SYMPOSIUM POSTMA

Evolution of spatial cognition: mechanisms and tasks

Hanspeter A. Mallot • Kai Basten • Alexander Schnee

Abstract Findings places and orienting in space are among the most basic behavioral performances of all mobile animals. In many different species, simple mechanisms have been identified for recognizing places, returning to a "home" after an excursion, or concatenating simple navigational steps to longer routes. These mechanisms form the basis of human spatial performances. The talk will explore the relation between animal and human spatial cognition along two dimensions, (1) animal roots of human performances, and (2) features of spatial cognition uniquely found in humans. In the first part of the talk, we will present a novel behavioral paradigm for studying large-scale spatial performances in rats (Hölscher in J Exp Biol 208:561–569, 2005). The setup consists of a running ball in a socket, hovering in a stream of air. The rat is fixated over the pole of the ball such that the rat's legs touch the ball. Translatory movements of the rat are thus transformed into rotations of the ball about horizontal ("equatorial") axes. Rotations of the rat about its vertical (dorso-ventral) axis are not restricted while the ball is prevented from such rotations by guiding wheels. In effect, then, the system is open-loop for translations and closed-loop for rotations of the rat. The rotation of the ball is measured by an optical system and used to control a virtual reality projection surrounding the rat on a panoramic screen. Initial results indicate that rats accept the virtual environment and run for long distances, up to several hundreds of meters. In addition, they can be trained to search for rewards at places specified by landmarks. In ongoing experiments, we investigate route behavior in rats, which is considered a stepping stone to topological navigation in humans. In the second part of the talk, we will discuss in what ways human spatial abilities differs from animal performances. We suggest that human spatial behavior, while relying on abilities found already in the animal wayfinding hierarchy (Trullier et al. in Prog Neurobiol 51:483–544, 1997), has taken advantage of two trends of the cognitive evolution in the social domain. First, communicating spatial knowledge, either face-to-face, by publishing or by sign-posting enables us to travel to almost every point in the world with a minimum of prior knowledge. Second, cooperative behavior in building cities, roads, and transportation systems shapes the environment in ways that may be more easy to navigate. We will argue that human wayfinding differs from animal behavior in the ability of utilizing these "socio-spatial" types of knowledge. The cognitive apparatus needed for these performances is not specifically spatial, but includes general problem solving and working memory abilities.

H. A. Mallot (✉) • K. Basten • A. Schnee
Department of Zoology, University of Tübingen,
Tübingen, Germany
e-mail: hanspeter.mallot@uni-tuebingen.de