

Directional alignment of turn-related activity in the superior colliculus with locomotor dynamics and hippocampal representations of future paths

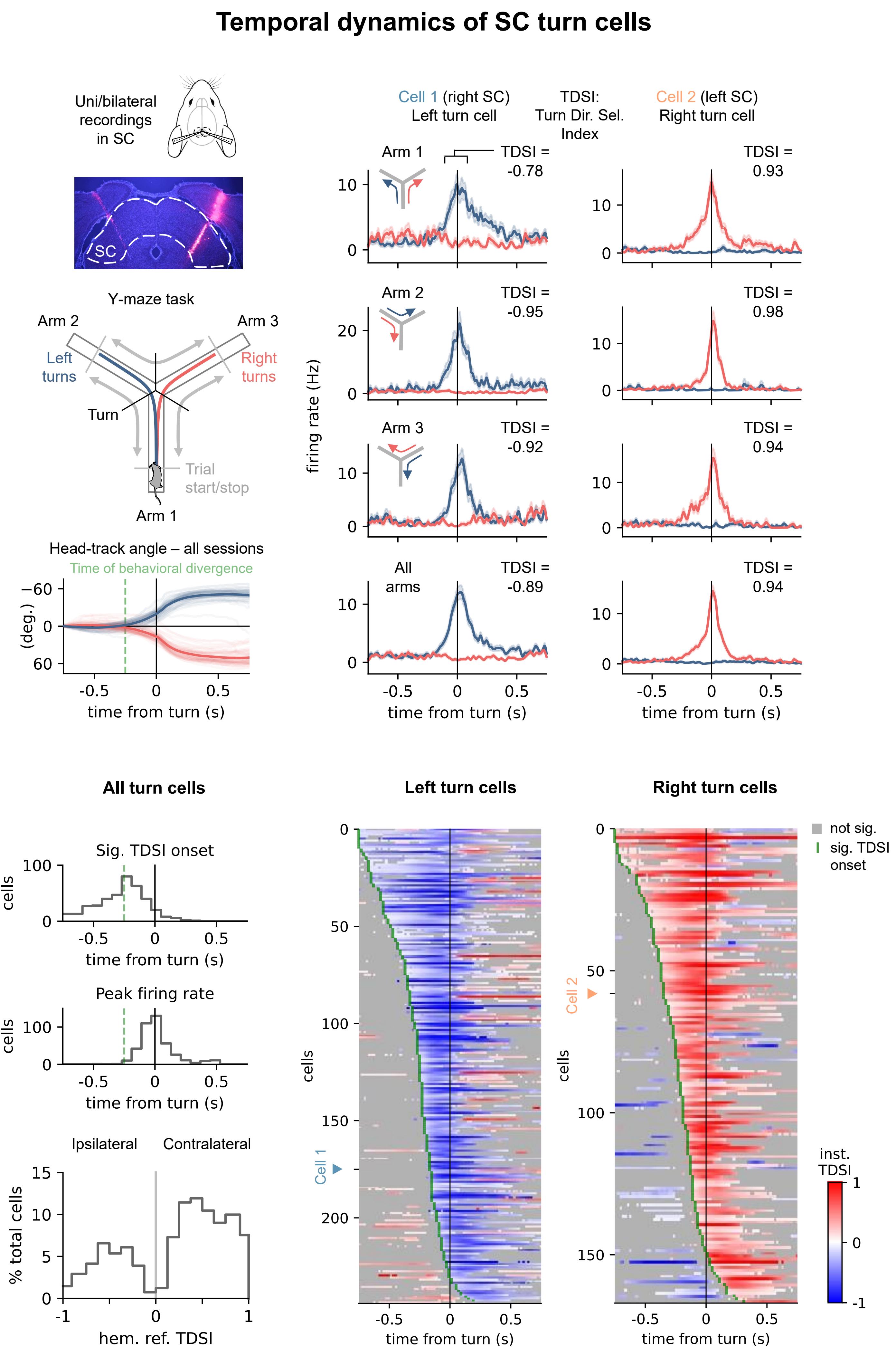
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Introduction

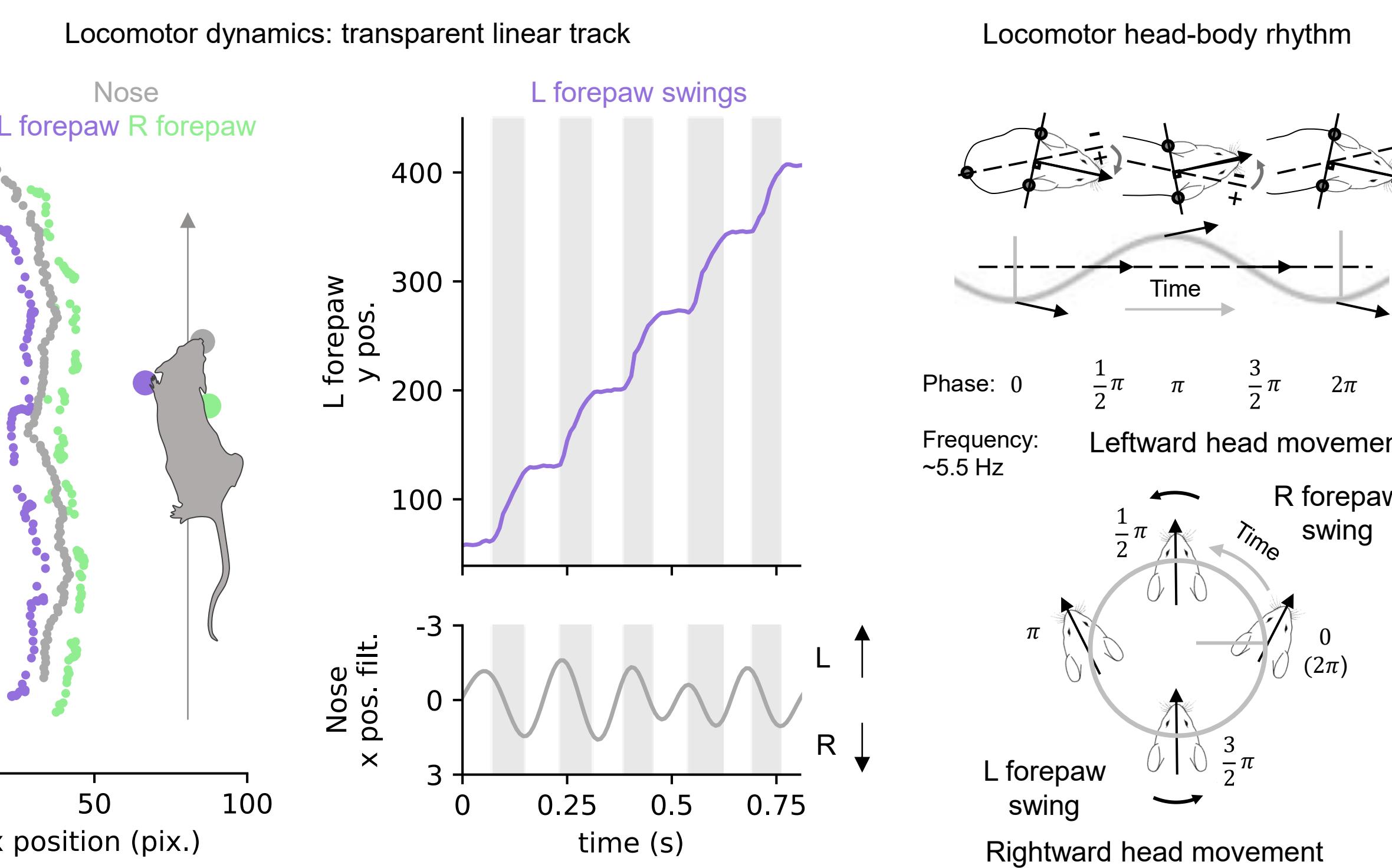
The ability to direct locomotion by turning left or right is a core element of animal navigation. Such turns occur in precise coordination with the ongoing stepping rhythm and require internal planning for the animal's future path. The superior colliculus (SC) is a conserved vertebrate midbrain structure involved in turning. The intermediate/deep motor layers of the SC contain neurons whose activity reports turn direction and whose stimulation triggers turning movements. Whether neuronal activity in the motor layers of the SC is coordinated with rhythmic locomotor dynamics and internal representations of future paths is unknown. Here we recorded from motor layer SC neurons as mice navigated a Y-maze while tracking locomotor dynamics and decoding representations of future paths from the hippocampus. We find that turn cell activity is directionally coordinated with both locomotor dynamics and hippocampal representations of future paths. This coordination may allow animals to seamlessly execute turns during locomotion while navigating toward spatial goals.

Turn cells in the intermediate and deep layers of the SC

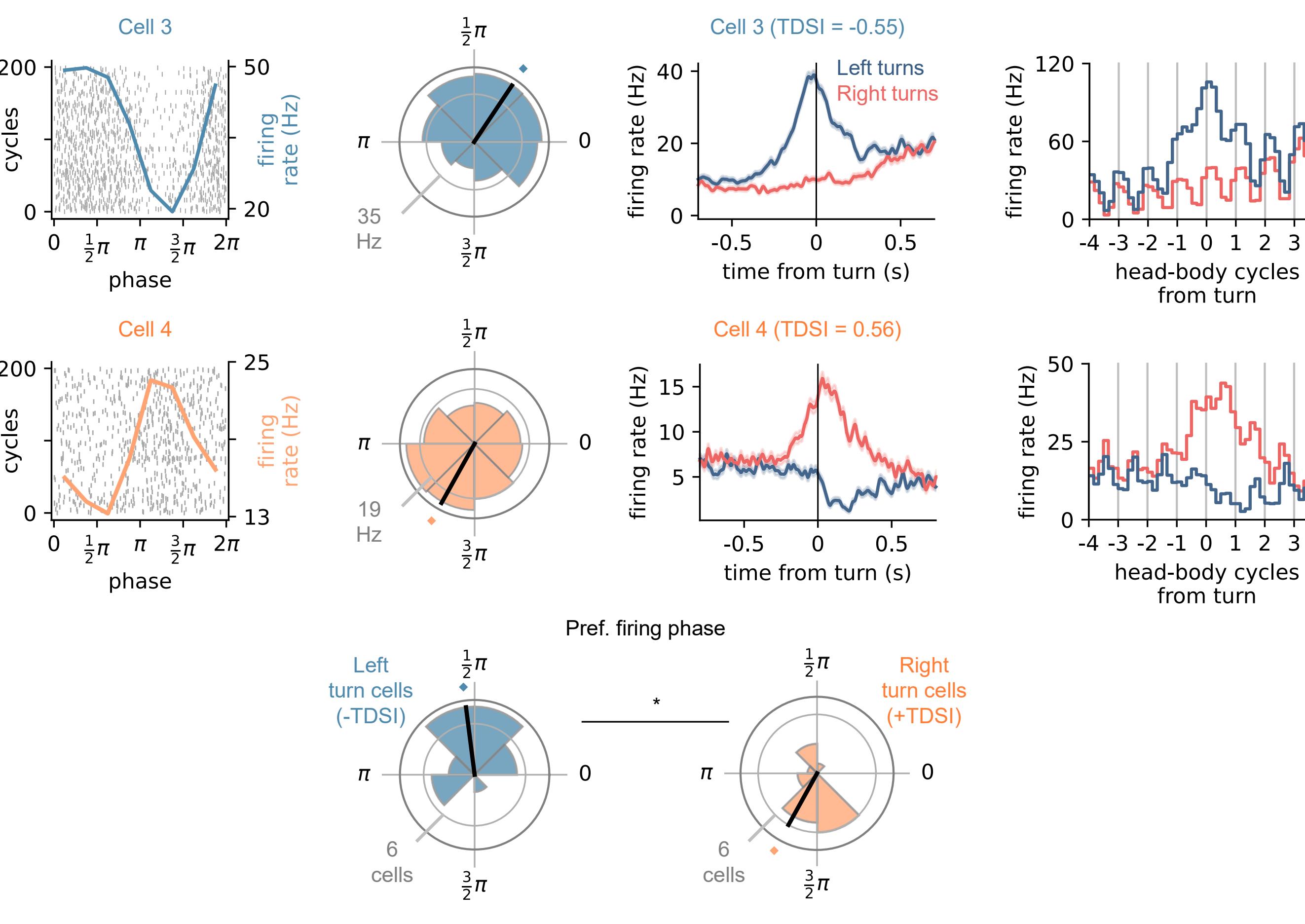


SC turn cell activity is coupled to the locomotor rhythm

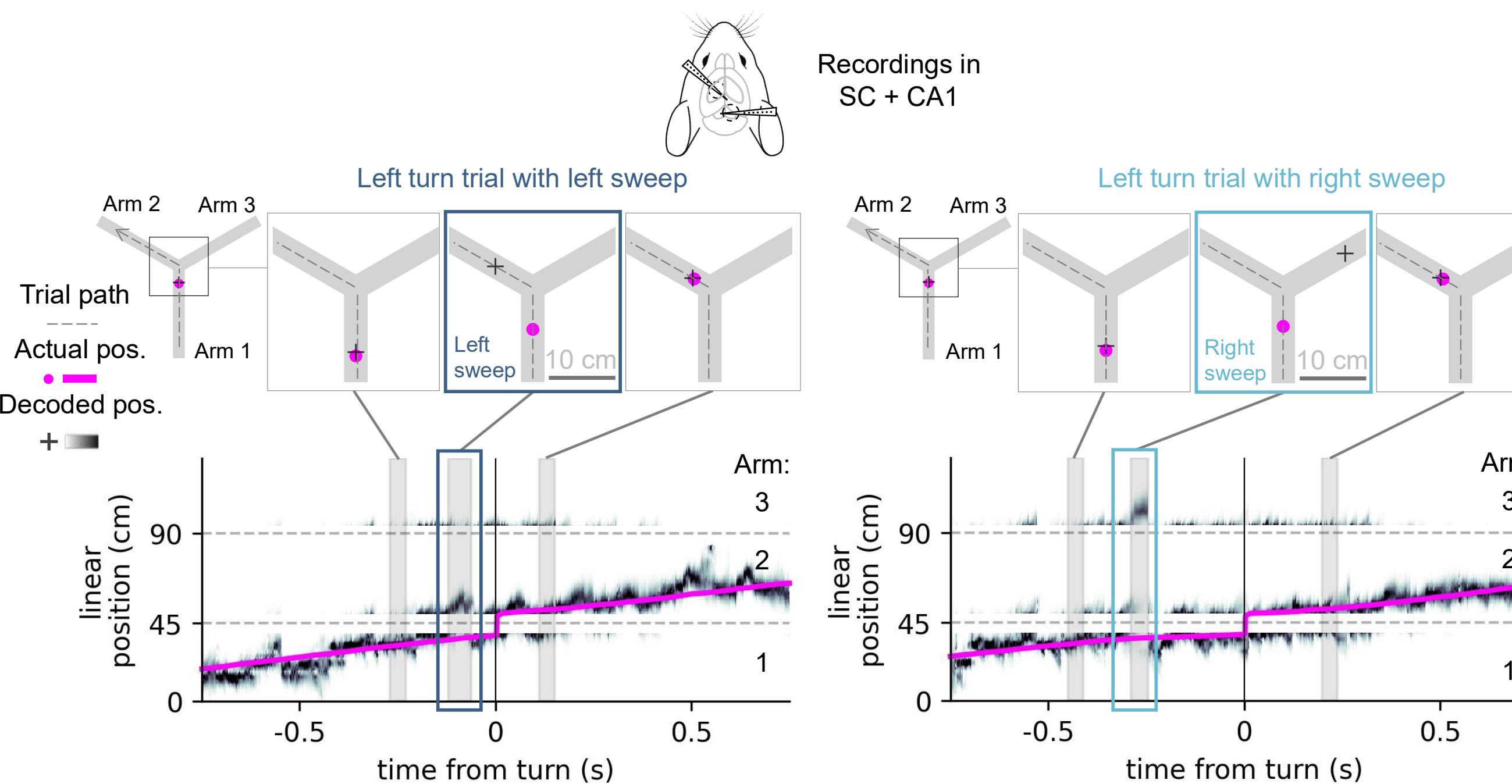
Head-body angle as a proxy for the locomotor rhythm



Left and right turn cell activity alternates in phase with the locomotor rhythm



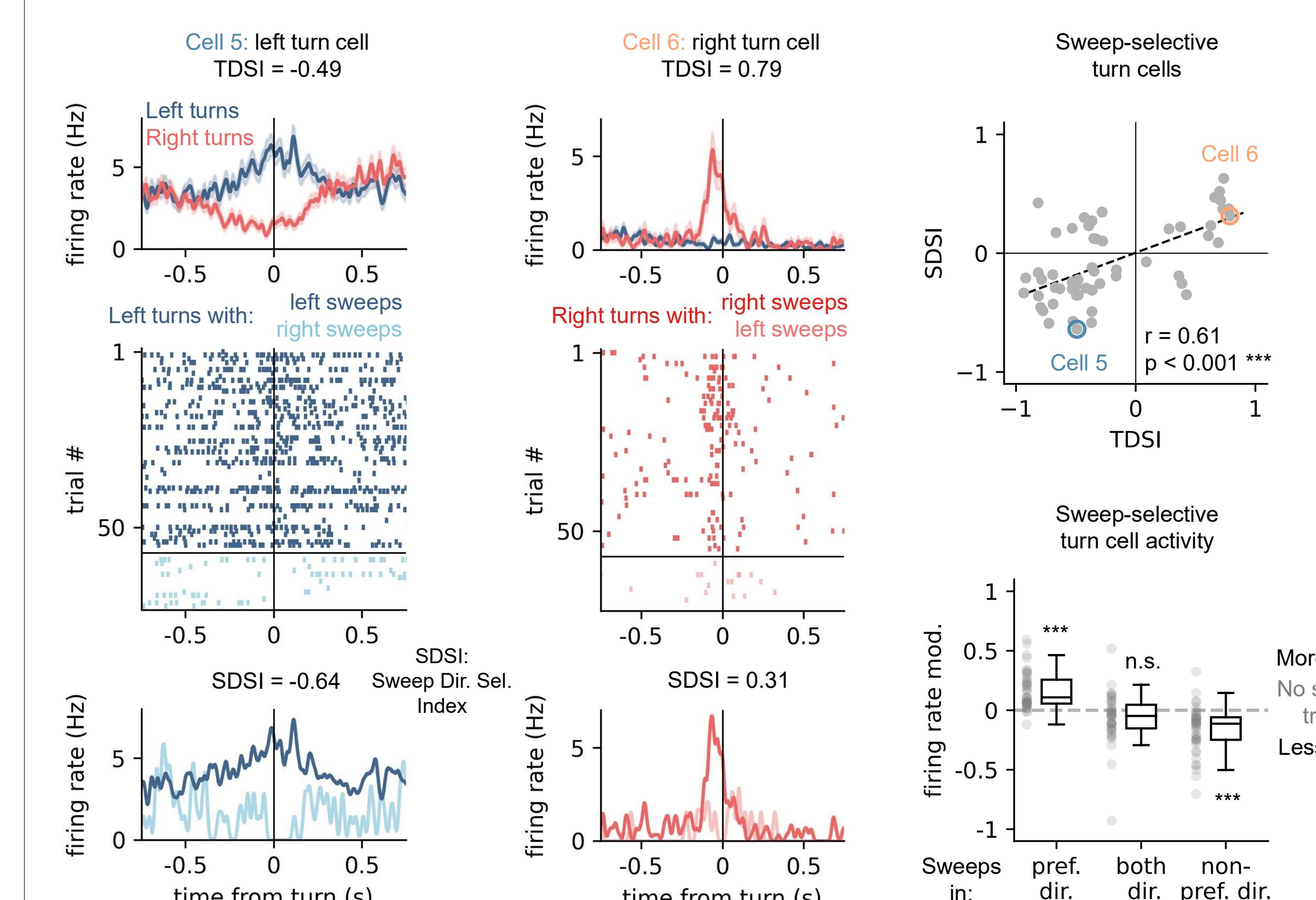
Decoding hippocampal sweeps from CA1 place cell activity



Summary

- Turn cells in the intermediate/deep SC fire more as the animal turns either left or right.
- Turn cell activity is coupled to the left-right head-body (stepping) rhythm during locomotion.
- Turn cell activity is modulated in directional coordination with hippocampal sweeps. Sweeps can predict turn cell activity and this predictability is related to the time at which turn cells become directionally selective.
- The coordination of SC activity with locomotor dynamics and hippocampal representations may ensure that turns are executed at optimal phases of the stepping rhythm and in alignment with the animal's internal spatial goals.

SC turn cell activity is modulated in coordination with hippocampal sweeps



Hippocampal sweeps predict turn cell activity at the time of the turn

