How does the human brain deal with spatial information?

Kinga Iglói • Mohamed Zaoui • Alain Berthoz • Laure Rondi-Reig

Abstract To find the way to a hidden goal, a navigating human first needs to acquire spatial knowledge (spatio-temporal relations between environmental cues) and then to organize this information properly. The subject performs a multimodal integration of the sensorial inputs in order to get a coherent representation of space (Berthoz and Viaud-Delmon, 1999). This spatial knowledge can then be used to adapt one's motor behaviour to the specific context in which the navigation takes place. Choosing and maintaining a trajectory from one place to another involves many concurrent processes, thus requiring that the subject adapts a goal-directed strategy.

That for, multiple strategies can be used: we investigated two navigation strategies, both of which have been shown or are suspected to be dependent on the hippocampus (Lambrey and Berthoz, 2003). Namely the allocentric or map strategy and the egocentric or route strategy. We used a virtual maze, adapted from the 'Starmaze' designed for mice (Rondi-Reig et al., 2005). This paradigm has the specificity of showing the navigation strategy spontaneously used by a tested subject.

The purpose of our work was, first, to characterize the spontaneously used navigation strategy(ies) during the spatial task and then to investigate whether these strategies could have been encoded simultaneously.

Our results show that people can use different strategies to solve the proposed task. Using a probe test we have dissociated three different ones: the allocentric strategy, the egocentric strategy and the "correcting" strategy. Subjects using this latter one spontaneously perform a trajectory based on previously realized body-turns (egocentric strategy) but they reorient themselves during the navigation using allothetic information of the environment, hence correcting the egocentric strategy to finally reach the allocentrically defined goal. The three identified strategies have the same learning profiles, and their performances during navigation are similar. On the contrary, participants using the allocentric strategy execute the task more slowly and present an increased exploration of environmental cues. We have shown as well that, regardless of the strategy spontaneously used, all the participants are able to use the allocentric strategy when they are forced to do so. Possible conservation of basic navigation functions between humans and animal models will be discussed.

Kinga Iglói (✉) • Mohamed Zaoui • Alain Berthoz • Laure Rondi-Reig
LPPA, UMR CNRS 7152, Collège de France, Paris, France
E-mail: kinga.igloi@college-de-france.fr