

# Coordination between nonlocal hippocampal representations and the collicular orienting system

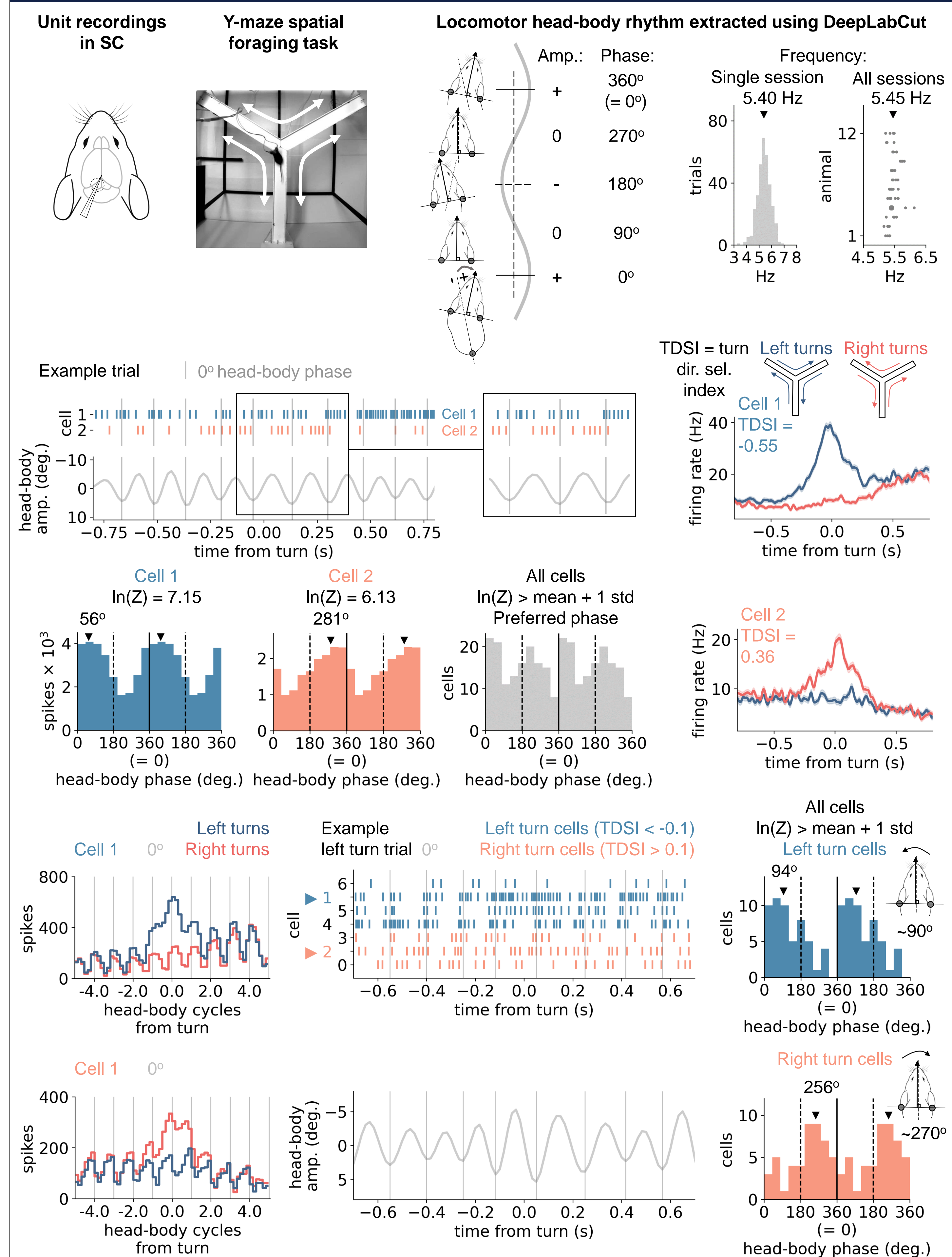
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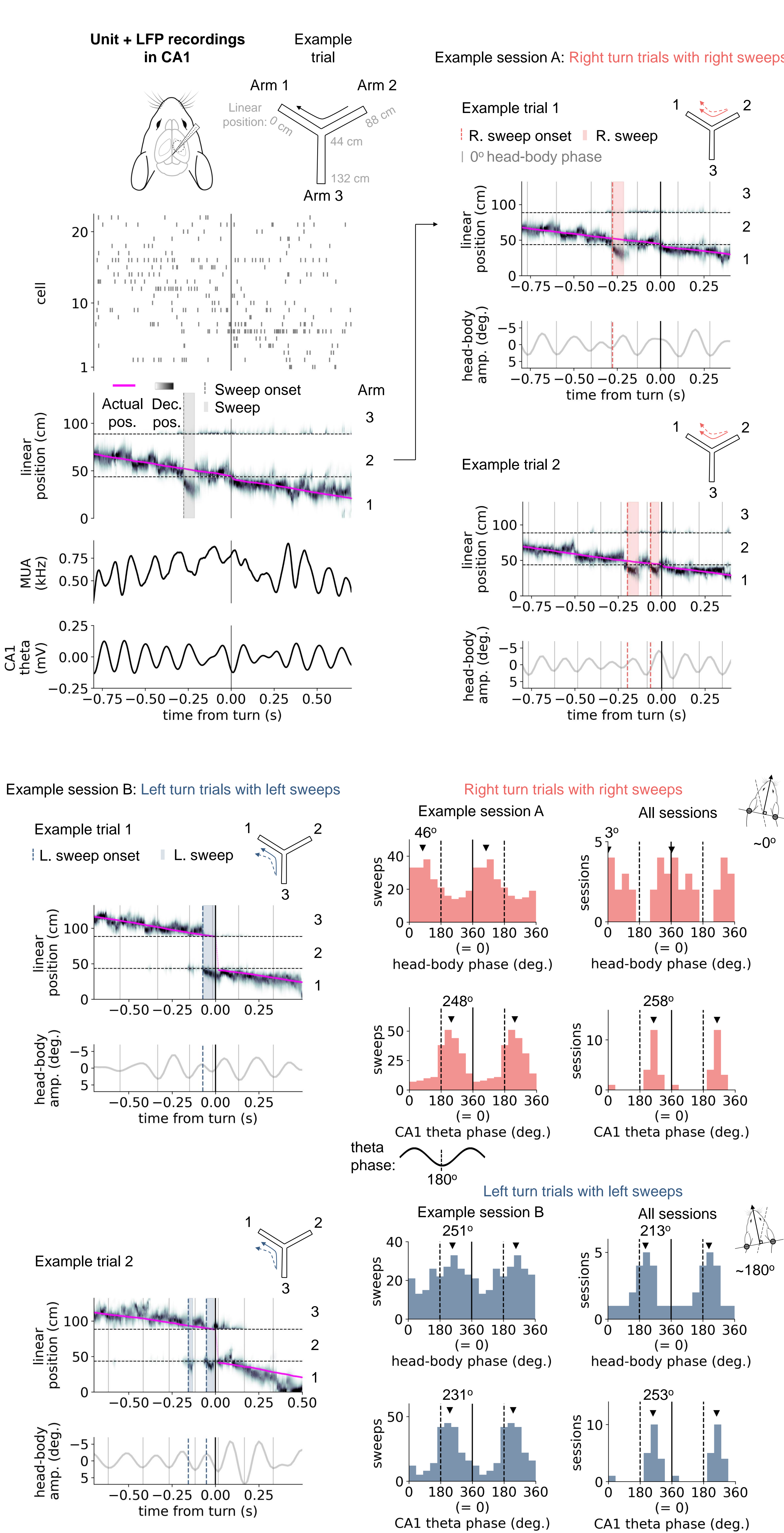
## Abstract

Studies on hippocampal place cells have found neuronal sequences representing nonlocal spatial trajectories that sweep ahead of the animal and orient towards possible left or right future paths. **Do these nonlocal orienting sweeps in the hippocampus occur in coordination with an orienting command center in the brain?** To address this question, we recorded neural activity in the hippocampus and the superior colliculus (SC), a midbrain structure implicated in the control of spatial orienting movements, as mice navigated a Y-maze. We classified hippocampal sweeps based on their directionality and SC neurons based on their turn direction preference on the maze. We discovered that the activity of SC neurons is modulated by a left/right head-body oscillation characteristic of locomotion. Strikingly, SC neurons with opposite direction preferences fire preferentially at opposite phases of the head-body oscillation. Similarly, we found that the onsets of hippocampal sweeps occur in phase with the locomotor head-body oscillation. Notably, the onsets of hippocampal sweeps of opposite directions occur at opposite phases of the head-body oscillation. Lastly, we investigated whether SC neurons fire more during trials that contain sweeps in their preferred direction compared to trials that contain sweeps in their non-preferred direction. Together, our results reveal a coordination between nonlocal hippocampal representations and the SC orienting system.

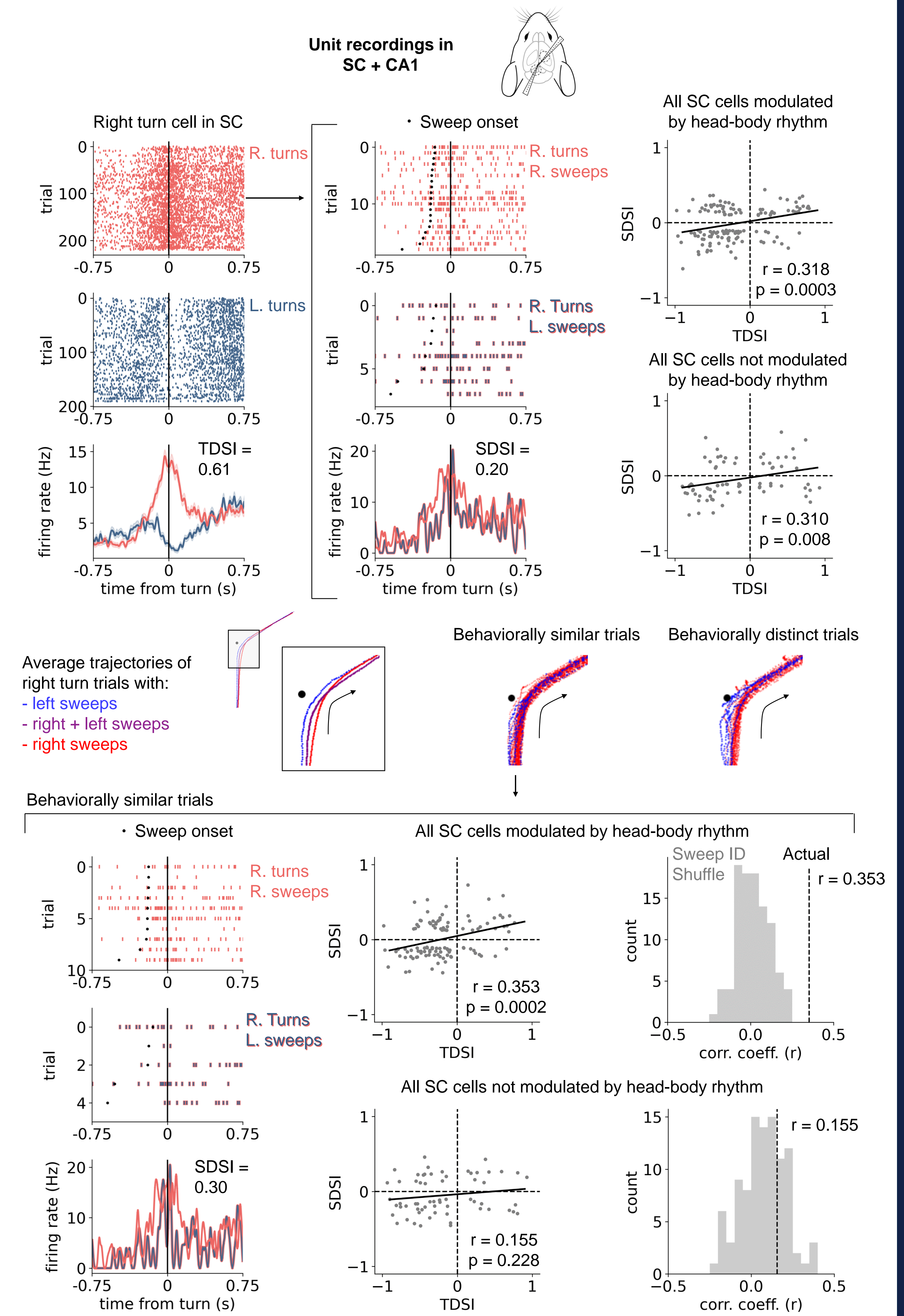
## A locomotor rhythm organizes directional firing of SC neurons



## The onsets of hippocampal sweeps occur in phase with the locomotor rhythm in a direction-dependent manner



## SC neurons fire more during trials that contain hippocampal sweeps in their preferred direction



## Conclusions

- The activity of SC neurons is modulated by a ~5.5 Hz locomotor head-body rhythm.
- SC neurons with opposite direction preferences fire preferentially at opposite phases of the locomotor rhythm.
- The onsets of hippocampal sweeps of opposite directions occur at opposite phases of the locomotor rhythm.
- SC neurons modulated by the locomotor rhythm fire more during trials that contain hippocampal sweeps in their preferred direction.
- These results reveal a coordination between hippocampal sweeps and the SC orienting system and point to a role for motor command centers in the organization of nonlocal or 'simulated' experience.**

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