Individual Differences in Calculating Posterior Probability: Do Statistics Education and Math Proficiency Matter?

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Introduction

Undergraduates frequently have misconceptions about how to calculate posterior probability.

Posterior probability involves combining the prior probability of an event occurring (base rate) and the probability of a diagnostic test being accurate (specificity).

It is uncertain how statistics education and math proficiency may be associated with accuracy in solving posterior probability problems.

Statistics education is positively associated with one common statistical misconception (equiprobability bias) and negatively associated with another common statistical misconception (representativeness heuristic; Morsanyi et al., 2009). Therefore, it's uncertain how statistics education will be associated with posterior probability problem solving.

Math proficiency is positively associated with course grades in introductory statistics (Johnson & Kuennen, 2006), but associations with probabilistic reasoning tasks have been mixed (Stanovich & West,1998).

Research Question

How are previous statistics education and math proficiency associated with performance on a posterior probability problem?

Methods

Participants

210 undergraduate students

Procedure

Participants solved one posterior probability problem and then reported their previous statistics coursework and ACT/SAT math scores. Approximately 20% of the students solved the problem correctly.

Materials

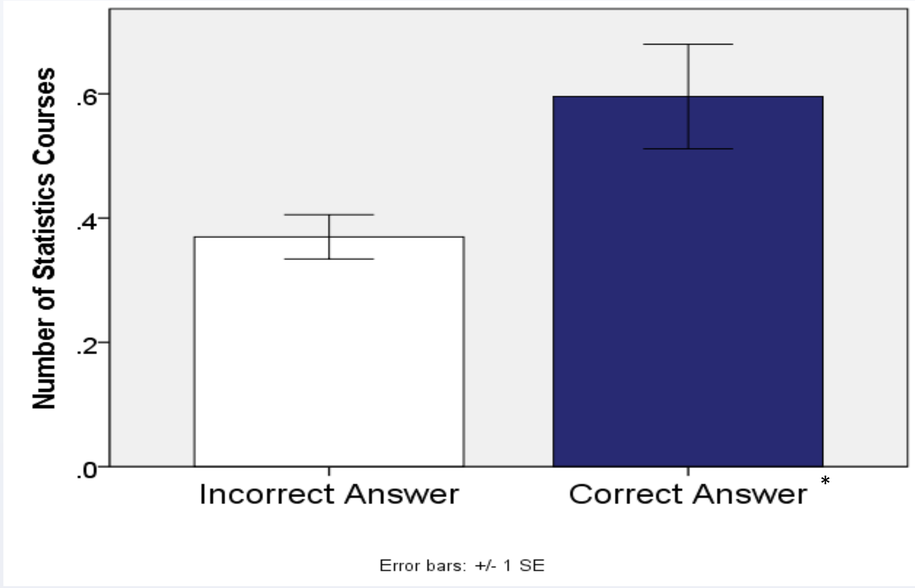
One posterior probability problem (adapted from Bramwell, West, & Salmon, 2006):

"All medical tests have error. For example, the serum test screens pregnant women for fetuses with Down syndrome. The test is a very good one, but not perfect. Roughly 100 fetuses out of 10,000 have Down syndrome. Of these 100 fetuses with Down syndrome, 90 pregnant women will have a positive test result. Of the remaining 9,900 unaffected fetuses, 99 pregnant women will still have a positive test result. What is the probability a pregnant woman who has a positive result on the test actually has a fetus with Down syndrome?"

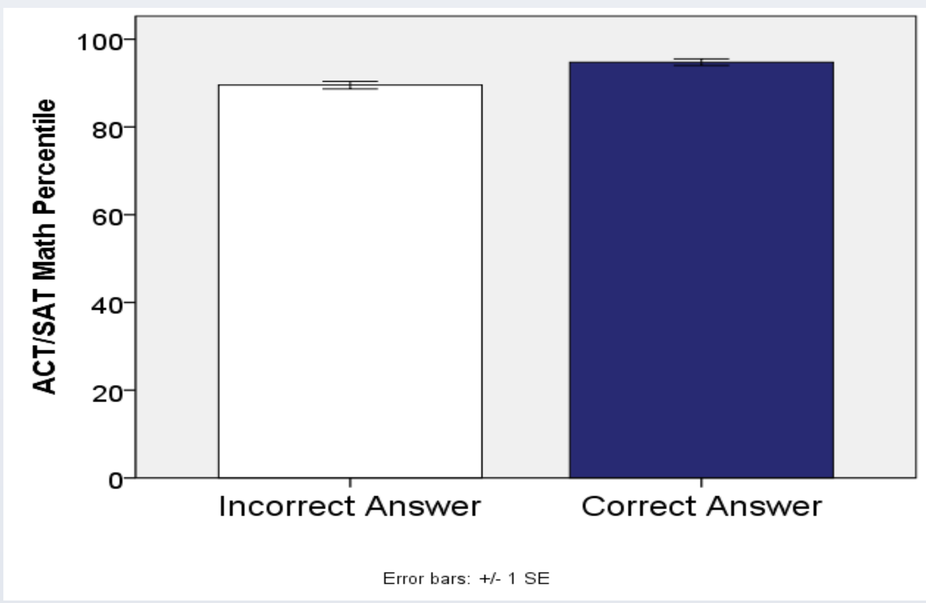
The correct answer is the proportion of true positives over all positive test results (true and false): 90/(90 + 99) = 90/189

Results

Statistics Education



Math Proficiency



Discussion

The findings regarding statistics education are consistent with findings on the representativeness heuristic, but inconsistent with findings on the equiprobability bias (Morsanyi et al., 2009). This could be because incorporating base rate data is necessary for solving representativeness heuristic and posterior probability problems, but not for equiprobability problems.

Although the posterior probability problem required only basic arithmetic, math proficiency was positively associated with accurate answers. This is inconsistent with previous findings regarding probabilistic reasoning, but consistent with findings on math proficiency and grades in statistics courses.

These findings suggest that for student populations with weak mathematics skills or with little statistics background (e.g., introductory statistics students), posterior probability problems may require special attention.

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