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# Path integration, continuous attractors and grid cells

## Path integration

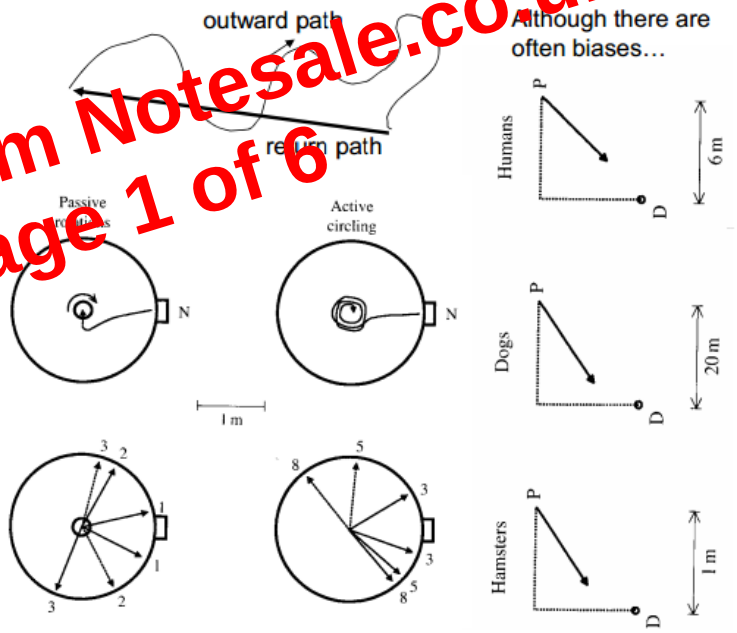
It is a behaviour phenomenon that occurs in animals where their outward path (e.g. from nest towards food) is unpredictable and windy, but the return path to the starting place is direct. This suggests that as an animal is moving from a starting point, it is constantly updating and storing a vector of its current location from its starting location. It is called 'path integration' because the return path is calculated mathematically by continuously integrating the distance and direction travelled, e.g. add all of the steps of the outward path then revert the information for the return path.

Experimentally, path integration is tested in total darkness because the animal's own motion is the only information needed for path integration, i.e. doesn't rely on cues/landmarks. However, it is not always accurate, a path integration bias has been found: it's been shown in many species that the test subject always underestimate the angle from the goal to the starting point. The reason behind this is unknown, but there might be an advantage. It is always better to be short of the starting location than to be too long off, because you might receive environmental cues as you've gone back over where you've been, i.e. more likely to re-cross a path you've taken. Perhaps this is why people walk in circles when lost in desserts.

Experimentally it has been shown that path integration is more accurate if the person is actively moving themselves rather than being moved passively by another force. The capacity to retain path information is limited to around three passive or five active rotation in hamsters returning to the nest.

Etienne et al. 1996

"The hamster was lured from its nest (N) to a food source located on a small platform at the arena centre. While it pouched food, the platform was rotated clockwise or counterclockwise. Or the hamster followed a bait from the nest to the central region of the arena, then along a circular path around the arena centre and finally to a food source at the centre. In both situations, the subjects returned fairly directly to the arena periphery and then searched for the nest along the arena wall. All trials occurred under infrared light.




The greater the number of unidirectional passive rotations or actively performed unidirectional circles, the less they were compensated for and the greater the scatter of the homing direction. Yet, the homing direction was more affected by passive rotations than by walking in circles: on average, the subjects continued to orientate in the general direction of the nest provided they had not been submitted to more than one full rotation; however, if they walked actively, they continued to orient towards the nest even after performing three circles."

## Place cells and path-integration

Path integration appears to orient the place cell representation.

Jeffery et al. 1997