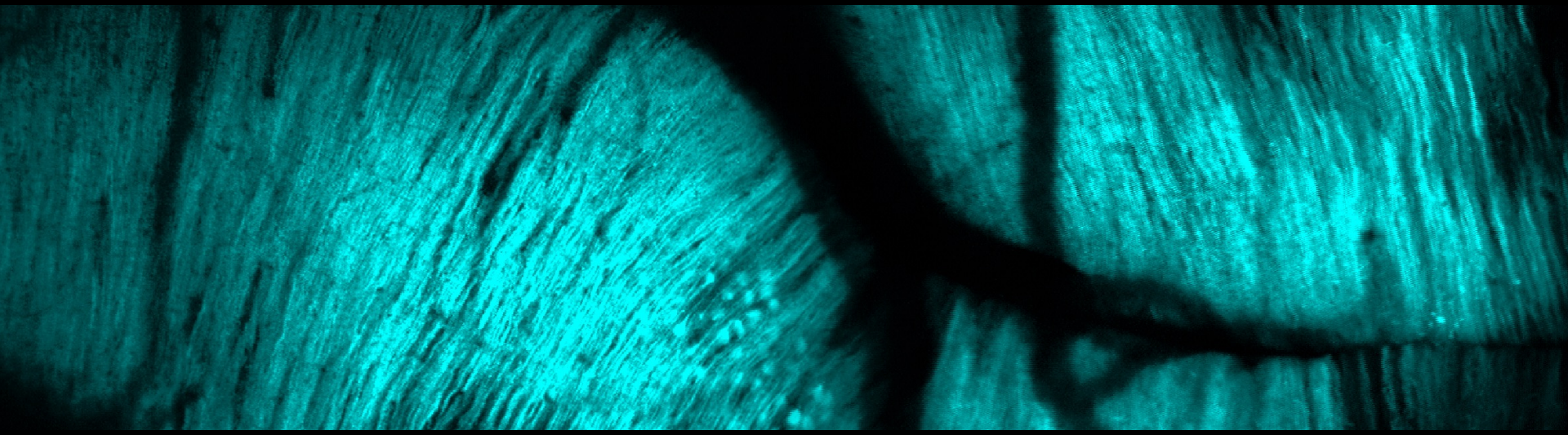
Fast and slow learning signals mediated by climbing fiber inputs to cerebellar Purkinje cells



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Wolfson Institute for Biomedical Research

University College London

Society for Neuroscience Annual Meeting

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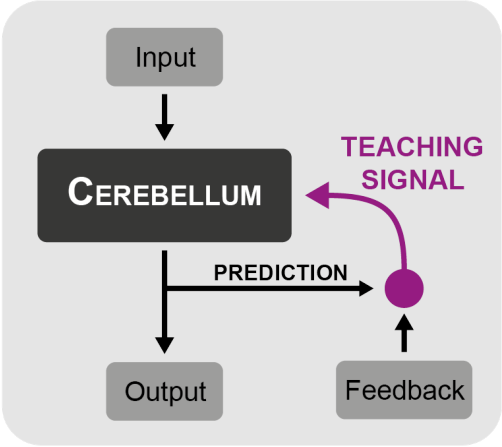
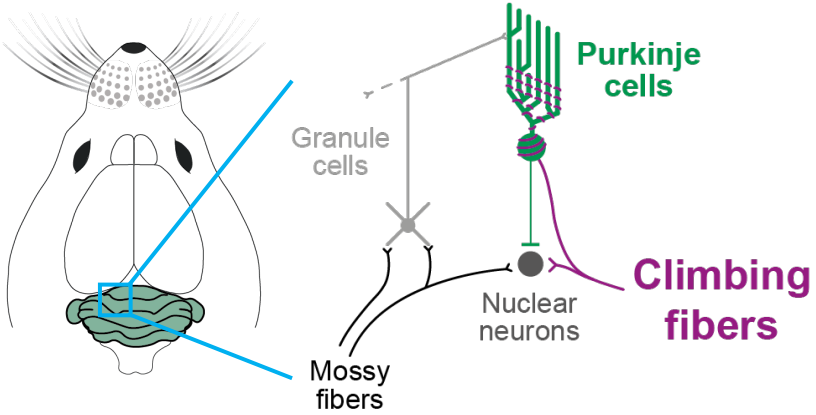
Learning on multiple time scales

Slow learning: skill acquisition

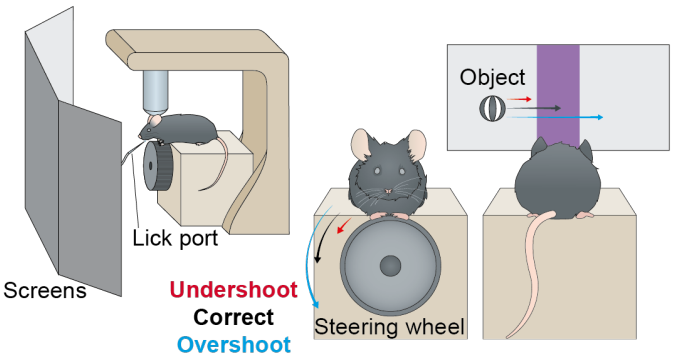
Fast learning: adaptation

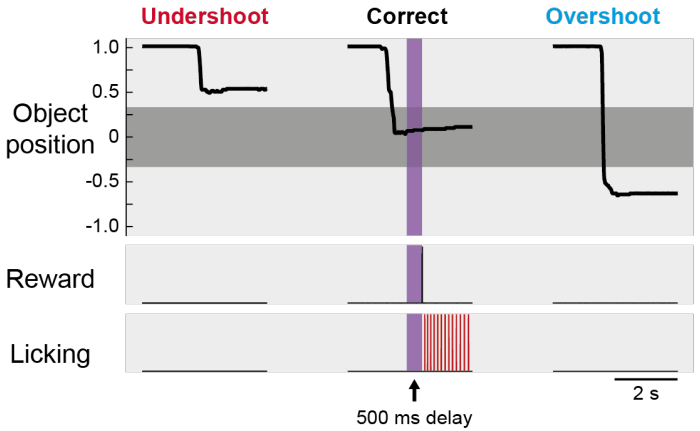


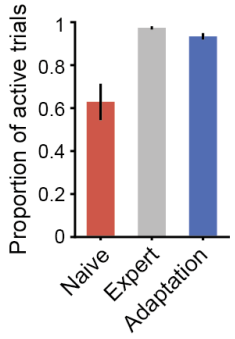


Kawato et al., 1987, *Biol. Cybernetics*
Wolpert et al., 1998, *Trends in Cog. Sci.*
Ito, 2008, *Nature. Rev. Neuro.*
Raymond and Medina, 2019, *Annu. Rev. Neuro.*

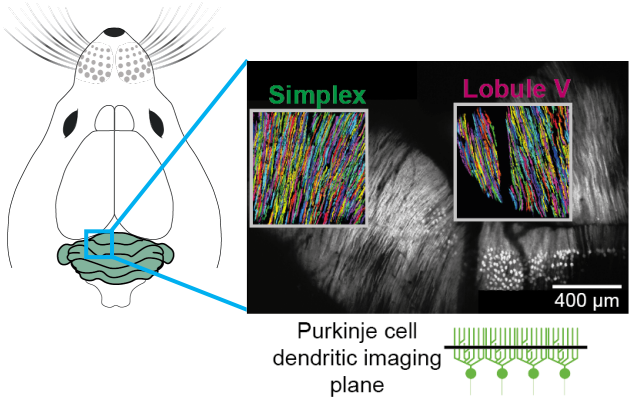
A visuomotor integration task to study learning

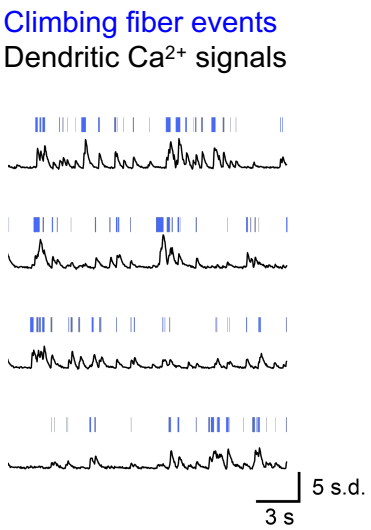


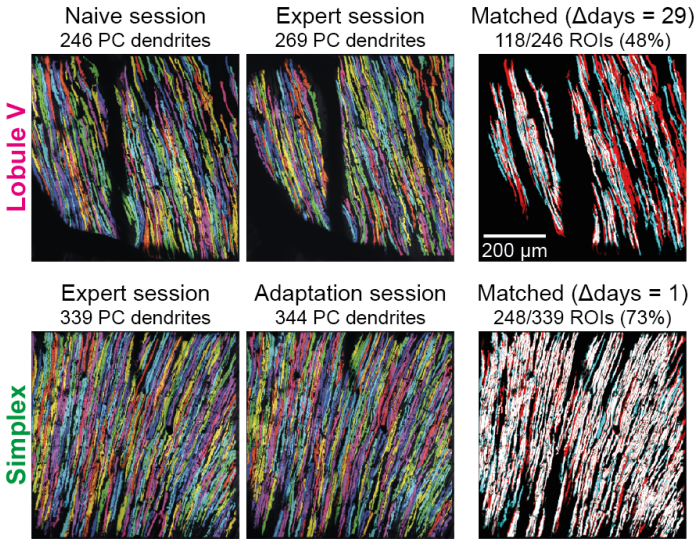




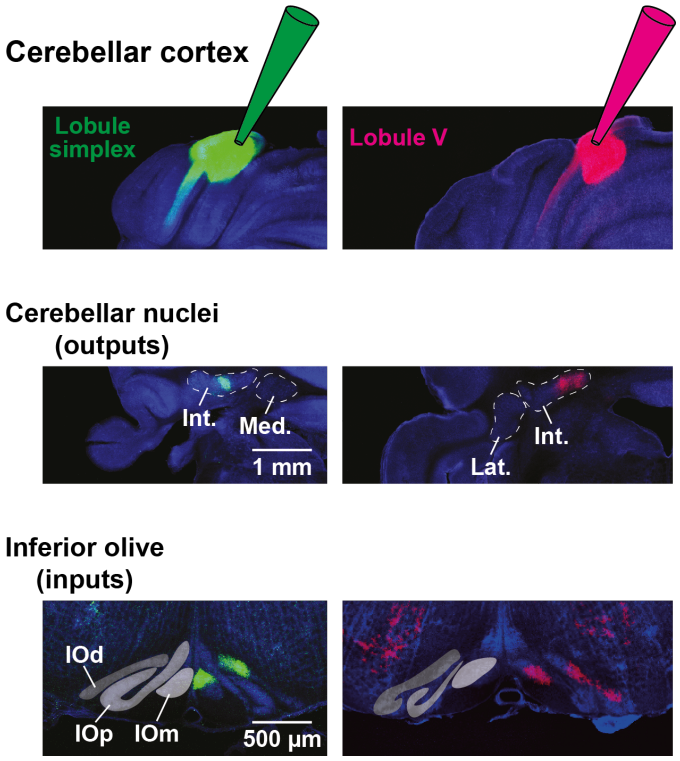
Chronic imaging of climbing fiber inputs to identified Purkinje cell populations during task acquisition and adaptation

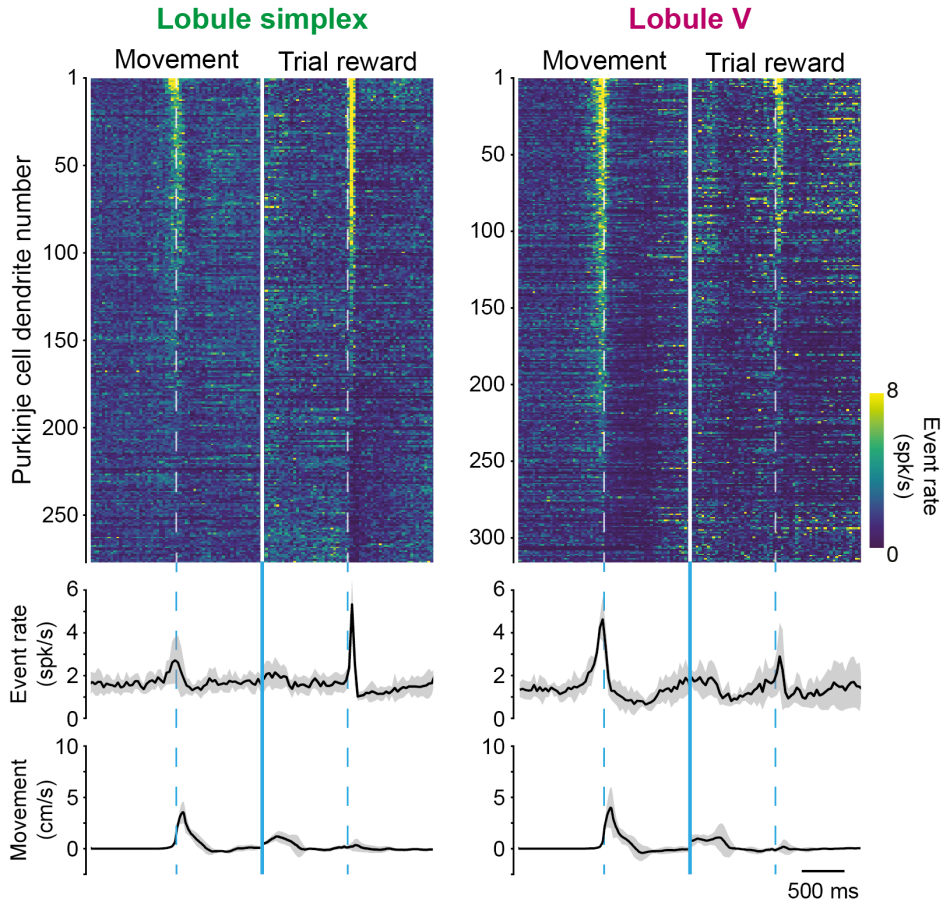






Climbing fiber inputs to Purkinje cells in Lobules V and Simplex arise from different olivary regions and exhibit distinct task encoding

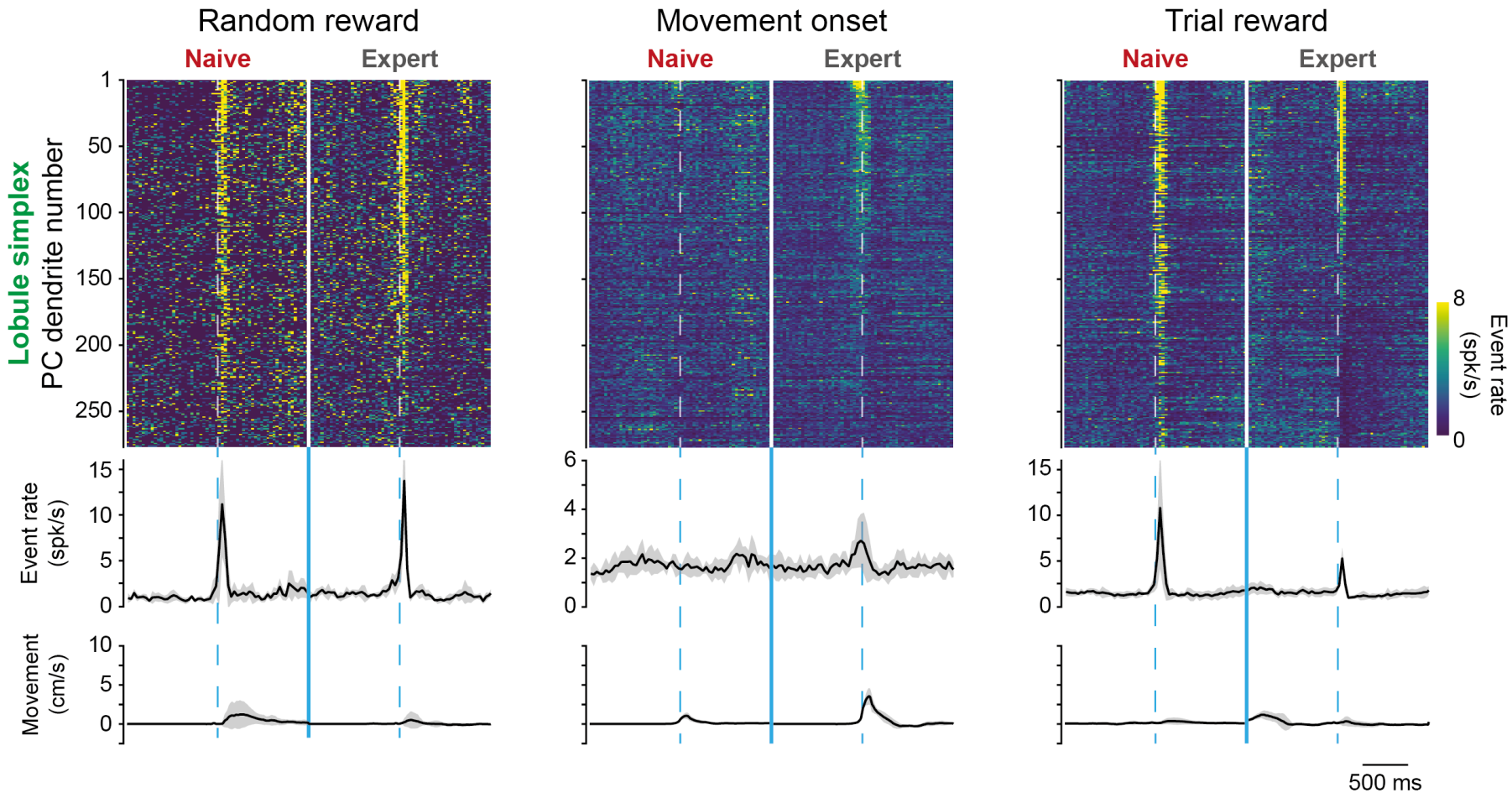




Lobule V climbing fiber inputs preferentially signal movement

Simplex climbing fibers inputs preferentially signal trial outcome

Dynamic climbing fiber signals during task acquisition



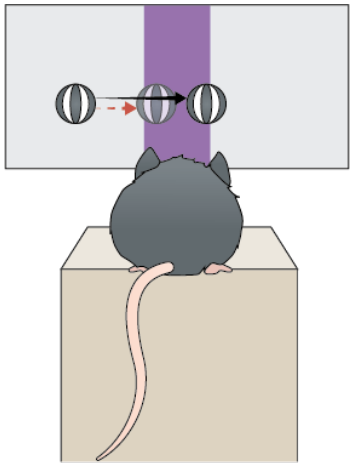
Unpredictable events like random rewards evoke strong responses at all stages

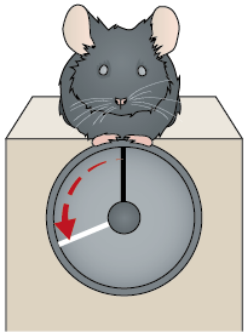
Signals predicting task events such as movement onset emerge with learning

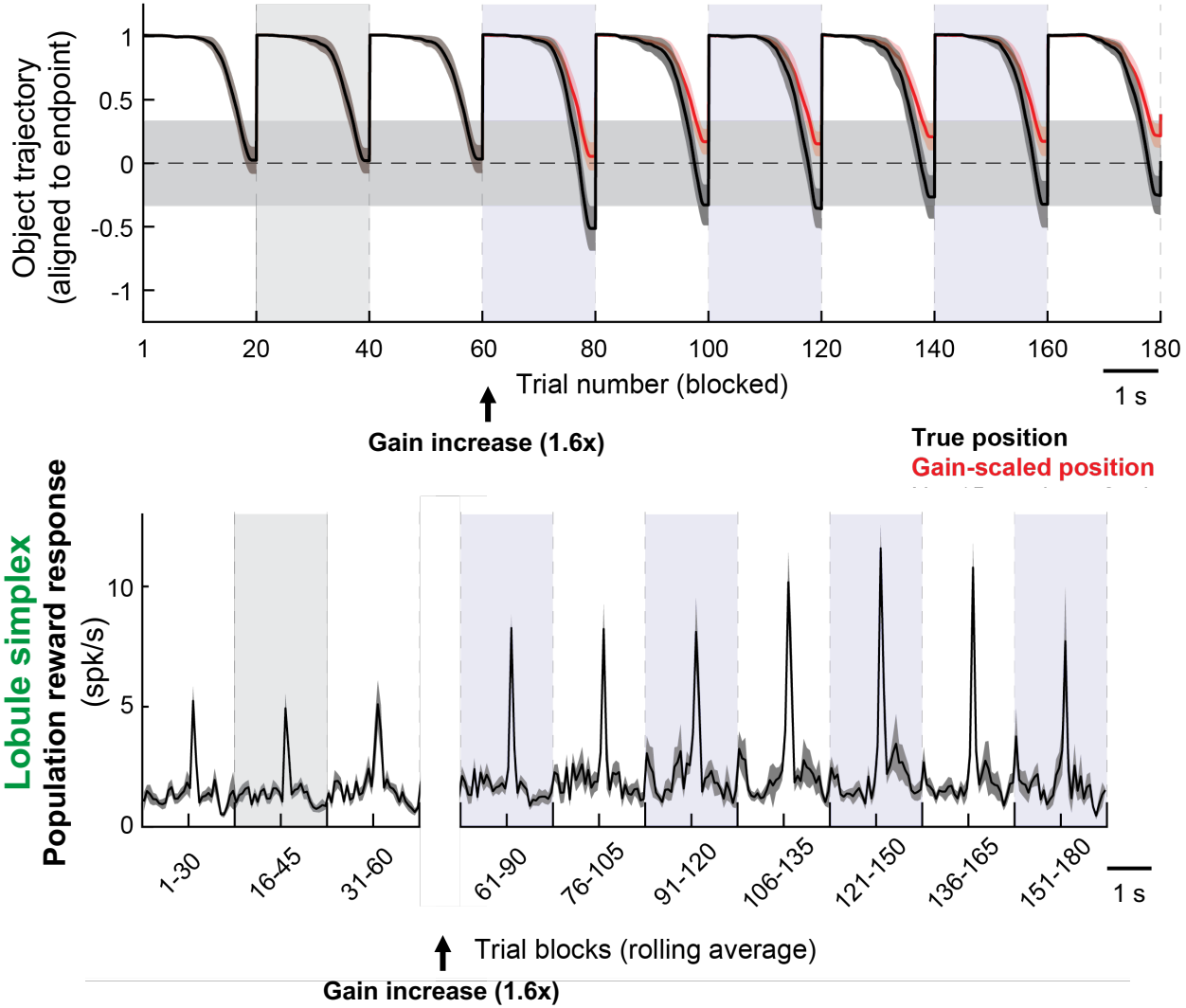
Responses to predictable events such as operant reward signals are suppressed with learning

Dynamic climbing fiber signals during sensorimotor adaptation

Adaptation late







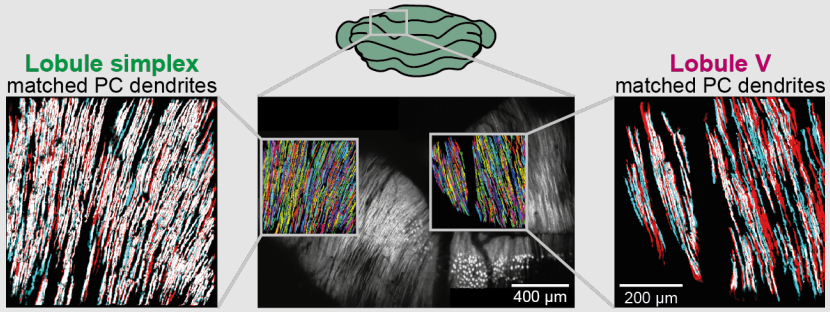
Reward-related signals increase transiently during learning phase of adaptation

Summary

Chronic two-photon Ca^{2+} imaging of climbing fiber inputs reveals dynamics of teaching signals during learning on fast and slow time scales

Lobule V climbing fibers preferentially signal movement

Simplex climbing fibers preferentially signal trial outcome

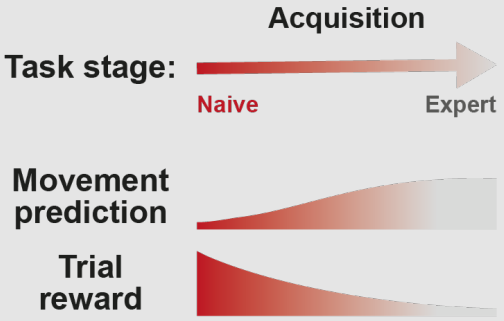


Slow learning:

Climbing fiber signals evolve over task acquisition

Predictive signals emerge

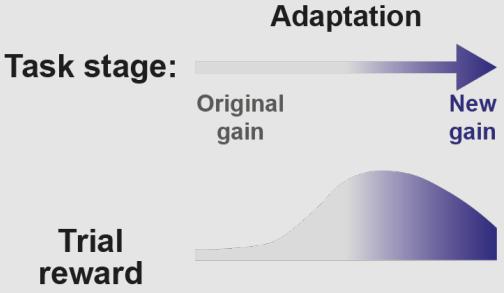
Predictable events are suppressed



Fast learning:

Teaching signals are reinvigorated during sensorimotor adaptation

Operant reward responses grow transiently during the learning phase of adaptation



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