Sophie Sackstein
BCS 153- Cognition

Ever since von Frisch's (1949) pivotal discovery that bees can use the polarized light in the sky as an effective compass cue, the field of cognitive science has been intrigued by the mechanisms of path integration. In simple terms, path integration is the ability to represent the world and navigate in real space. This cognitive way finding allows an organism to keep track of the magnitude of the vector it has covered since the beginning of the journey, (the straight line distance and direction from the starting point). The summation of this vector addition through its journey will allow it to calculate its updated position by monitoring its trajectory in relation to a start location (Gallistel, 1990; Whishaw and Wallace, 2003). Disturbance in light may lead to errors, which can be mediated by "compass neurons" firing based on particular direction. Other proposed biological mechanisms have different methods of attaining direction. Cells of the dorsal rim transduce polarized sunlight, and signal medullar POL interneurons to fire in corresponding spike frequencies represented as sinusoidal functions of e-vector orientation (Labhart 2000). In cockroaches these "compass neurons" are predominantly linked with movement selection- but this varies quite a bit across species.

Ants and bees will continue to update their path integrator and, upon leaving the landmark route, choose the course leading directly to the nest when they return (Wehner 1997). However they will maintain a "sector fidelity", landmarking the previously visited feeding site (with a non-renewable food source, like an insect corpse) then foraging past there, they triangulate paths for new routes. I would expect that most foraging creatures have path integration- or at the ability to represent their relative position in space.

An experiment for path integration in humans could be devised using just landmark memories and limited visual cues. MRI data would suggest that awareness of distance to a "home vector" is correlated with increase gray matter volume in areas critical for path integration. The variation in individual performance on these tasks may obscure any neurological data. However given a location tracking task, as shown in the loop paradigm and distance tracking, adapted from Chrastil et al., 2015, it is possible to test some components of human path integration. In the loop paradigm, a video of an object in repeating loops will continue for a period of time, after which participant will be asked the object ended in the same location in which it started or if it ended in a different location. In the next task subjects will watch a short video with random trees that will generate at certain time intervals followed by a landmark at which the virtual character will delay then either rotate and continue to walk past the landmark (so it isn't visible) or will stay in place. Subjects will then predict the direction and distance to the "home" where the character started. I predict that subjects will have difficult predicting the direction of the rotated character but will have an accurate sense of distance, however it is possible that foraging elsewhere could update our triangulation.

A character staying in place may allow the distance tasks and direction tasks to be easier, but it may also cause an unnatural stop in the information flow leading to spatial confusion. In

conclusion, it may be possible that we did not evolve path integration in the same way to other species had, perhaps this landmark based system was not conducive to fitness evolutionarily. Since the neolithic revolution we have gone from nomadic wonderers to stationary beings that rely less on interior compasses and more on symbolic systems (like maps). Perhaps this vestigial cognitive mapping is overwritten by other intelligent abilities and we can only transform these mappings into computational and formal cognitive configuration. In any case, if studies suggest this mapping does exists, the more important and useful question is how.