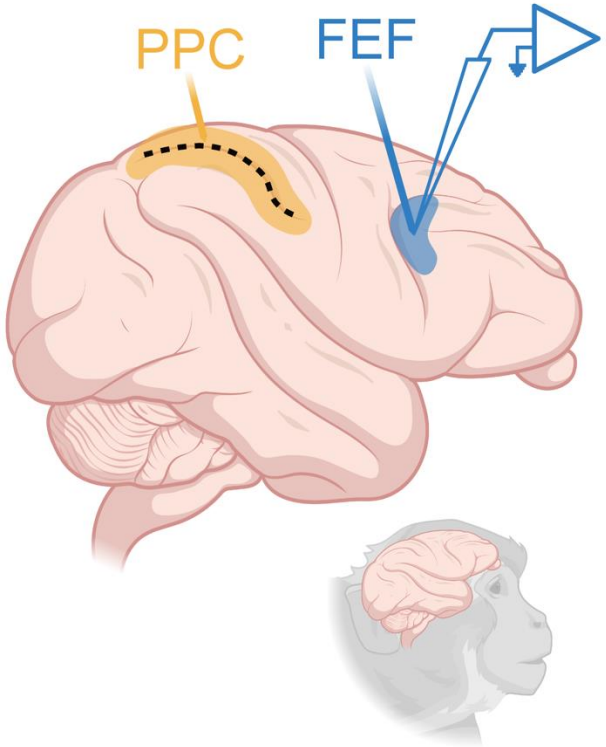
PPC Inactivation Alters Intrinsic Neural Timescales and Attentional Processing in FEF Neurons

Soyuhos, O., Moore, T., Chaudhuri, R., & Chen, X.



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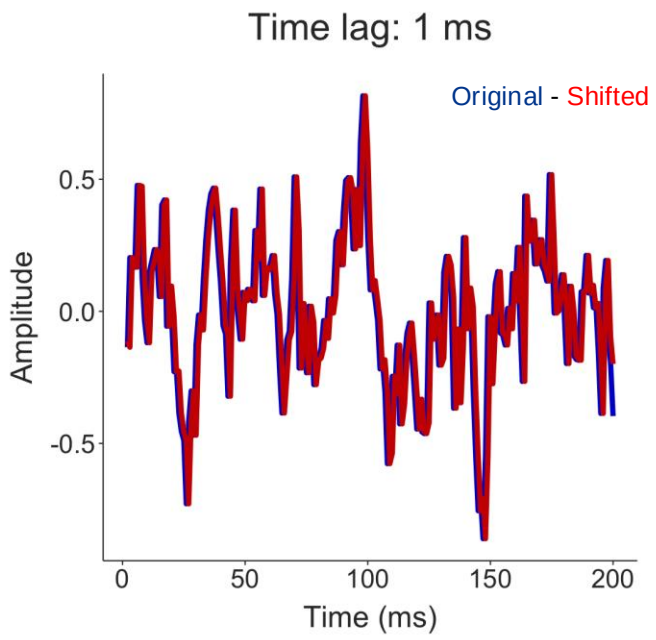
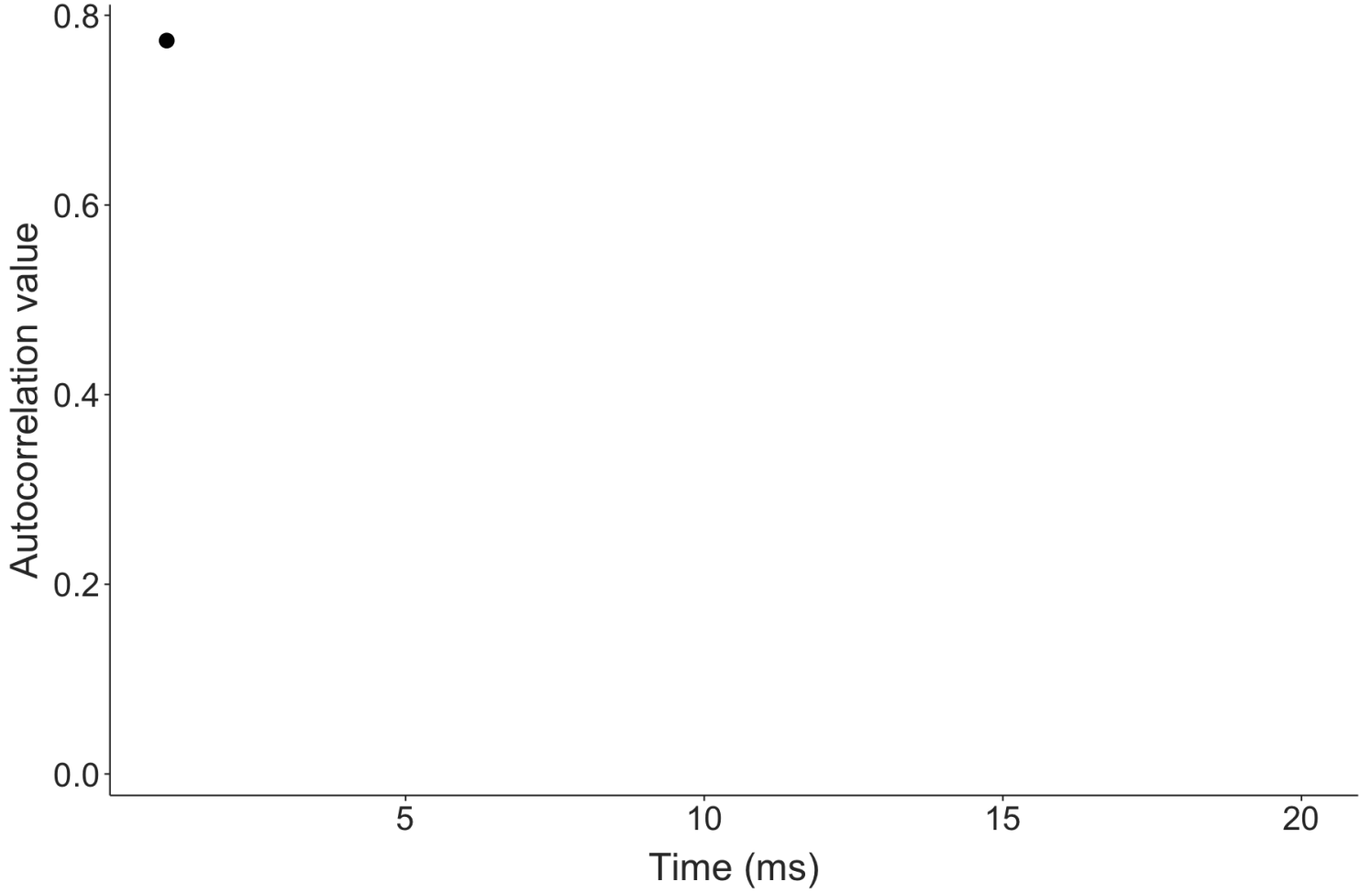
Introduction to neural timescales (tau)

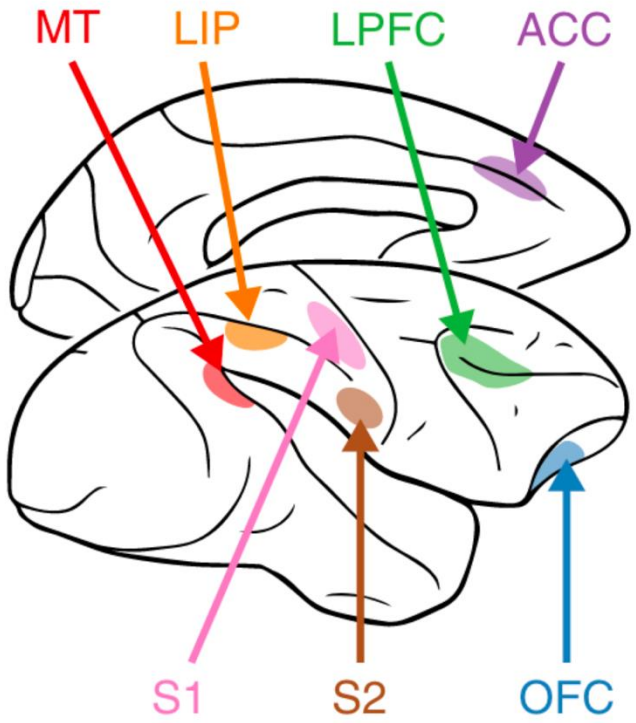
- Neural timescales measure the rate at which **intrinsic** neural activity is carried over time, reflecting how quickly or slowly neuronal signals decay in the absence of task-related input.

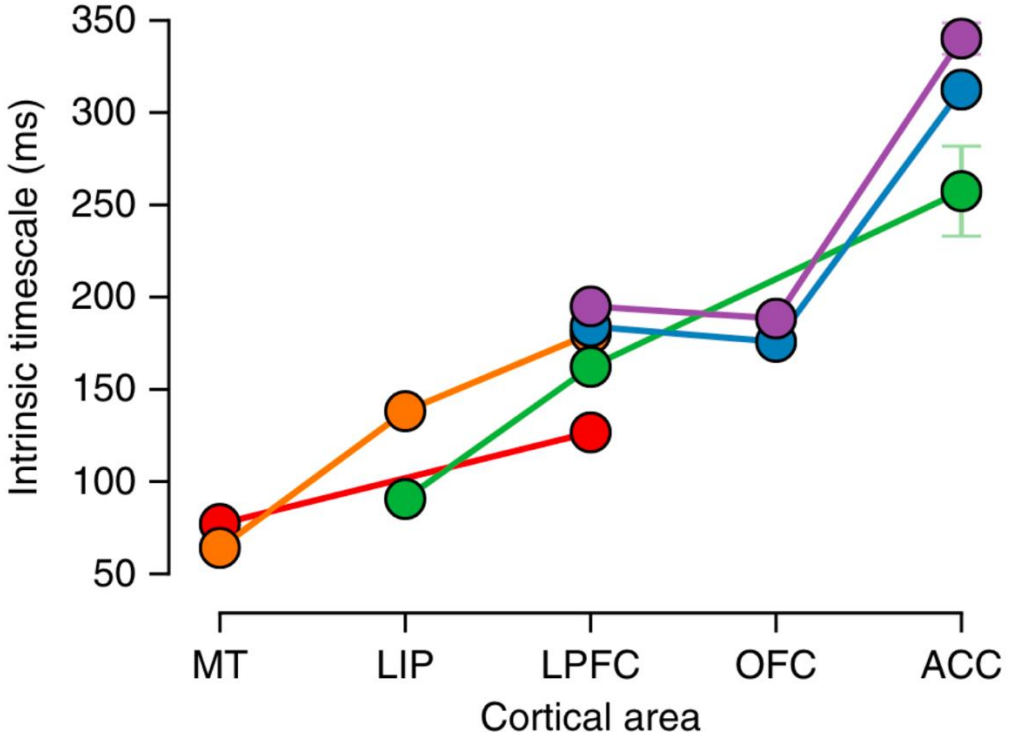


e.g., spike count = [1 2 3 4 5]
Lag 0: [1 2 3 4 5] and [1 2 3 4 5]
Lag 1: [1 2 3 4] and [2 3 4 5]
Lag 2: [1 2 3] and [3 4 5]



A hierarchy of intrinsic timescales across primate cortex

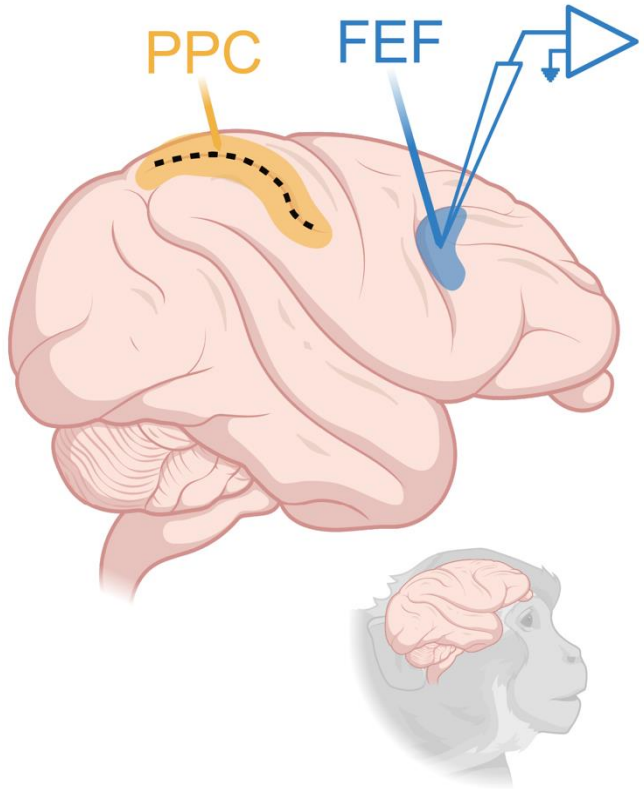




Murray et al., (2014)

Dorsal attention network: FEF and PPC

- The frontal eye field (**FEF**) is a key part of the attention network, responsible for controlling visual attention.
- Together with the posterior parietal cortex (**PPC**), the fronto-parietal attention network play an important role in both stimulus-driven and goal-directed attention.



Dorsal attention network: FEF and PPC

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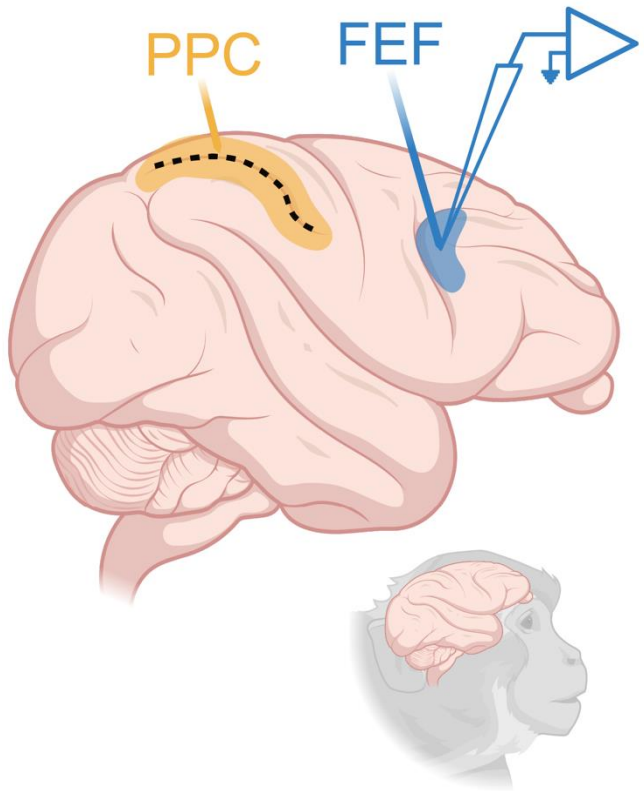
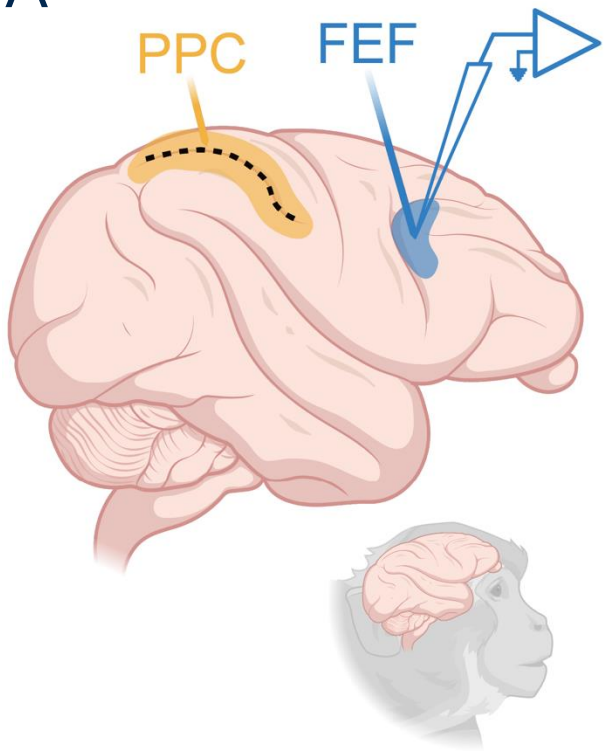
- Together with the posterior parietal cortex (**PPC**), the fronto-parietal attention network play an important role in both stimulus-driven and goal-directed attention.

- **Research questions:**
  - The nature of neural dynamics in the FEF.
  - Their functional relevance in visual and attentional processing.
  - The causal role of PPC inactivation in regulating these neural dynamics and attention processing in FEF.



Experimental setup

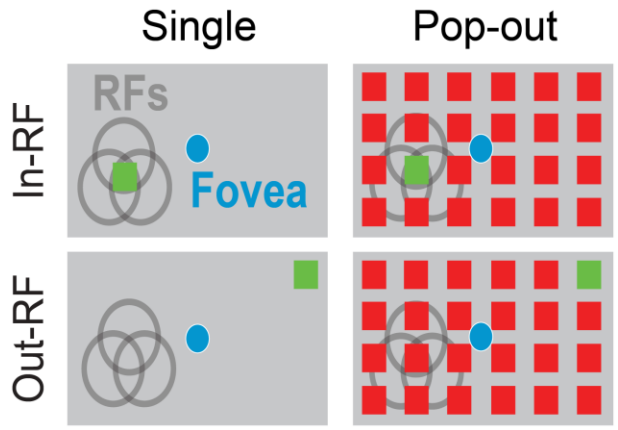
A



- Two macaque monkeys performed a passive viewing task.
- FEF neurons were recorded using linear array probes under two conditions: with and without PPC inactivation.
- PPC was reversibly inactivated using cryo-inactivation.

Experimental setup

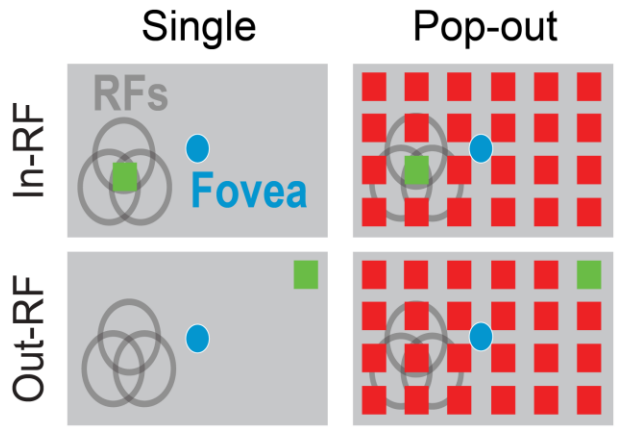
B



- Single stimuli are linked to visual sensitivity.
- Pop-out stimuli lead to stimulus-driven attention.

Experimental setup

B



- Single stimuli are linked to visual sensitivity.
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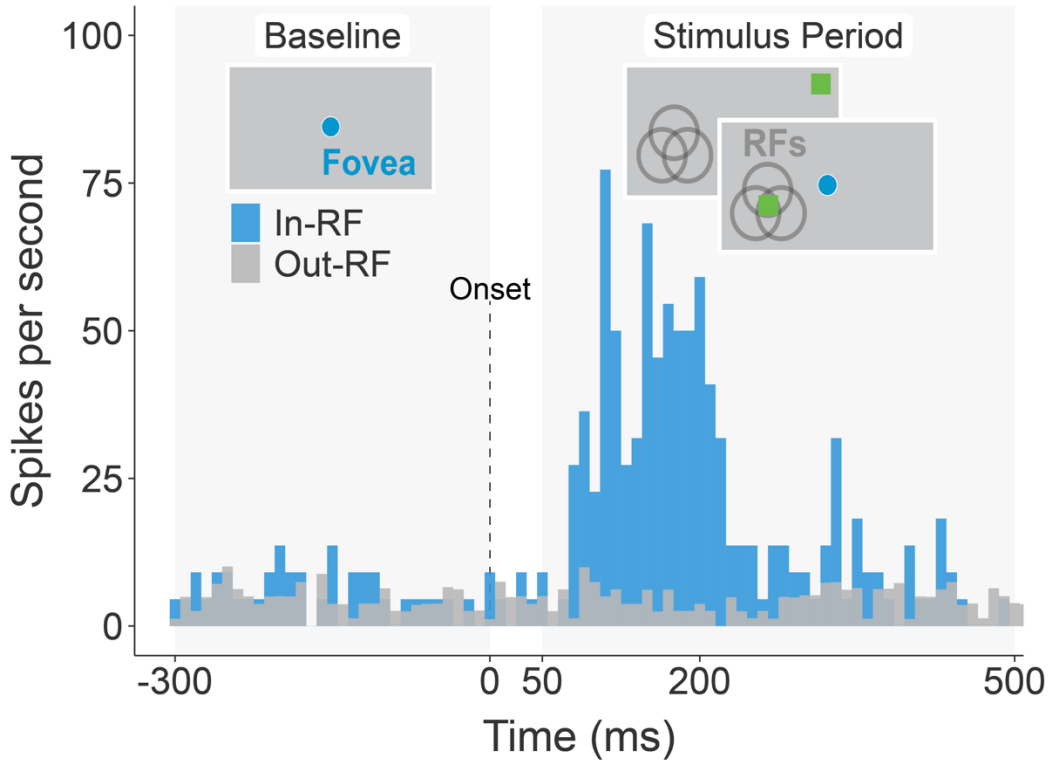
C



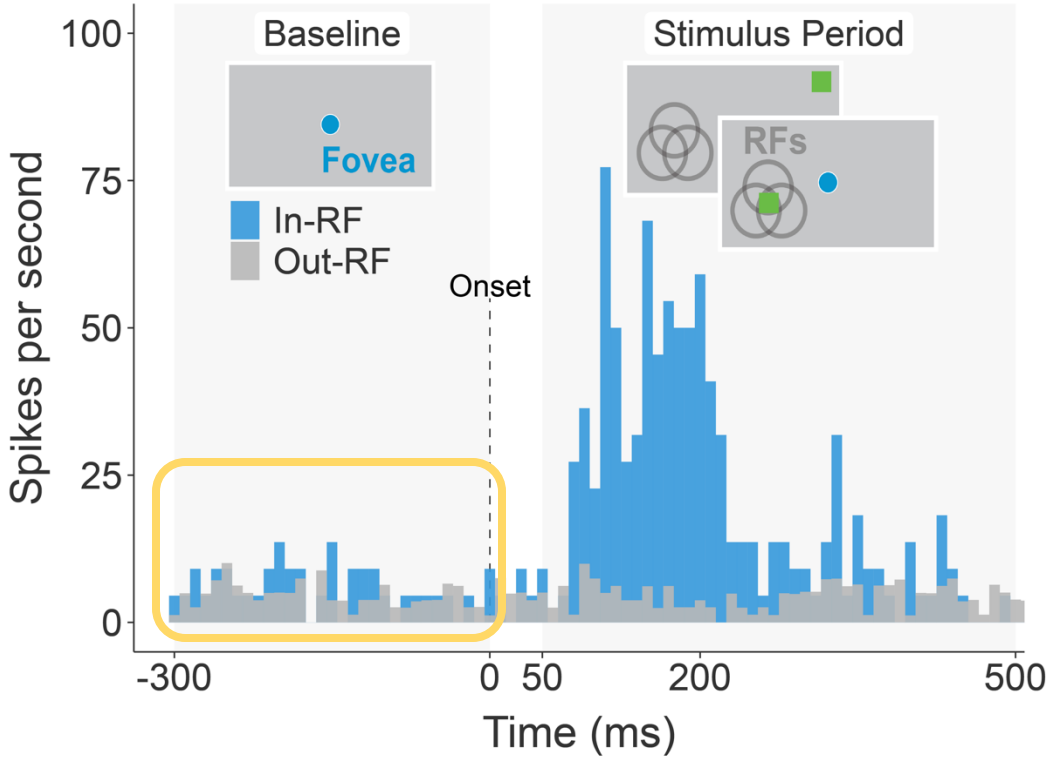
-300 to 0 ms → Baseline period

50 to 200 ms → Transient stimulus period

200 to 500 ms → Sustained stimulus period

Neural timescales (tau) calculated over baseline

C



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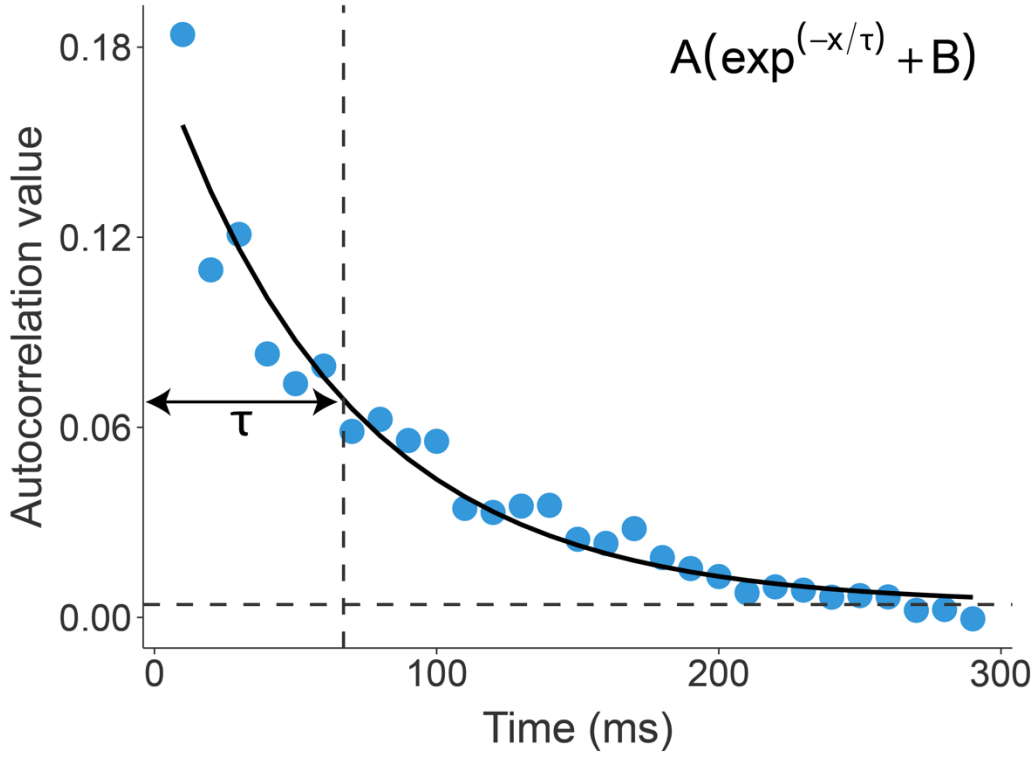

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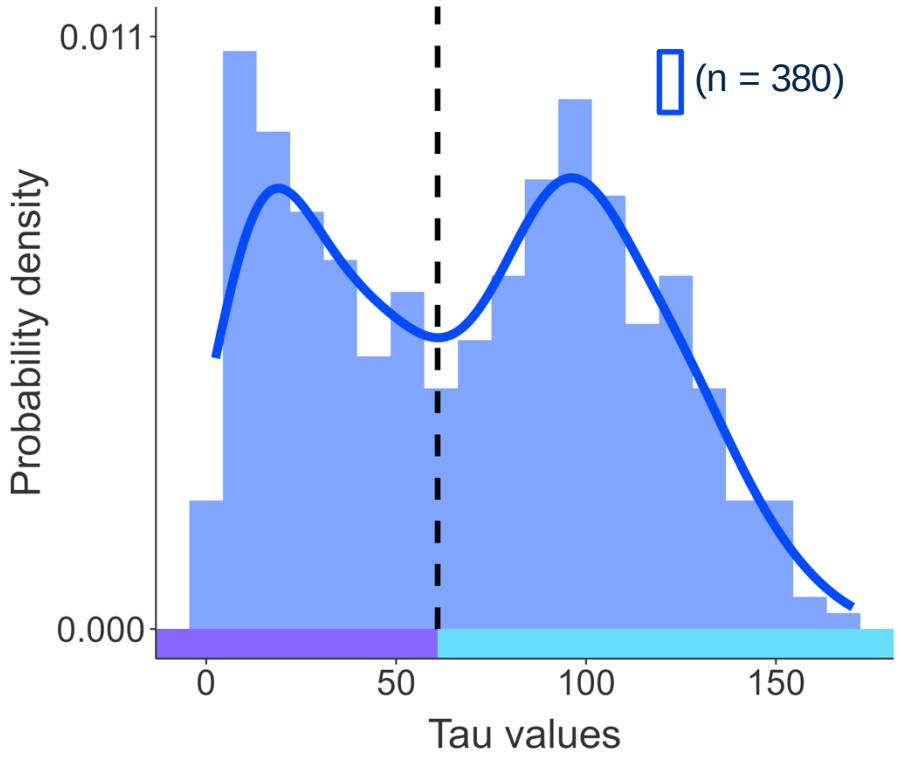
Two distinct neural timescales in FEF.

A



UCDAVIS

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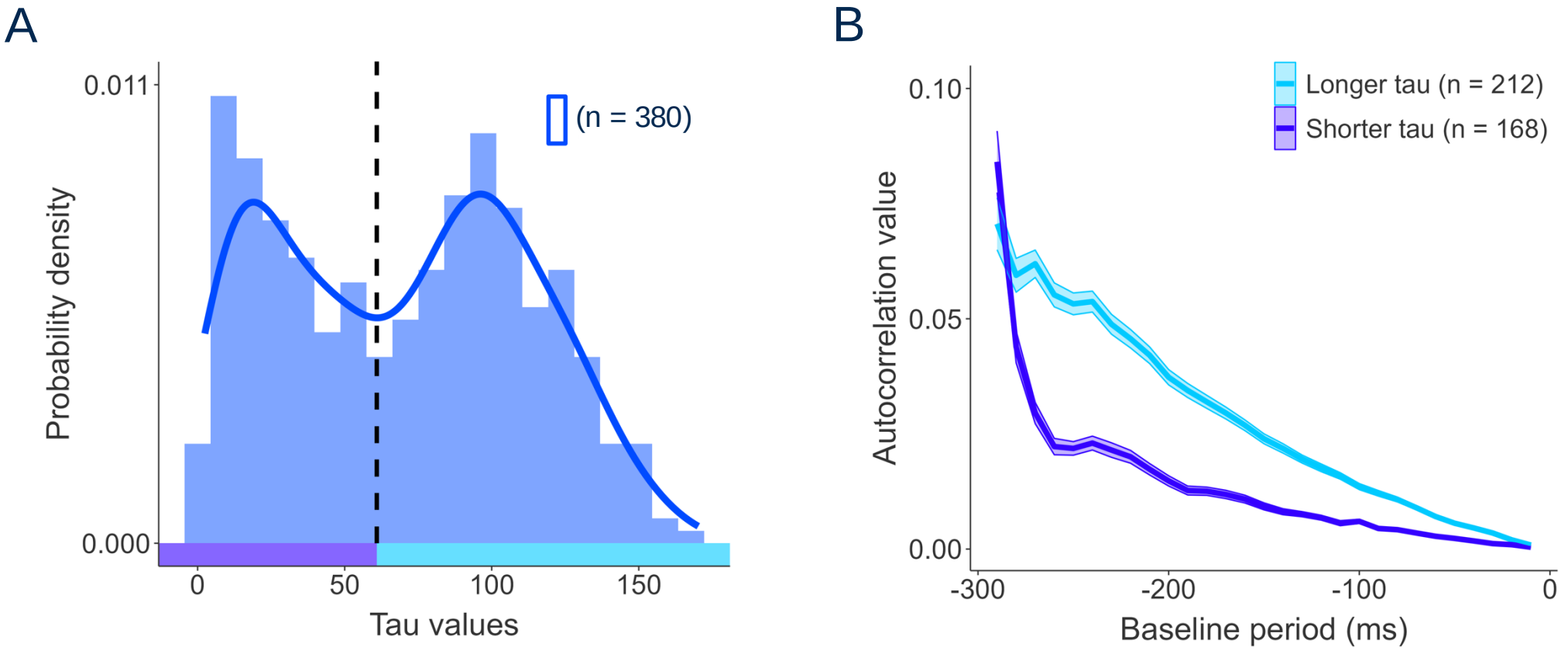

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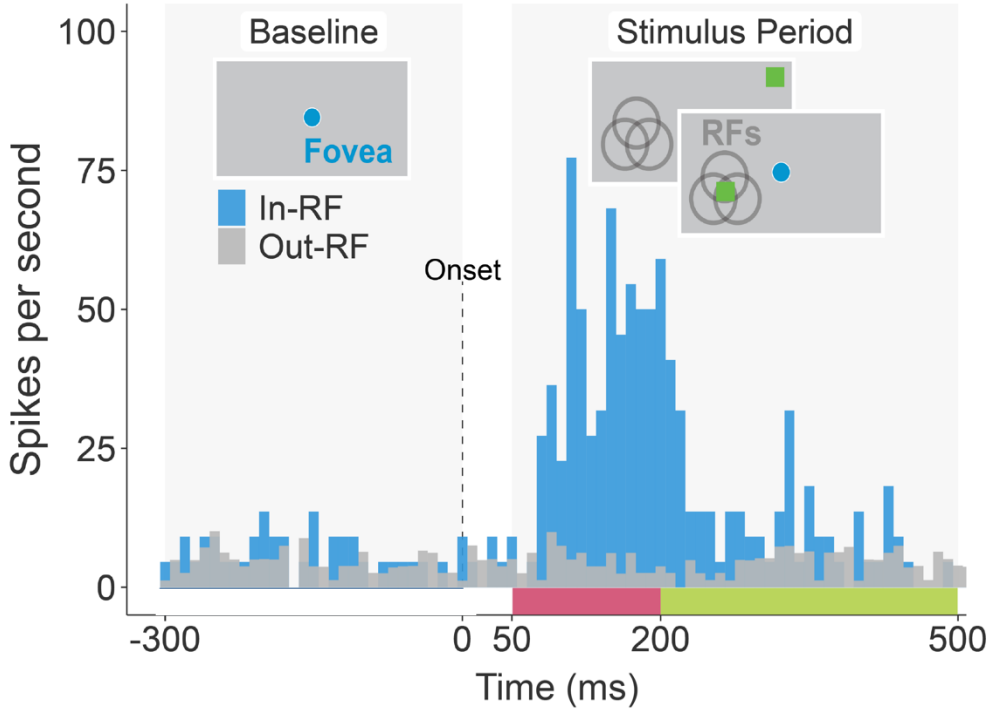
Functional relevance of FEF intrinsic neural timescales.

A

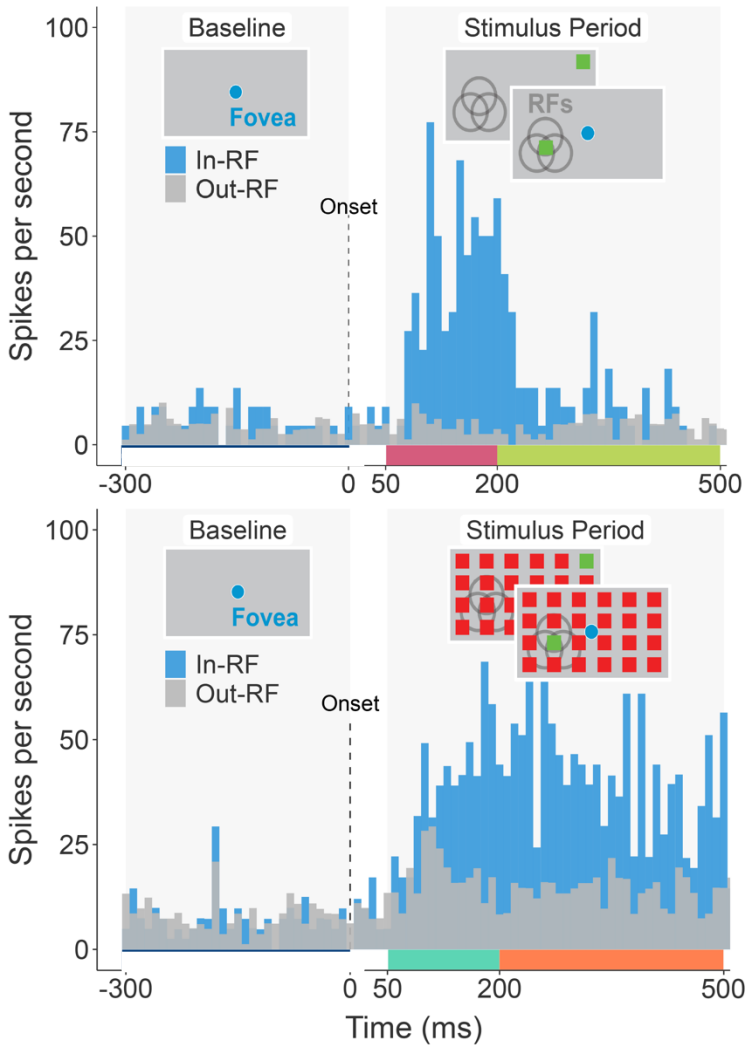


Visual transient

Visual sustained

Functional relevance of FEF intrinsic neural timescales.

A



Visual transient

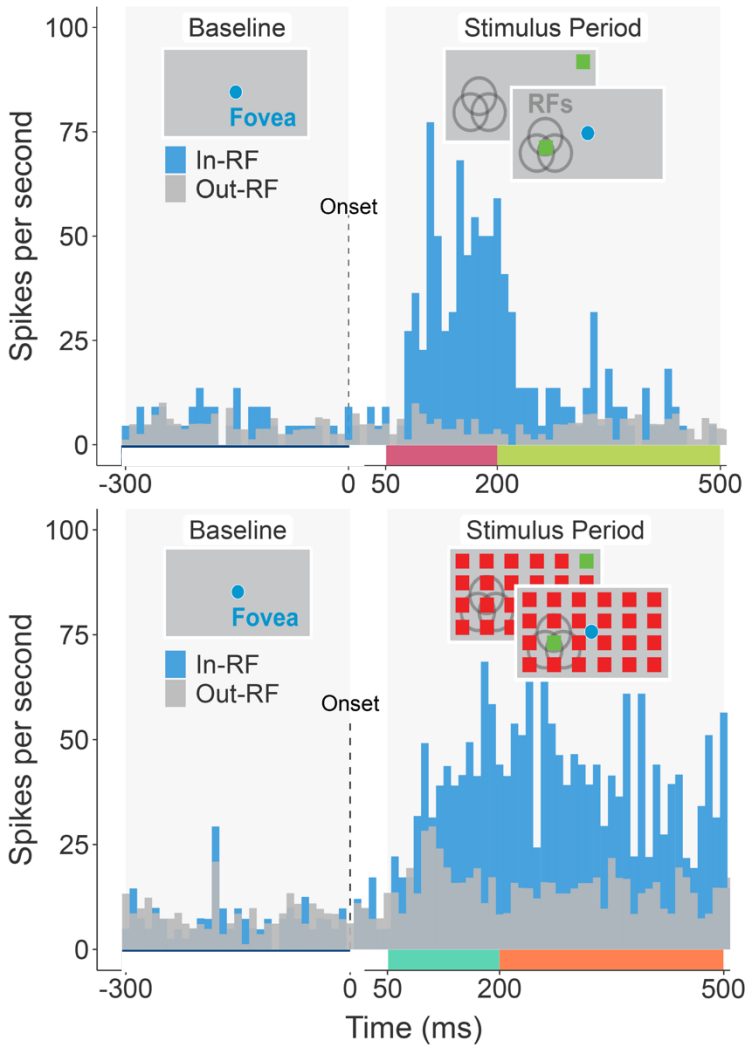
Visual sustained

Attention transient

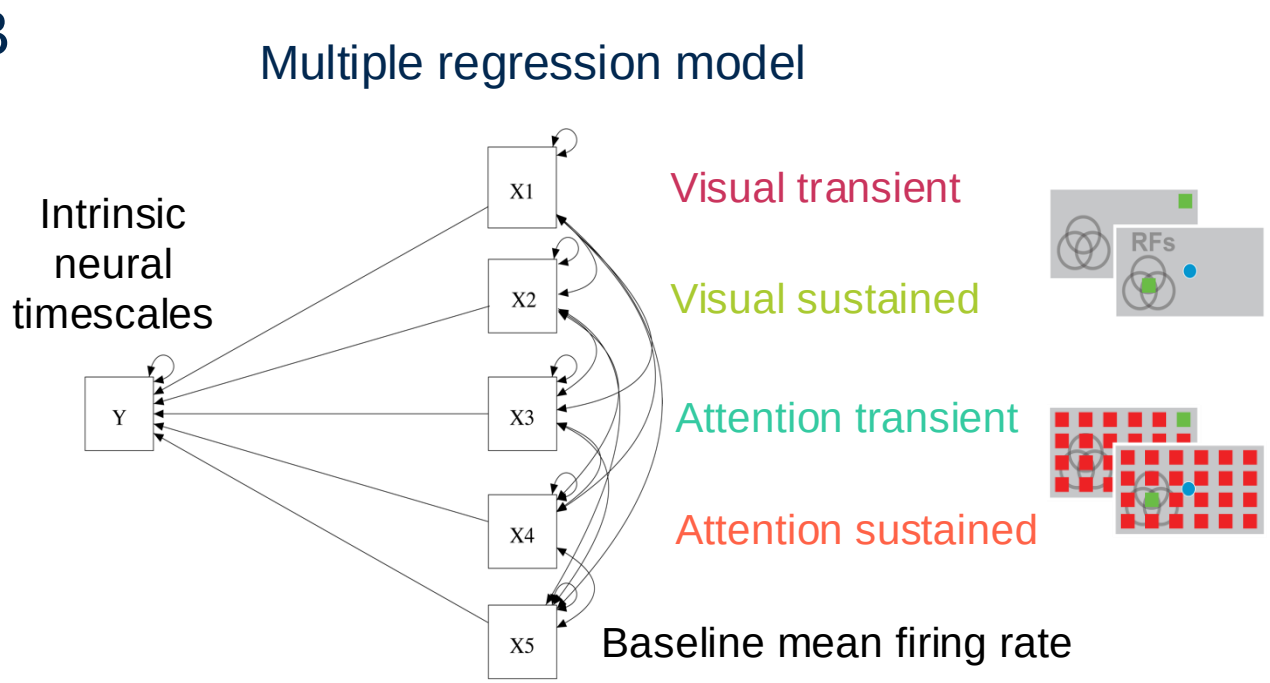
Attention sustained

Functional relevance of FEF intrinsic neural timescales.

A

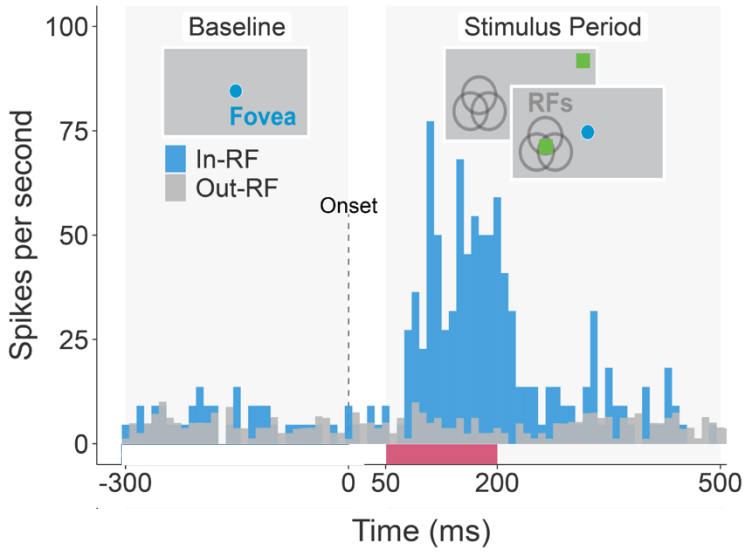


B



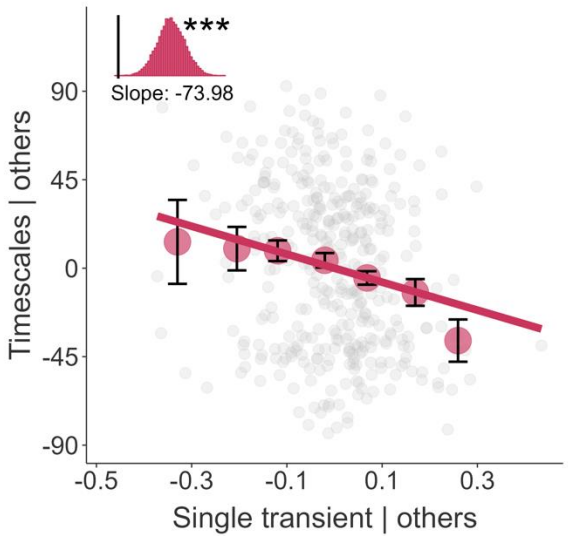
Functional relevance of FEF intrinsic neural timescales.

A



C

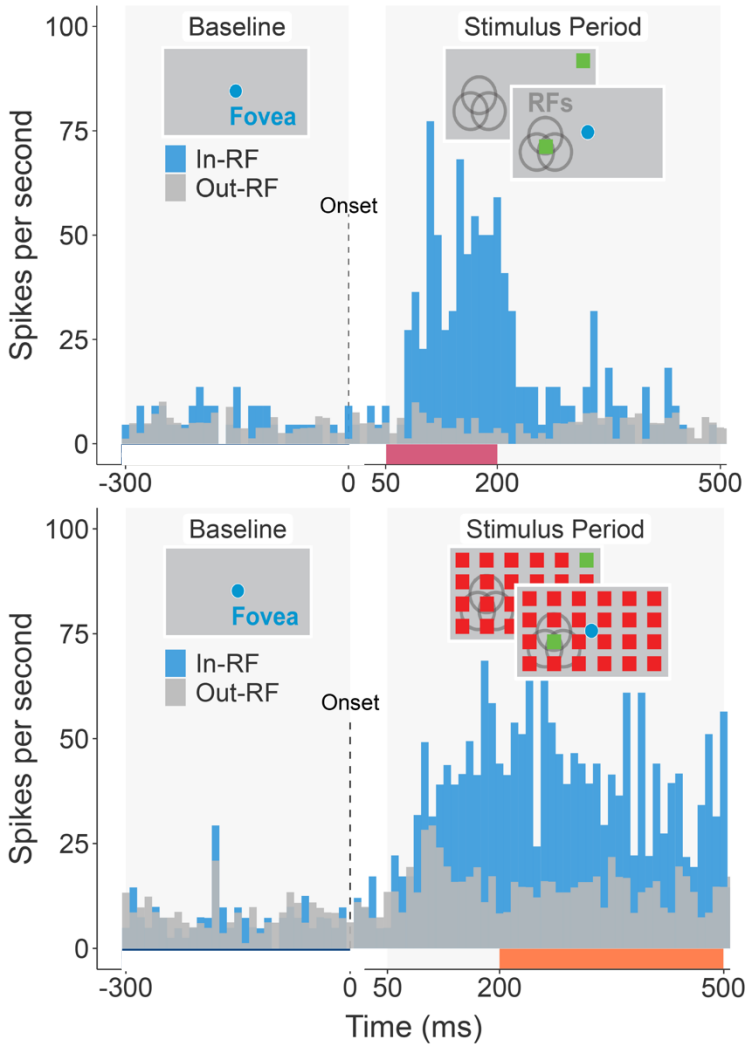
Visual transient



- Neurons with faster timescales have higher visual sensitivity.

Functional relevance of FEF intrinsic neural timescales.

A



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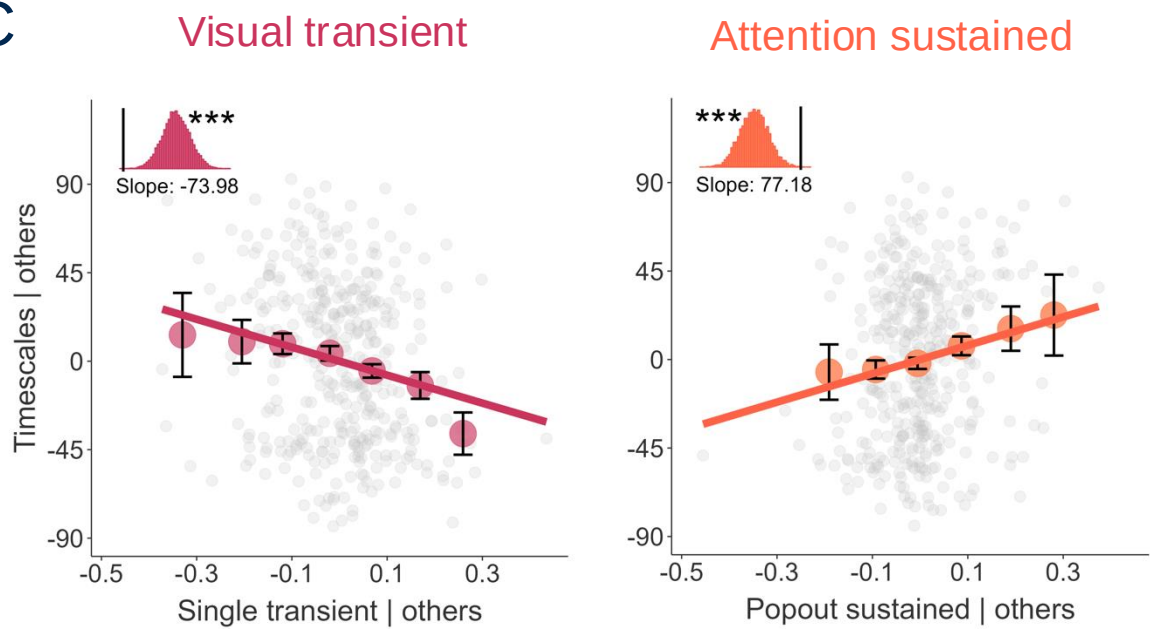
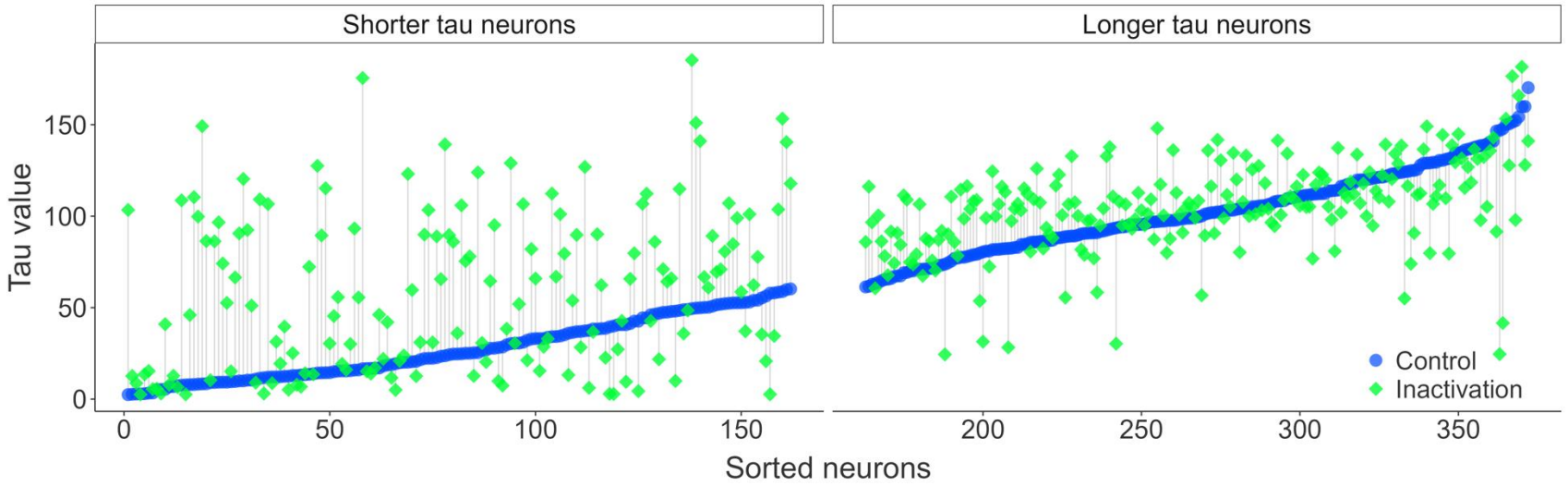


- Neurons with faster timescales have higher visual sensitivity.
- Neurons with slower timescales have stronger attentional modulation.

PPC inactivation selectively increases the intrinsic timescales of shorter tau neurons in FEF.

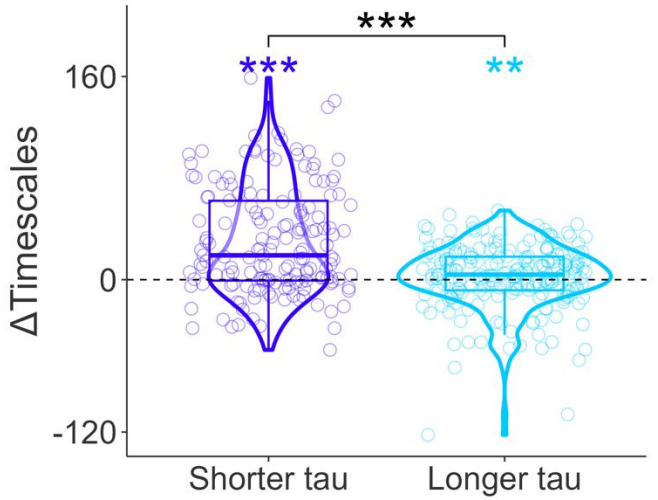
C



$p < 0.001$, effect size = 0.432

- Shorter tau neurons are more feedforward recipient neurons from the PPC.

D



- $p < 0.001$, effect size = 0.35
- Δmean: 30 ms for shorter tau
- Δmean: 2 ms for longer tau

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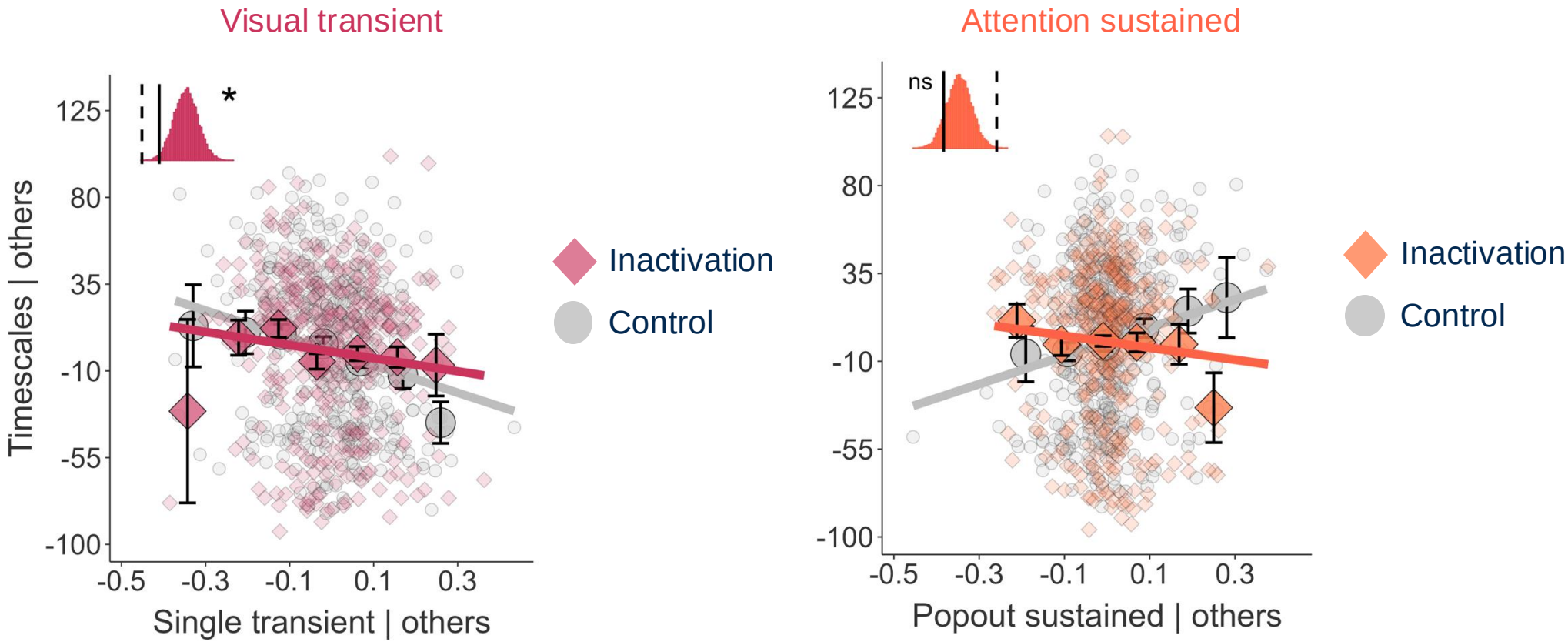
PPC inactivation selectively modulate attention processing.



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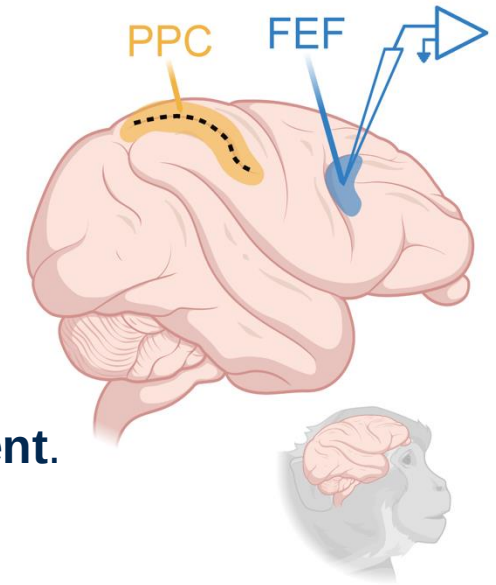
Summary



- There are two distinct neural timescales in the FEF.

- FEF's intrinsic neural timescales are linked to their functional roles.
  - **Shorter timescale** neurons are more involved in **visual processing**.
  - **Longer timescale** neurons are more involved in **attentional deployment**.

- PPC inactivation disrupts FEF neural dynamics, showing the causal role of long-range connectivity between PPC and FEF in regulating FEF neural timescales.

- PPC inactivation selectively modulates attention processing in FEF, demonstrating the parietal cortex's role in regulating salience signals in FEF.

Thank you!

- Mentors: Dr. Xiaomo Chen and Dr. Rishidev Chaudhuri
- Cognitive Control Lab (CCLAB) members
- NeuralStorm Training Program (NSF Award number: 2152260)

Questions?