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Distance-tuned neurons drive specialized path integration calculations in medial entorhinal cortex

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During navigation, animals estimate their position using path integration and landmarks, engaging many brain areas. Whether these areas follow specialized or universal cue integration principles remains incompletely understood. We combine electrophysiology with virtual reality to quantify cue integration across thousands of neurons in three navigation-relevant areas: primary visual cortex (V1), retrosplenial cortex (RSC), and medial entorhinal cortex (MEC). Compared with V1 and RSC, path integration influences position estimates more in MEC, and conflicts between path integration and landmarks trigger remapping more readily. Whereas MEC codes position prospectively, V1 codes position retrospectively, and RSC is intermediate between the two. Lowered visual contrast increases the influence of path integration on position estimates only in MEC. These properties are most pronounced in a population of MEC neurons, overlapping with grid cells, tuned to distance run in darkness. These results demonstrate the specialized role that path integration plays in MEC compared with other navigation-relevant cortical areas.

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