MRC Brain Network Dynamics Unit

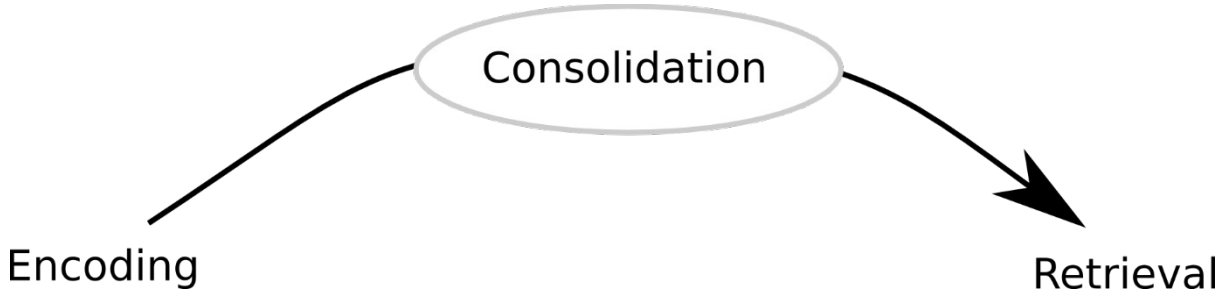
UNIVERSITY OF OXFORD

Hippocampal reactivation stabilizes recently formed cell assembly patterns

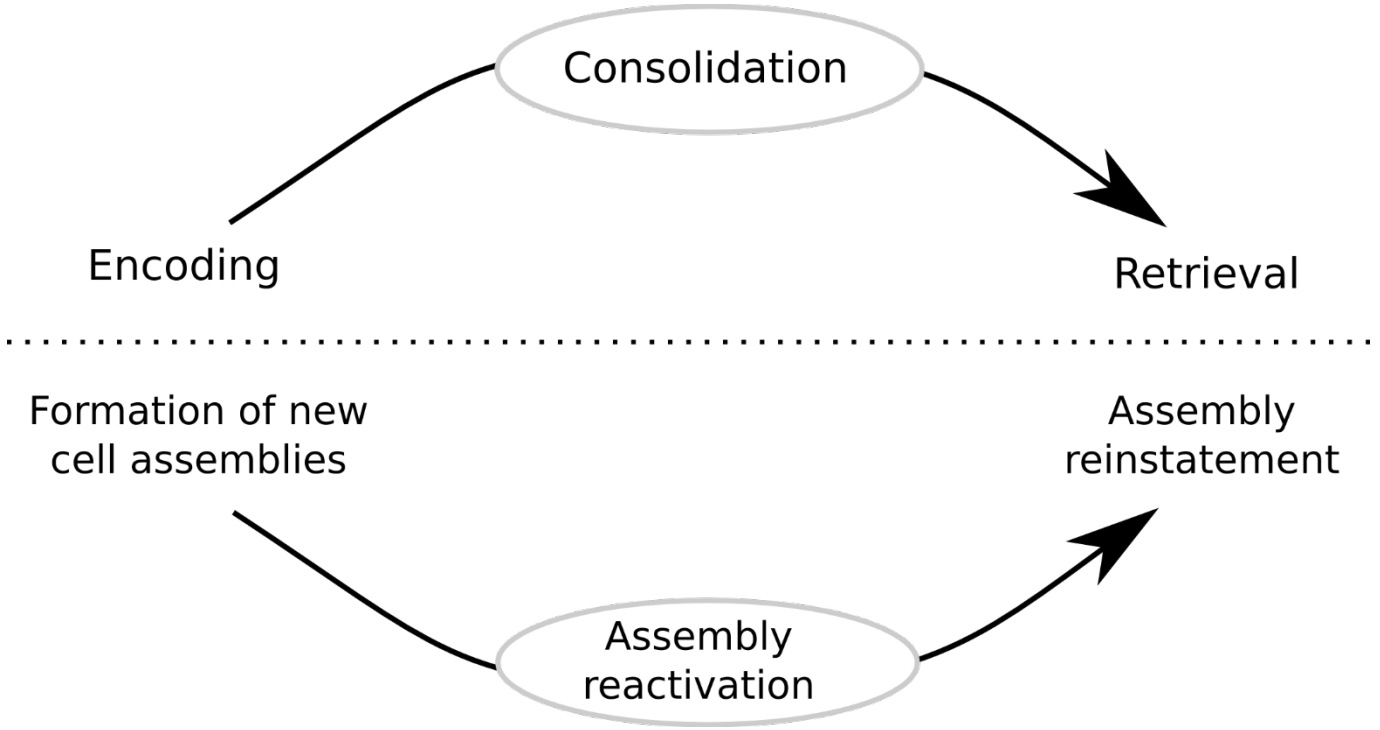
Gido van de Ven

26 April, 2017

Memory-consolidation



Memory-consolidation:
cell assembly / reactivation hypothesis



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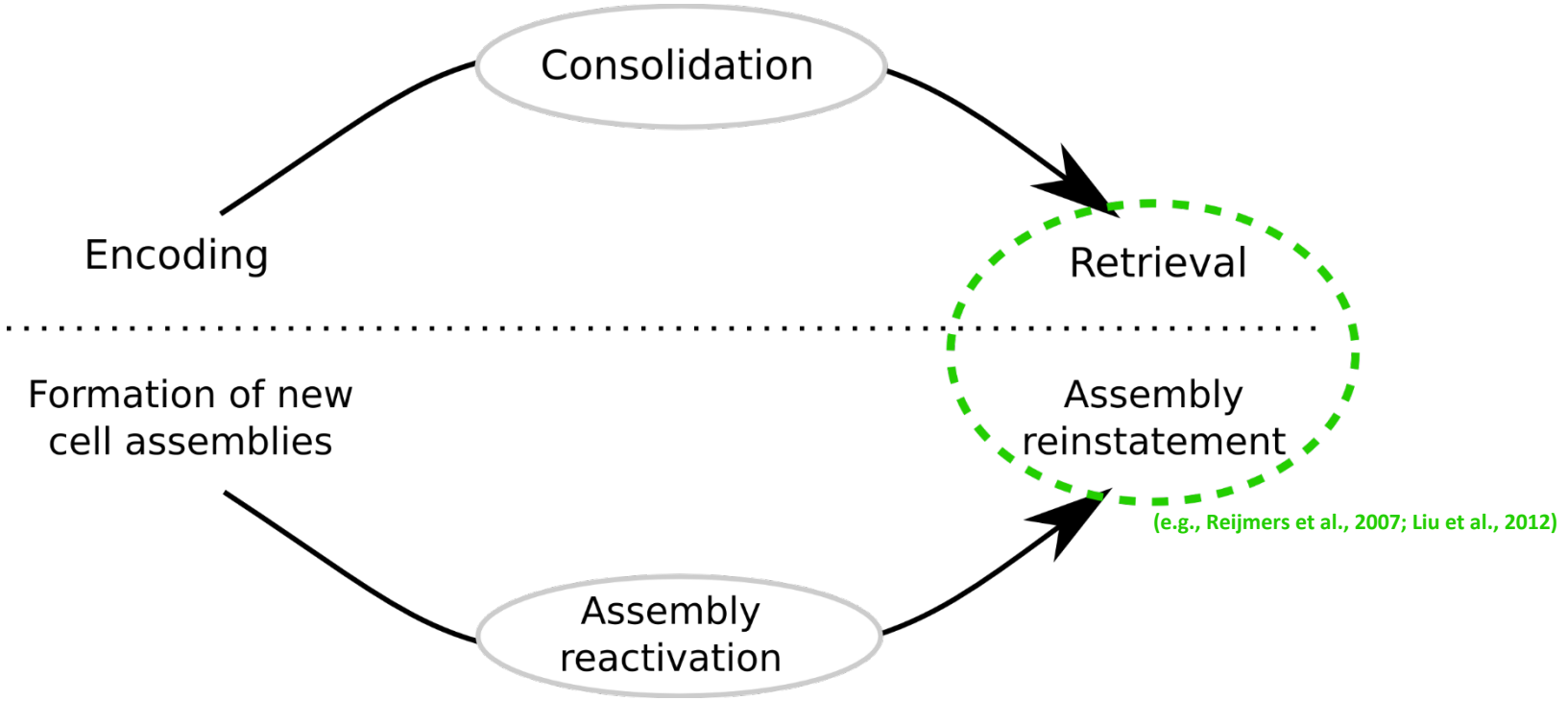
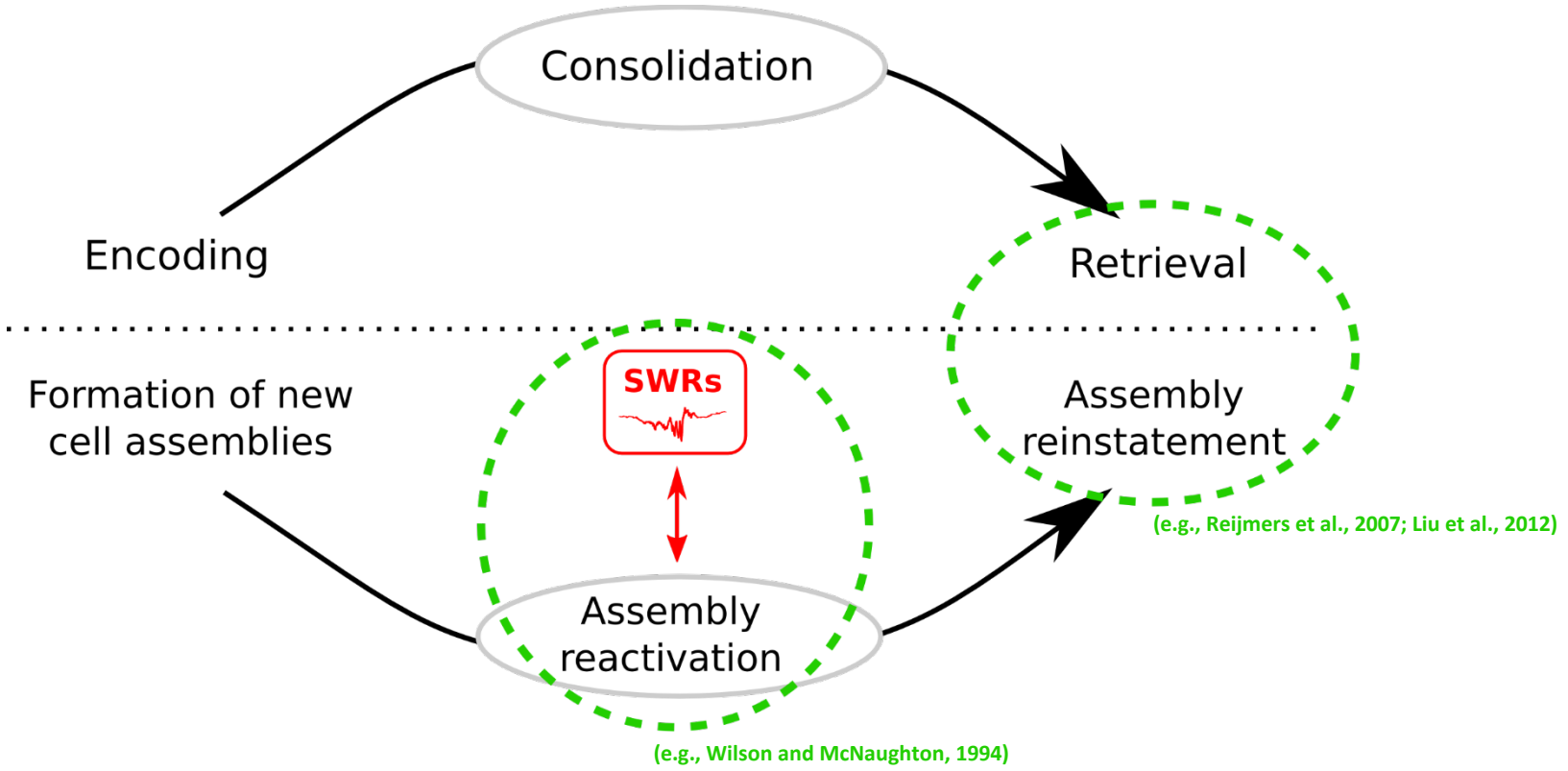


(e.g., Reijmers et al., 2007; Liu et al., 2012)

Memory-consolidation:
cell assembly / reactivation hypothesis



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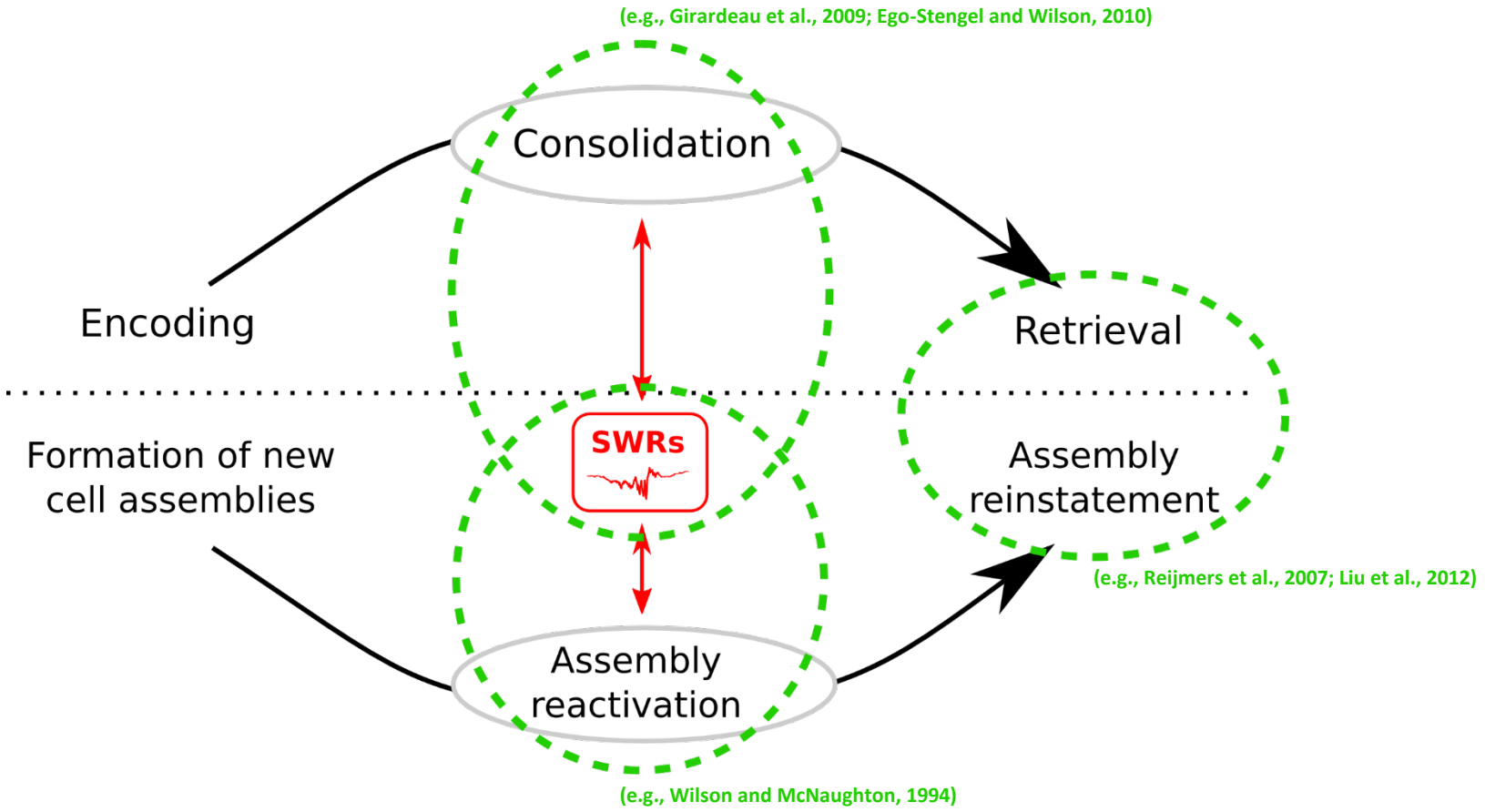

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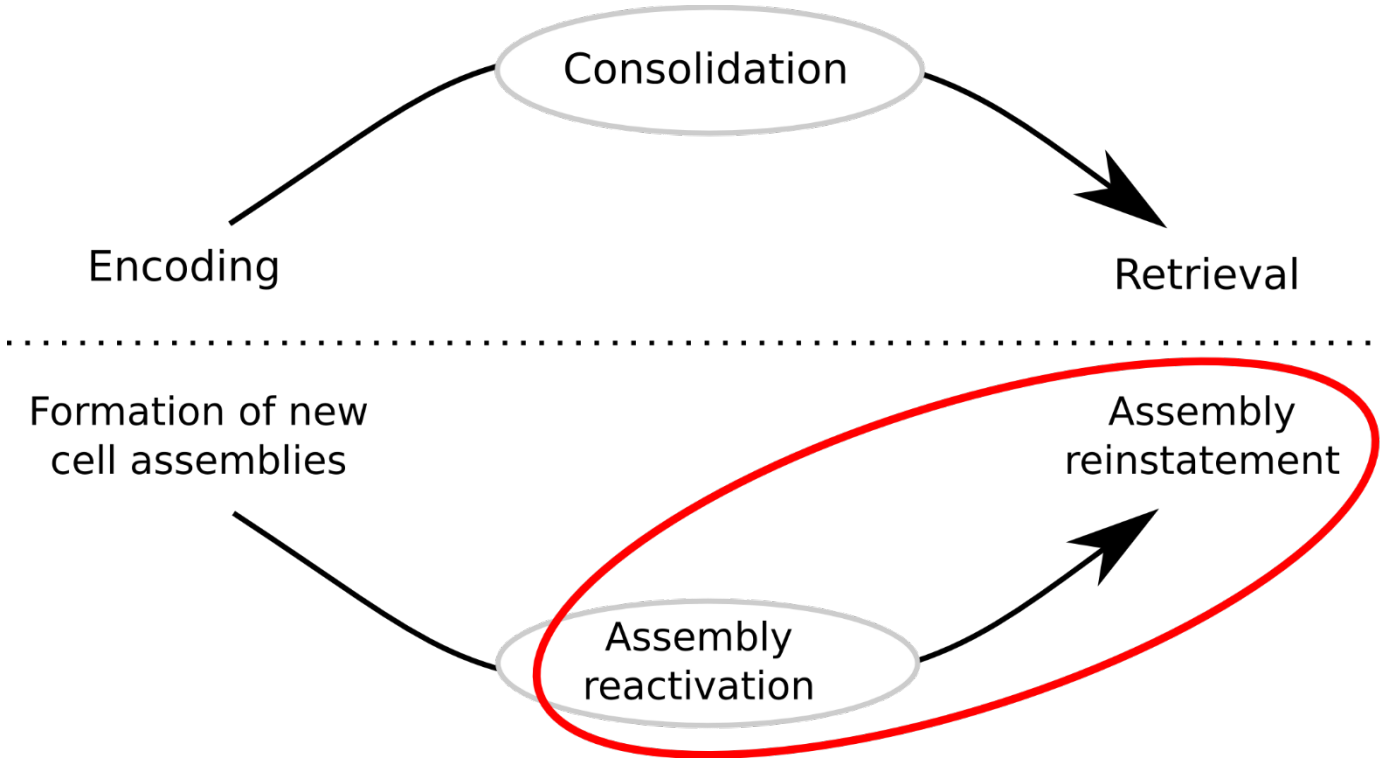

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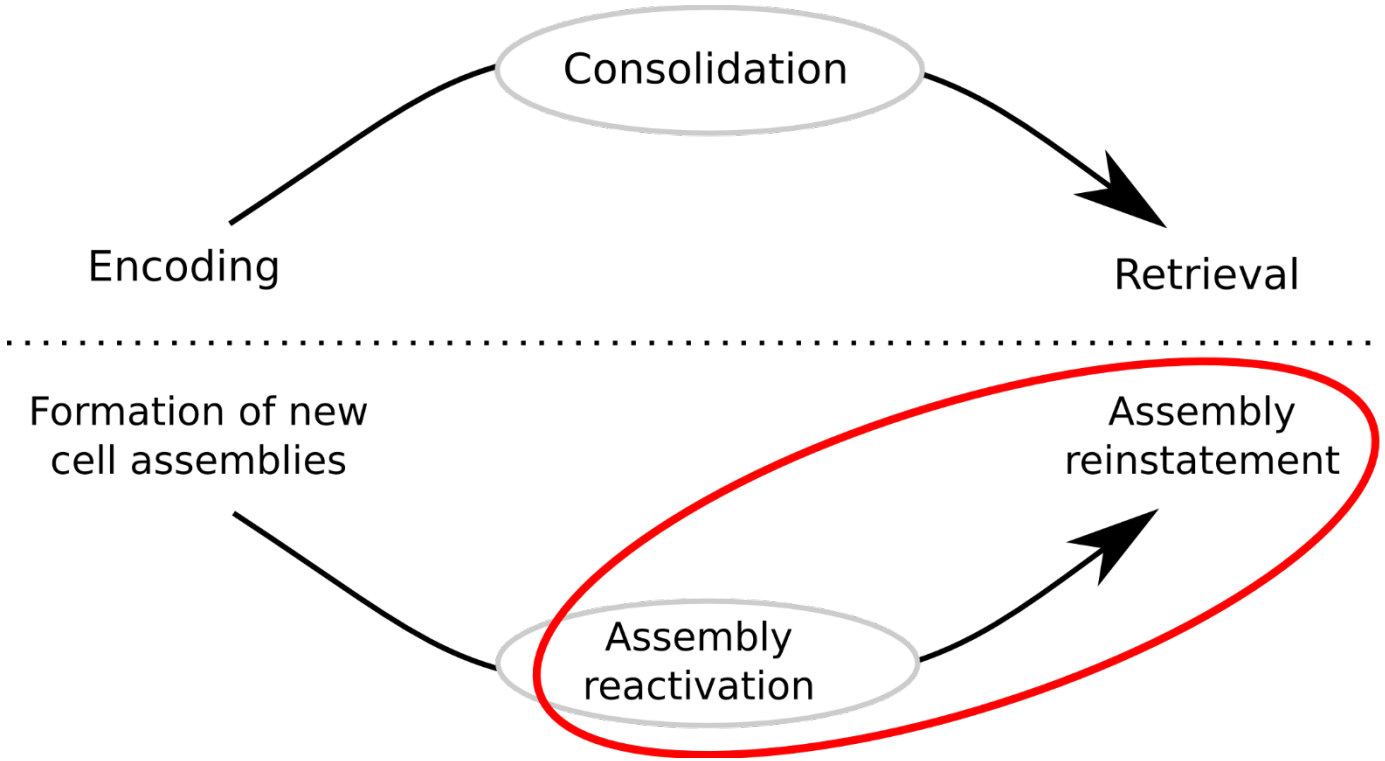
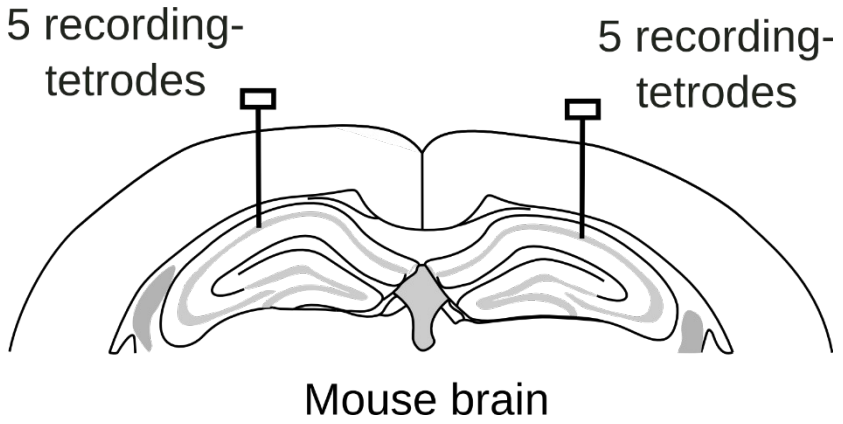
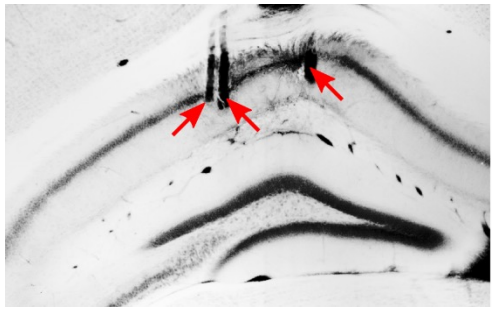


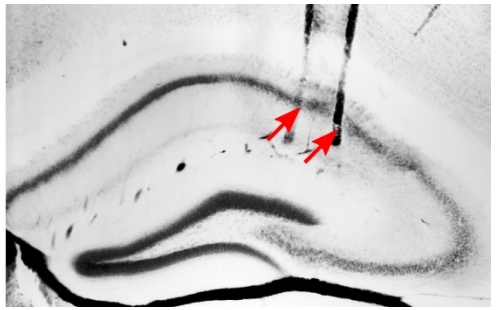
2 challenges: → Identification & tracking of "memory-representing" cell assemblies
→ Selective disruption of reactivation

Identification of “cell assemblies”

= challenge 1







Identification of “cell assemblies”

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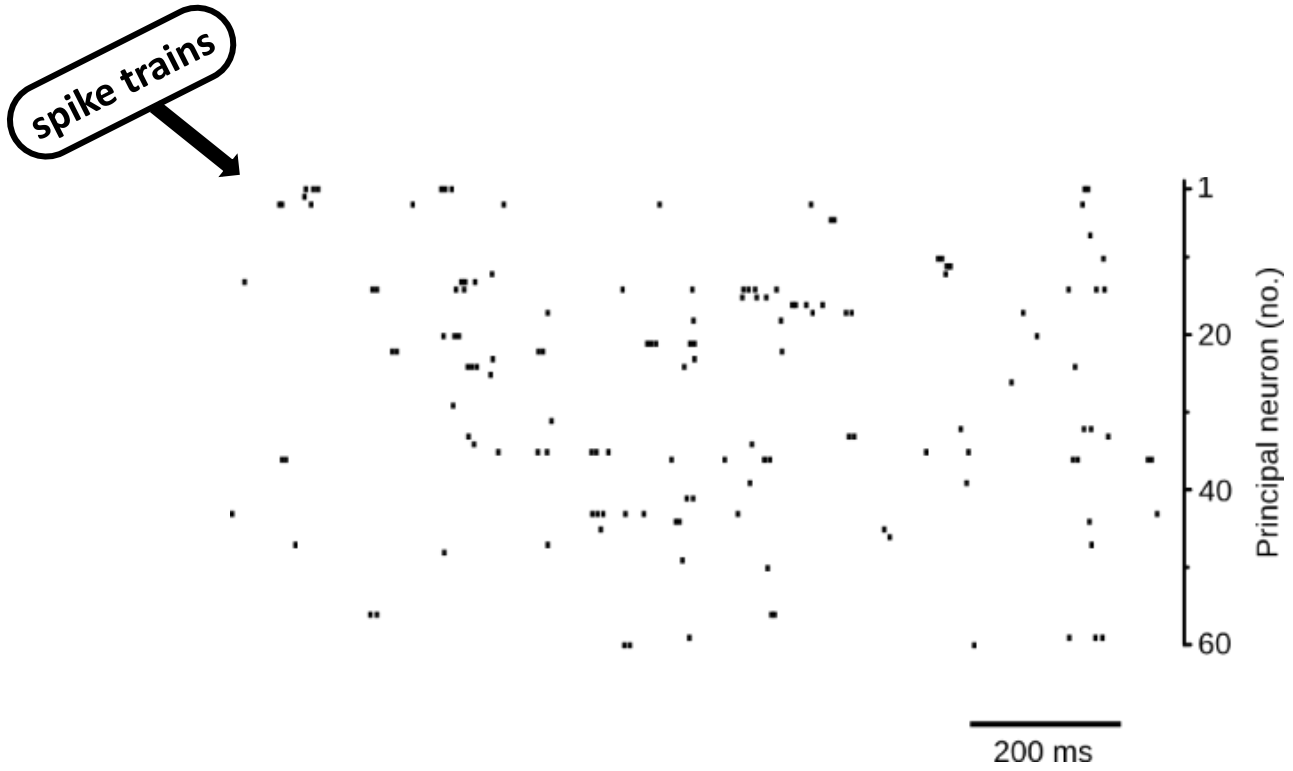
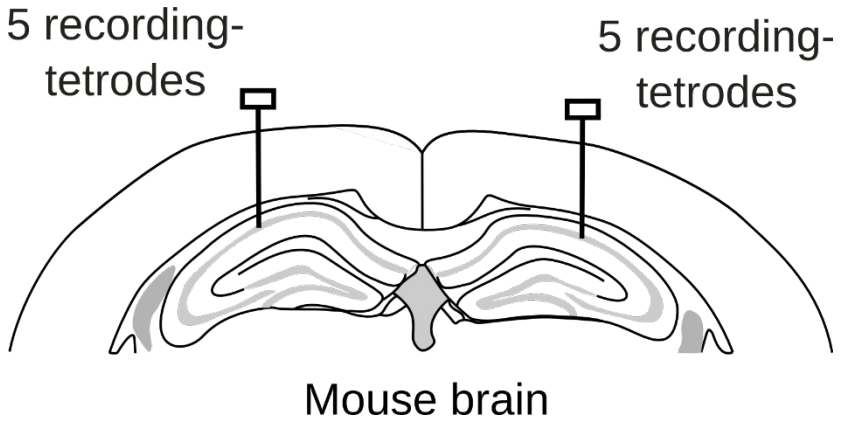
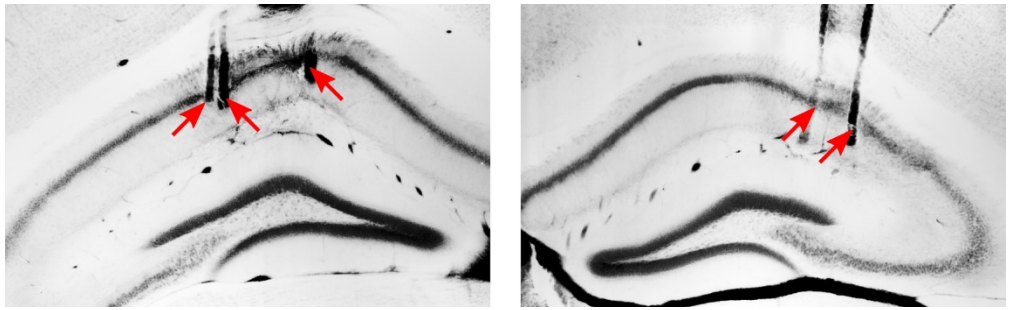
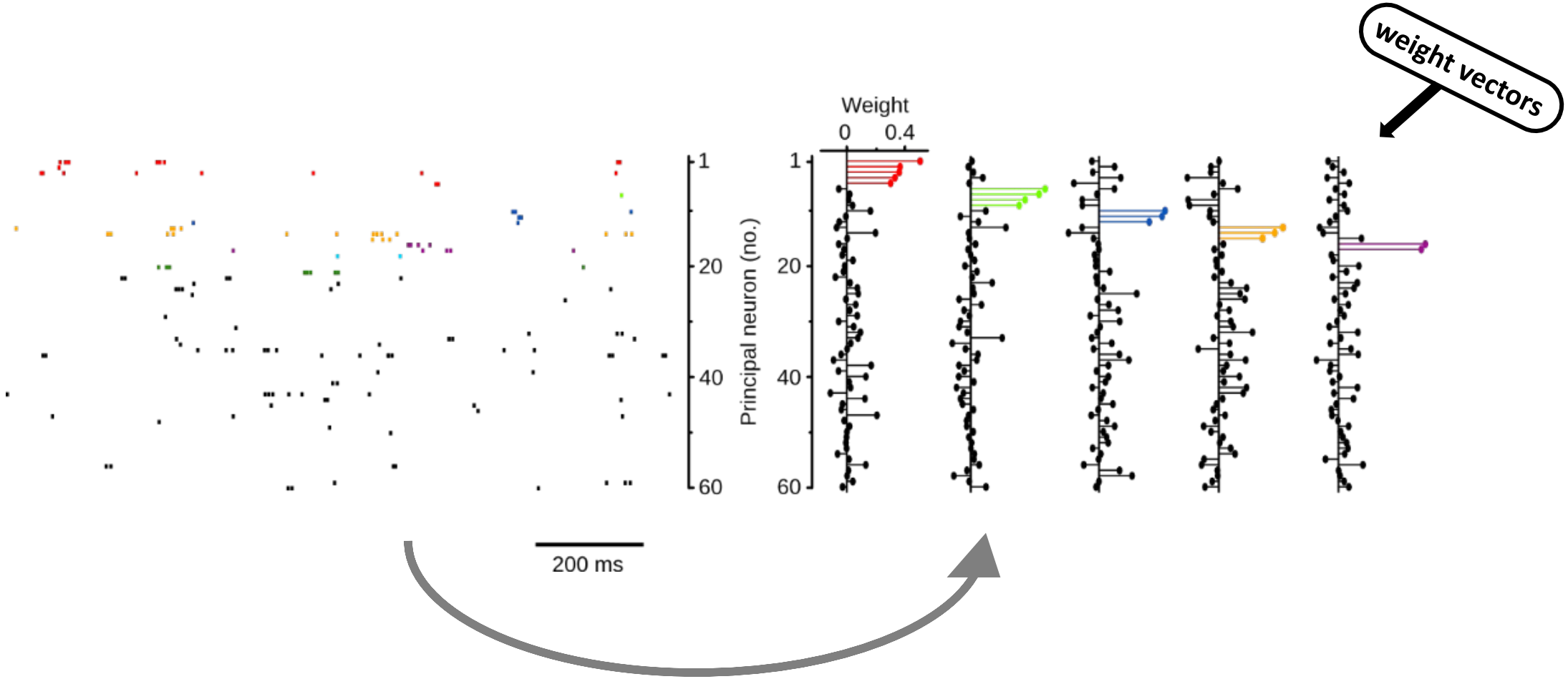




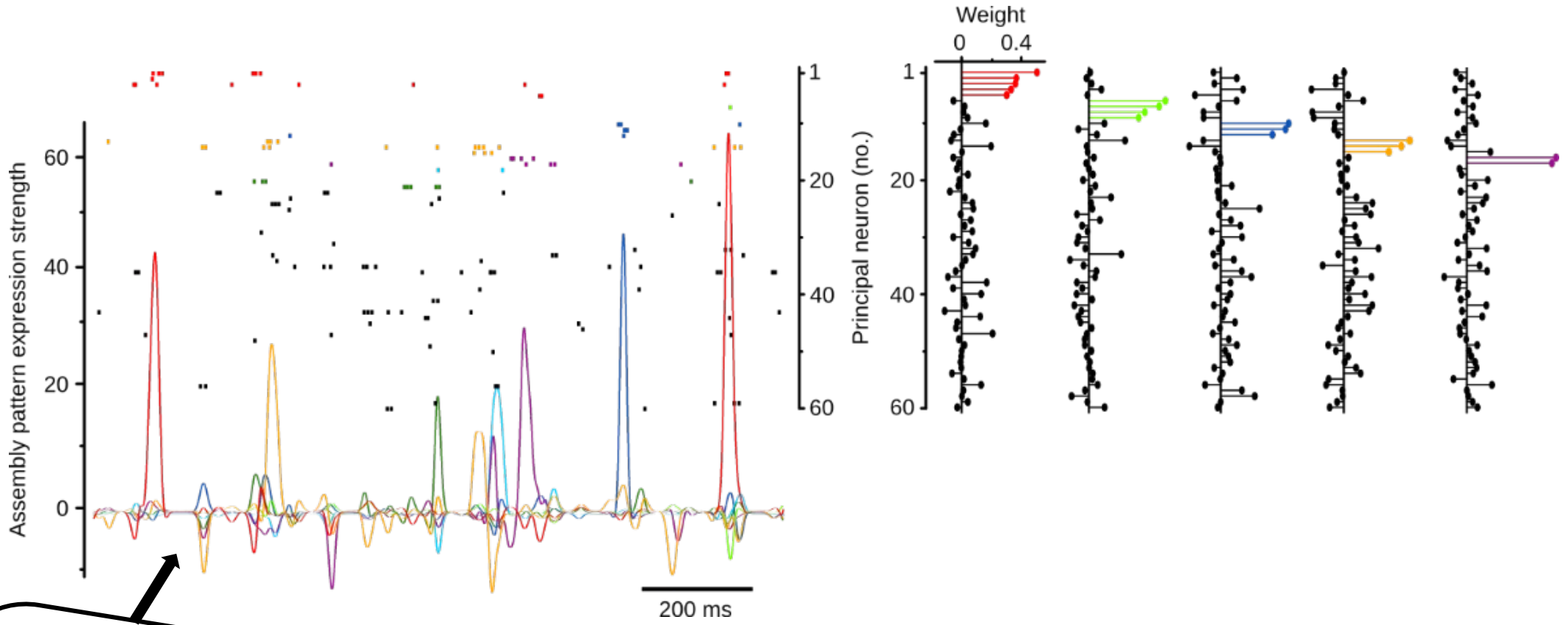


Identification of “cell assemblies”



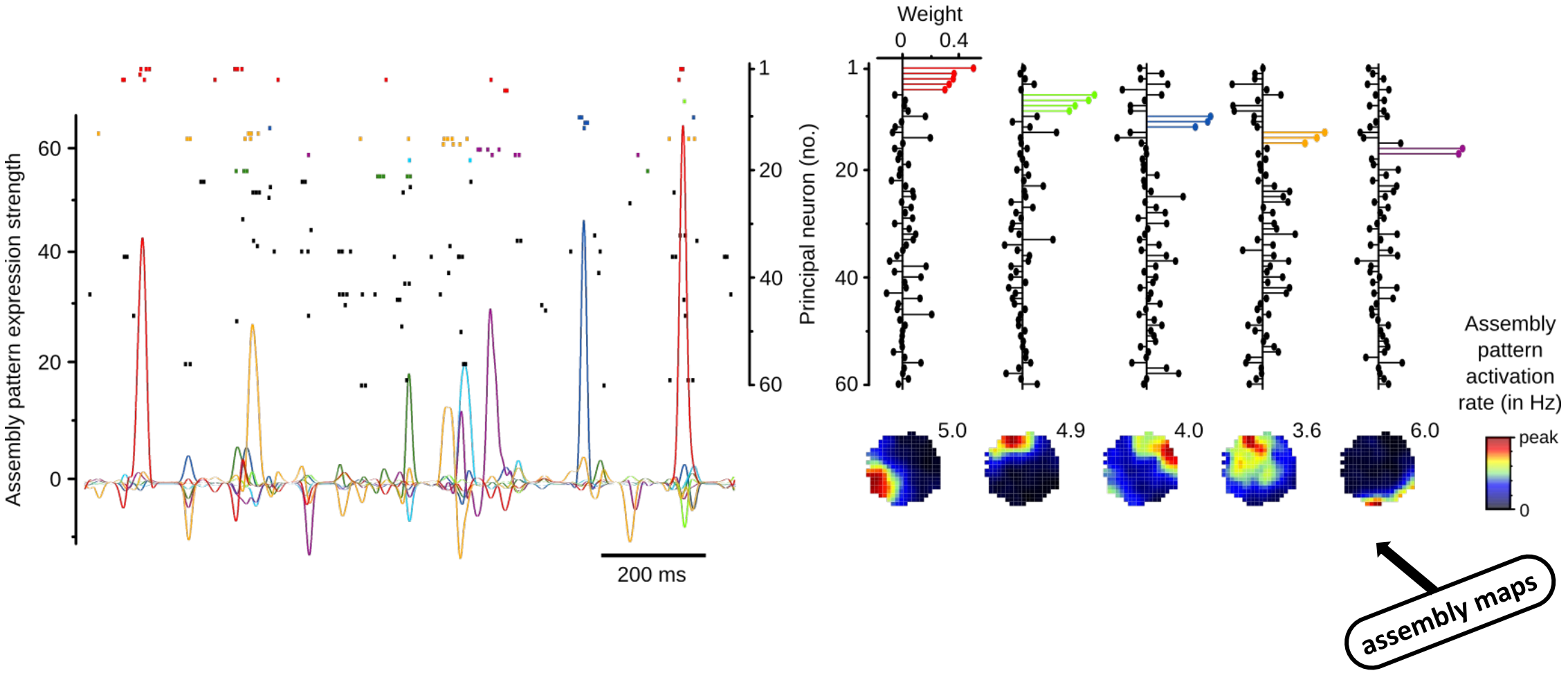
Assembly-detection method based on PCA and ICA

Identification of “cell assemblies”



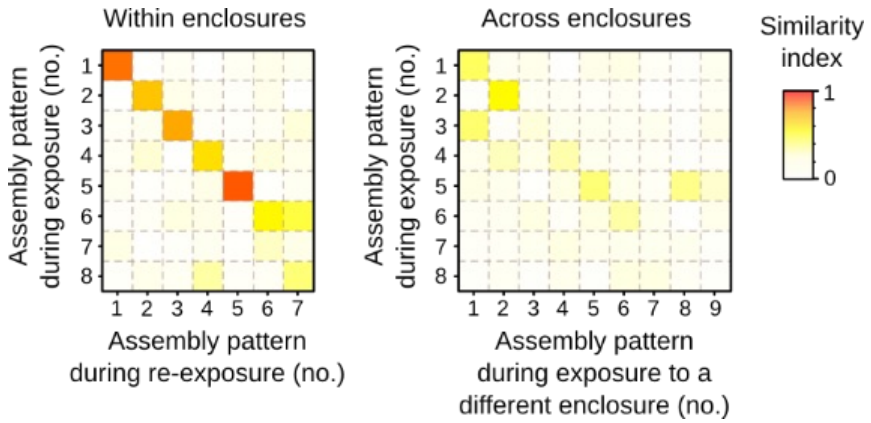
assembly pattern expression-strength tracked over time

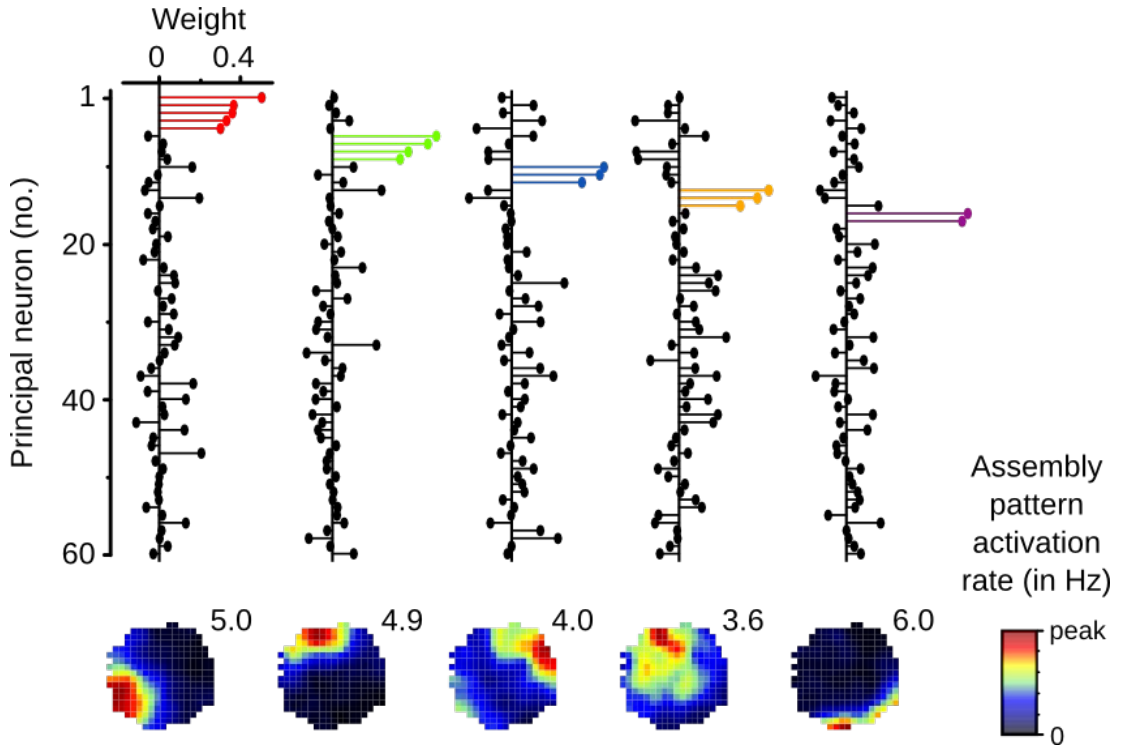
Identification of “cell assemblies”



Identification of “cell assemblies”

assembly patterns are environment-specific





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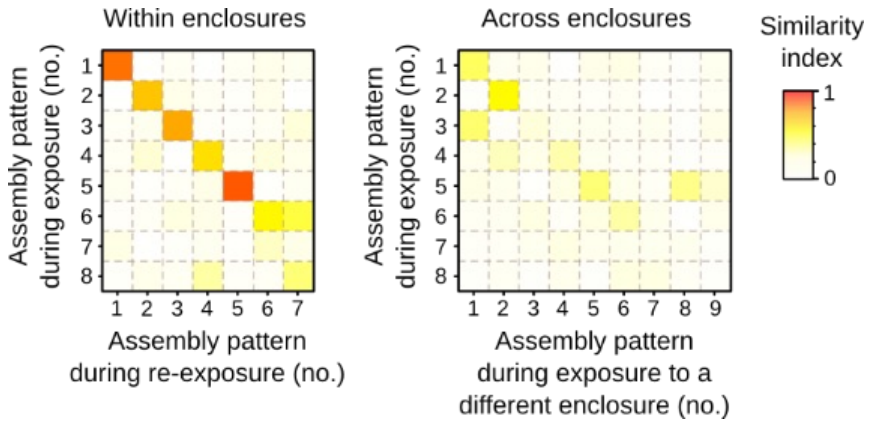
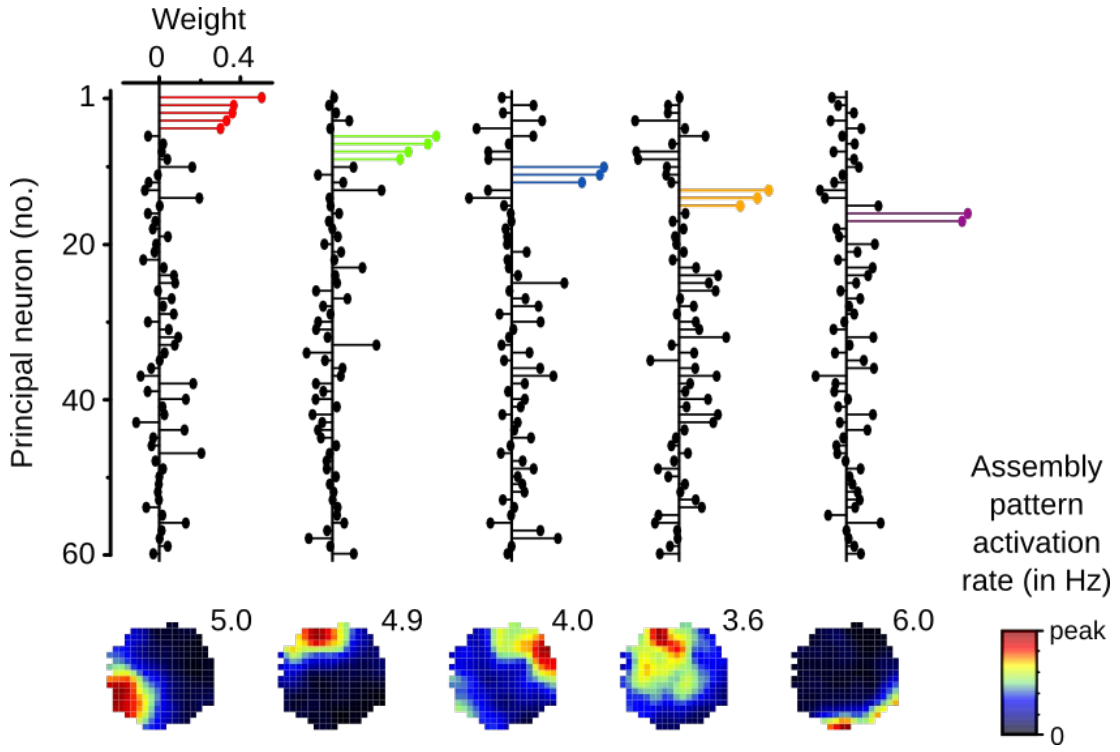
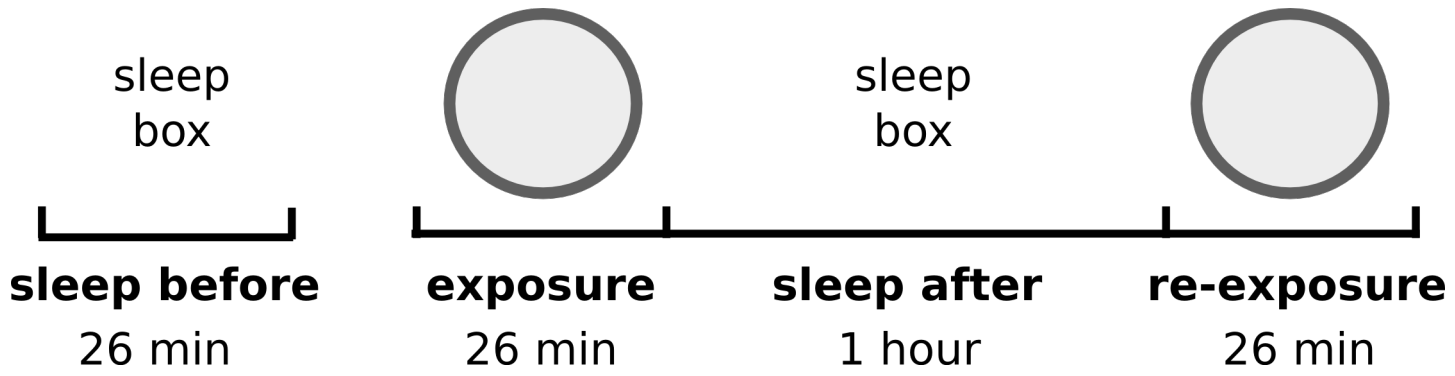


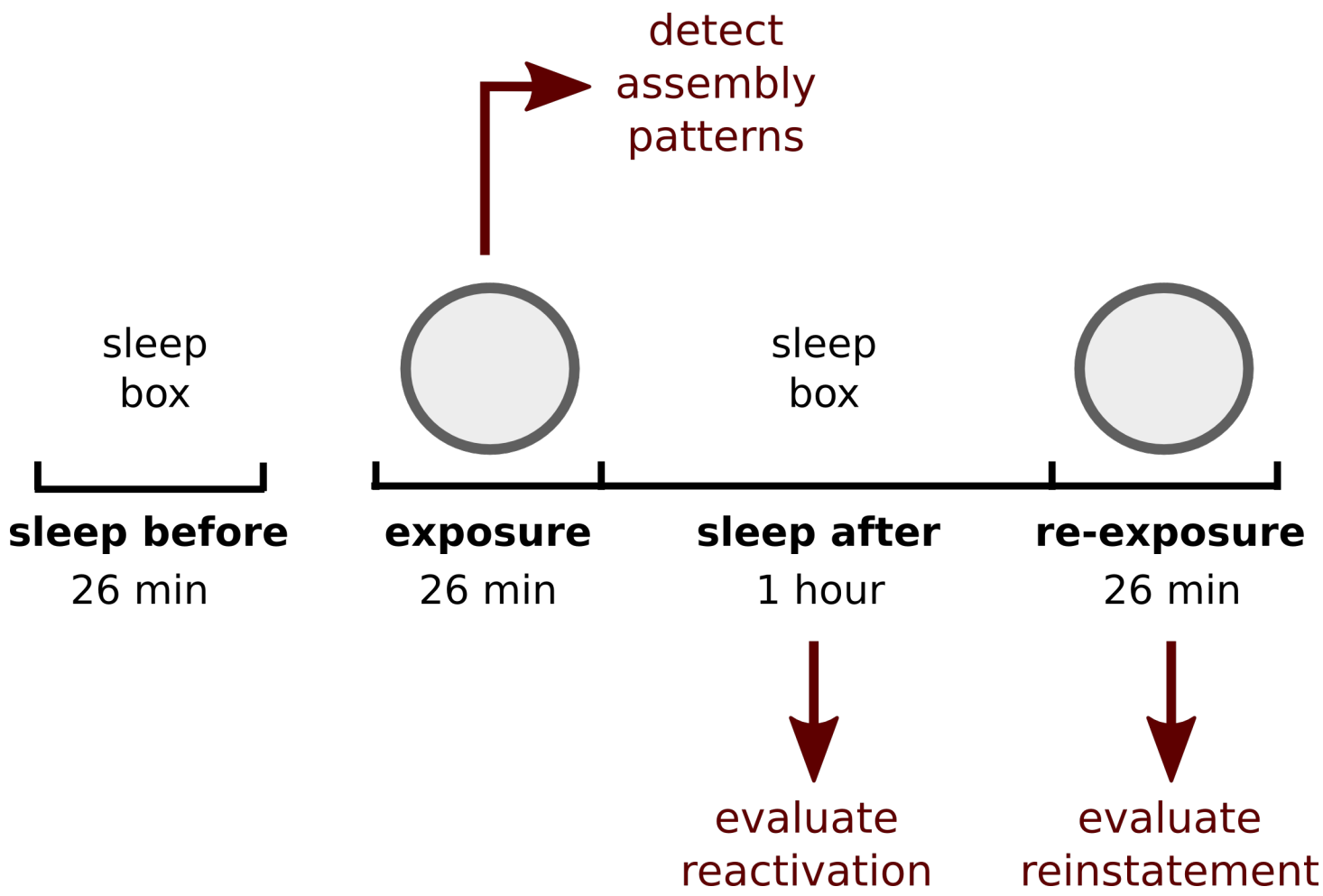


→ **challenge 1**: Identification & tracking of “memory-representing” cell assemblies

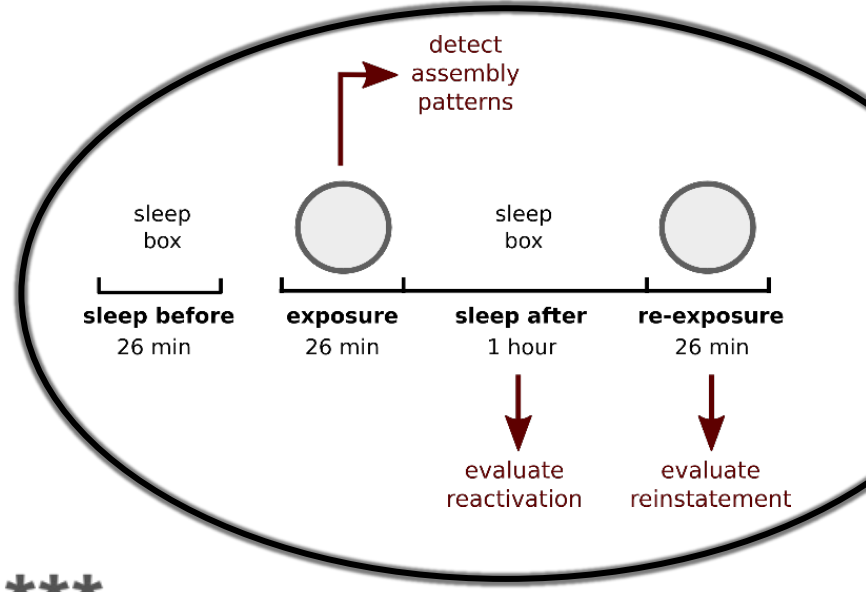
Experimental protocol

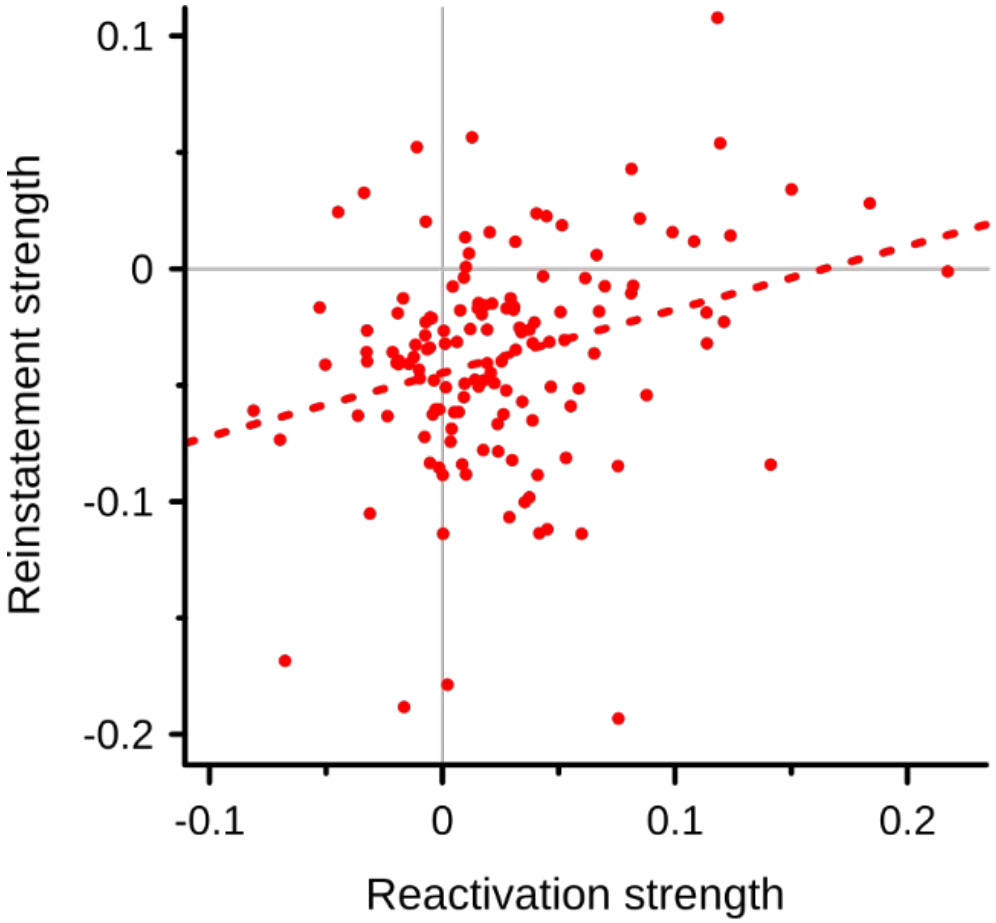


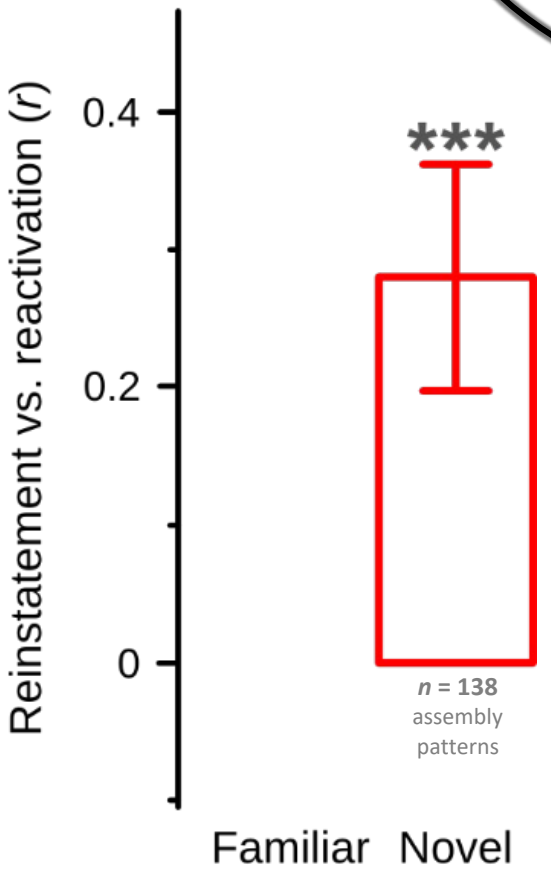
Experimental protocol - (*correlation*)



An assembly pattern's reactivation predicts it subsequent reinstatement

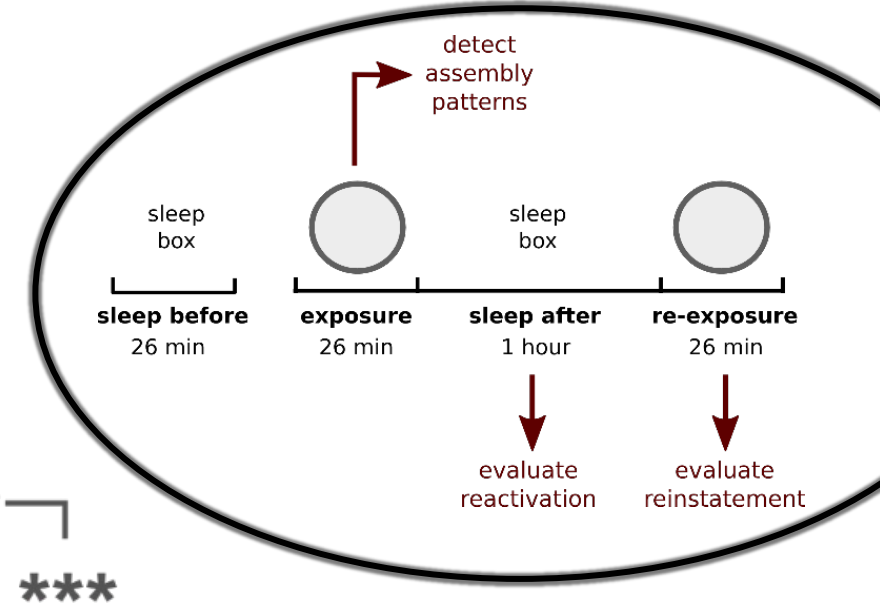


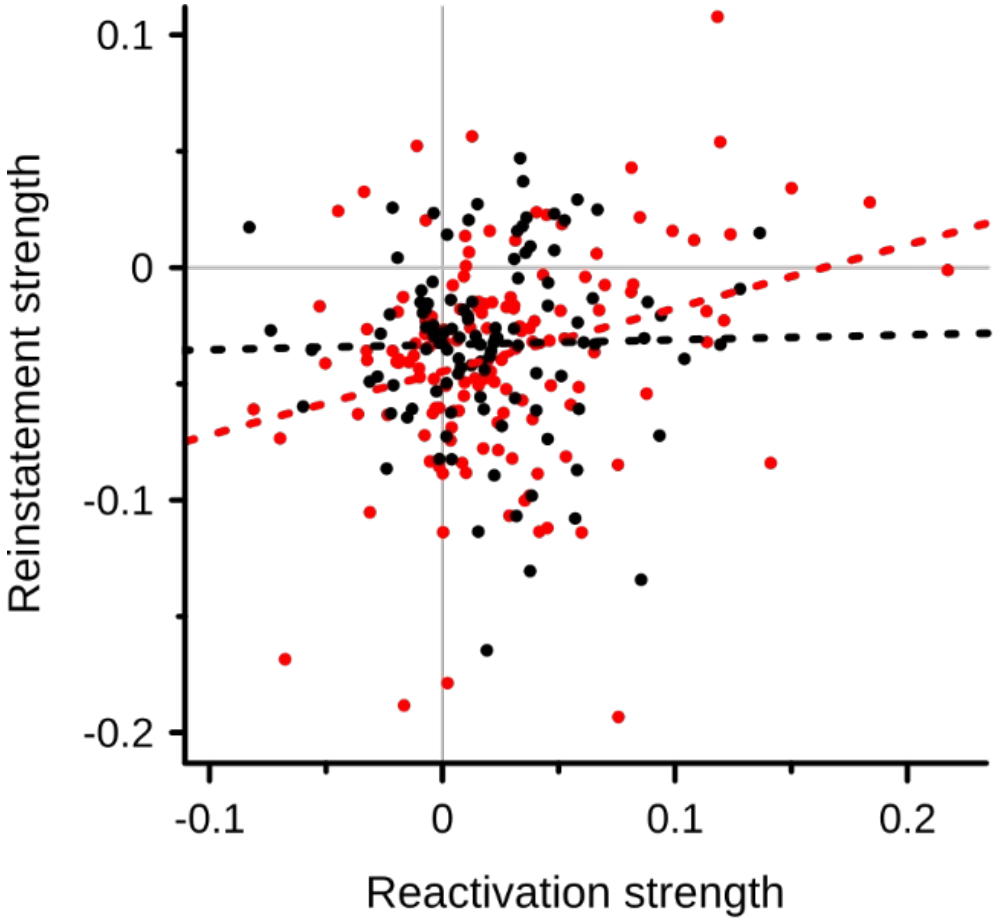


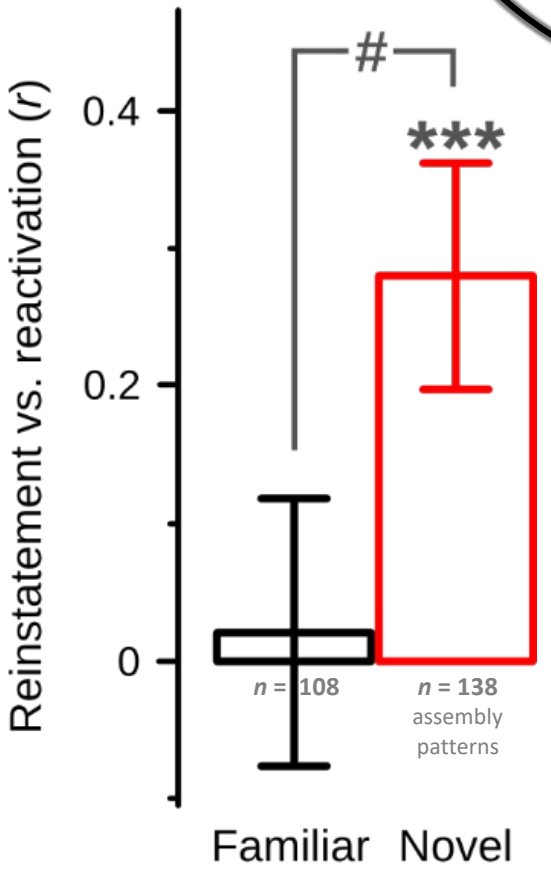


(based on 43 recording-blocks from 8 mice)

An assembly pattern's reactivation predicts it subsequent reinstatement







(based on 43 recording-blocks from 8 mice)

Selective disruption of reactivation?

= **challenge 2**

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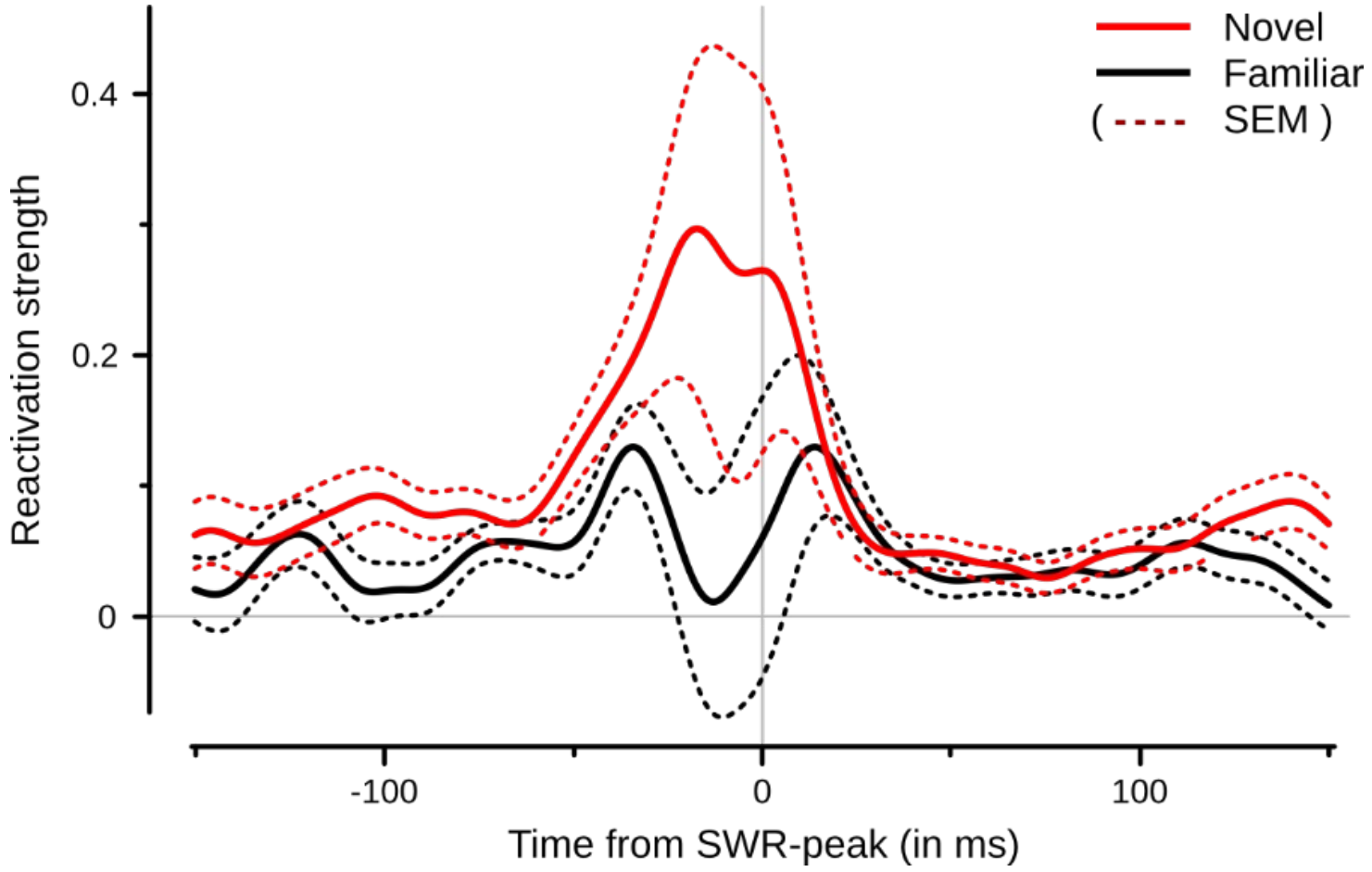
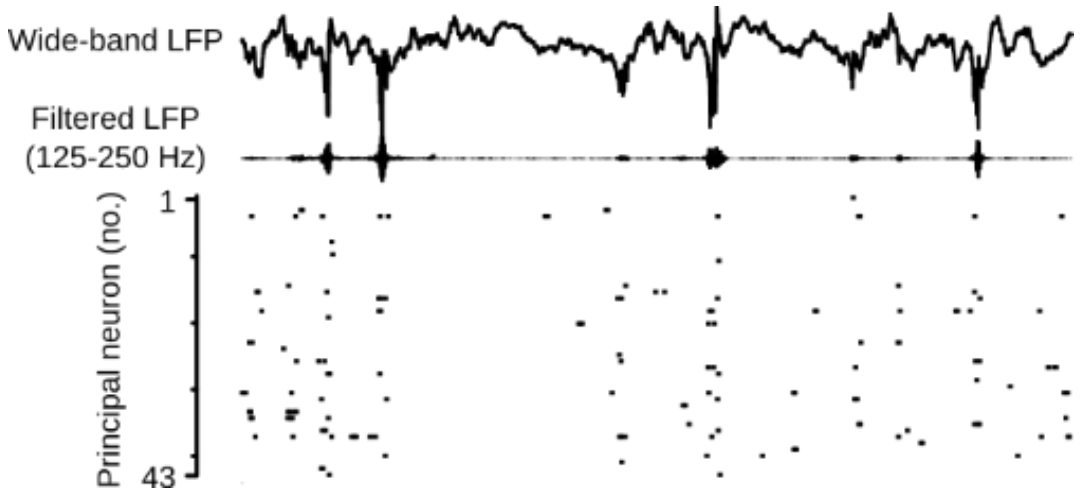


Novel: *n* = 139 assembly-patterns
Familiar: *n* = 108 assembly-patterns
(based on 43 recording-blocks from 8 mice)

Selective disruption of reactivation: *optogenetic SWR silencing*



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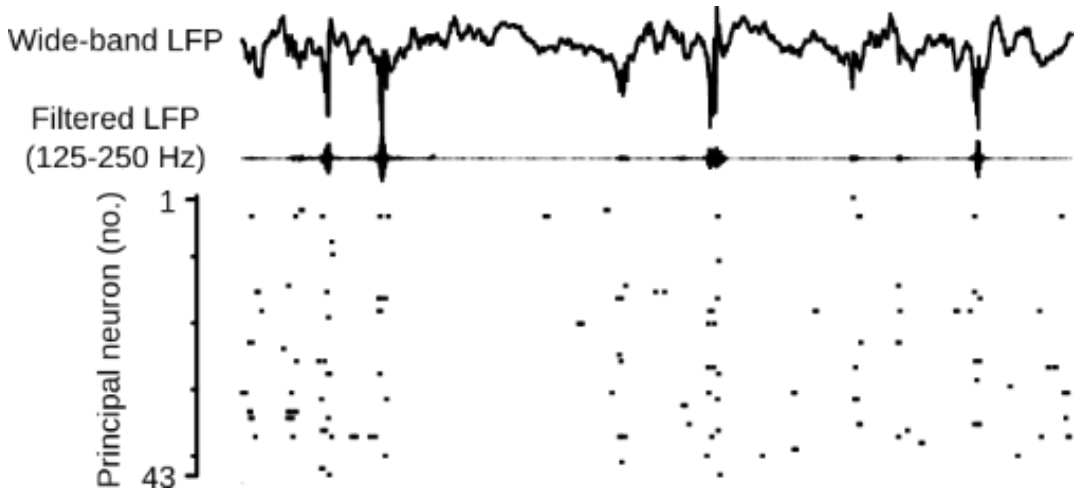

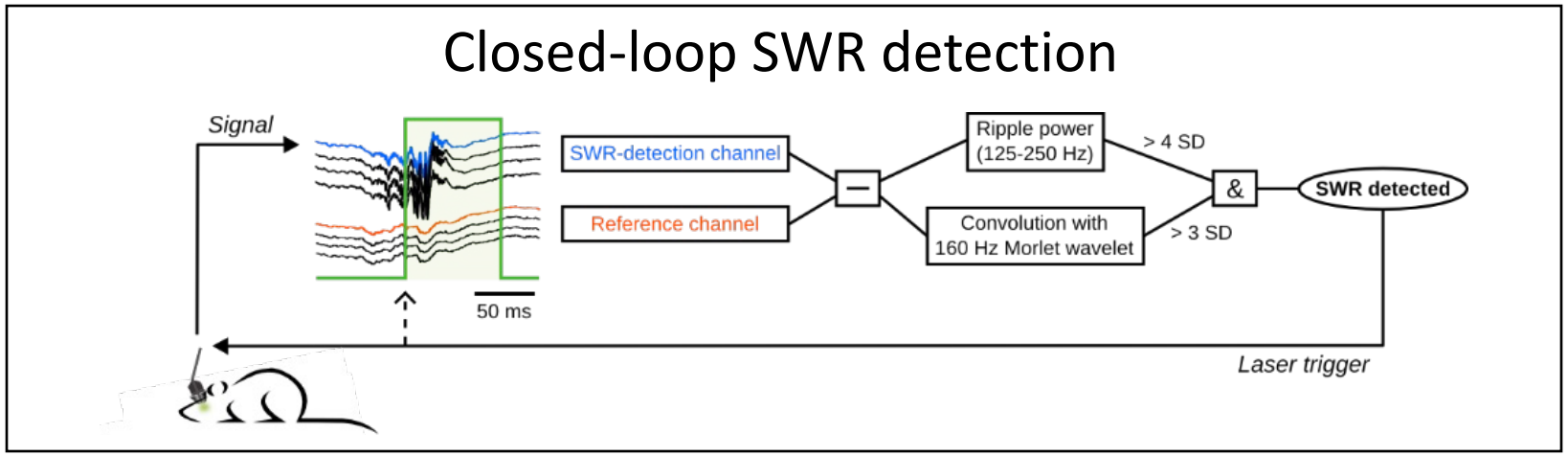

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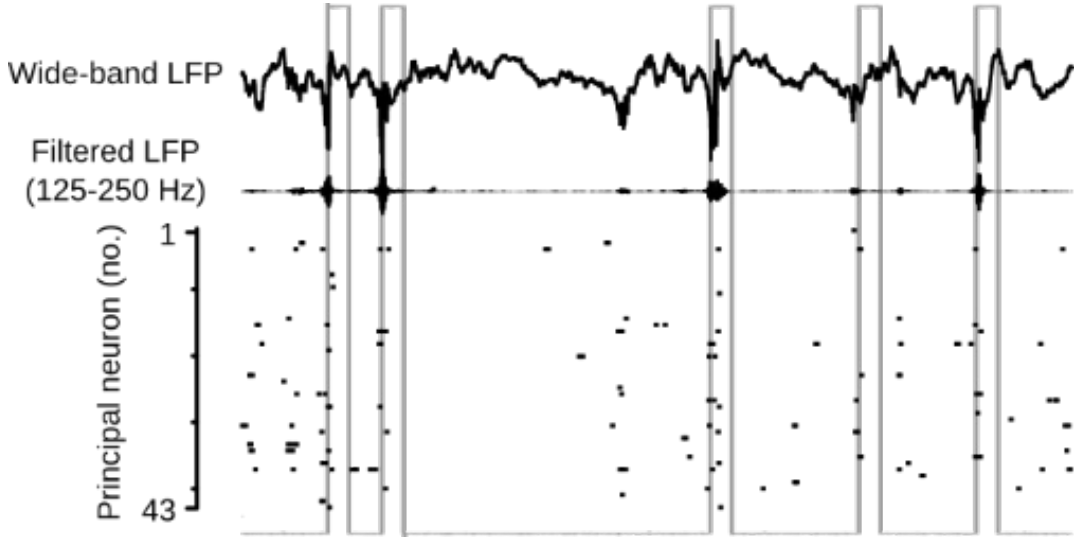

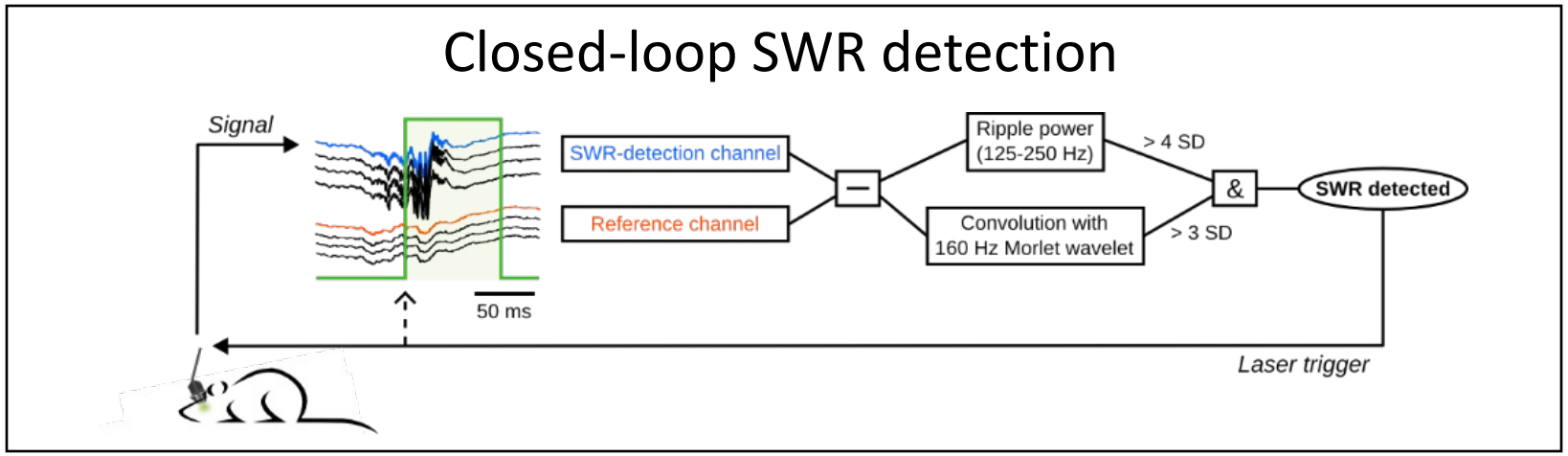

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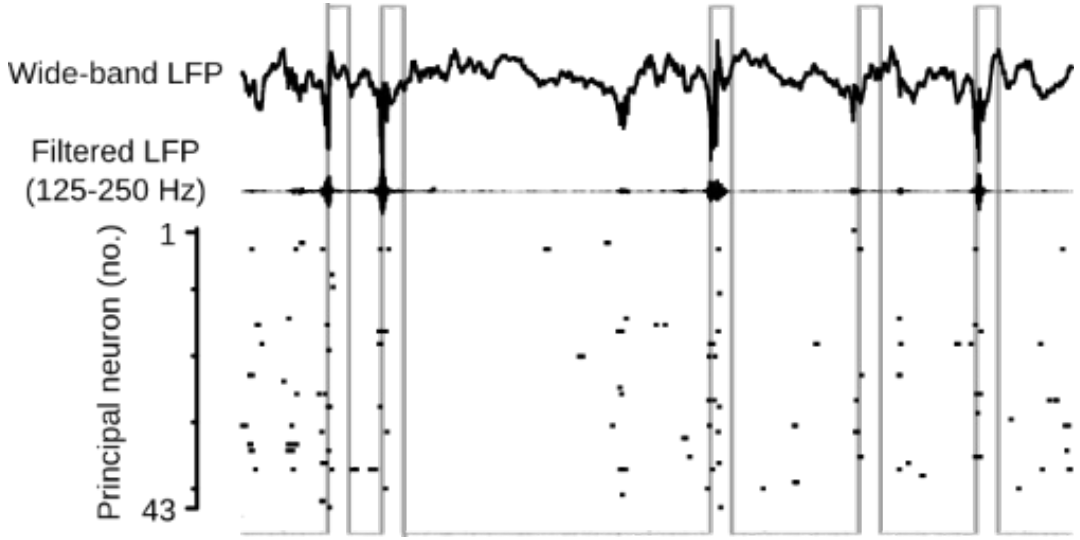
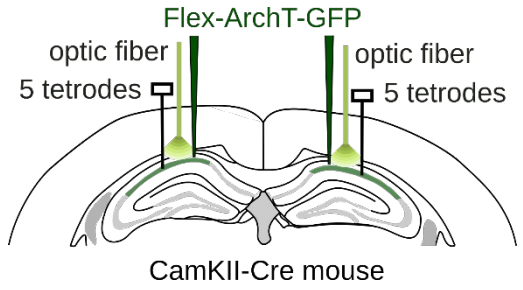
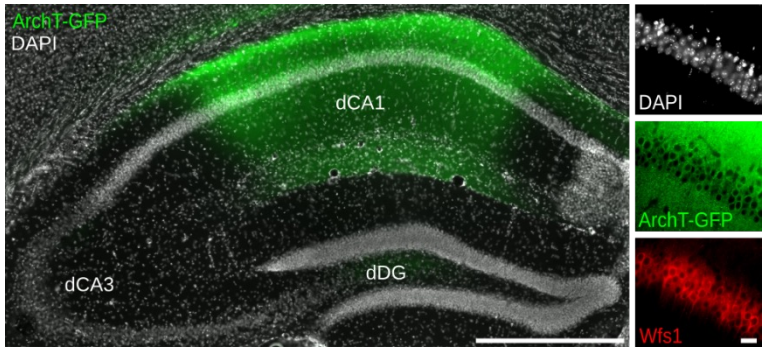


Optogenetic silencing of CamKII-positive cells using ArchT





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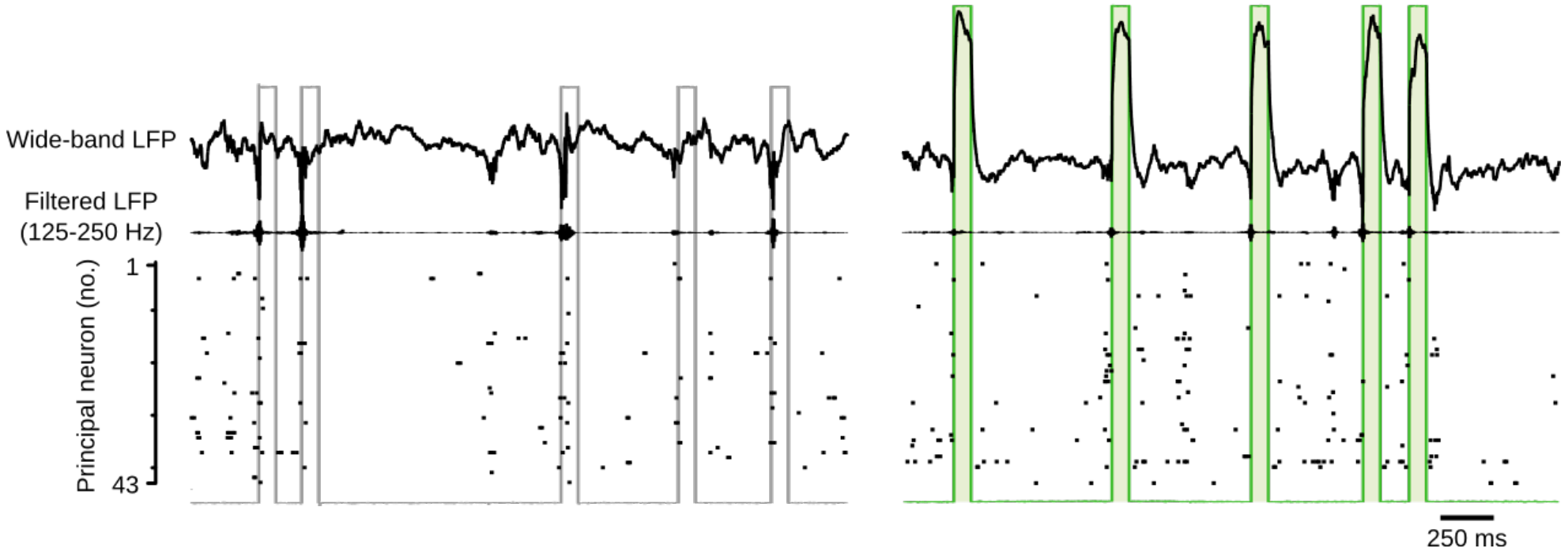

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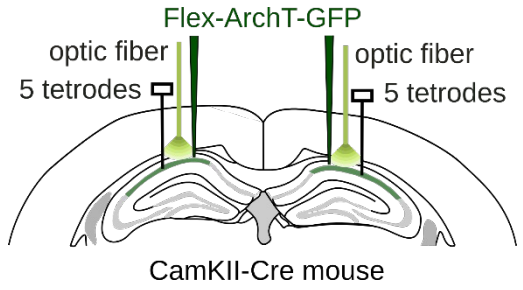

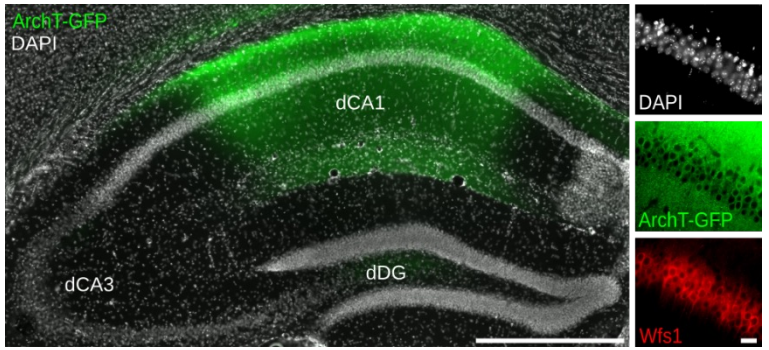

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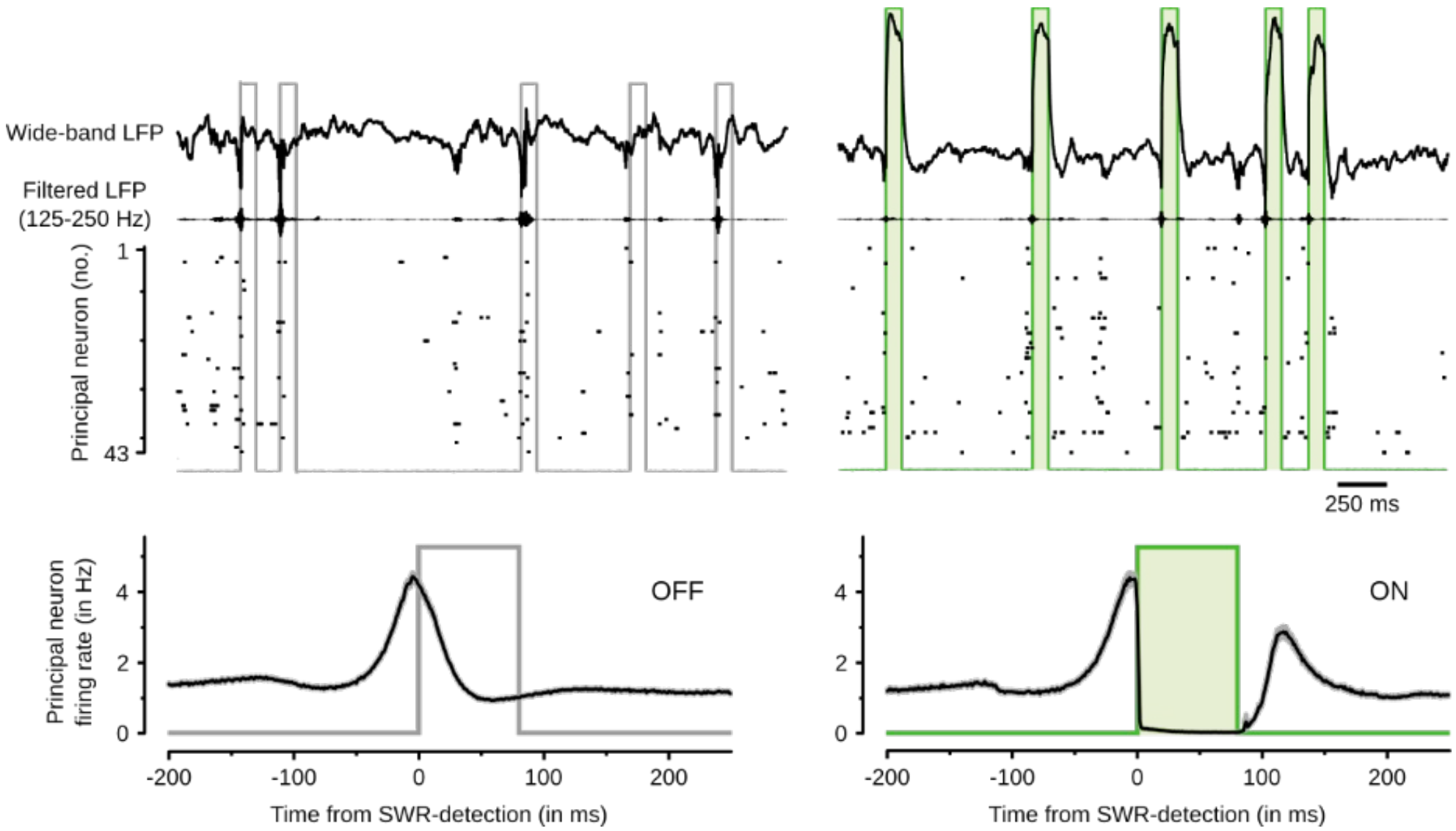
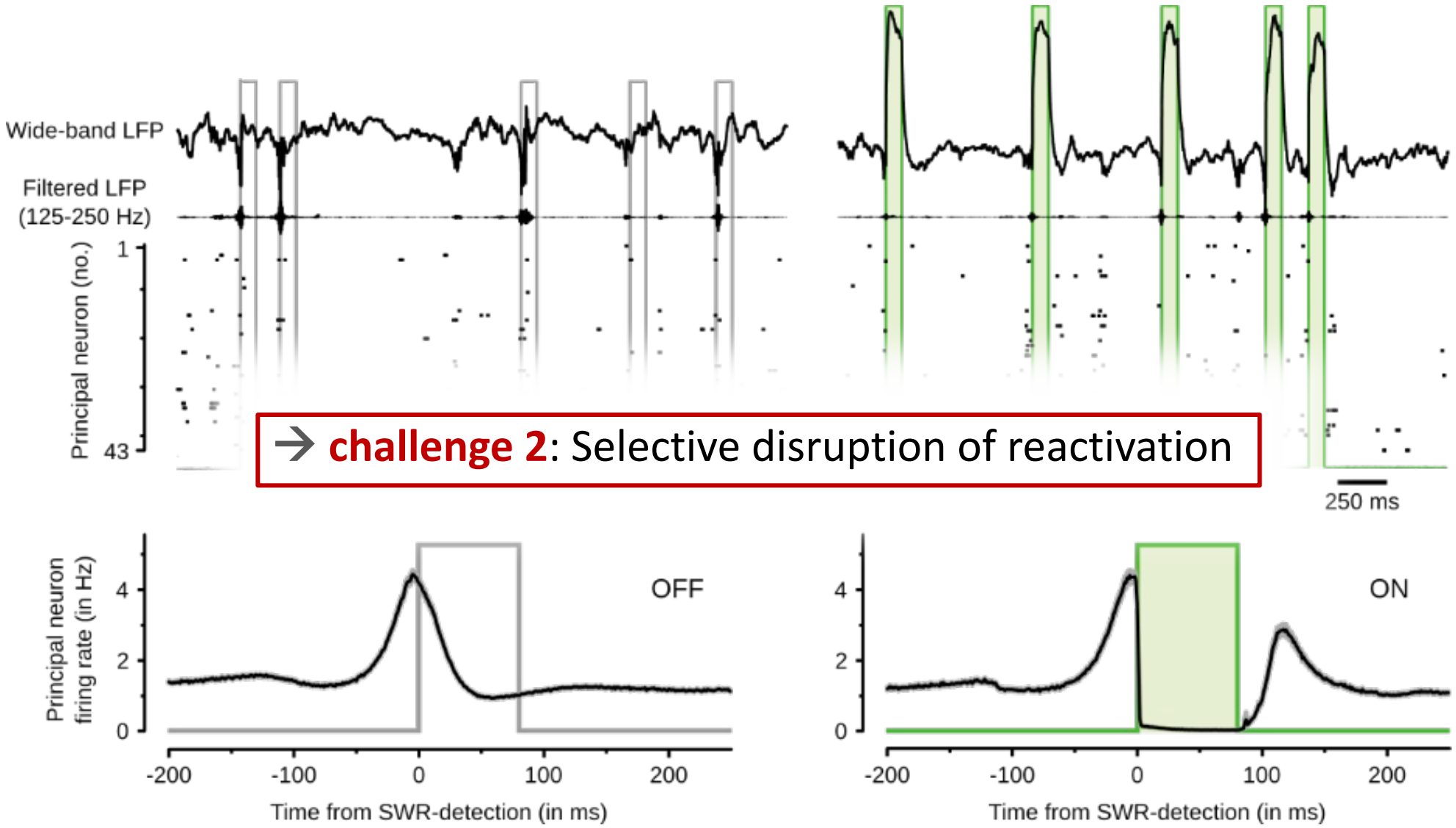


OFF: *n* = 1,988 neurons (from 43 sessions)
ON: *n* = 1,527 neurons (from 37 sessions)

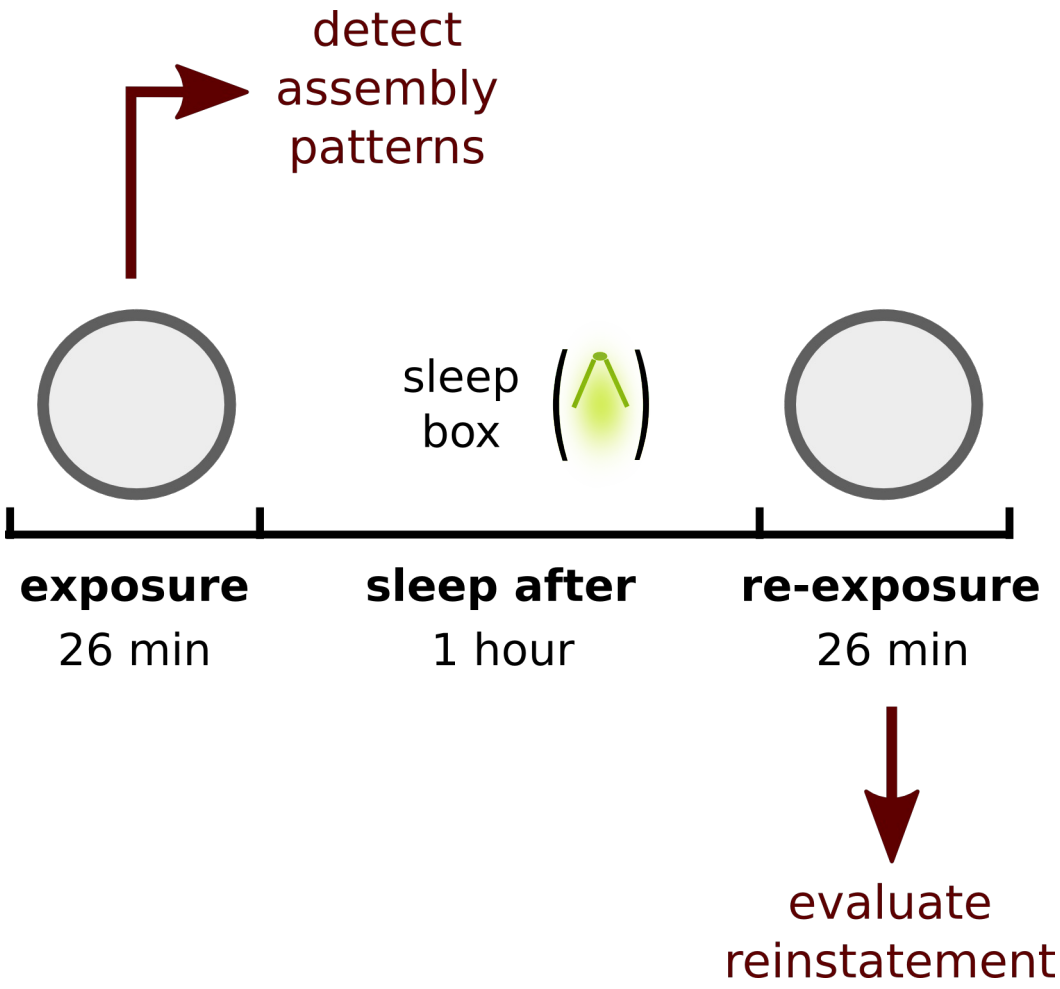
Selective disruption of reactivation: *optogenetic SWR silencing*



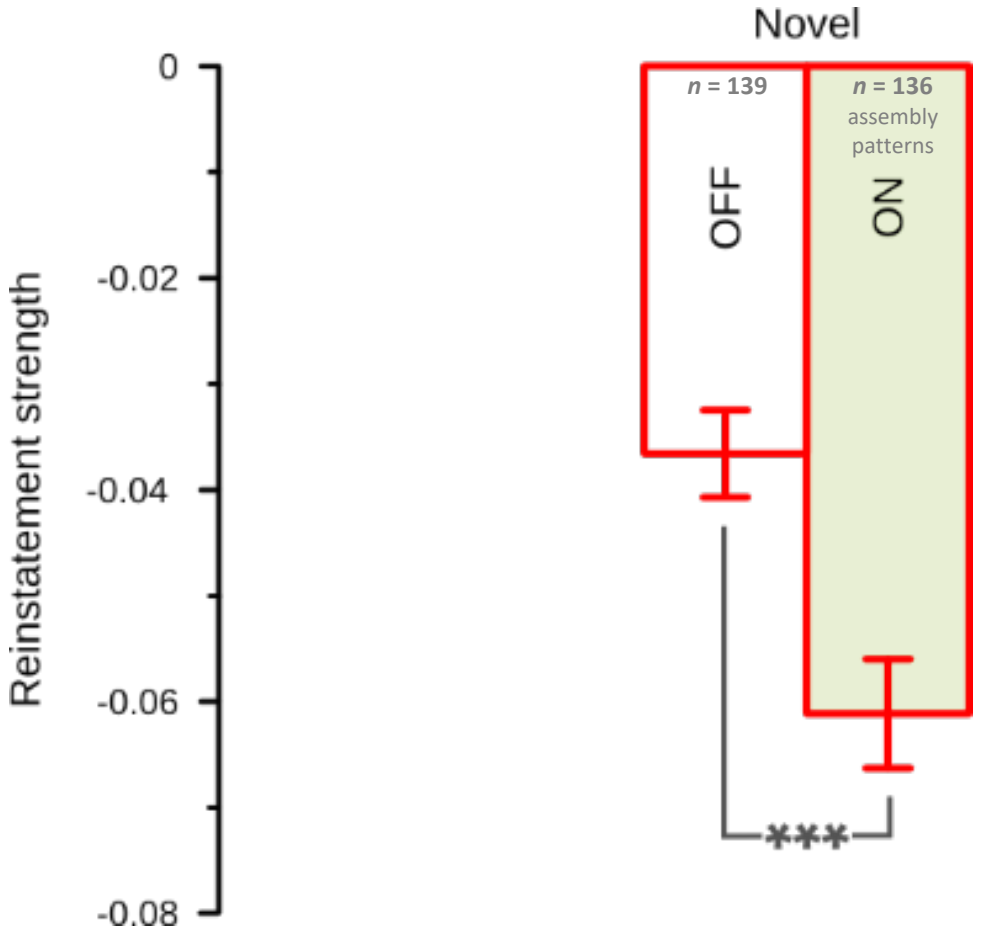
→ **challenge 2**: Selective disruption of reactivation

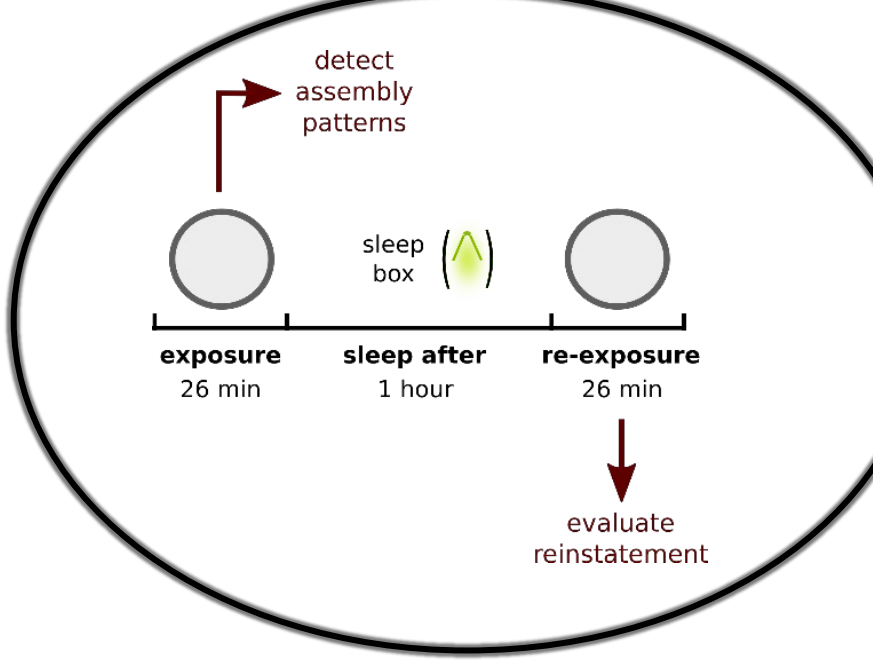
OFF: *n* = 1,988 neurons (from 43 sessions)
ON: *n* = 1,527 neurons (from 37 sessions)

Experimental protocol - (*causation*)



SWR-silencing impairs assembly pattern reinstatement





(based on 50 recording-blocks from 8 mice)

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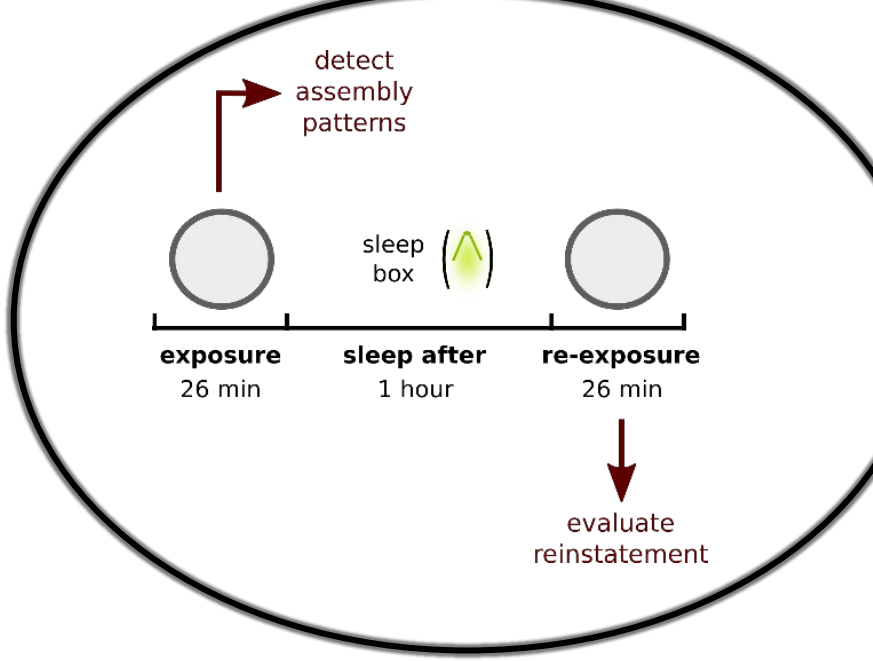
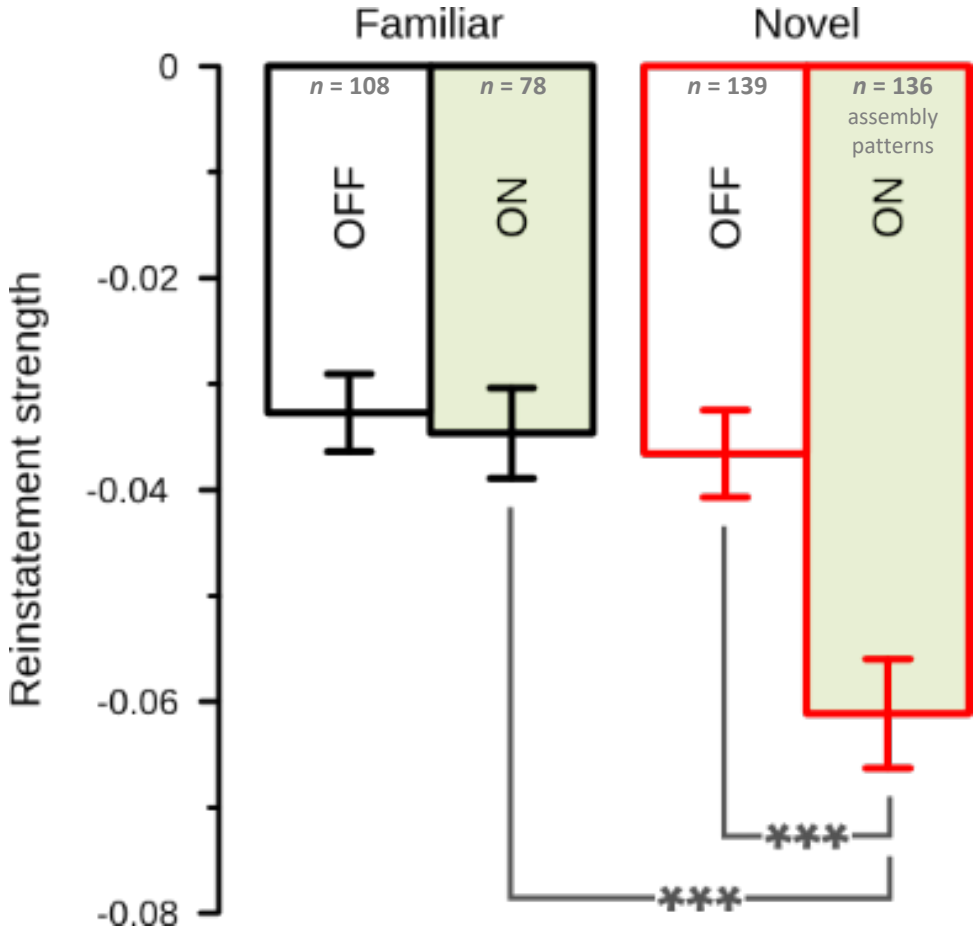
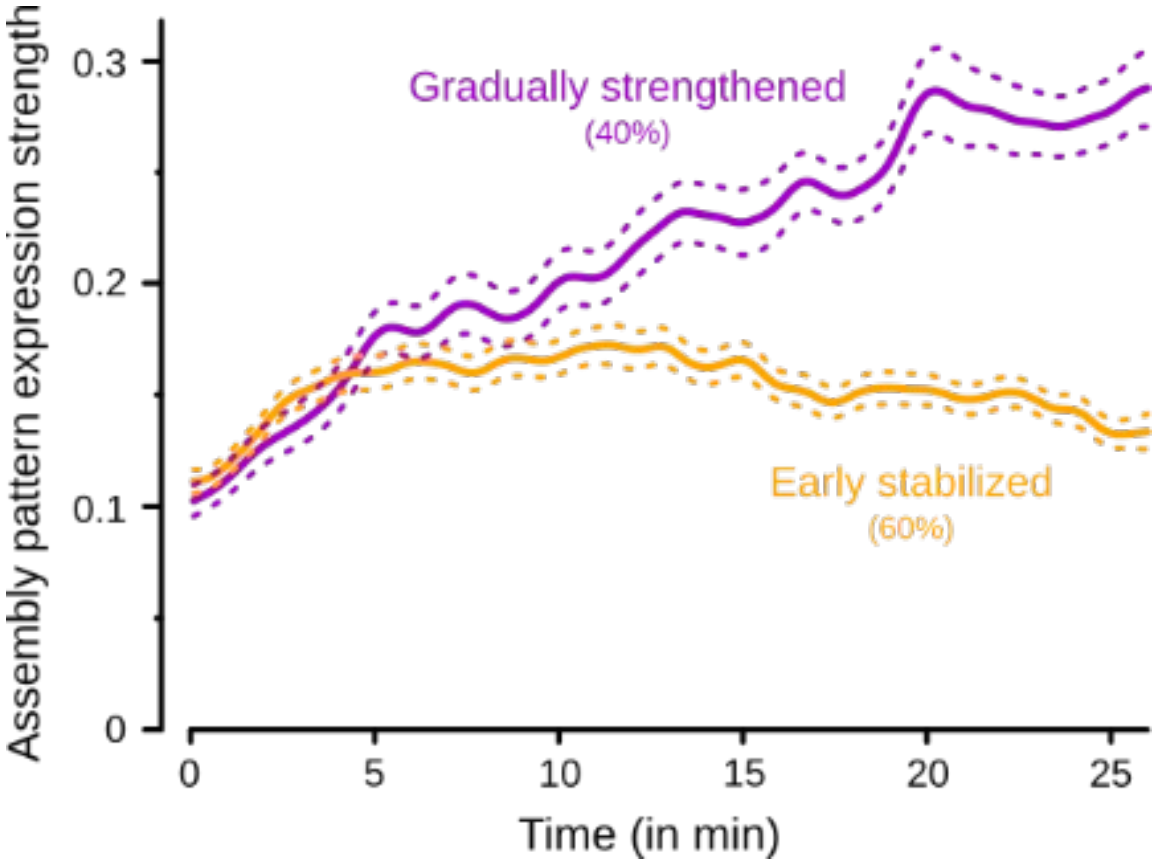


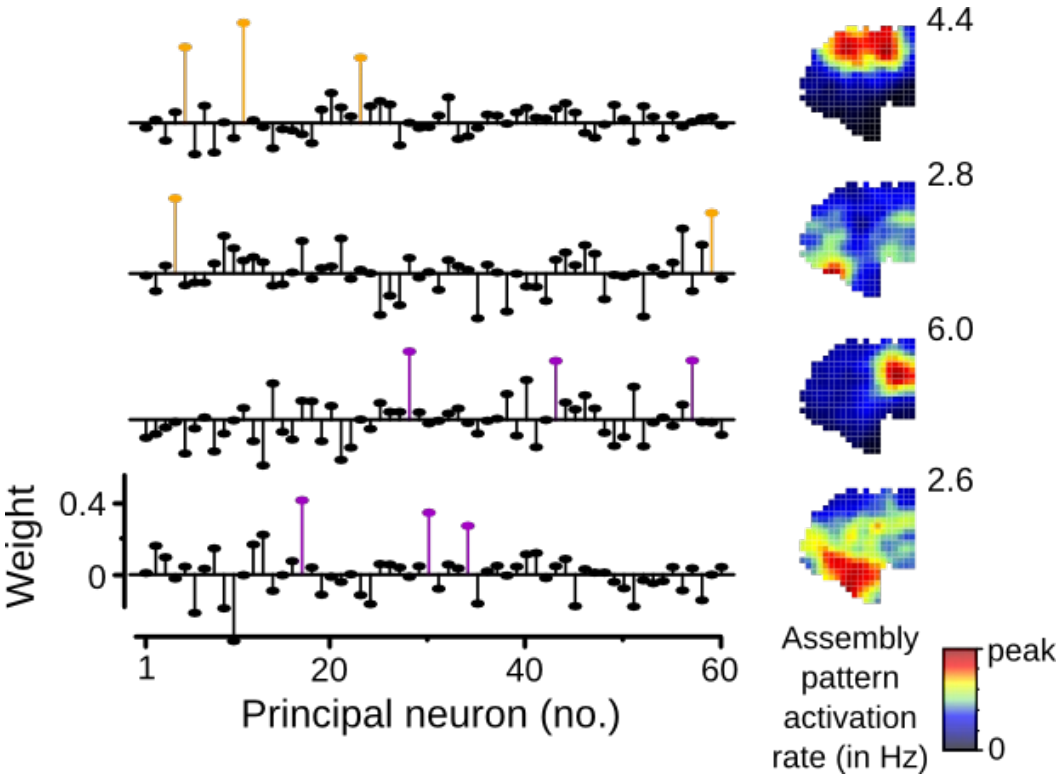


interaction SWR-silencing x enclosure type:
$F(1,318) = 5.05$, $P < 0.05$

(based on 80 recording-blocks from 8 mice)

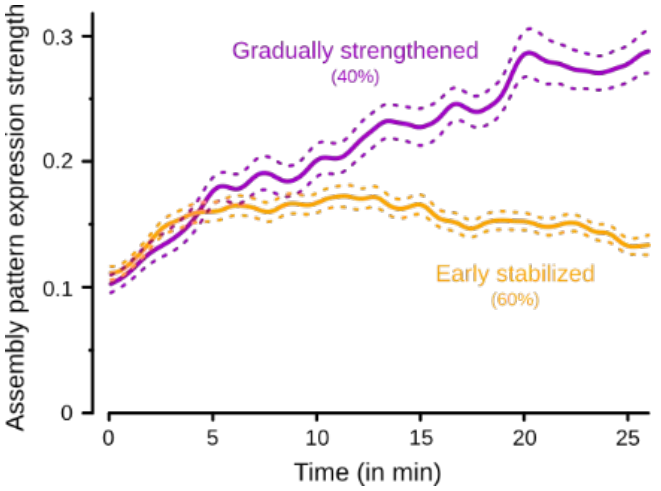
Only stability of gradually strengthened patterns requires offline reactivation

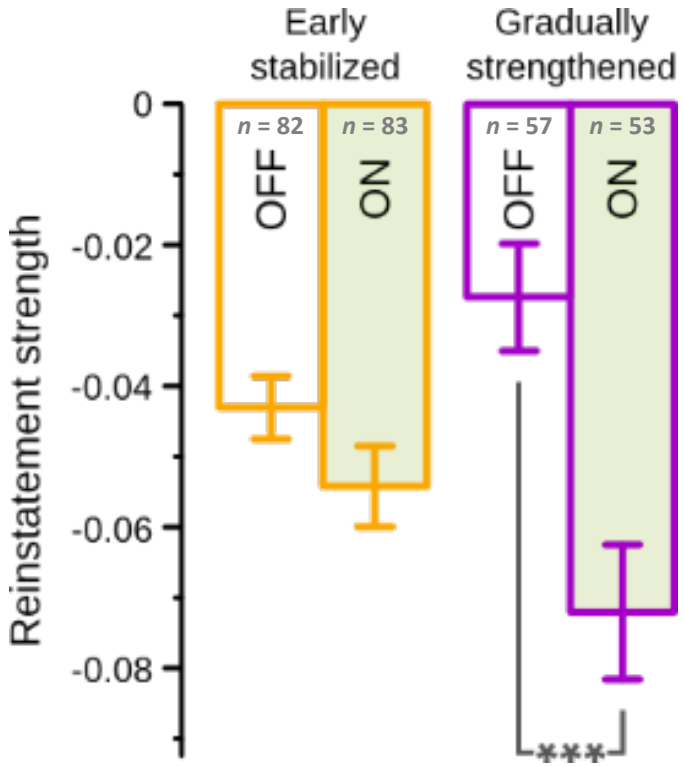




Gradually strengthened: *n* = 134 assembly-patterns
Early stabilized: *n* = 201 assembly-patterns
(based on 50 recording-blocks from 8 mice)

Only stability of gradually strengthened patterns requires offline reactivation

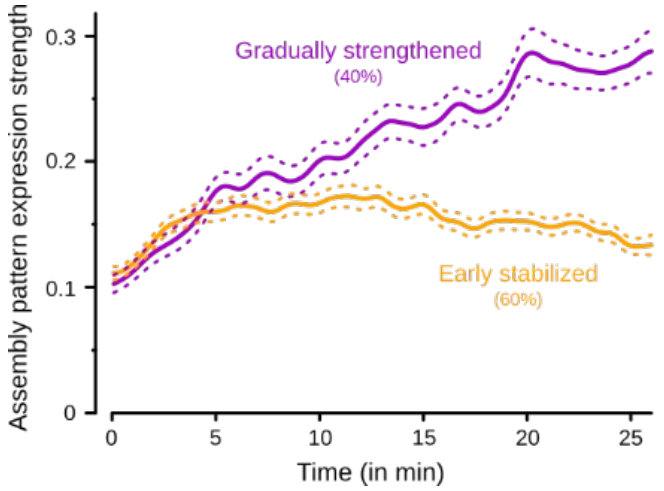


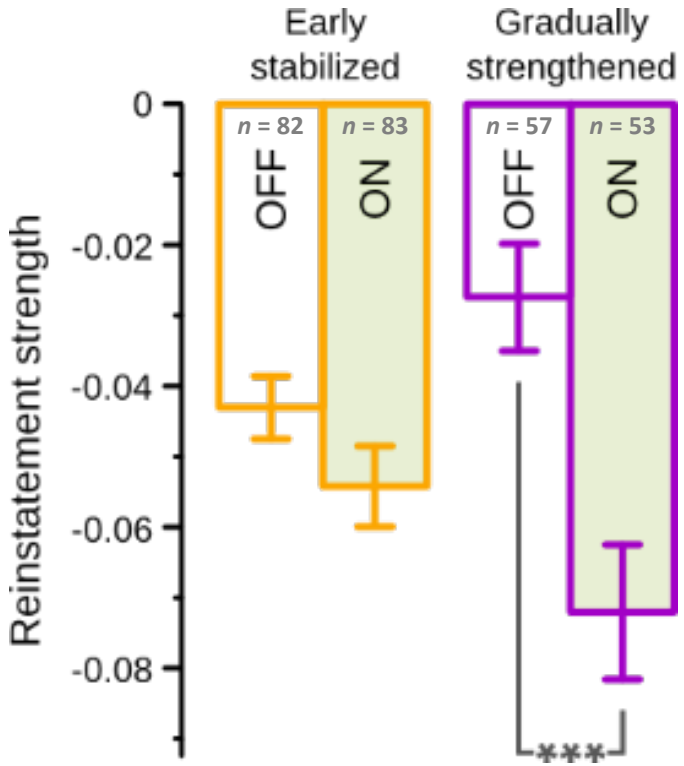


interaction SWR-silencing x pattern type:
$F(1,271) = 6.28$, $P < 0.05$

(based on 50 recording-blocks from 8 mice)

Only stability of gradually strengthened patterns requires offline reactivation





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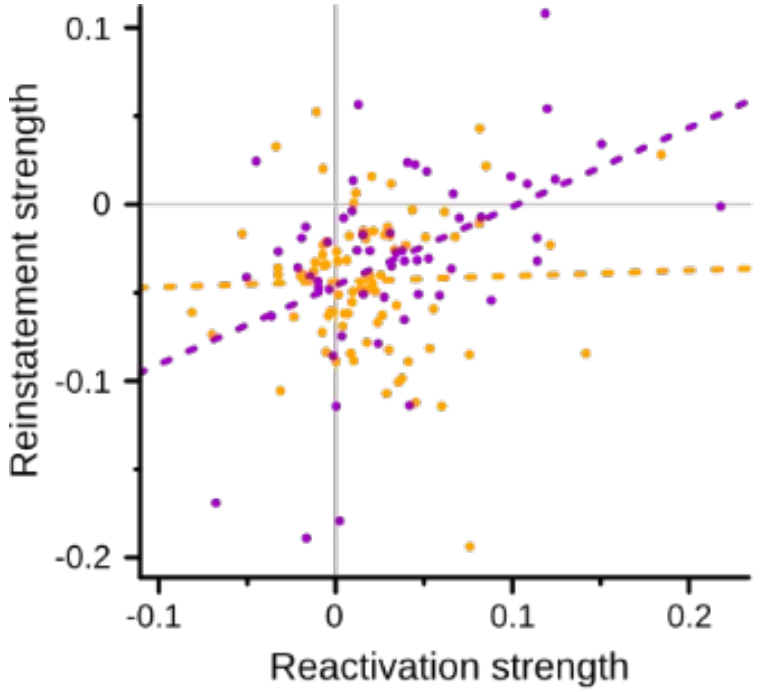

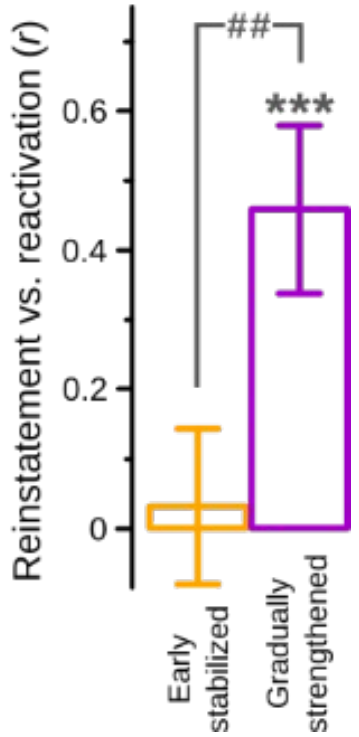

(based on 50 recording-blocks from 8 mice)

One-sentence summary

The stability of “Hebbian-like” cell assembly patterns, which are gradually strengthened during their initial expression, depends on their offline reactivation.

Acknowledgements

Dupret lab
David Dupret
Stephanie Trouche
Colin McNamara
Natalia Campo-Urriza
Vitor Lopes dos Santos
Alvaro Tejero-Cantero
Claire Bratley
Pavel Perestenko
Vadim Koren
Helen Barron
Alexander Morley
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More details: van de Ven et al. (2016) *Neuron* **92**, pp. 968-974