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The Role of Problem Fluency and Difficulty in Math Problem Solving

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Overview

Fluency, the subjective evaluation of how easily material is processed, can influence learners' judgments regarding how easy material will be to learn (Oppenheimer, 2008). Sometimes the fluency of items provides insight about the actual difficulty level of the material; in other cases fluency may make material seem easier than it actually is. We examined whether participants can make fine-tuned distinctions between fluent/disfluent and easy/difficult problems when solving math problems. We taught participants in each of the five conditions how to solve sample modular arithmetic problems (e.g., 10 = 5 [mod 5]), by subtracting the second number from the first and then dividing by the mod number, where resulting whole numbers mean the problem is true and resulting fractions mean the problem is false (Beilock, Kulp, Holt, & Carr, 2004). We then asked participants to provide ease of solving (EOS) judgments for 20 different problems on a scale of 0 to 100, where 0 = difficult and 100 = easy to solve, before they mentally solved the 20 problems at their own pace. They provided retrospective confidence judgments (RCJs), reflecting how confident they were that their answer was correct (0 = no confidence, 100 = complete confidence) after completing each problem. Participants were then asked to select the 10 problems they found easiest to solve before solving all 20 problems a second time. Finally, after Trial 2, we asked them to indicate which 10 problems they found most difficult to solve. Of interest were which problems participants within each condition would select as easiest and most difficult, given the variations in the types of problems participants in each condition received. Fluent problems contained numbers that appeared related to one another (e.g., 9 = 6 [mod 3]), whereas disfluent problems had more random numbers (e.g., 43 = 18 [mod 5]). Easy problems contained single digits; difficult problems had double digits, often requiring borrowing. Thus, the sample fluent problem would also be classified as easy, whereas the disfluent problem would be considered difficult. Fluency and difficulty were crossed to yield four types of problems. We expect the distinction between problem types will vary across the five conditions. Knowing whether participants can distinguish between items that vary in difficulty and fluency has implications for how to structure and order math problems to help math anxious students. If learners can identify which problems seem easier or more difficult to learn, then that sets the stage for sequencing problems in different orders (e.g., by presenting easier or more fluent items first) to help math anxious students overcome their anxiety while still learning math.

Explanation

- Participants obtained better problem solving performance for easy and fluent items that were true. In contrast, for problems that were difficult and disfluent, they obtained better problem solving performance for false problems.
- Participants showed greater separation in their classification of problems as easy and difficult when problems were divided as a function of difficulty (i.e., fluency conditions) than when problems were divided as a function of fluency (i.e., difficulty conditions).
- The results indicate that individuals are able to make fine-tuned distinctions between problems based on problem difficulty and fluency. This sets the stage for these manipulations to be used to help offset math anxiety, and in turn, improve math problem solving performance.

Impact

The current research could provide an insight to whether individuals pay more attention to the difficulty or fluency of math problems.

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Key Findings