

Can Honey Bees Create "Cognitive Maps"?

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Introduction

Honey bees have attracted the attention of scientists, philosophers, and the world at large for several reasons (Crane 1983; Gould and Gould 1988). For centuries, honey bees were the only source of a sweetener available year-round in much of the world. Beeswax, too, contributed to the economic importance of honey bees: candles of beeswax burn cleaner than tallow candles, and do not sag in warm climates. (Indeed, in some parts of Europe taxes were levied as quantities of beeswax.) The economic importance of honey and beeswax led to practical attempts to understand the behavior and social organization of honey bees, with the very tangible goal of improving the ease and efficiency of harvesting these valuable resource.

Another source of interest was the peaceful and apparently efficient social organization of honey bees, as well as their seemingly selfless work ethic. Countless sermons and philosophical essays took inspiration from this paragon of insect socialism.

Finally, and most importantly, the techniques developed to study honey bees made the details of their behavior and sensory abilities relatively easy to discover. Thus it was that color vision, ultraviolet vision, polarized-light sensitivity, an internal time sense, sun compensation, polarized-light navigation, the use of backup systems in behavior, and a host of other abilities were uncovered first in honey bees (Frisch 1967; Gould and Gould 1988). Perhaps the most remarkable of the (then) novel abilities of bees was their dance-language system of communication.

Cognition?

Prior to about 1980, honey bees provided perhaps the best example of intricate innate programming to be seen in nature (Gould and Gould 1982). The dance language -- second only to human language in its ability to communicate information -- was one example; the remarkable navigational abilities provided another; and the elaborate innate organization of their flower-learning programming was the most complex instance of species-specific learning known (Gould and Gould 1988). In addition, bee learning displayed many apparent similarities to the learning behavior of vertebrates (Bitterman 1996), inviting comparisons with the seemingly mindless conditioning so extensively studied by Behaviorists (Schwartz 1984).

And yet there were hints that innate wiring might not entirely account for honey bee behavior (Lindauer 1961; Frisch 1967; Griffin 1976, 1984). The decision-making process in swarming, eerie anomalies during training to a food station, and a too-quick ability to grasp learning tasks combined to sow seeds of doubt. But to ask intelligently whether honey bees might have abilities beyond the basics of instinct and conditioning requires criteria for cognition.

Technically, cognition is knowing or knowledge; by this rather generous standard, innate information provides animals with one level of cognition. But to most minds, cognition implies an ability to step outside of the bounds of the innate, including the innate wiring that permits animals to learn through classical and operant conditioning. It means, instead, a capacity to perform mental operations or transformations, and thus to plan or make decisions.

This definition may still be too broad, since some mental operations (such as the ability to infer the sun's position from the polarization of a patch of blue sky, or compensate for the sun's movement) are hardwired in honey bees (Gould and Gould 1988). There is a real danger of a double standard in such criteria. For instance, one common component of certain sorts of human intelligence tests is the ability to recognize a rotated object. It now transpires that both honey bees and bumble bees can do the same (Gould and Gould 1988; Plowright, et al. in press); so can pigeons (Holland and Delius 1983). Because pigeons are faster and more reliable at this task than are humans, the usual interpretation is that the ability must be hardwired in