Decoding a turn: The Latent Spaces Within Stereotypical Turns in Drosophila

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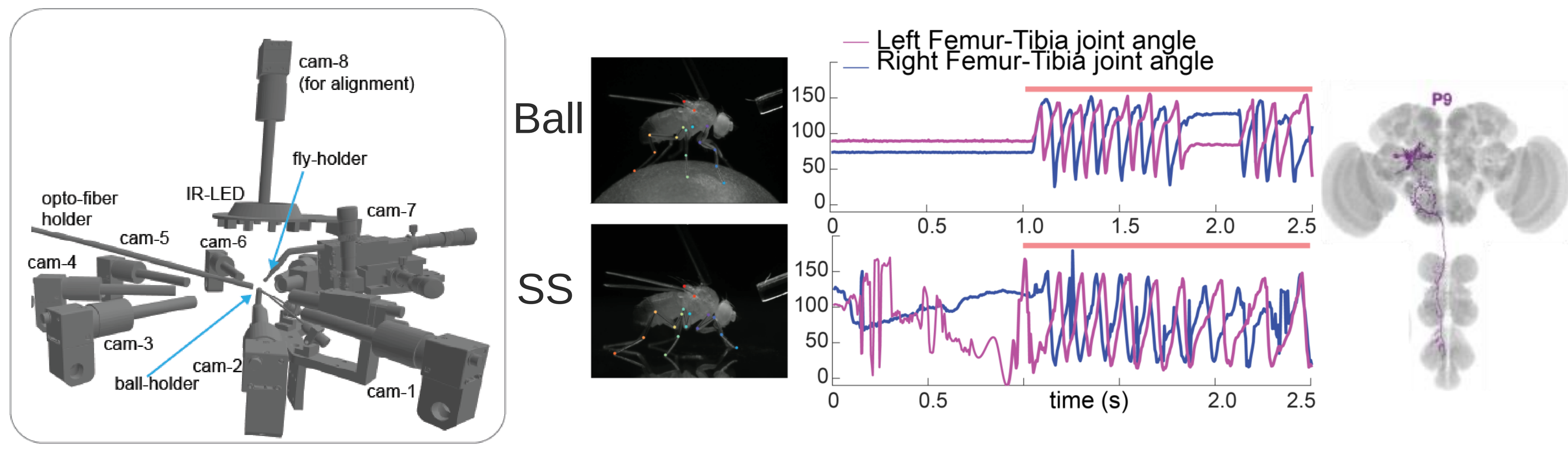
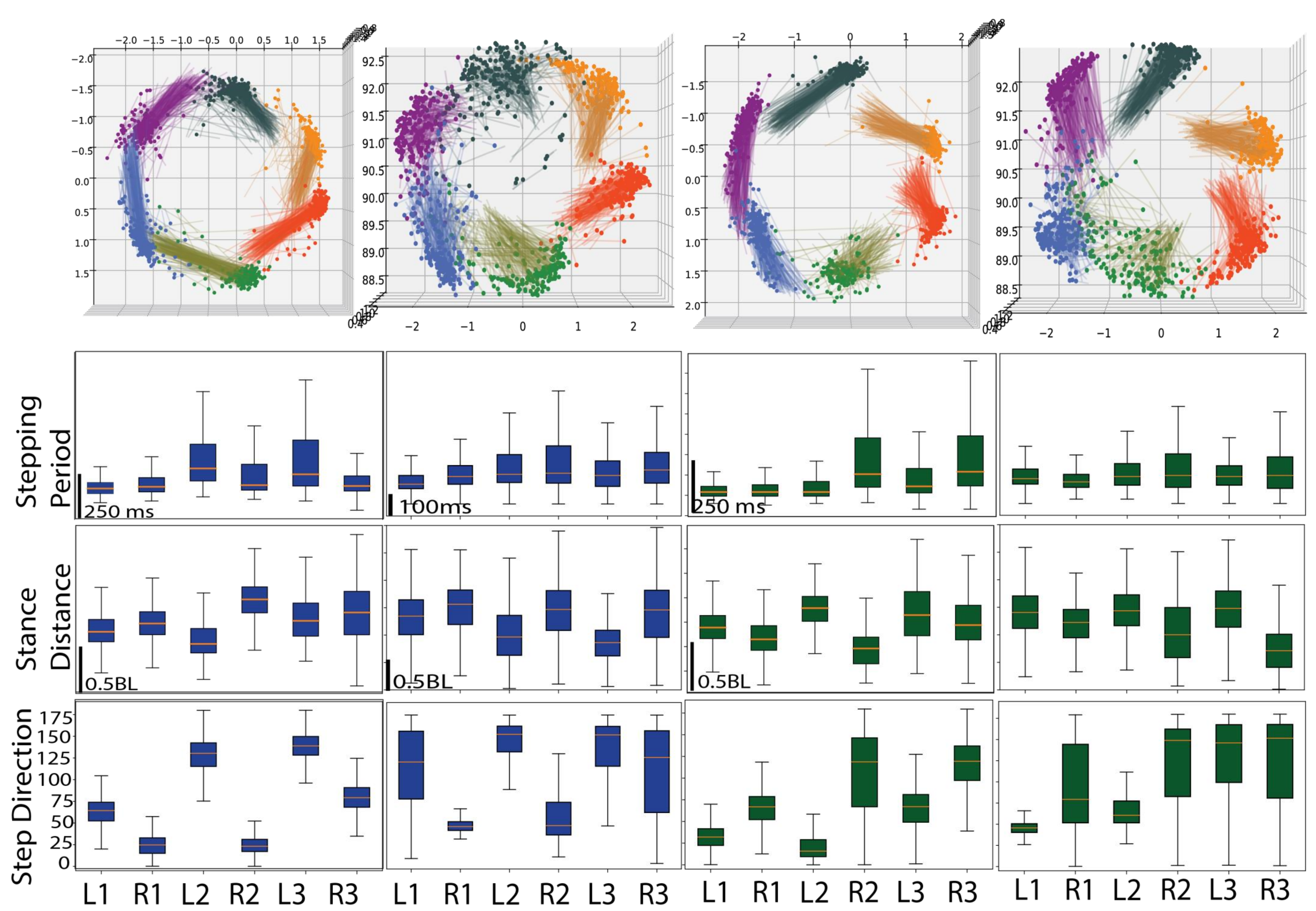
Introduction



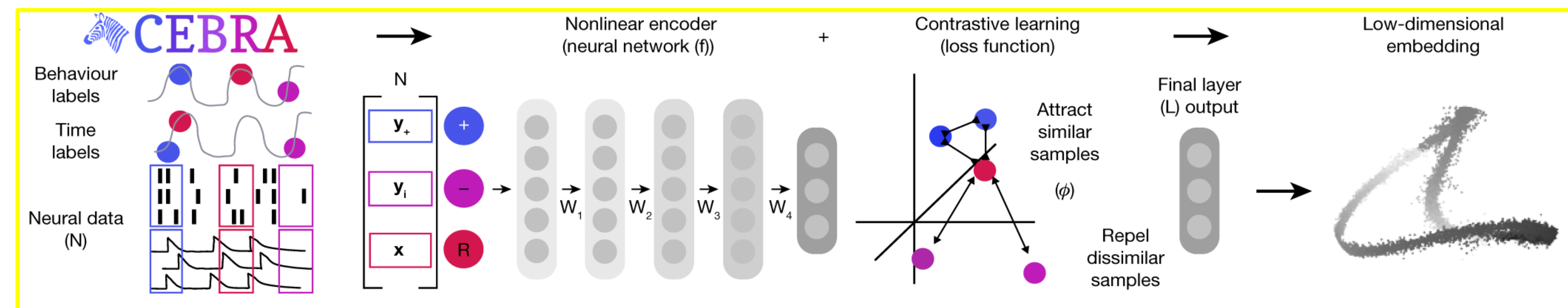
Turning is a complex locomotor maneuver requiring the asymmetric articulation of legs on both sides of the body. Characterizing the leg kinematic changes that compose a turn is a necessary pre-requisite to understanding the neural circuit mechanisms that underlie it. By analyzing leg kinematics in flies performing turns in response to optogenetic activation in surfaces with and with out friction, we aim to understand the role of mechanical coupling in coordinating these movements. Given the high dimensional leg kinematics space explored by the legs during turning, we employ dimensionality reduction to identify latent dimensions in this space. Advancing this line of investigation could help identify the degrees of freedom employed by the nervous system of the fly to execute turning in context appropriate ways.

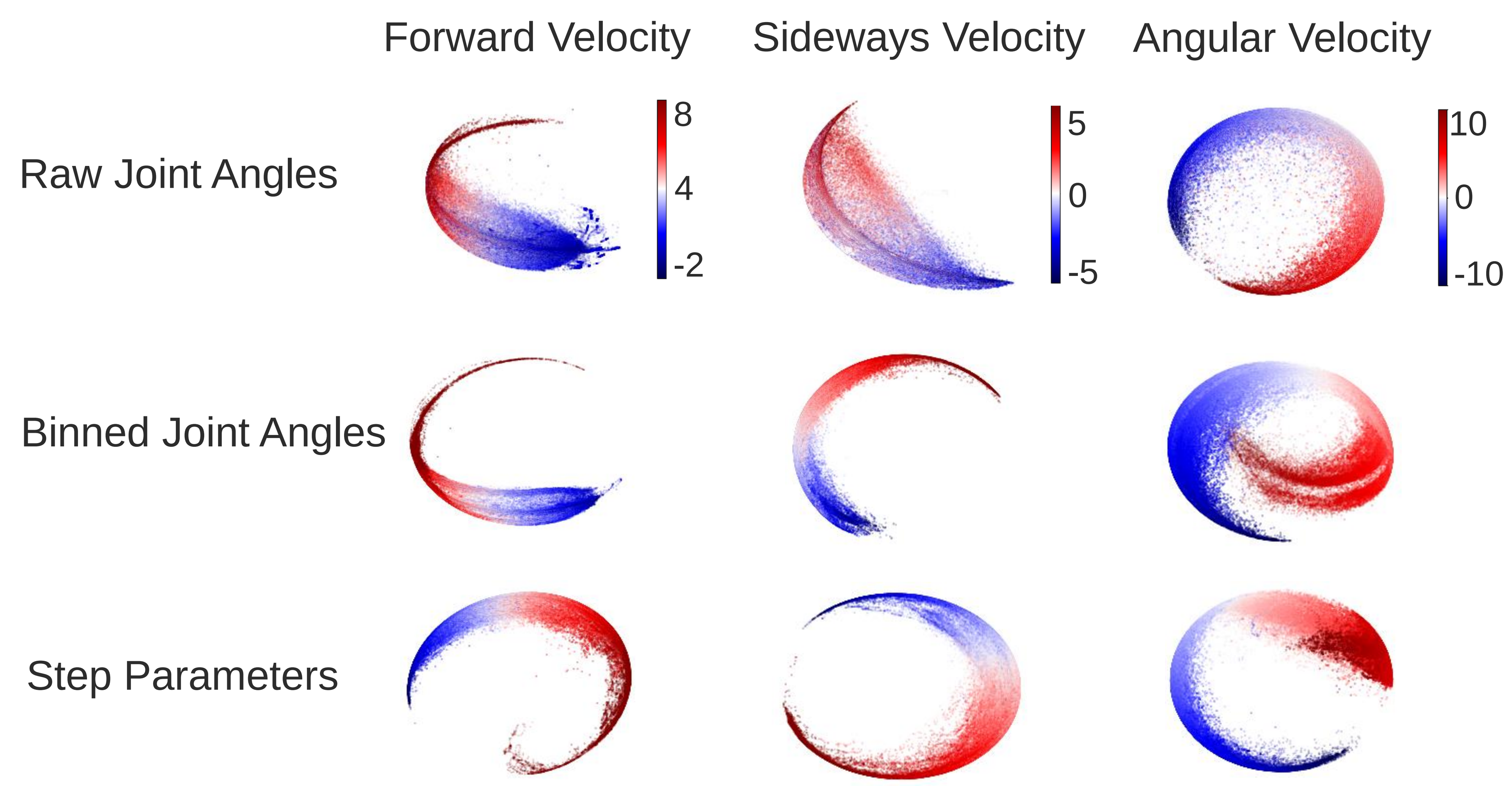
All 6 legs are actively modulated during turning

Ball	SS	Ball	SS
P9- LT	**P9- LT**	**P9- RT**	**P9- RT**

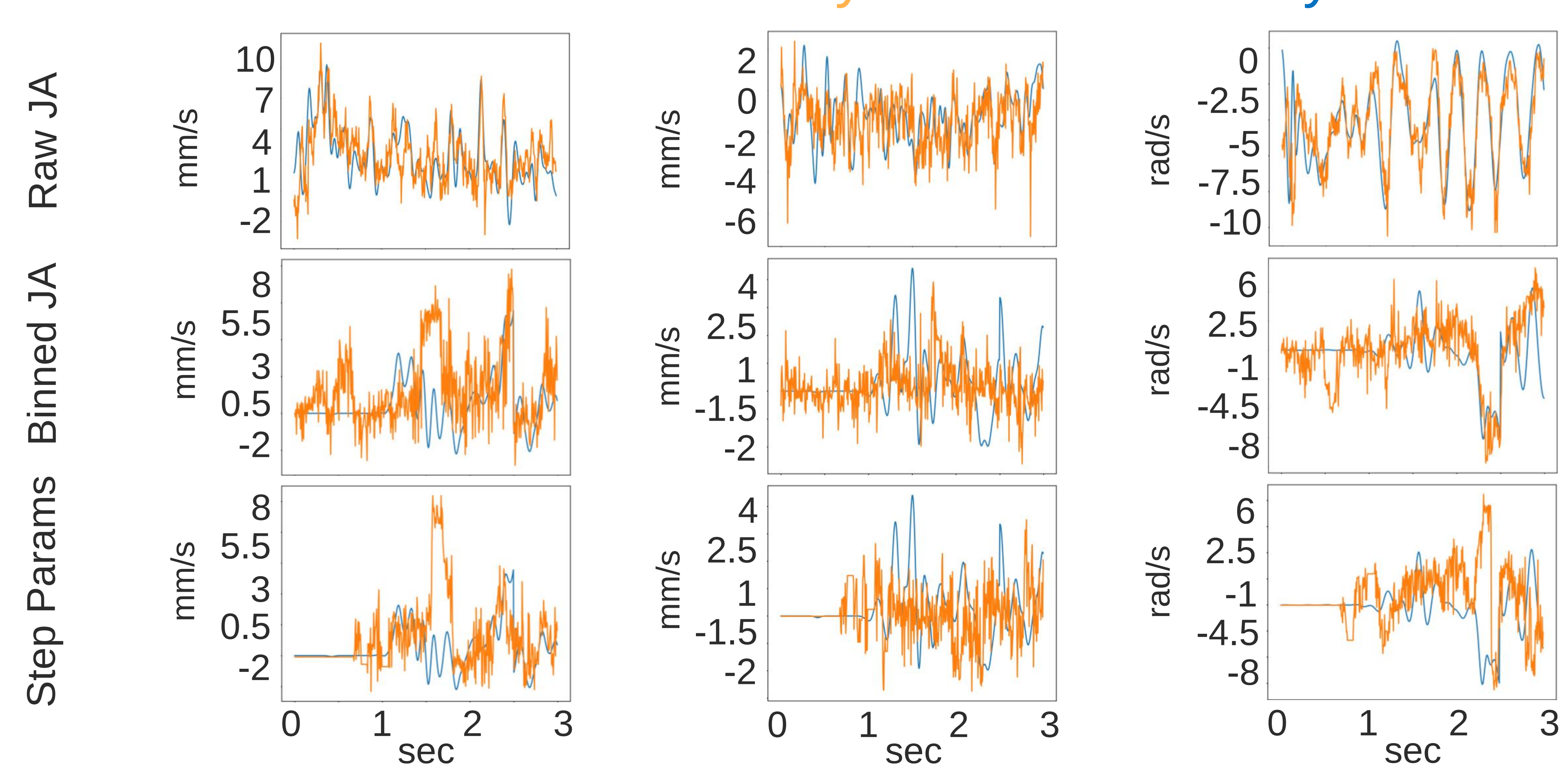


Contrastive learning reveals non linear latent embeddings in kinematics



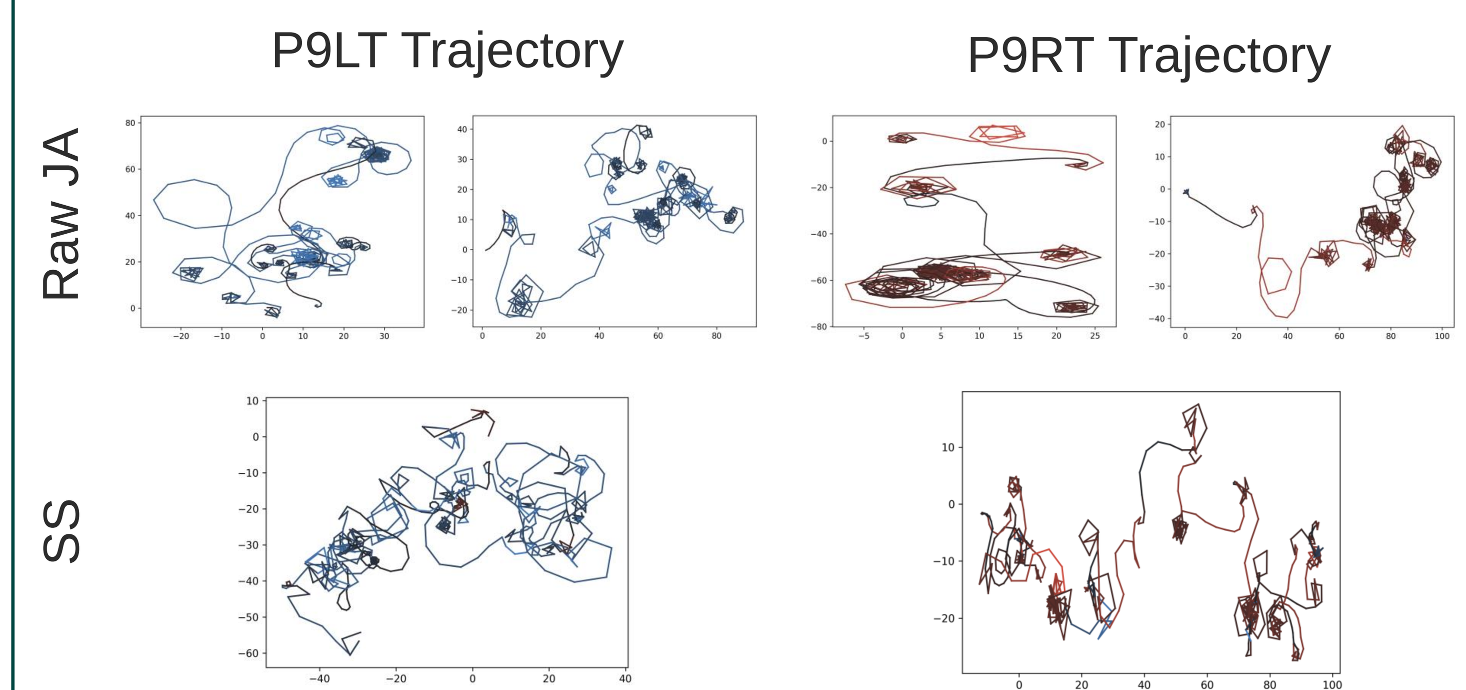


Predicted Velocity vs Actual Velocity



Virtual trajectories can be decoded from latent embeddings

Actual Trajectory vs Predicted Trajectory



Mechanically coupled and decoupled turns explore distinct sub spaces

Conclusions

- DNp09 activation causes kinematic changes in all 6 legs to cause turning.
- Mechanical decoupling using the 'slippery surface' reveals that all kinematic changes are actively induced by DNp09, although variability in stepping is increased.
- CEBRA reveals a low dimensional latent space in leg kinematics that can be used to decode all velocity components during turning.
- CEBRA can segregate leg kinematics during turning on the ball and slippery surface reliably, revealing systematic stepping changes on the slippery surface.

Future Directions

- CEBRA can be used to explore differences between turns, such as tight and wide turns, test the reliability of principle components in representing velocities, and link behavior to neuron activation.

Acknowledgements

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