Active Dendrites Contribute to Hippocampal Place Field Formation
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2 m linear VR track

CA1 somatic population imaging

Co-acquired CA1 somatic and basal dendritic imaging
Switching the Virtual Environment Causes Remapping of the Hippocampal Cognitive Map

78 Place cells covering linear track 1

Mean place field position

Cell number

Track Position

Virtual teleportation

Linear track 1

Linear track 2

Mean place field position

Cell number

Track Position
The majority of place fields appear within the first ~15 laps of exposure to a novel environment.

Sheffield et. al., Neuron, 2017
Branch spiking throughout the arbor can vary between place field traversals.

Soma & all branches

Place field transient 1

Soma & no branches

Place field transient 2 (same cell)
Branch spike prevalence across basal dendrites is highest when place fields first appear
Branch spike prevalence predicts future place field location

First few laps in novel environment

Somatic place field

Many laps in novel environment

Sheffield et. al., Neuron, 2017
Localized dendritic branch spikes in CA1 basal dendrites

7 spines
0.5 ms laser duration
0.12 ms interstim interval
<0.5 ms to stimulate them all
dSpikes occur prior to the formation of delayed place fields

Example cell: delayed place field

Sheffield et. al., Neuron, 2017
Interneurons that target CA1 dendrites could regulate dendritic spikes

Ethan Goldberg & Douglas Coulter (2013)

Sheffield et. al., Neuron, 2017
Dendritic inhibition is transiently reduced during novel environment exposure
Inducible knock out of NMDA receptors in CA1 neurons disrupts active dendritic signals.

Branch spikes reduced during place field formation in NR1KO.

Localized dendritic spikes absent during place field Formation in NR1KO.

Sheffield et. al., Neuron, 2017.
NMDA KO in CA1 neurons decreases the number of place fields that form

Sheffield et. al., Neuron, 2017
Initial exposure

- Increased branch spike prevalence
- Somatic place field firing

Reduced dendritic inhibition

Localized dendritic spiking

Reduced dendritic inhibition

Sheffield et. al., Neuron, 2017
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