### Conjunctive Coding in the Primate Entorhinal Cortex

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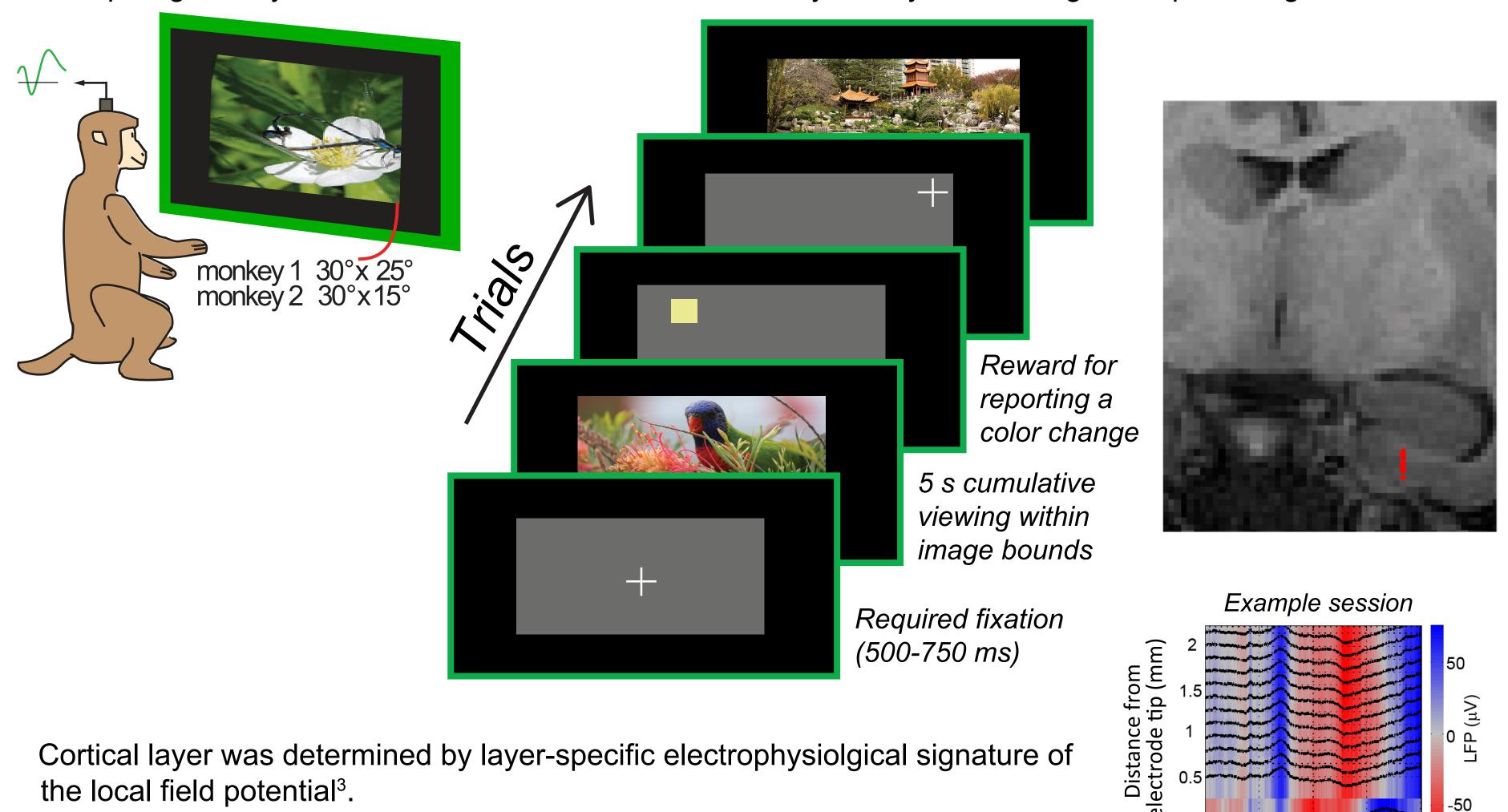
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#### Introduction

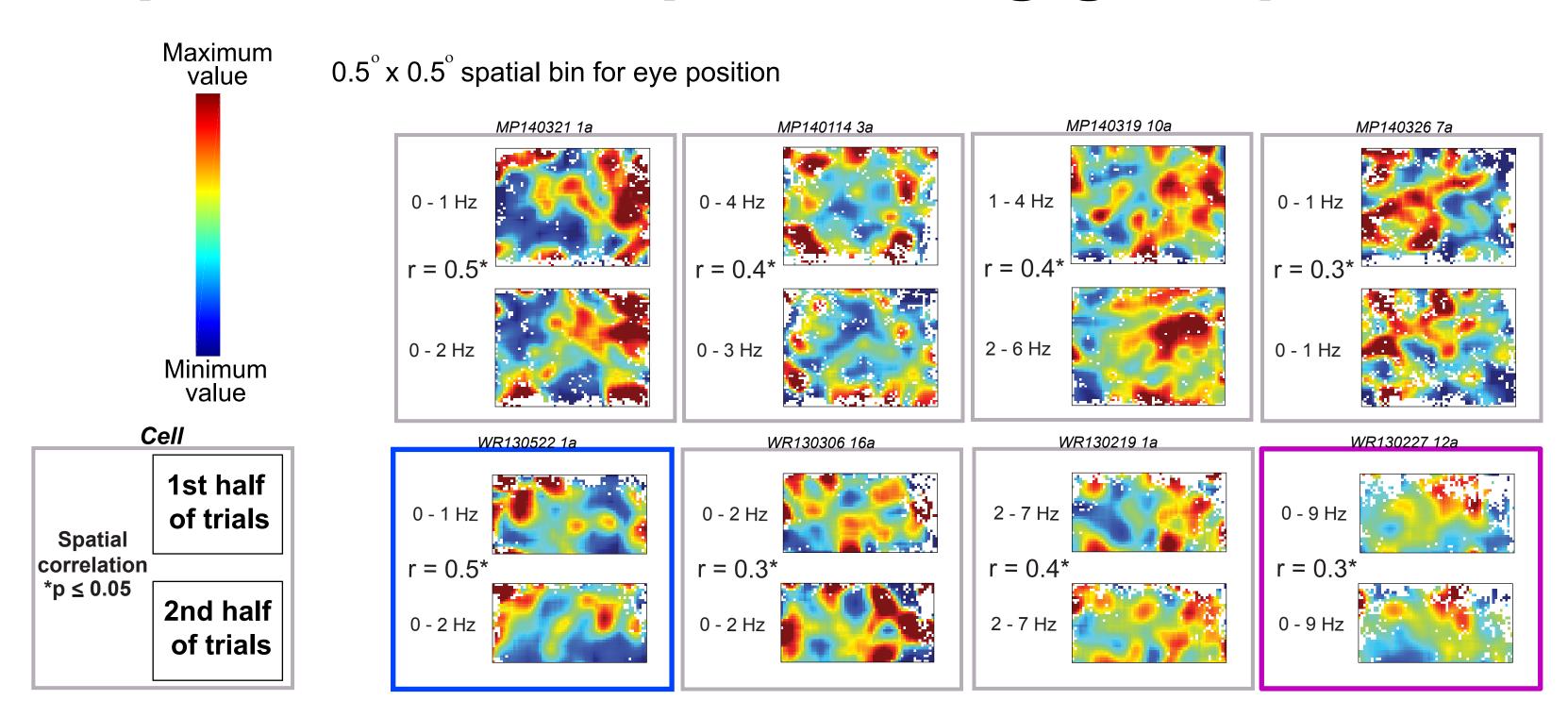
- Neurons that represent spatial position have been identified in the entorhinal cortex (EC) of rodents<sup>1</sup>, bats<sup>2</sup>, monkeys<sup>3,4</sup> and humans<sup>5,6</sup>.
- We recently identified spatial representations in a majority (63%) of EC neurons in monkeys freely viewing complex images for 5-second viewing periods<sup>4</sup>. These neurons demonstrated reliable responses that reflected the location of the monkey's gaze on a computer screen.
- EC neurons also responded strongly to the appearance of an image, and these responses were strikingly diverse, especially with respect to response duration.
- Here, we determined whether single neurons conjunctively code gaze position, the onset of the visual stimulus, and stimulus novelty.
- We then quantitatively described the diverse visual responses (latency and response duration) of individual EC neurons across the population, and examined whether visual response properties relate to coding of gaze position, stimulus novelty, or cortical layer.

### Methods

The spiking activity of EC neurons was recorded as monkeys freely viewed large, complex images.

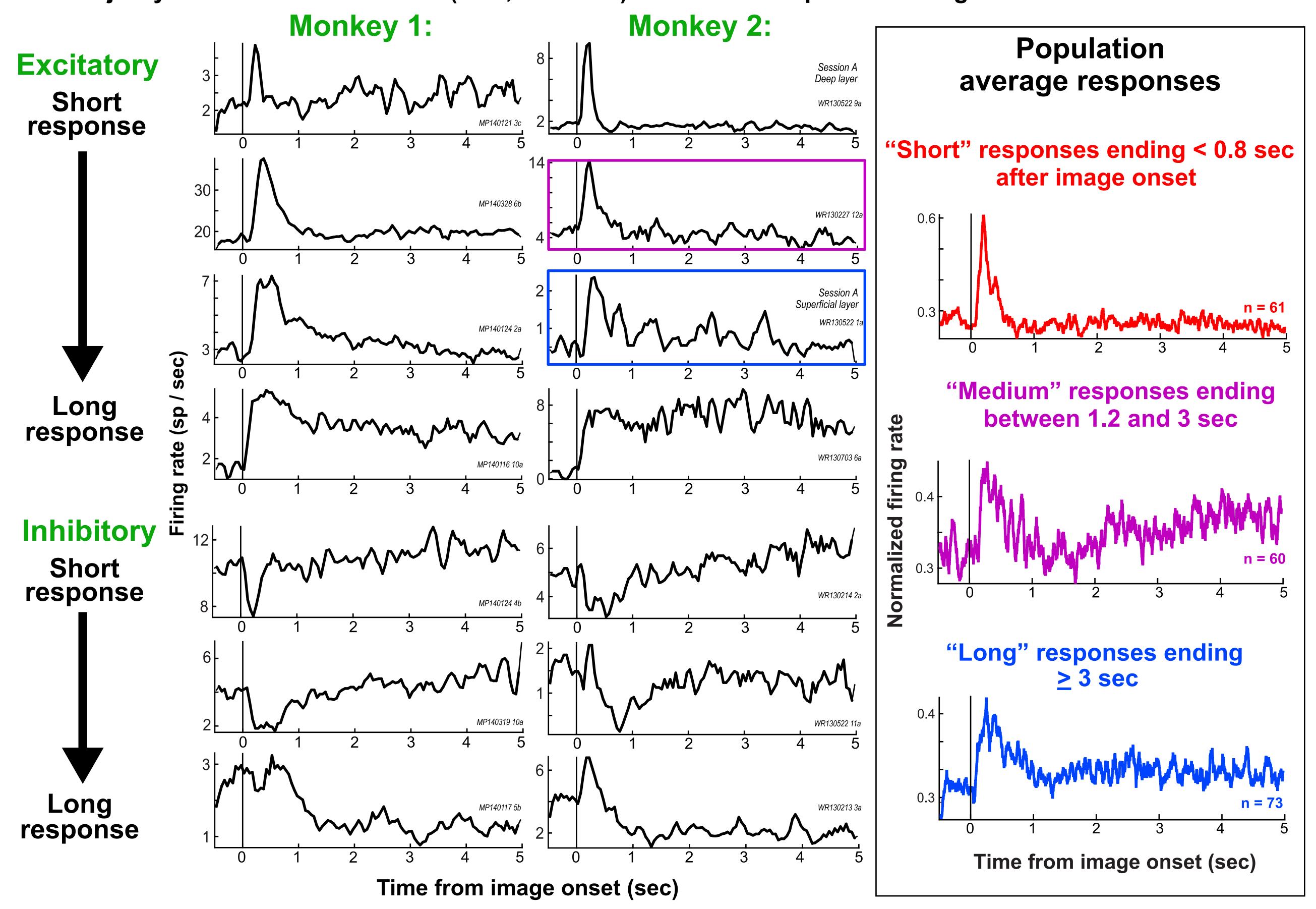


### Examples of cells representing gaze position

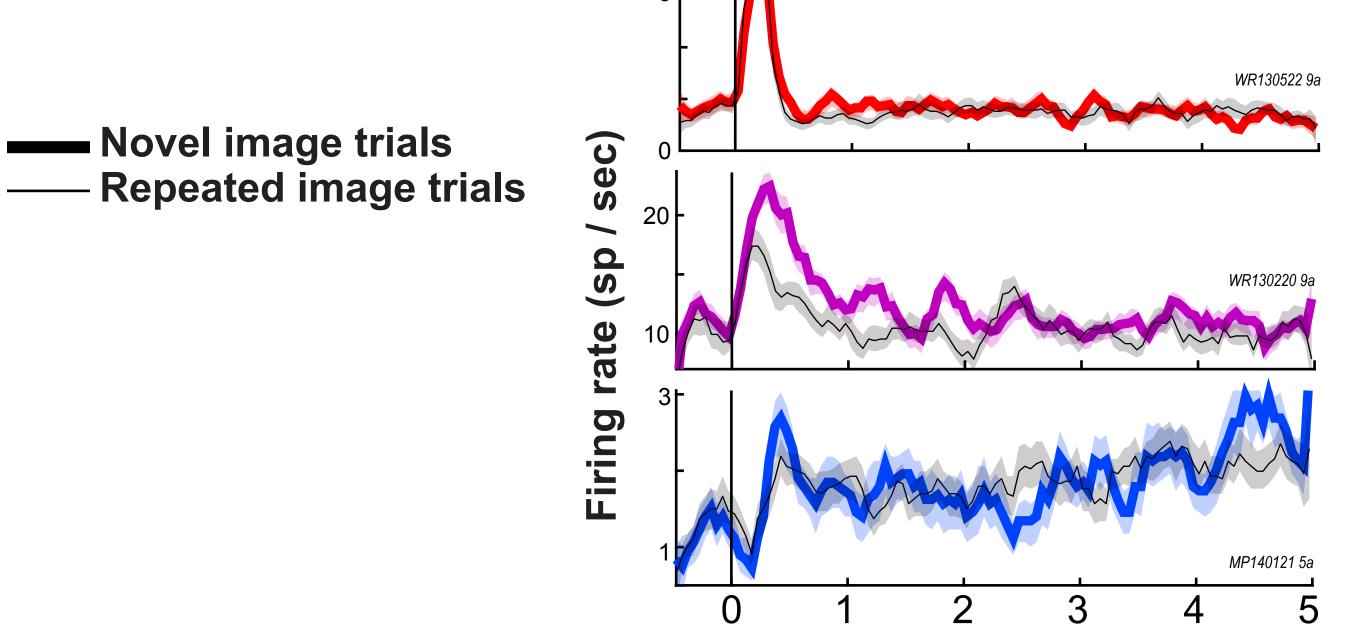


### Visual response duration varies widely

The majority of all recorded neurons (78%, 271 / 349) exhibited a response to image onset.



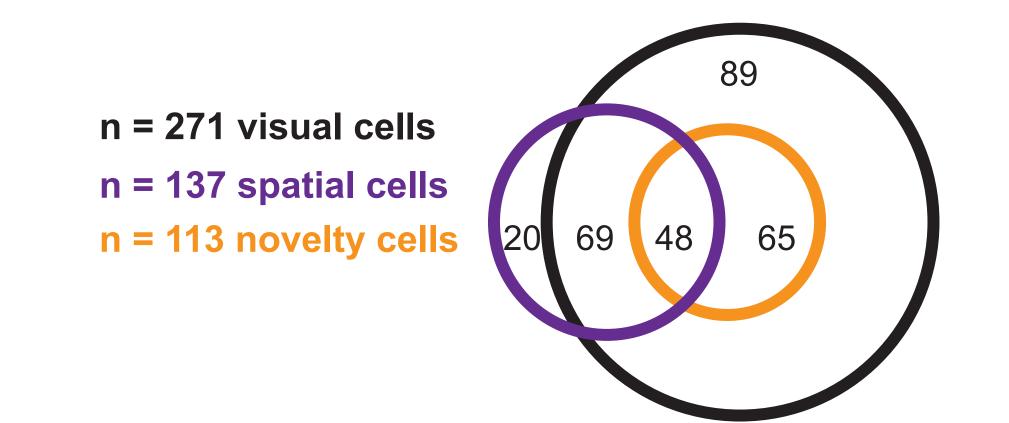
# Examples of visual cells with and without novelty response



Time from image onset (sec)

# The majority of cells show conjunctive coding

67% of <u>visually responsive cells</u> (182 / 271) indicate <u>gaze position</u>, <u>novelty of an image</u>, or both.



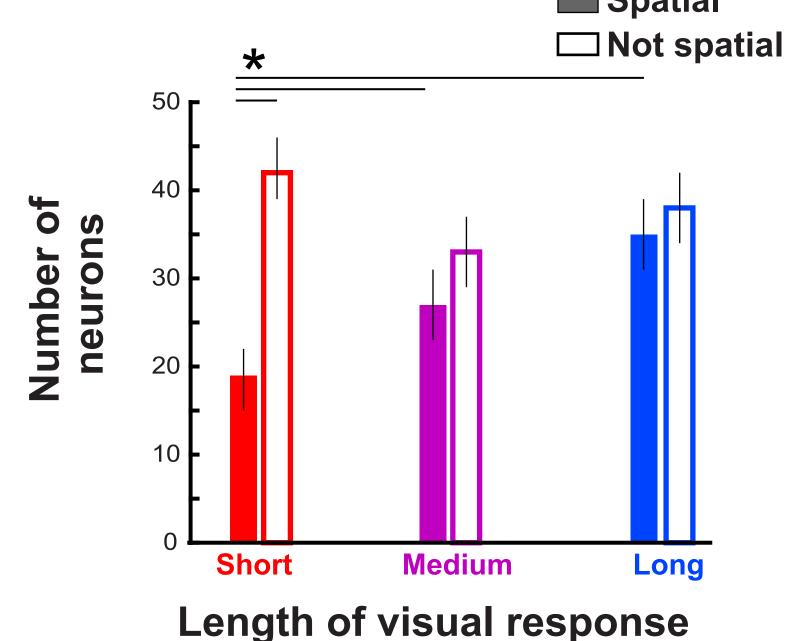
#### Conclusions

- Over half (52%) of EC neurons showed conjunctive coding, representing at least two types of information: Appearance of visual stimuli, gaze position, and stimulus novelty.
- A striking majority of EC neurons were visually responsive, with many responses lasting at least three seconds.
- Visual response properties, especially response duration, related to cortical layer, spatial representation, and novelty response.

-Taken together, these data suggest that a large majority of entorhinal neurons are visually responsive and often conjunctively code other information including gaze position and stimulus novelty. It is possible this conjunctive signalling in the primate EC supports episodic memory by processing both stimulus position and identity. Specifically, the greater spatial signaling of cells with long-decaying responses suggests that a sustained visual response may allow stimuli viewed by successive fixations within a scene to be linked together in memory.

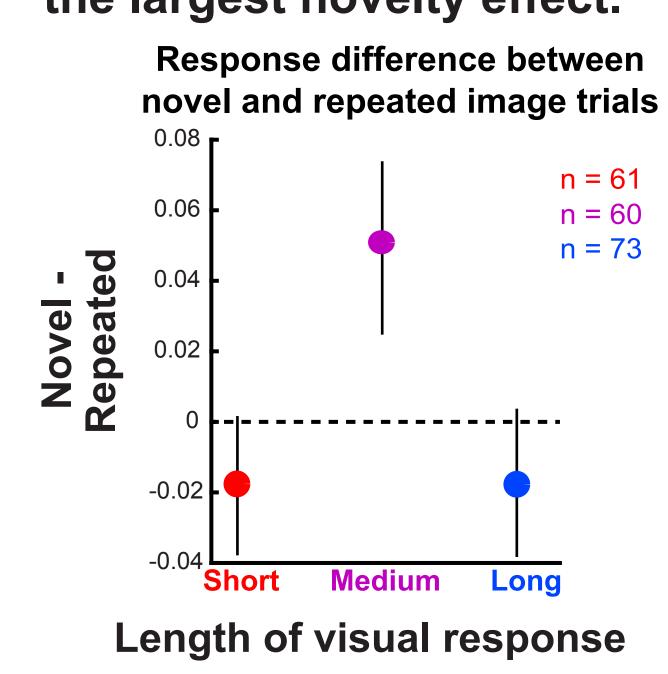
## Spatial cells have longer visual Novelty response differs responses. Novelty response differs across visual cell groups



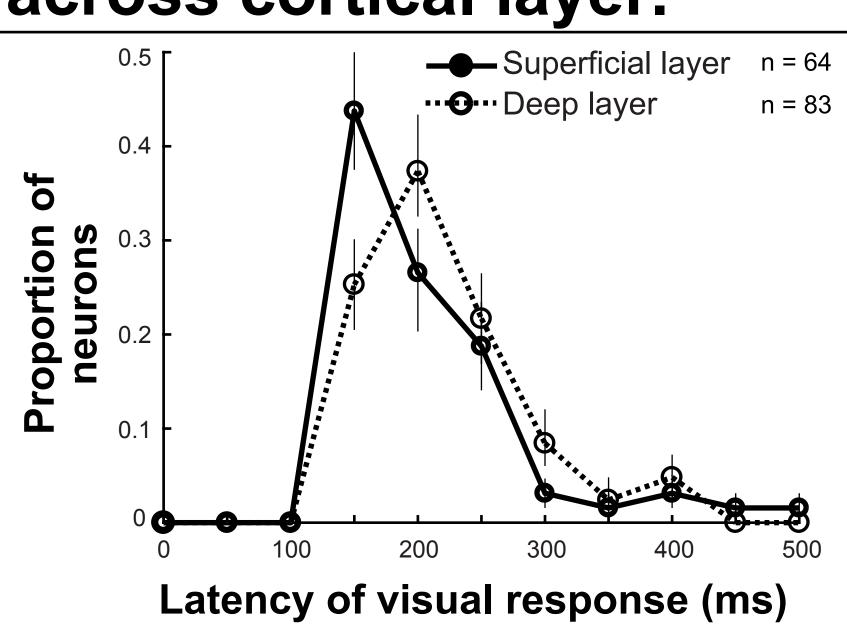


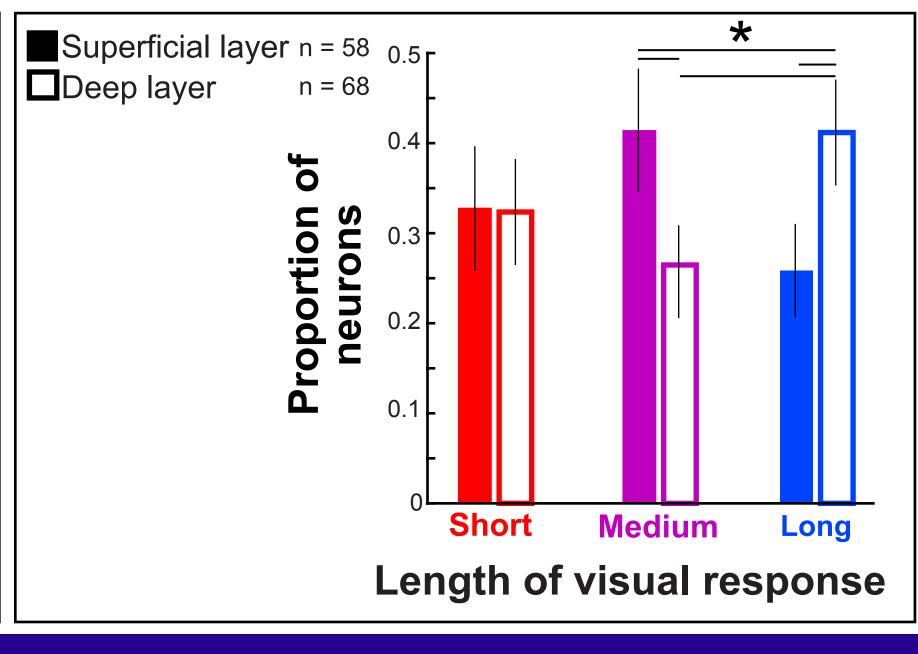
# across visual cell groups. Medium length cells show





## Latency and duration of visual response differ across cortical layer.





#### References

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### Acknowledgements

Thanks to Megan Jutras, Laura Kakalios, Kiril Staikov and Kelly Morrisroe for technical assistance, and to all the members of the Buffalo lab for helpful discussion.

Funding for this work was provided by NIH 2R01MH080007, R01MH093807 and NIMH P51 OD010425.

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