

Simulating Cross-Cultural Differences in Spatial Reasoning via CogSketch

How does spatial reasoning work? Does it vary across cultures? Researchers at the Spatial Intelligence and Learning Center (SILC) have used their CogSketch simulation of spatial reasoning to investigate these questions. Prior work by Dehaene and Spelke used a visual Oddity task, where participants identify which image of six is “odd” or “different”, to compare spatial reasoning in Americans and Mundurukú (a South American indigenous group). Andrew Lovett, Kate Lockwood, and Ken Forbus used CogSketch to simulate their findings. CogSketch was given as input the same Power Point files used to generate displays for human subjects. CogSketch automatically computes a variety of qualitative spatial relationships, such as whether lines are parallel or intersect. Analogical processing, based on SILC researcher Dedre Gentner’s structure-mapping theory, is used to compare images and compute generalizations from them, to find the “odd” one. CogSketch was able to solve most of the problems that human participants solved, and problems that were hard for people were also hard for the simulation. Moreover, the differences between Americans and Mundurukú were further explored by selectively ablating capabilities of the simulation, to make its performance correlate more strongly with one group or the other. The ablation study suggests that Mundurukú have more difficulty focusing on groups of shapes, and that they focus more on the individual edges of shapes -- possibly because Americans, unlike the Mundaruku, have names for shapes such as triangle and rectangle, which could invite a focus on the whole object. In addition to improving our understanding spatial reasoning in people, such simulation studies help provide the science base for creating educational software that can understand student sketches.

