11-14-2015

Current Studies on the Role of Graviception in Spatial Cognition

Rhen M. Biggs
Indiana University - Purdue University Fort Wayne

Lucas C. Carstensen
Indiana University-Purdue University Fort Wayne

Elyse A. Miller
Indiana University-Purdue University Fort Wayne

Crysta A. Terry
Indiana University-Purdue University Fort Wayne

Alexandria D. Trainer
Indiana University-Purdue University Fort Wayne

See next page for additional authors

Authors
Rhen M. Biggs, Lucas C. Carstensen, Elyse A. Miller, Crysta A. Terry, Alexandria D. Trainer, and Ryan M. Yoder

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Rhen M. Biggs[1], Lucas C. Carstensen[1], Elyse A. Miller[2], Crysta A. Terry[1], Alexandria D. Trainer[1], and Ryan M. Yoder[1]
Depts. of Psychology[1] & Biology[2]

Background

Most species use external and internal (self-movement) cues to learn about their environment and to guide navigation.

Visual cues usually dominantly control navigation, but self-movement cues are also necessary – even in visual environments.

These self-movement cues include the detection of head movements and head position relative to gravity.

Methods

Our model of graviception involves genetically modified mice lacking the inner ear mechanism responsible for gravity detection.

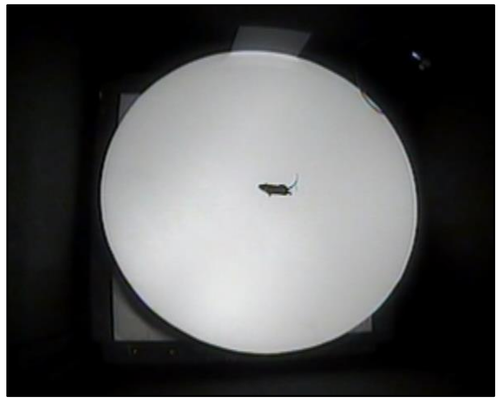
Graviception serves as a reference for postural movements, as well as for one's sense of direction.

We currently use behavioral tests to determine which aspects of spatial cognition rely on graviception.

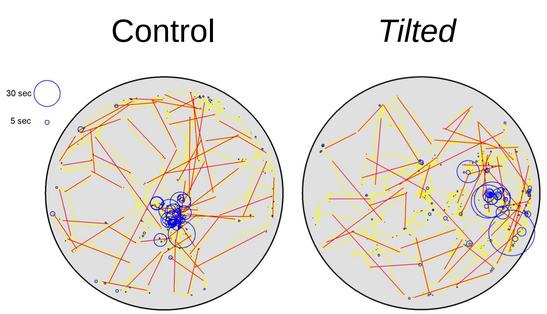
Our results have important implications for space travel and for the treatment of vestibular disease.

Exploratory Movements

Open-Field Exploration*
Normal mice organize their exploratory movements around a "home base" in darkness.



Impaired graviception disrupts the pattern of returns to the home base, and this disruption may contribute to general navigation deficits.

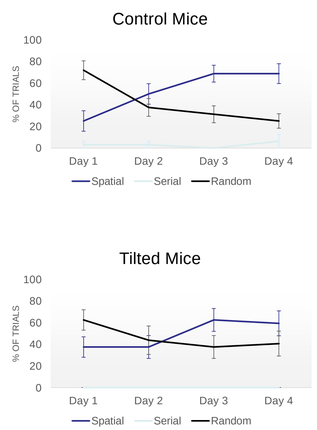


*Collaborative effort with the lab of Douglas G. Wallace (Dept. of Psychology, Northern Illinois University)

Goal-Directed Movements

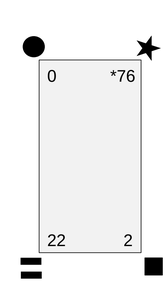
Barnes Maze
Normal mice rapidly learn to walk toward the hole that allows escape from bright overhead lights. This ability is termed a "spatial" search strategy.

Impaired graviception disrupts the preferential use of a spatial search strategy.

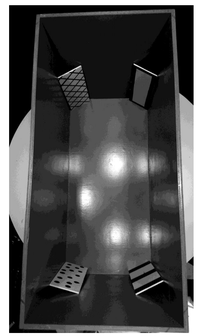


Discrete Cues vs. Geometry

Geometry Test
Many species quickly learn to walk directly toward a discrete cue located in one corner of a rectangular arena. However, they frequently visit the corner that is incorrect, but geometrically equivalent.



(Redrawn after Cheng, 1986)



We are currently testing whether geometry influences navigation in the absence of graviception.

Recent Publications

Yoder, R. M. & Kirby, S. L. (2014). Otoconia-deficient mice show selective spatial deficits. *Hippocampus, 24*(10), 1169-1177.

Yoder, R. M., Goebel, E. A., Köppen, J. R., Blankenship, P. A., Blackwell, A. A., & Wallace, D. G. (2015). Otolithic information is required for homing in the mouse. *Hippocampus, 25*(8), *890-899*.

External Funding

National Institute on Deafness and Other Communication Disorders
Grant #R15 DC012630