INTRODUCTION

Head direction (HD) cells demonstrated in the post subiculum [1, 2] provide information about heading direction during spatial navigation.


Current Model: Ring Integrator model of the HD cells.

Benefits: Same functionality with fewer neurons and explains alignment to orienting cues.

RING INTEGRATOR MODEL

HD cells are arranged in a single ring of the HD neurons and interneurons (Fig. 1). Each neuron is connected to two interneurons – clockwise (CW) and counter CW (CCW)

CW interneuron
• receives inputs from the neuron to its left and provides inputs to the neuron to its right.
• receive vestibular inputs

CCW interneuron
• receives inputs from the neuron to its right and provides inputs to the neuron to its left.
• receive vestibular inputs

HD neurons
• feedback to themselves
• receive sensory inputs – become aligned to orienting cues

Single inhibitory interneuron
• inhibitory input to all neurons and interneurons

HD cell firing at rest
• Feedback back to itself to maintain the firing activity
• Provides excitatory input to the single inhibitory interneuron– inhibits all neurons
• Activates both CW and CCW

Movement in clockwise direction
• the right horizontal semi-circular canal gets activated
• provides inputs to all the CW neurons

Movement in the counter-clockwise direction
• the left horizontal semi-circular canal gets activated
• provides inputs to all the CCW neurons
• Get enough excitation to activate the adjacent HD
• HD cell also starts receiving sensory input
• The previously firing HD cell stops receiving sensory inputs

Improvements over Attractor Dynamic Model
• Explains role of sensory cues
• Simpler model – a single ring of neurons for both CW and CCW movements

Visual/sensory input

Table 1. Connectivity of neurons in the ring.

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<th>Excitatory inputs</th>
<th>Inhibitory inputs</th>
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<td>Sensory-along its preferred direction</td>
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<td>CW/CCW</td>
<td>Corresponding HD cell</td>
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<td>All the HD neurons in the ring</td>
<td>Single inhibitory interneuron</td>
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REFERENCES

