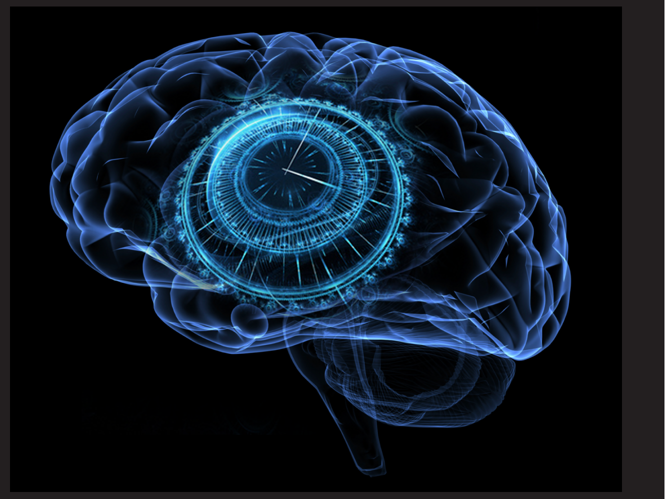

Predictive visual motion extrapolation emerges spontaneously and without supervision from a layered neural network with spike-timing-dependent plasticity

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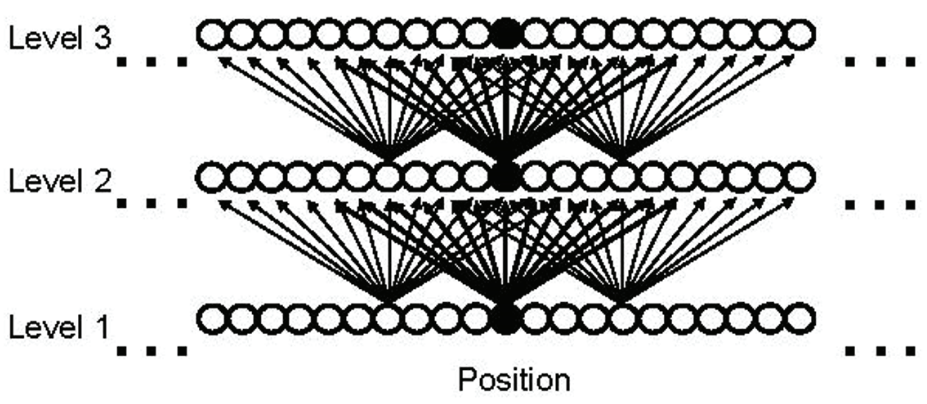
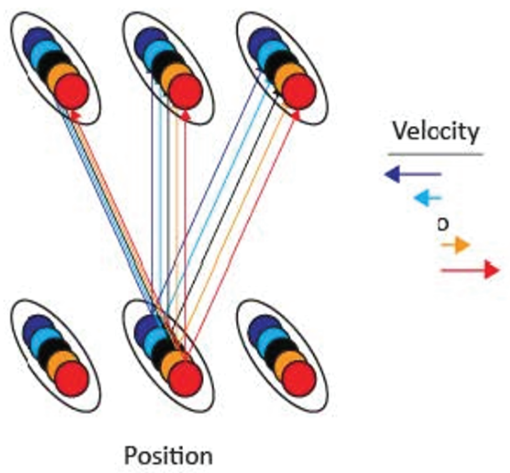
Introduction

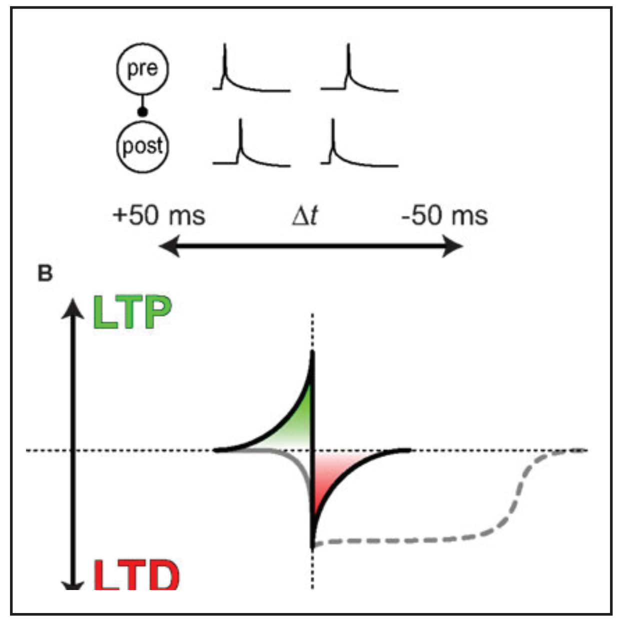
- Neural transmission takes time.
- Transmission delays might be compensated by motion extrapolation.
- How might a neural network learn to implement motion extrapolation?
- We simulate a hierarchical neural network of motion-selective neurons, expose the network to moving objects, and allow the network to learn by spike-timing dependent plasticity (STDP).

- **We compare the simulated receptive field shifts that emerge from exposure to different velocities to perceptual shifts as measured using the perceptual flash-lag effect.**

Methods



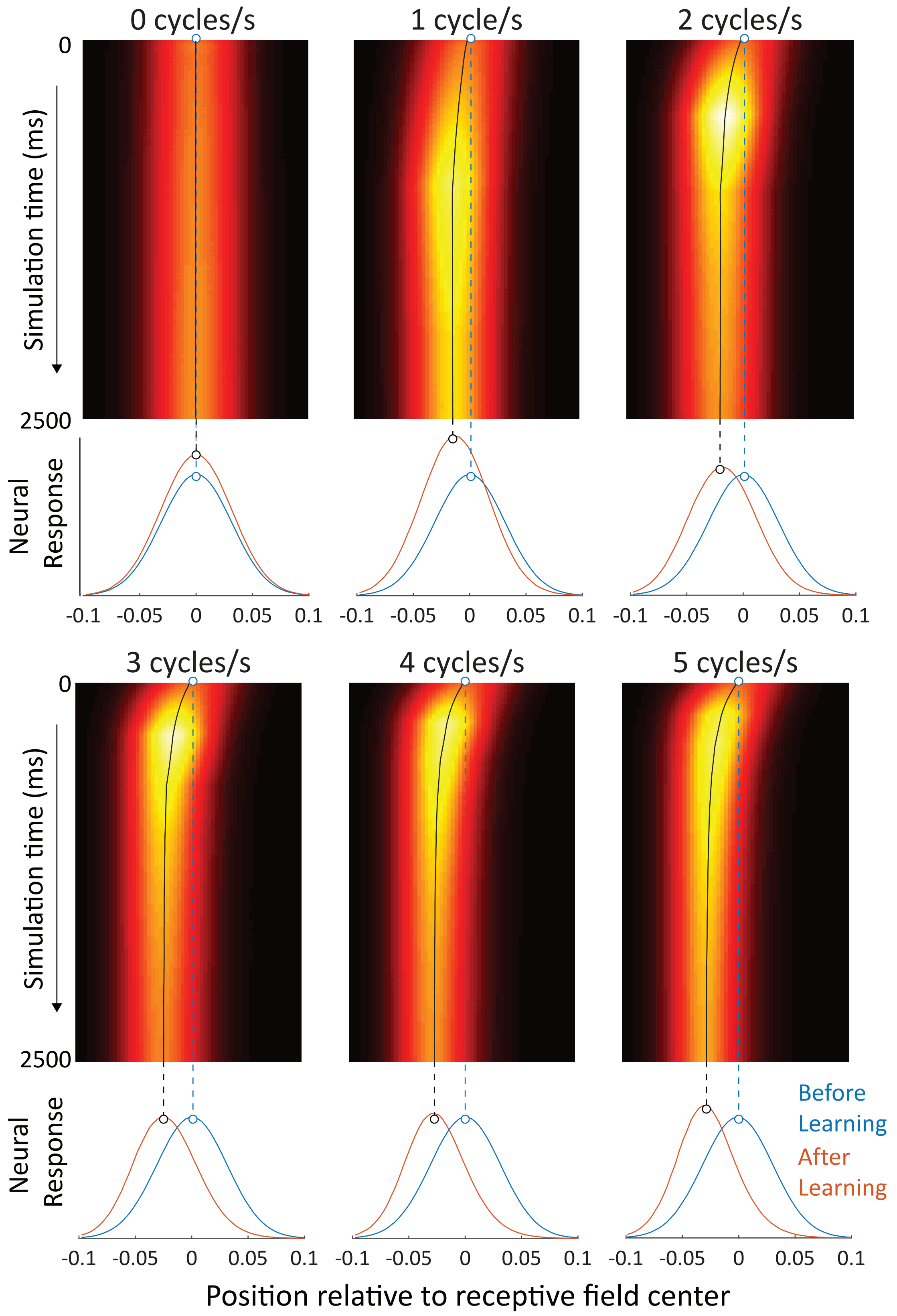




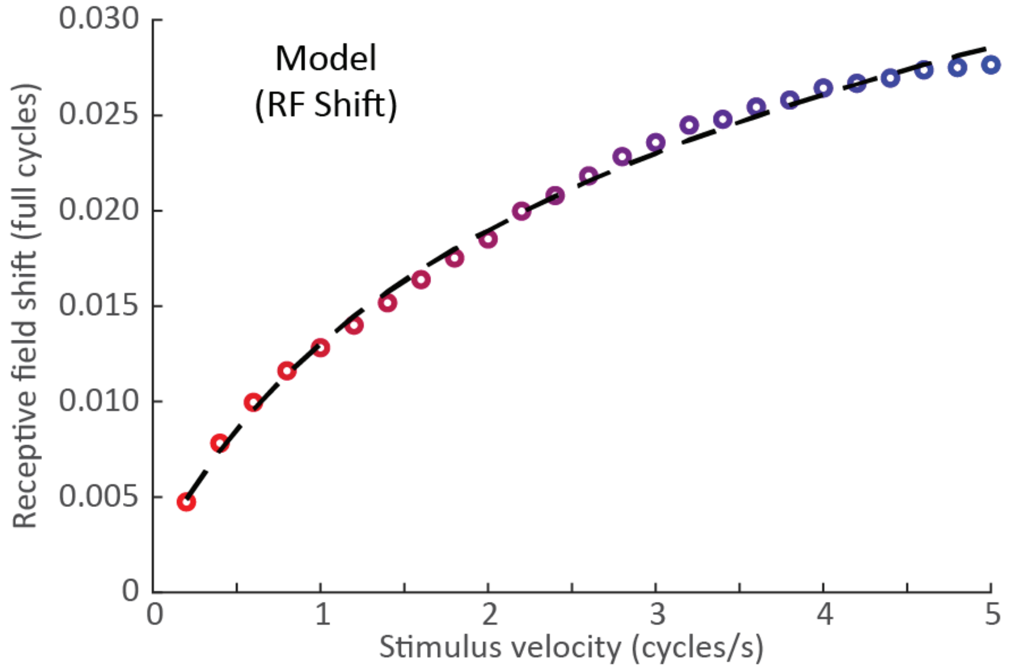
We simulate two layers of a perceptual hierarchy. Neural populations are selective for position, with subpopulations selective to specific velocities.

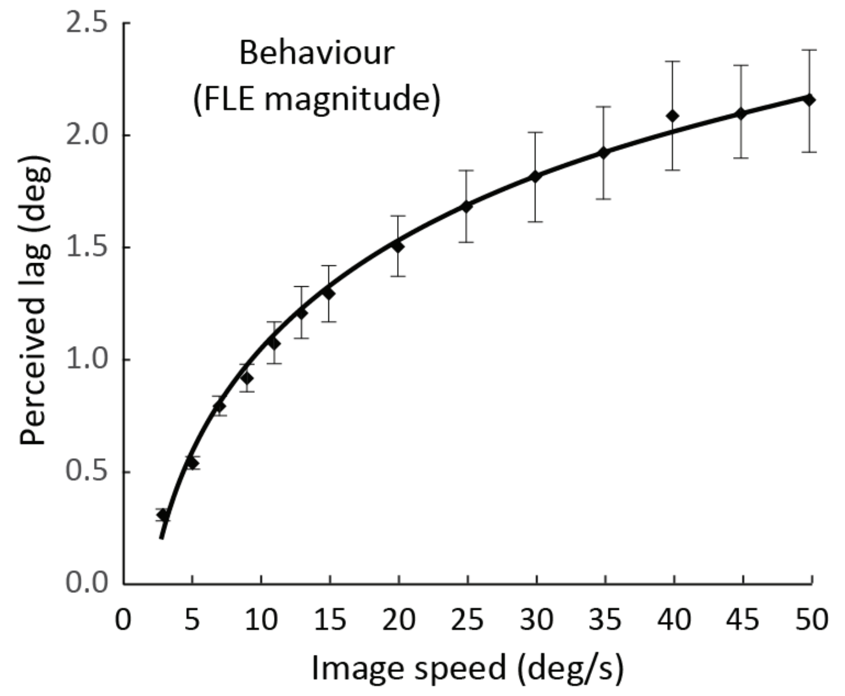
<- The network learns through STDP: synapses that are active before a post-synaptic cell fires are potentiated, and those that are active after the cell fires are depressed.

Results

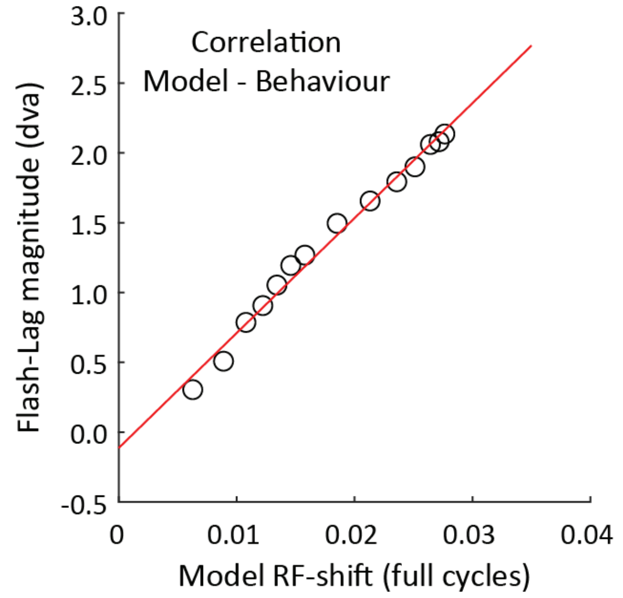


Due to spike-timing dependent plasticity, simulated receptive fields rapidly shift in the direction opposite to motion, effectively resulting in motion extrapolation.





Simulated receptive field shifts increase logarithmically with velocity (left panel), precisely replicating the pattern of velocity dependence observed in the perceptual flash-lag effect (right panel; Wojtach et al 2008).



The correlation between predicted shifts and perceptual shifts is 0.99

Conclusions

Spike-timing-dependent plasticity causes shifts of receptive field in velocity-selective subpopulations.

These shifts emerge spontaneously and without supervision, and effectively implement visual motion extrapolation.

Modeled shifts almost perfectly predict behaviourally measured perceptual shifts in the flash-lag effect.

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Download the preprint: https://doi.org/10.1101/2020.08.01.232595