The Space Between the Lines: Young Children's Understanding of 2D Diagrams of 3D Objects

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From very early on, children experience two-dimensional (2D) representations of and three-dimensional (3D) objects and spaces. For example, looking at picture books is very popular among parent-child interactions in western cultures and diagrams are frequently used to teach children about the real world. Furthermore, developmental research and assessments often require 3D spatial reasoning based on 2D line drawings (e.g., mental rotation, paper folding, surface development). However, to date we still have a very limited understanding of how young children understand 2D representations.

Even though there is quite some research on children's use of spatial information displayed in photographs [e.g., 1, 2], surprisingly few studies have investigated young children's understanding of abstract 2D representations, such as line drawings and diagrams. Most of these studies investigated whether children use depth cues or preserve spatial relations when asked to produce drawings [e.g., 3-5]. Yet, paradigms that require active productions may underestimate children's understanding of diagrammatic displays.

In the present study we investigated 4- to 7-year-olds' comprehension of line drawings of simple objects. Children were shown photographs of geometric objects and ask to choose the corresponding line drawing among a set of four (see Fig. 1). On half of the trials the task direction was reversed, so that children saw a line drawing and had to choose the best matching photograph among four alternatives. Furthermore, item complexity was varied by presenting objects that consisted of single geometric forms (e.g., cone) or combined forms (e.g., cone on top of a cylinder). Children received 24 trials with 6 trials of each stimulus type, and one introduction trial with a real object. Foils were created by changing the shapes (pyramid vs. cone; sphere vs. hemisphere) or proportions of the objects (short vs. long cylinders; cubes vs. cuboids).

Results showed considerable developmental progression in the ability to understand line drawings, especially between 5 and 6 years of age. However, even at age 7, there was still room for further improvement (79% accuracy). A significant interaction between age and task direction was mainly driven by 4-year-olds performing better when they were asked to compare one diagram to a choice of four

photographs, as opposed to the opposite task direction. This suggests that young children had difficulties when having to differentiate multiple line drawings. Furthermore, the younger children performed slightly better when seeing single rather than combined objects, but this effect did not reach significance. There were no sex differences in accuracy. Overall, our findings show that children gain an increasing understanding of diagrammatic representations around the time of school entry. However, the fact that even the oldest age group tested performed far from perfectly on this (perceptually) rather simple matching task should alert educators and researchers to be cautious when presenting diagrams and line drawings of objects to young children.

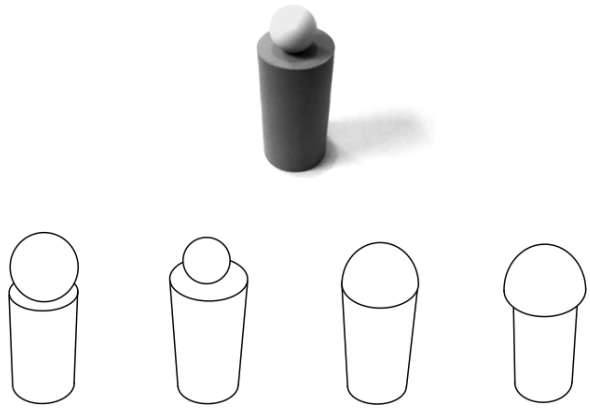

Fig. 1. Example of a stimulus item, showing a photograph of a 'combined' object and a choice of four line drawings

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