How do Children Draw, Describe, and Gesture about Motion?

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Abstract: Grade 3 and 4 children (n = 19) created “motion maps” (including both static and dynamic representations) that could be used to find a hidden object. Their drawing, oral description, and gestures used while describing, as well as the evaluation of the motion maps by their teacher were analyzed. Results suggest differences between lower and higher achieving children in the production of all the coding categories and in their conceptualizations of large-scale space.

Introduction

Maps assist children in developing conceptual understandings of small- and large-scale spaces (Uttal, 2000). Children’s ability to use and to interpret maps in small- and large-scale spaces increases with age and this has been proposed to be related to increased experience with maps, encoding experiences, broader environmental experiences, and conceptual changes related to abstraction of space (Clements, 2004, p. 280; Piaget, Inhelder, & Szeminska, 1960). Studies have predominantly focused on children’s ability to use maps (i.e., navigation) or to interpret maps (Frick & Newcombe, 2012; Uttal, 2000). Less prevalent are studies that explore children’s ability to depict and to explain symbol-to-referent relations in 2-D representations that involve motion. Such studies may contribute understanding into the challenges that children face when asked to interpret and use maps.

In this research, we examined how children aged 8-9 years depict, describe, and gesture about symbol-to-referent relations in drawings (i.e., on an iPad) that also involve motion in what we refer to and describe shortly as “motion maps.” For the purpose of this research, motion in children’s drawings is understood as static representations of geometry (e.g., translations, rotations, symmetries, dilations, etc.) that reflect changes in one or more objects’ spatial and geometric identities (i.e., initial location and properties).

The question guiding our research was: *How do children depict, describe, and gesture about motion in their drawing of motion maps?* Our central premise guiding this research was that in order for children to effectively interpret and use maps, they must be able to create maps and to conceptualize and engage in motor actions that align with topographical representations within the map. The inclusion of motion elements in maps may force a child’s conceptual model to include elements of dynamic geometry that may facilitate increased ability to discriminate between locations in space and scale by having to think and plan for the object’s movement across space.

Methods

In total, 19 children (girls n = 11, boys n = 8) who had a mean age of 8.97 years (SD = 0.71) participated in this research. As part of a culminating summative task to a transformational geometry unit of study, children were asked to create a drawing referred to as motion maps which are two-dimensional representations of space and contain objects that may depict motion (e.g., arrows). The children had the option of creating the motion maps on chart-sized paper (84 cm by 63 cm) or using drawing software on their iPads (paper n = 13, iPad n = 6). Paper motion maps were captured to iPads by cameras on the iPads. The motion maps children created digitally were “locked” so that children were not able to manipulate the objects in them after they were captured to their iPads. Children were asked to verbally explain their motion maps. The verbal explanations, along with the motion maps, were captured by screencasting (i.e., image and audio narration) on iPads positioned on stand about 30 cm from the child so that the child’s hands were free. To capture the gestures, the children were simultaneously videotaped by the second author using a digital video camera on a stationary tripod.

Parameters of the task required that children construct motion maps that could guide a peer or an avatar of them to a hidden object (i.e., school mascot) somewhere in the school. The motion maps were to include one or more objects represented as geometrical shapes which moved across at least two distances (e.g., Point A to point B and then Point B to C) and to change shape either in scale or in orientation (e.g., dilate, rotate, reflect). The task was considered a large-scale spatial task because children could not see the whole space of interest at once (Quaiser-Pohl, Lehmann, & Eid, 2004). Objects in the motion maps could not be moved but the avatar could be moved.

The motion maps were assessed by the teacher (second author) using levels one, two, three and four, with four being the highest and one being the lowest level. Two curriculum expectations were addressed in the task considering both the drawing and the verbal explanation. A level of achievement was given for the drawing component and the verbal component, and then an overall level was computed based on the mean of the other two levels rounded up. Coding of the objects in the motion maps, the verbal descriptions, and the gestures were then described in terms of whether they represented *static* or *dynamic* properties of the motion map (Uttal, 2013). Göksun, Goldin-Meadow, Newcombe, and Shipley's (2013) coding scheme related to the study on gesture in mental rotation tasks was also adapted for the coding of the gestures. There were two components to the coding of the gestures: (1) actual gesture (pointing and iconic), and (2) static or dynamic aspects of the motion map. In total, 25% of the transcriptions, coding, and assessments were done twice with discrepancies discussed and then resolved between coders. Descriptive statistics and non-parametric measures of differences between groups were computed using the Mann-Whitney U test. We make the distinction in the reporting of our results between "high" and "low" achievers and "higher" and "lower" achievement. High achievers refer to the total group of children achieving overall levels three or four. Low achievers refer to the total group of children achieving overall levels of one or two. Higher achievement refers to those children assessed in either levels three or four, and lower achievement may refer to those children who were assessed as either level one or two.

Results

There were more static objects (n = 583) than dynamic objects (n = 88) in the drawings. Approximately 47% of the children received a level three or four for their drawings on the drawing component of the rubric. Those children that were the highest achieving, overall level four, produced less overall objects, static, and dynamic objects than those in levels two and three. These students showed efficiency and also a higher degree of effectiveness in their depictions.

There were more dynamic verbal descriptions (n = 186) than there were static verbal descriptions (n = 84). Approximately 26% of the children received a level three or four for their verbal descriptions on the verbal component of the rubric. Highest achieving children produced the least amount of verbalizations were able to communicate their ideas more efficiently using less verbal descriptions.

Children produced few gestures when describing their motion maps. High achieving children produced more overall gestures (n = 40), compared to low achieving children (n = 31). There were more static-type gestures (n = 51) than there were dynamic gestures (n = 20).

Based on the overall assessment (mean of verbal and drawing component of the rubric) there were 11 high achievers (58%) and eight low achievers (42%). Using the Mann-Whitney U test, statistically significant differences were found between high and low achievers in the production of dynamic objects (U = 142, ρ = .000), total verbalizations (U = 523, ρ = .048), dynamic verbal descriptions (U = 392, ρ = .001), iconic-static gestures (U = 517, ρ = .005), iconic-dynamic gestures (U = 550, ρ = .032), and total production of dynamic gestures (U = 535, ρ = .040). High achievers produced more of each of these codes.

Conclusion

Results suggest that children were better at depicting motion in their motion maps than they were at describing motion verbally. Low achievers, compared to high achievers, produced very few objects and motion was particularly challenging for them to depict and describe. At the extreme levels, those children achieving an overall level four demonstrated what we refer to as *efficiency of representational relations*. They were able to use fewer verbal descriptions and fewer objects, but the most amounts of gestures, compared to those achieving an overall level of two or three, to convey their understanding. The results suggest that perhaps low achievers did not perceive the task to be large-scale, but rather a series of connected-smaller scale. The children's use of interconnected small-scale spaces to represent a larger-scale space could be used as a spring-board for developing large-scale spatial ability.

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