

An Introduction to Randomization Tests

Can subliminal messages help
students learn math?

A group of 18 students who had failed the mathematics part of the City University of New York Skills Assessment Test participated in a summer program designed to raise math skills.

Is there evidence that the positive subliminal messages caused a greater improvement than the neutral messages?

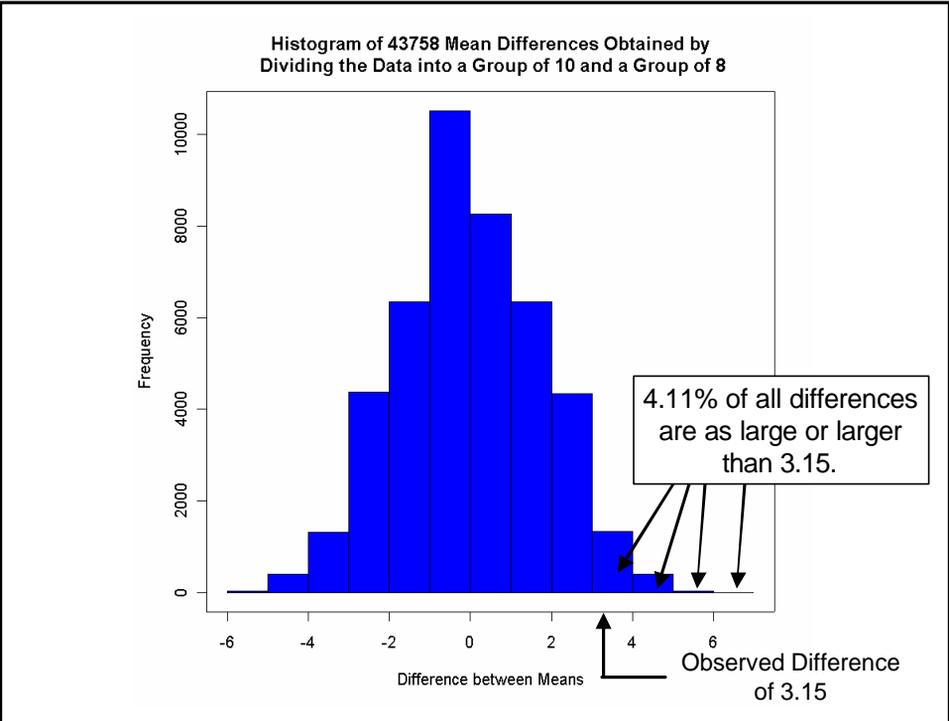
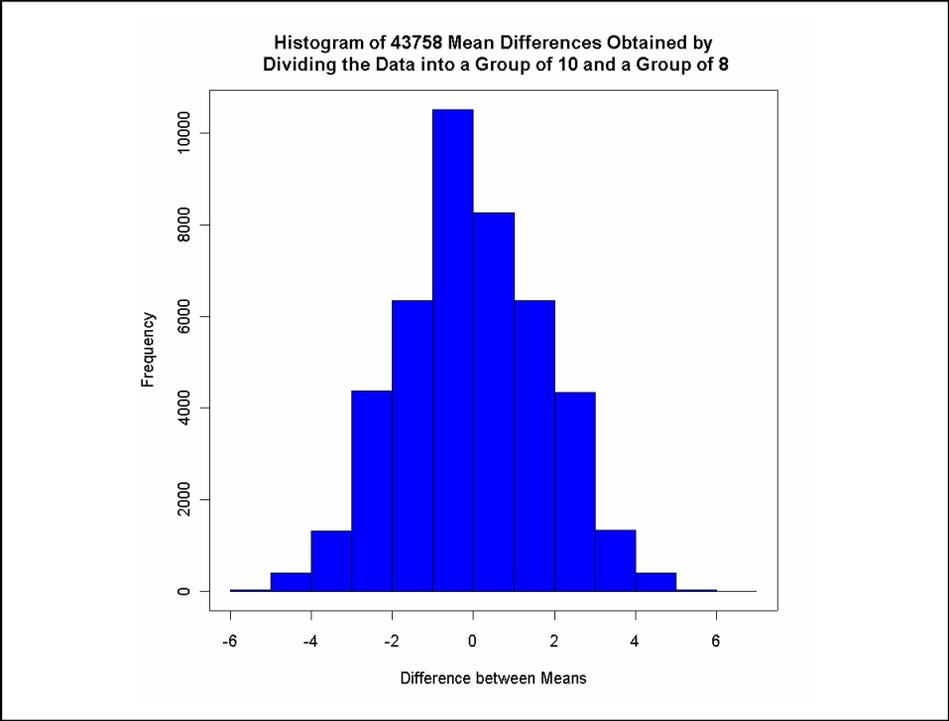
A skeptic might argue as follows:

The subliminal messages had nothing to do with the improvements. Each student would have scored exactly as he or she did on the follow-up test regardless of the message. The difference is due only to the fact that the better students ended up seeing the positive message by chance assignment of students to groups.

There are 18 choose 10 ways to randomly divide the 18 data values into a group of 10 and a group of 8.

$$18 \text{ choose } 10 = {}_{18}C_{10} = 18! / (10! * (18-10)!) \\ = 43758$$

We can see if the observed difference of 3.15 seems unusually large by comparing it to the 43758 differences that could have been seen due to random assignment alone.



1799 of the 43758 mean differences are as large or larger than 3.15. Thus the one-sided p -value for the randomization test is $1799/43758=0.04111248$. There is moderate evidence that the positive messages caused a greater improvement in scores than the neutral messages.

Each day I am getting better at statistics.