

The project aims at identifying the mechanisms of geometric cognition. It will help to explain human geometric skills and develop methodological base for the cognitive science of geometry. In particular, emphasis will be put on the analysis of the role of language in transition from the biological basis of spatial orientation to the use of advanced Euclidean geometry.

So far, cognitive scientists have focused on the use of geometric structures in modeling human cognitive processes. Numerous studies within cognitive psychology, developmental psychology, neuroscience and ethology shed light on the origins of the human ability to use geometry. In particular, early developmental psychology has studied process of creating spatial representations in the mind of a child. On the other hand, in recent years research has been focusing on innate cognitive systems that may play a role in acquisition of geometry. Etiological studies have been concentrated on evolutionary origins of these systems and their operation resulting in spatial orientation of animals and humans. Neurobiological research awarded in 2014 with Nobel Prize in Physiology or Medicine for “discovery of cells forming neural positioning system” – known colloquially as “neural GPS” - is also connected with this area of studies. However, so far these findings did not lead to development of a general theory explaining geometric cognition. Methodological basis of such a theory will be developed as a result of the project. Mechanistic conceptual framework, characteristic of the philosophy of biology and philosophy of cognitive science, will be used for this purpose.

The project is interdisciplinary – it will be implemented at the intersection of cognitive science, philosophy of mathematics and methodology of science. In addition to philosophical and historical-philosophical analyzes, analysis of the results of research in psychology, neuroscience and ethology will also be used. Mechanisms of spatial orientation, results of developmental psychology research concerning acquisition of geometric skills, language of geometry characterized by the repetition of certain formulas, mechanisms of abstraction, as well as mechanisms of precision and conceptual stability in geometry will be analyzed in succeeding stages of the project. In the last stage of the project links between the mechanisms of geometric and numerical cognition will be examined.

Modern cognitive science of mathematics has its origin in the psychological studies of the representation and processing of numbers, which have been conducted since the sixties. On the other hand, geometry is an area neglected by cognitive scientists. This state of research is unsatisfactory if only due to the fact that geometric thinking is extremely important in modern mathematics, and it played an important role in the development of this discipline.

Implementation of the project can contribute to initiation of fruitful interdisciplinary discussions between cognitive scientists, philosophers and mathematicians themselves. The latter often are skeptical about the psychological and cognitive theories explaining the nature of mathematical cognition. Mathematicians point to the gap resulting from the fragmentation of theories that have concerned the numerical structures, at the same time neglecting geometry. In a wider perspective, the project may be valuable for the whole cognitive science, shedding new light on relations between the phylogenetically old spatial skills and language.