

Studying arithmetic word problem solving using eye tracking: A peek into mathematical representations

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How do adults think about situations involving numbers, and how can we investigate the nature of the mental representations they construct? To tackle this question, we created arithmetic word problems devised to promote contrasting representations and solving strategies. Following recent work on the perception of cardinality and ordinality (Gros, Thibaut, & Sander, 2021), we hypothesized that the use of specific quantities (weights, prices, collections) would foster a cardinal representation of the problems, whereas other quantities (durations, heights, number of floors) would favor an ordinal representation instead. The problems we created were thought to be easily solvable from an ordinal point of view but should require an extra step when solved from a cardinal perspective. We recorded the eye movements of pre-service teachers ($N = 50$) engaged in a solution validity assessment task on 18 such problems. We compared participants' gaze patterns on the problems to gather insights into their encoded representations. On problems featuring cardinal quantities, we found that specific sentences describing elements relevant in a cardinal understanding of the problems but irrelevant otherwise were looked at longer and were the focus of a higher number of backward eye movements. Additionally, increase in pupil dilation on correctly solved cardinal problems supported the idea that participants needed to engage in an additional step of semantic recoding only on cardinal problems. Overall, the results support the growing line of evidence that daily-life knowledge about the quantities featured in a problem may interfere with its solving by promoting one of two competing representations.