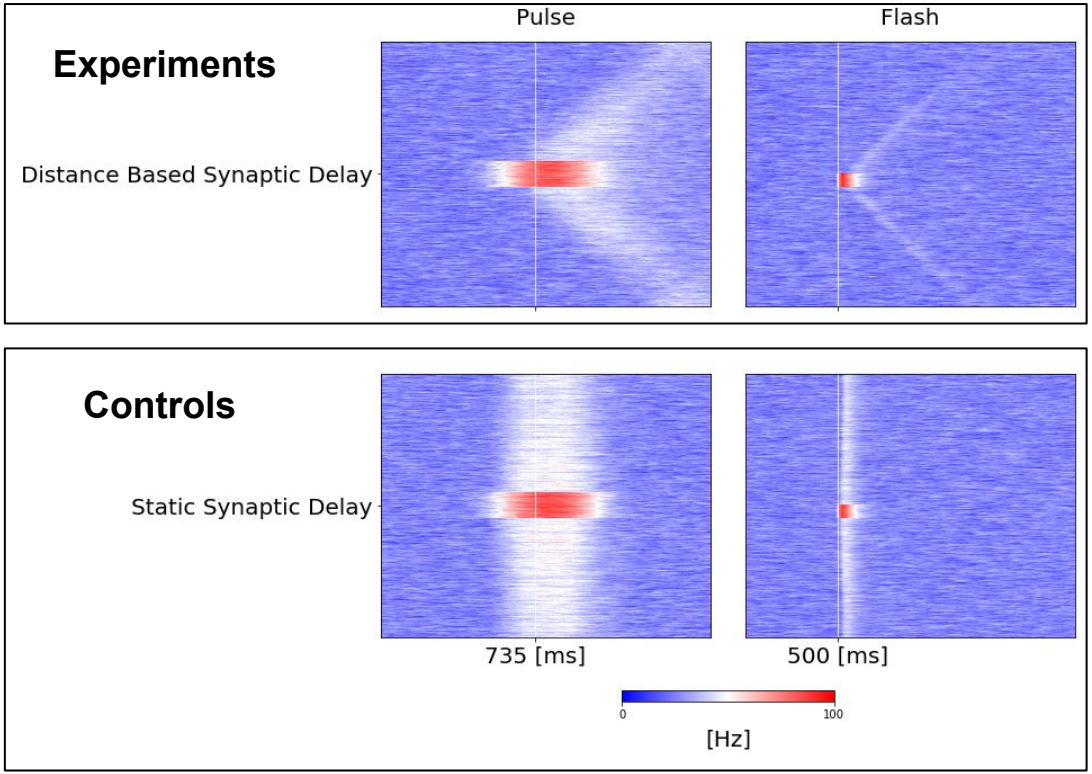
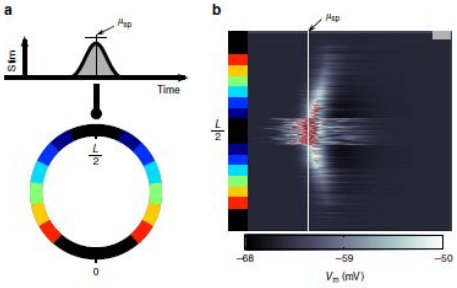




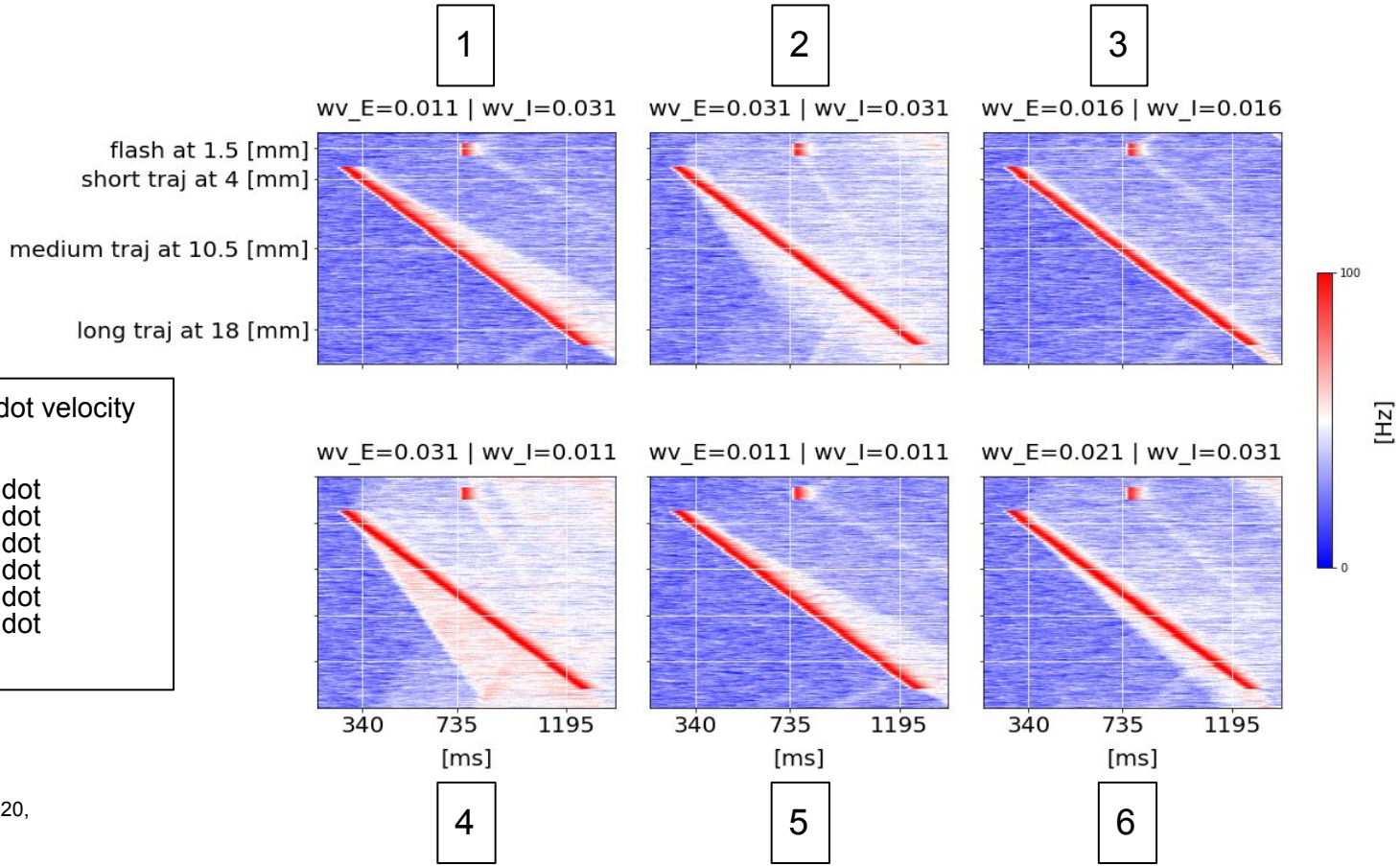
Muller et al 2014, waves response to stimulus



Traveling wave velocity shapes the wake profile on the cortical topography

How cortical waves velocities shape the stimulus related topographic activation?

Traveling wave velocity shapes the wake profile on the cortical topography



Waves velocity vs dot velocity **(0.016 [mm/ms]):**

1. E < dot, I > dot
2. E > dot, I > dot
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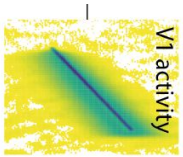

Benvenuti et al 2020, phen. model

Traveling wave velocity shapes the wake profile on the cortical topography

E has slower wave velocity than dot

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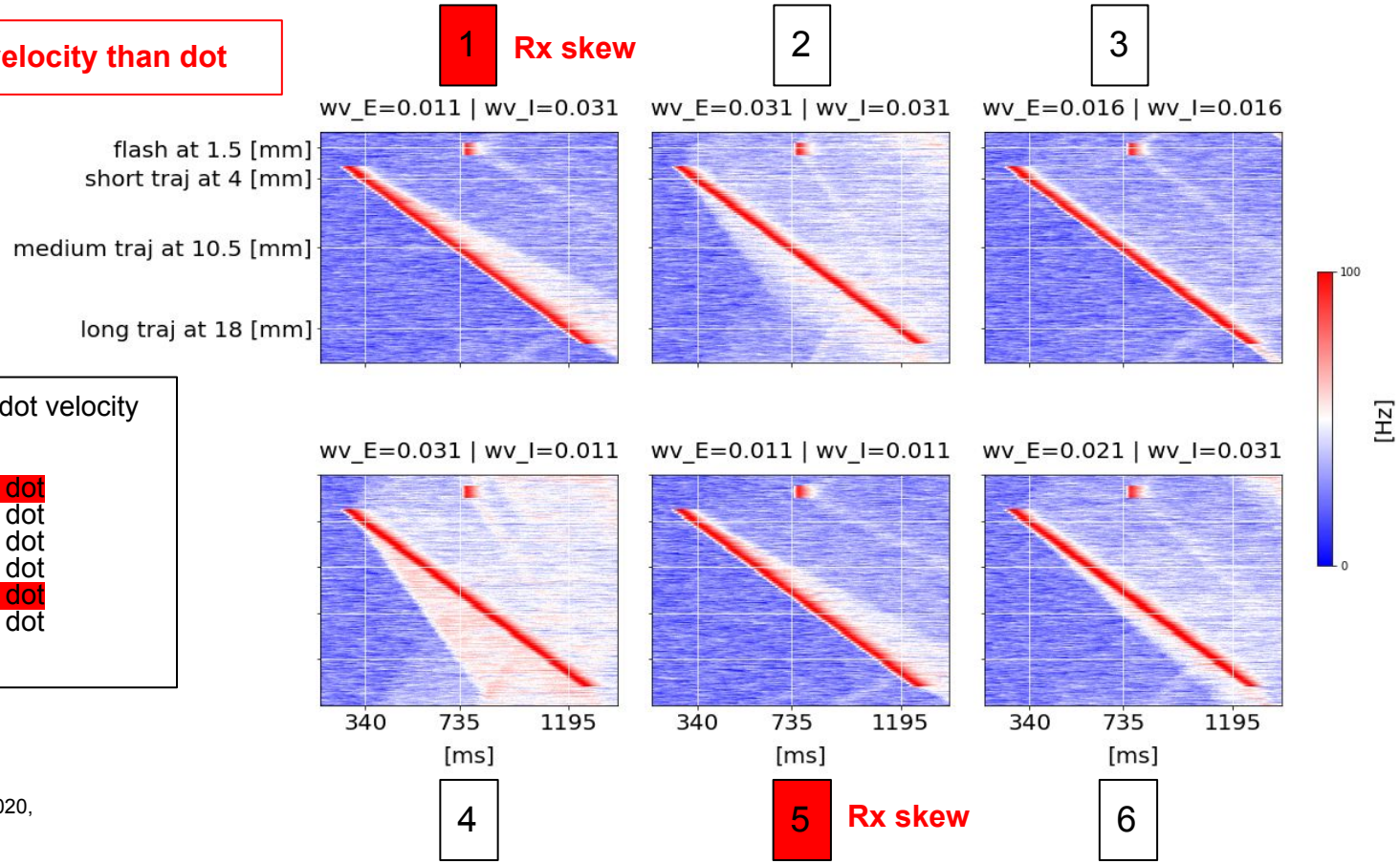

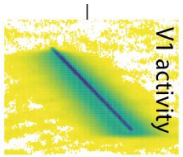

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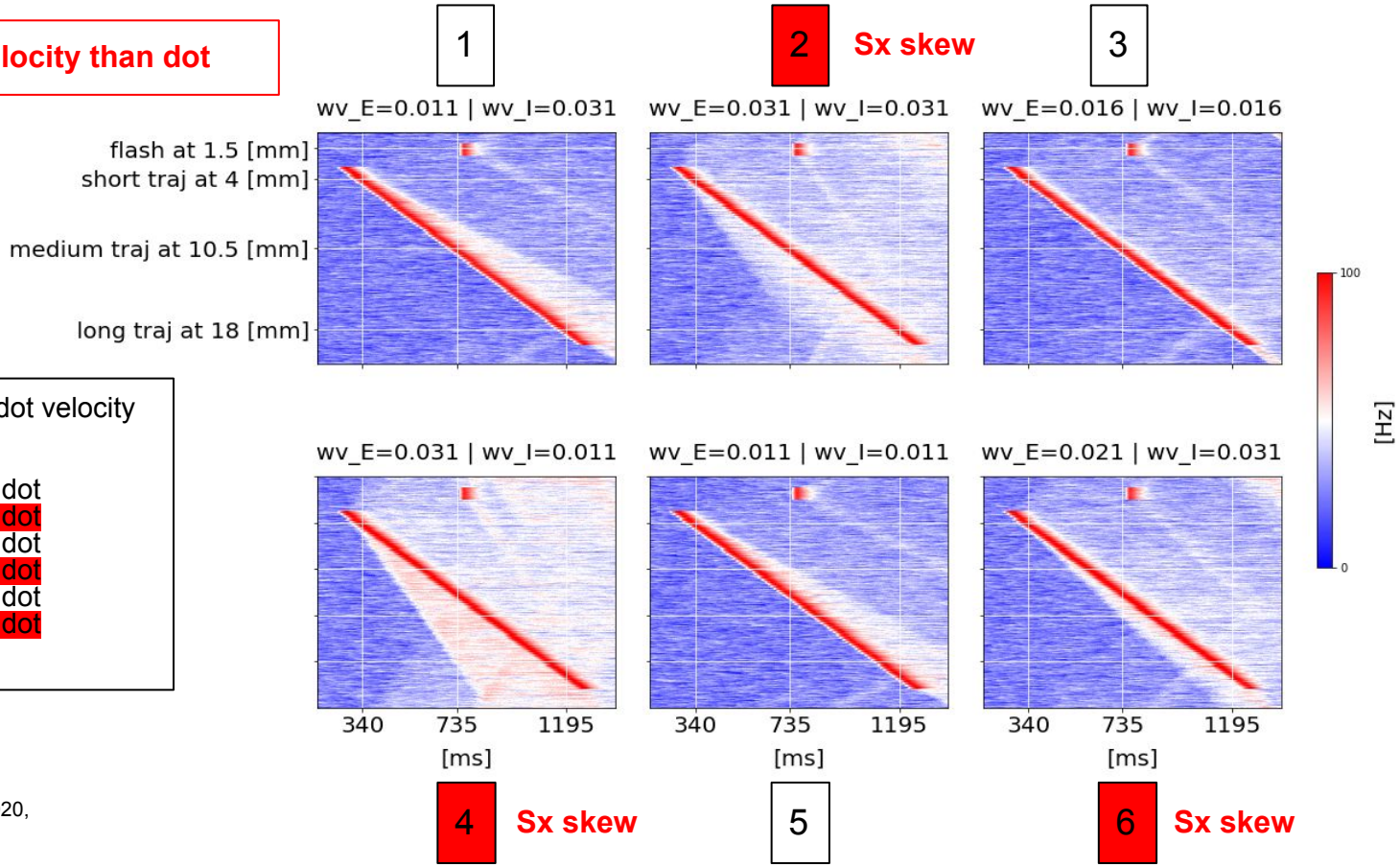

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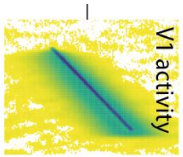
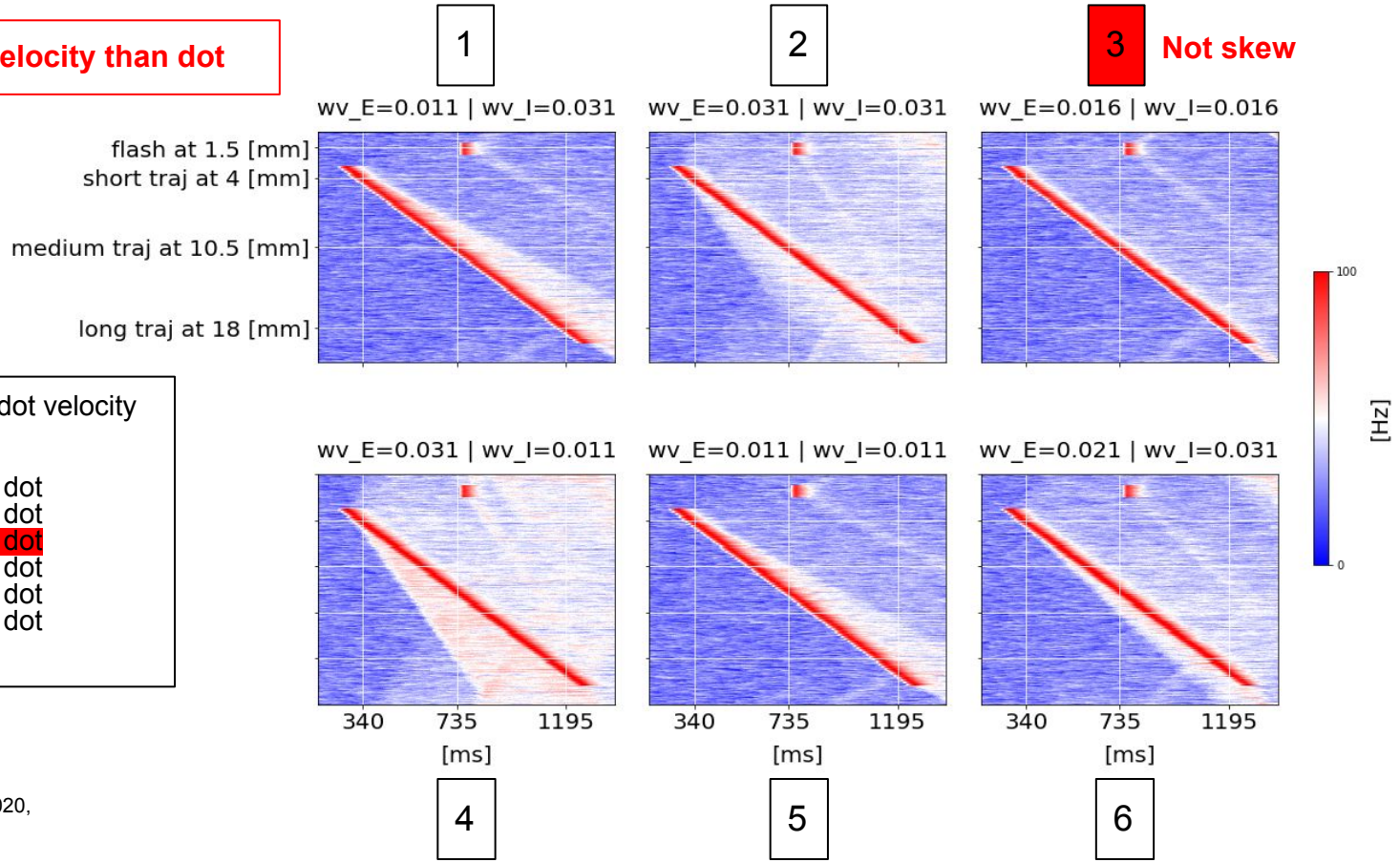


Benvenuti et al 2020, phen. model

Traveling wave velocity shapes the wake profile on the cortical topography

E/I has equal wave velocity than dot



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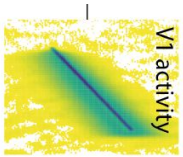

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Fast waves* determine an incremental neural preactivation on topography (anticipation)

What are the waves conditions able to generate preactivation?

*faster than the stimulus velocity 0.016 [mm/ms]

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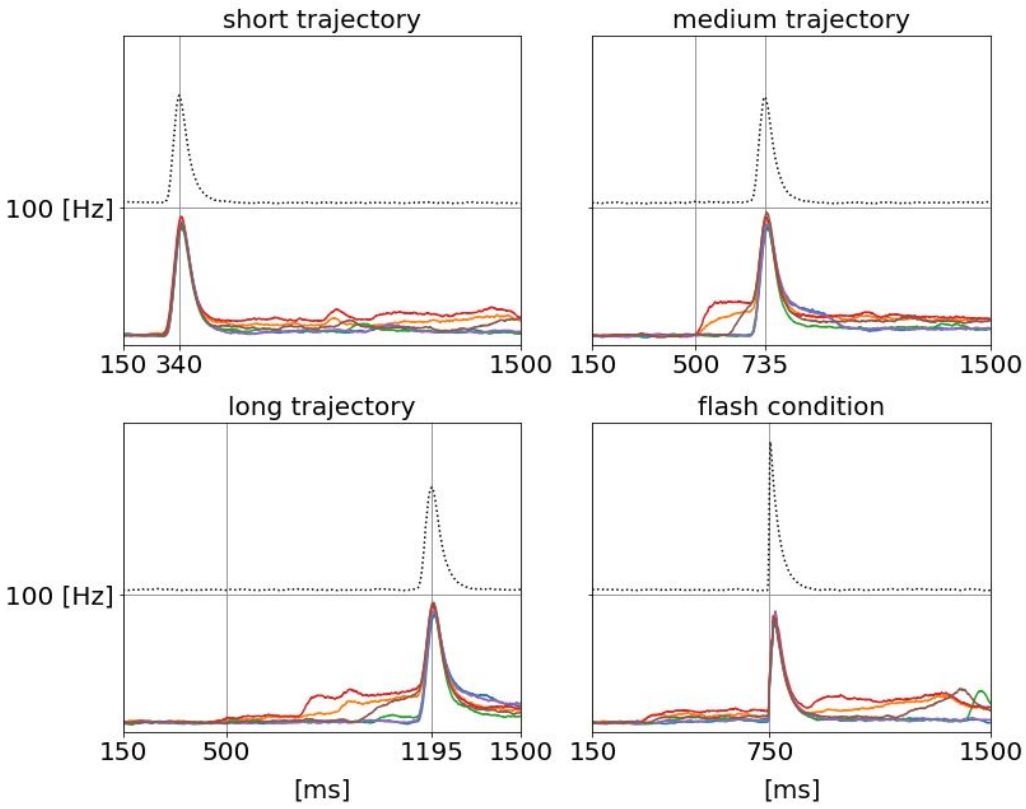

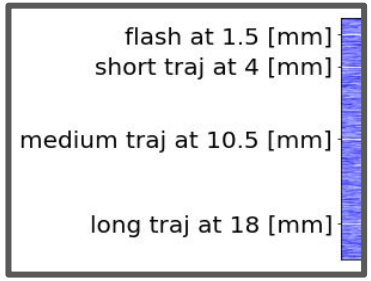

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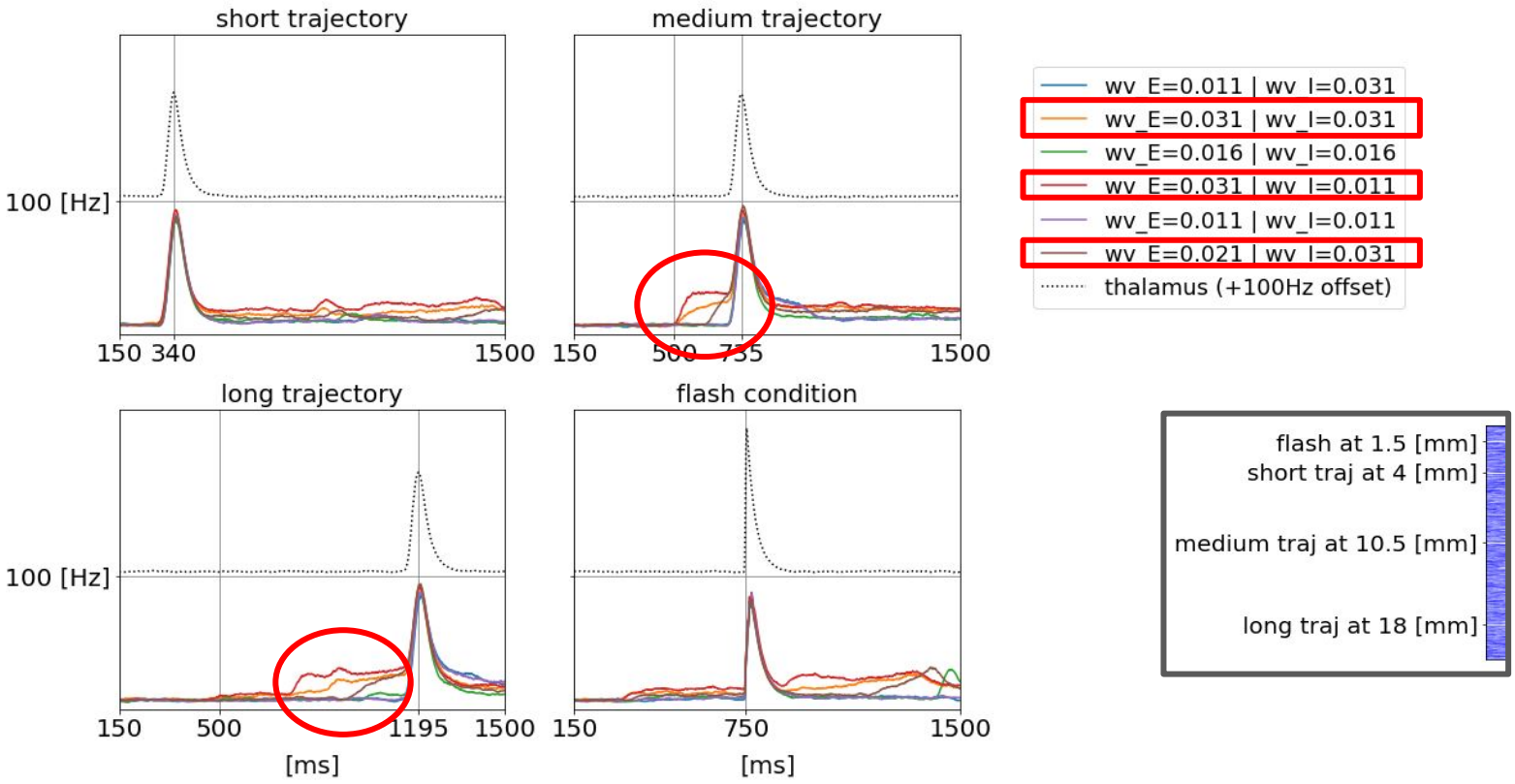

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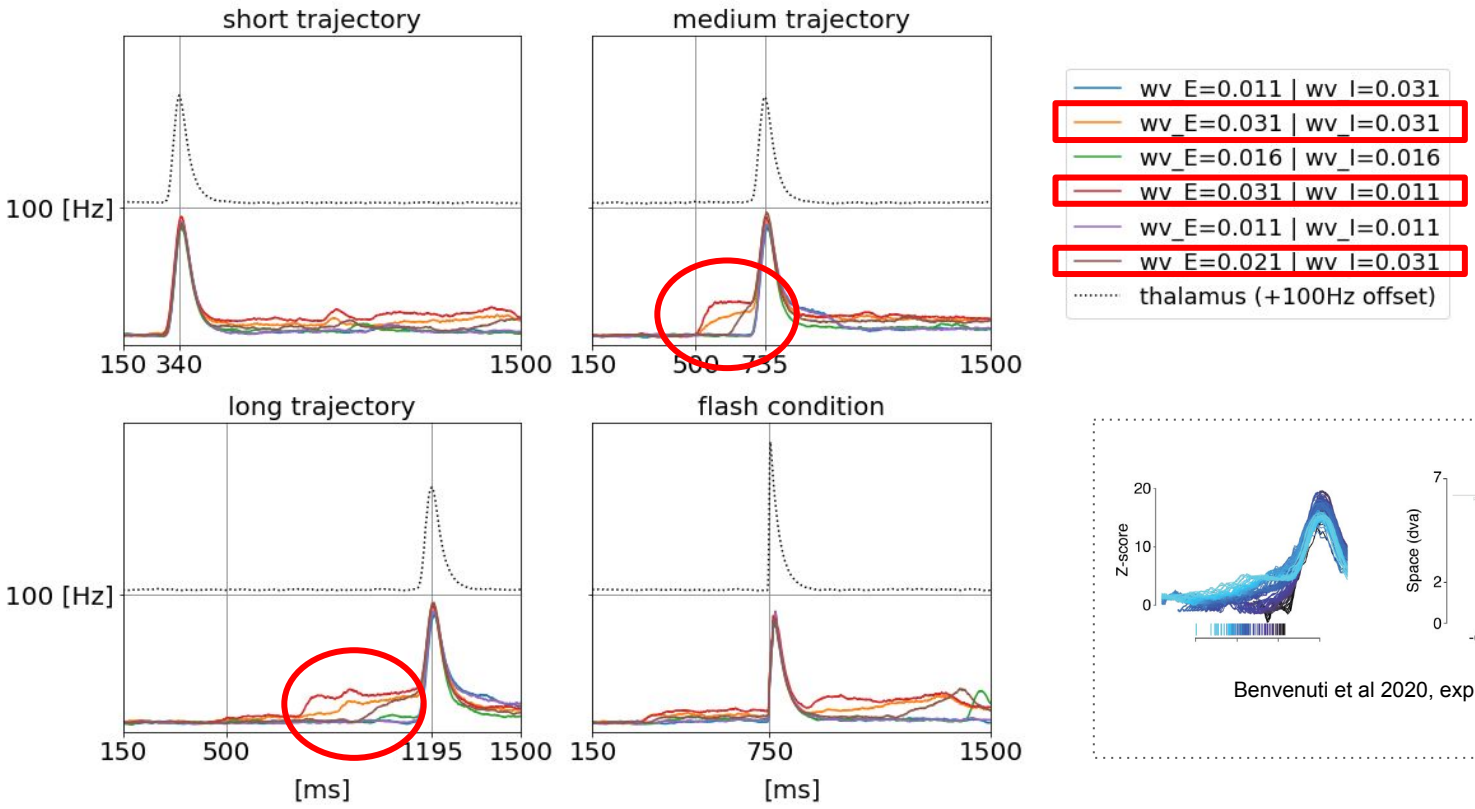
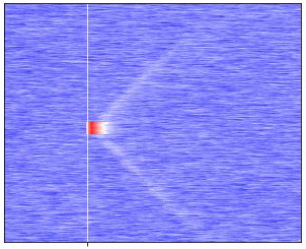


*faster than the stimulus velocity 0.011 [mm/ms]

Cortical waves interactions are results of neural non linearities

How cortical waves relates when they collide?

Cortical waves interactions are results of neural non linearities



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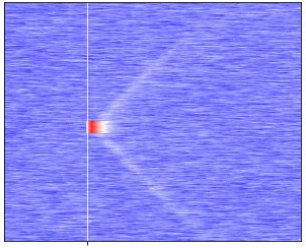

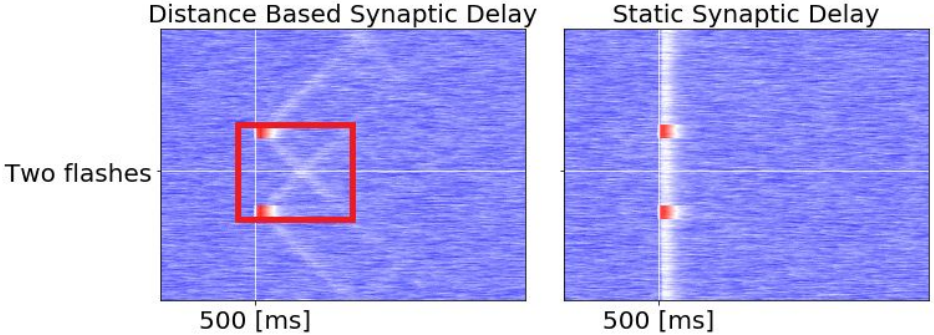

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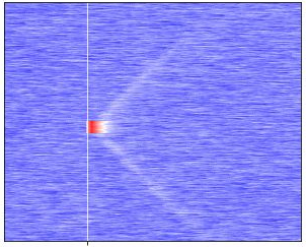

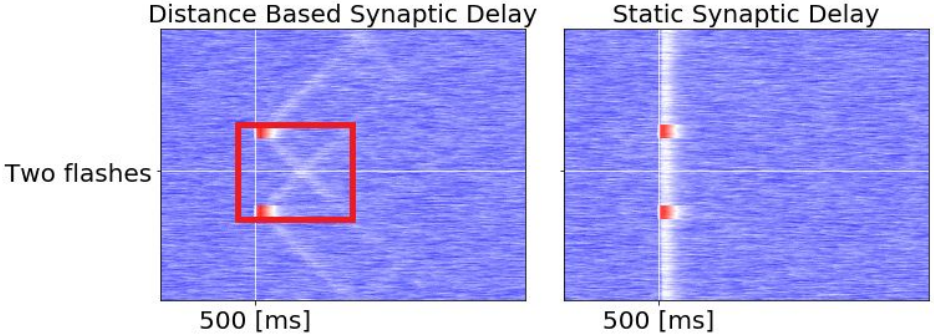

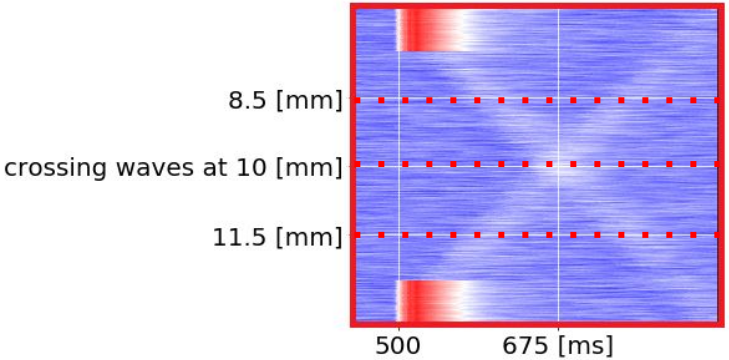

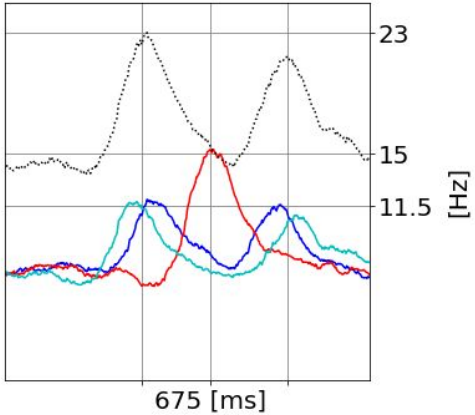

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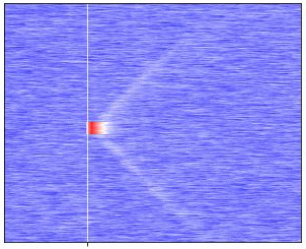
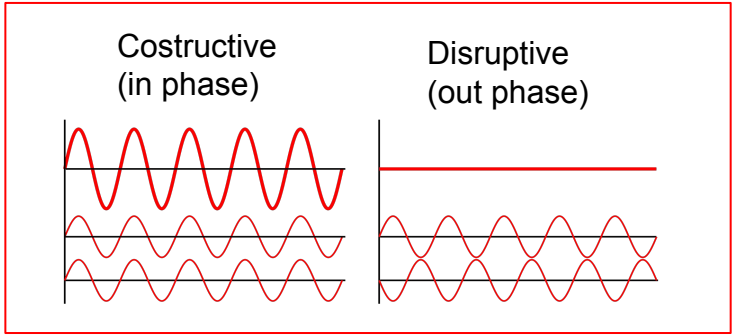
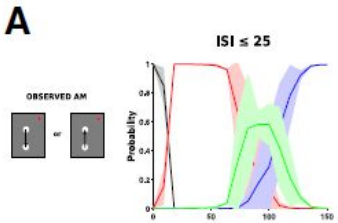


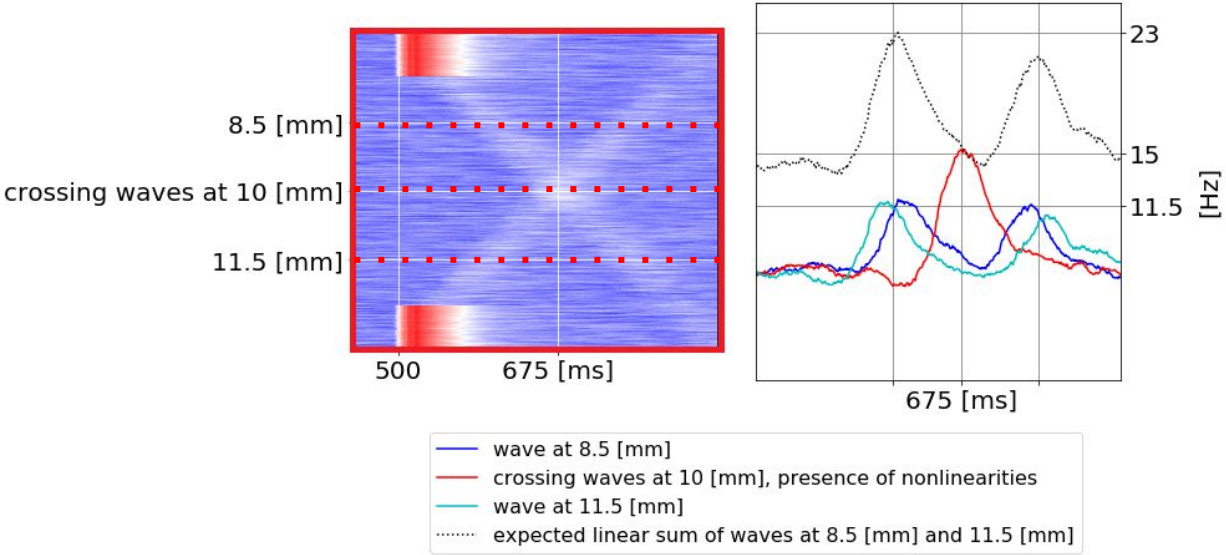


Two flashes at same time, waves mostly in phase.

To test: flashes with temporal succession



Chemla et al 2019, suppressive waves shape apparent motion illusion



Conclusions

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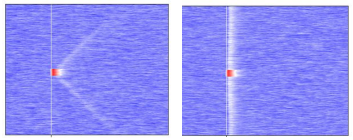

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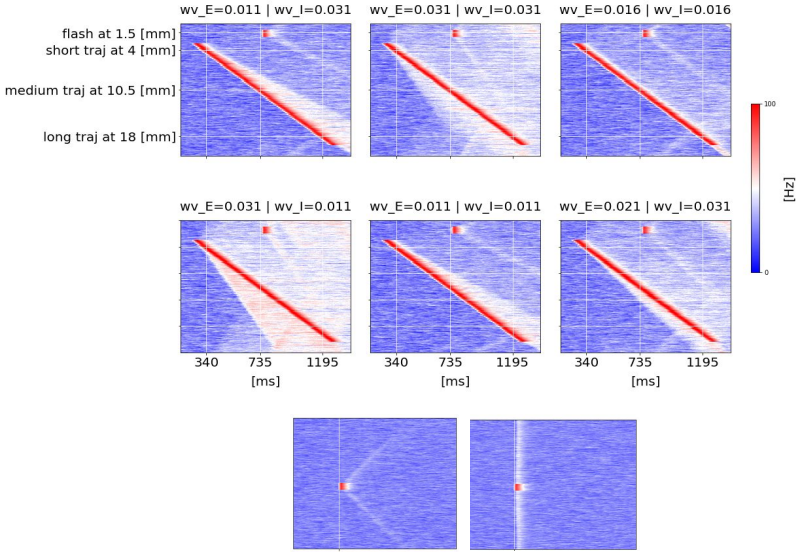

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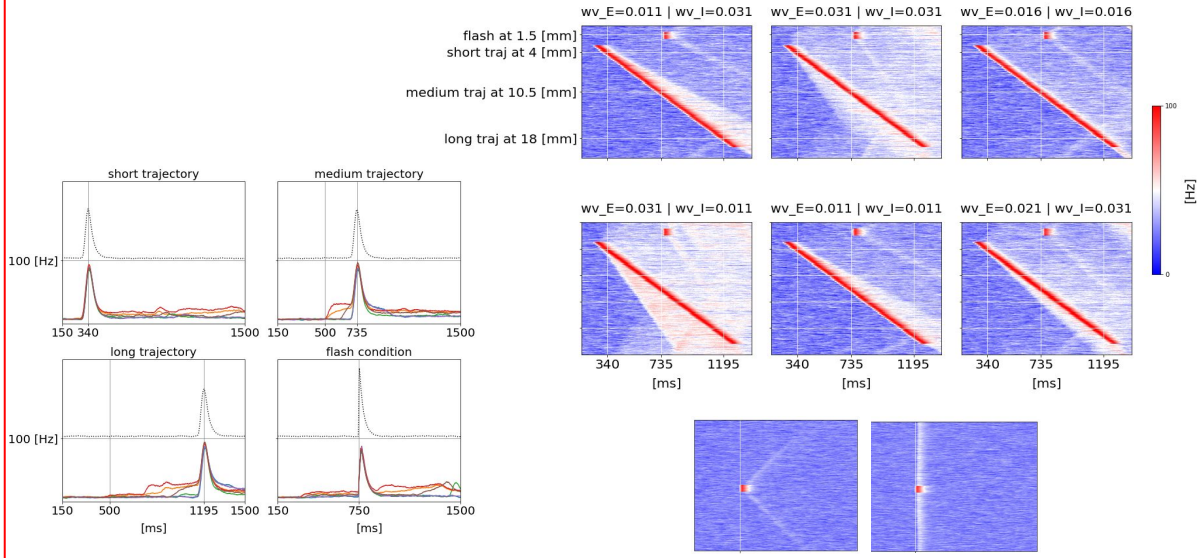

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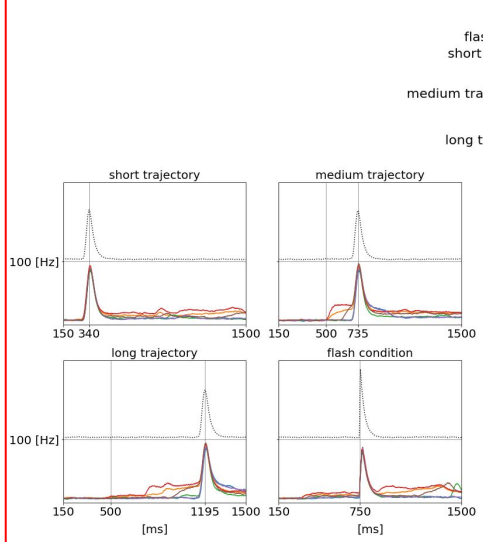

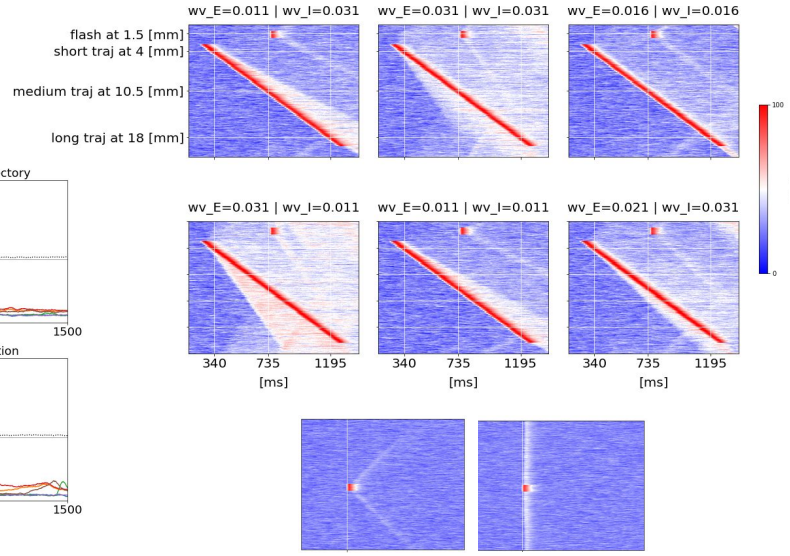

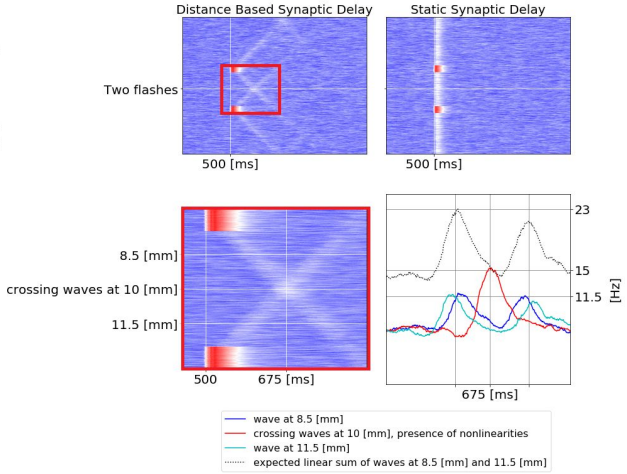

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- **How the brain is able to separate predictive from non predictive information?**
  - Results from the retina in primates
  - Liu B, Hong A, Rieke F, Manookin MB. 2021. Predictive encoding of motion begins in the primate retina. *Nat Neurosci* **24**:1280–1291. doi:10.1038/s41593-021-00899-1

(second part of the seminar)

Thanks, merci, grazie

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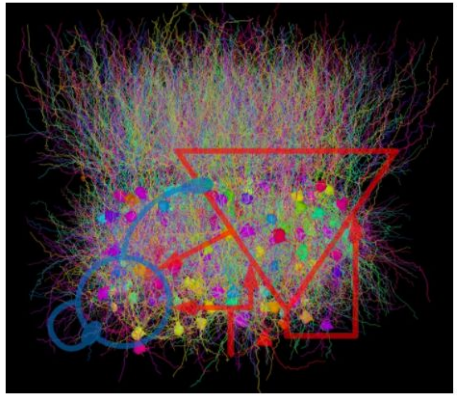

EEG data analysis and modeling in humans

1. Early dementia biomarkers
2. Emotions in healthy subjects

Sant'Anna
Scuola Universitaria Superiore Pisa

THE BIOROBOTICS INSTITUTE

COMPUTATIONAL NEUROENGINEERING LABORATORY

Prof. Alberto Mazzoni

Thanks, merci, grazie

Farewell party at 16:00 on Thursday the 30th at 4th floor