Two spatial memories for bee navigation

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Navigation in a known area can be achieved by two forms of spatial memory, route memory and map memory. Following routes relies on sequential associations between landmarks and directions of movements, a strategy well documented in insects. Map-like memory allows goal directed decisions at anyplace and towards any place in the experienced area, transfer across routes and inference of novel routes. Such a memory structure has not convincingly been documented in insects, and it remains a contentious issue.

However, a more flexible navigational memory than simple route memory was found in experiments that avoided route training of bees, and proved that bees are able to return to the hive from any place around the hive. The return flight times from these places were somewhat longer than would be expected for direct return flights, but were also much shorter than the time required to discover the hive by systematic searching. In these experiments bees presumably referred to the spatial memory acquired during observatory orientation flights from the hive. It was concluded (1) that bees possess besides a route memory, some form of general landscape memory that relates landmarks to the central place of their life, the hive. Such a behavior does not necessarily require a map structure of spatial memory, since bees might have associated homeward directed flight vectors with landmarks surrounding the hive during their exploratory flights. In recent experiments where we used harmonic radar to record the flight paths of bees, we again found that bees return to the hive from a unexpected release sites. During an initial search phase they appeared to inspect the relative location and characteristics of the unexpected release site by multiple returns to the site. The return flights followed rather straight routes. Bees also occasionally flew to the feeder station to which they had been trained following their orientation flights, indicating that the map-like behavior can not be explained by remembered home flight vectors associated with landmarks. We conclude that the bees must have formed a map-like general memory of the topological structure of the environment relating the spatial layout of the locations of at least the hive, the feeder and the release site.

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