Thinking in 3D improves mathematical skills

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Spatial reasoning ability in small children reflects how well they will perform in mathematics later. Researchers from the University of Basel recently came to this conclusion, making the case for better cultivation of spatial reasoning.

Good math skills open career doors in the natural sciences as well as technical and engineering fields. However, a nationwide study on basic skills conducted in Switzerland in 2019 found that schoolchildren

achieved only modest results in mathematics. But it seems possible to begin promoting math skills from a young age, as Dr. Wenke Möhring's team of researchers from the University of Basel reported after studying nearly 600 children.

The team found a correlation between children's spatial sense at the age of three and their mathematical abilities in primary school. "We know from past studies that adults think spatially when working with numbers—for example, represent small numbers to the left and large ones to the right," explains Möhring. "But little research has been done on how spatial reasoning at an early age affects children's learning and comprehension of mathematics later."

The study, which was published in the journal *Learning and Instruction*, suggests that there is a strong correlation between early spatial skills and the comprehension of mathematical concepts later. The researchers also ruled out the possibility that this correlation is due to other factors, such as socio-economic status or language ability. Exactly how spatial ability affects mathematical skills in children is still unclear, but the spatial conception of numbers might play a role.

The findings are based on the analysis of data from 586 children in Basel, Switzerland. As part of a project on language acquisition of German as a second language, the researchers gave three-year-old children a series of tasks to test cognitive, socio-emotional and spatial abilities. For example, the children were asked to arrange colored cubes in certain shapes. The researchers repeated these tests four times at an interval of about 15 months and compared the results with the academic performance of seven-year-old children in the first grade.

The researchers also closely examined whether the pace of development, i.e. particularly rapid development of spatial abilities, can predict future mathematical ability. Past studies with a small sample size had found a

correlation, but Möhring and her colleagues were unable to confirm this in their own study. Three-year-old children who started out with low spatial abilities improved them faster in the subsequent years, but still performed at a lower level in mathematics when they were seven years old. Despite faster development, by the time they began school these children had still not fully caught up with the children possessing higher initial spatial reasoning skills.

"Parents often push their children in the area of language skills," says Möhring. "Our results suggest how important it is to cultivate spatial reasoning at an early age as well." There are simple ways to do this, such as using 'spatial language' (larger, smaller, same, above, below) and toys—e.g. building blocks—that help improve spatial reasoning ability.

Spatial reasoning and gender

The researchers found that boys and girls are practically indistinguishable in terms of their spatial reasoning ability at the age of three, but in subsequent years this develops more slowly in girls. Möhring and her colleagues suspect that boys may hear more 'spatial language' and that toys typically designed for boys often promote spatial reasoning, whereas toys for girls focus mainly on social skills. Children may also internalize their parents' and teacher's expectations and then, as they grow up, live up to stereotypes—for example, that women do not perform as well in the areas of spatial reasoning and mathematics as men.

More information: Wenke Möhring et al, Developmental trajectories of children's spatial skills: Influencing variables and associations with later mathematical thinking, *Learning and Instruction* (2021). DOI: 10.1016/j.learninstruc.2021.101515

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