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The Relationships Among Working Memory, Math Anxiety, and Performance

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Individuals with high math anxiety demonstrated smaller working memory spans, especially when assessed with a computation-based span task. This reduced working memory capacity led to a pronounced increase in reaction time and errors when mental addition was performed concurrently with a memory load task. The effects of the reduction also generalized to a working memory–dependent transformation task. Overall, the results demonstrated that an individual difference variable, math anxiety, affects on-line performance in math-related tasks and that the locus is a specific disruption of working memory. The authors consider a possible mechanism underlying this effect—disruption of central executive processes—and suggest that individual difference variables like math anxiety deserve greater empirical attention, especially on assessments of working memory capacity and functioning.

> Affect is the least investigated aspect of human nature in psychology, yet it is probably the aspect most often mentioned as deserving further investigation. (Mandler, 1989, p. 3)

In this article, we examine a program of research that examines the possible cognitive consequences and correlates of mathematics anxiety. As discussed elsewhere (Ashcraft & Faust, 1994; Ashcraft, Kirk, & Hopko, 1998), this work attempts to integrate two rather independent lines of research that have coexisted since the early 1930s. The first concerns studies of math anxiety per se, beginning with the important article by Richardson and Suinn (1972) and largely conducted within the psychometric tradition. The second is the study of mathematical cognition itself, focusing on the underlying mental representations and processes used in arithmetic and mathematics performance, most stimulating principally from Groen and Parkman's (1972) classic article.

It is surprising yet apparently true that up until this integrative research was begun, no one had considered whether math anxiety had any on-line effect on an individual's math performance, that is, an effect on underlying cognitive processes as the individual performs a math task. To be sure, the literature contains many reports of the general negative effects that math anxiety has on math performance and achievement (see the thorough meta-analysis by Hembree, 1990). For example, individuals with high math anxiety take fewer math courses, earn lower grades in the classes they do take, and demonstrate lower math achievement and aptitude than their counterparts with low math anxiety. However useful this information is, it does not address the underlying cognitive processes involved in doing math, for example, mental processes that access the memory representations of mathematical knowledge. The state is largely less of the work reported in McLeod and Adams (1989). It focus on relatively slow problem-solving tasks, especially when evaluated in classroom settings, precludes a fine-grained examination of normal representations and processes. Thus, the general focus of our research is to examine performance in studied cognitive frameworks and on-line tasks. We hope to examine the influence that math anxiety exerts on mathematical cognition and to identify the processing components that are so influenced.

Math Anxiety and Performance

Across several initial studies, we have found substantial evidence for performance differences as a function of math anxiety. These differences typically are not observed on the basic whole-number facts of simple addition or multiplication (e.g., 2×9, 6×8) but are prominent when somewhat more difficult arithmetic problems are tested. In particular, Ashcraft and Faust (1994; also Faust, Ashcraft, & Fleck, 1996) have shown that high-math-anxiety participants have particular difficulty on two-column addition problems (e.g., 27 + 18), owing largely to the carry operation. When such problems were answered correctly, the time estimate for the embedded carry operation was nearly three times as long for high-anxiety participants as it was for low anxiety participants (Faust et al., 1996). Thus, high-math-anxiety participants showed slower, more effortful processing on a procedural aspect of performance, performing the carry operation (for suggestive evidence on math affect and procedural performance in numerical estimation task, see LeFevre, Greenham, & Waheed, 1993). Furthermore, they higher error rates on these problems, often showing classic speed–accuracy tradeoffs when confronted with relatively difficult arithmetic, indicated a willingness to sacrifice accuracy on especially difficult trials, either to avoid having to deal with the stimulus problem or merely to speed the experimental session along.

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