**Purpose of Random Assignment**

A manufacturer claims that they have created a shoe that can increase a person’s jumping ability. This shoe, called the strength shoe, is a modified athletic shoe with a 4-cm platform attached to the front half of the sole.

**Research Question:** How can you determine whether the manufacturer’s claim about the strength shoe is legitimate?

**Discuss the Following Questions**

1. If your friend who wears strength shoes can jump much farther than another friend who wears ordinary shoes, would you consider that compelling evidence that strength shoes really do increase jumping ability? Explain.
2. Now suppose that you take a random sample of individuals by randomly selecting them from the population. Identify who does and does not wear strength shoes, and then compare the two group’s jumping ability. If, on average, the group who wears strength shoes can jump much farther than the group who wears ordinary shoes, would you consider that compelling evidence that strength shoes really do increase jumping ability? Explain.

A 1993 study published in the *American Journal of Sports Medicine* investigated the strength shoe claim with a group of 12 intercollegiate track and field participants[[1]](#footnote-1). Suppose you also want to investigate this claim, and you recruit 12 of your friends to serve as subjects. You plan to have 6 people wear a strength shoe and the other 6 wear an ordinary shoe and then measure each group’s jumping ability.

You will explore the properties and benefits of random assignment in this activity.

1. Describe in detail (so another student could replicate the process) how you might implement the process of randomly assigning subjects to treatments.

Suppose that your 12 subjects are listed in the following table. You record their gender and height in inches because you suspect that these variables might be related to jumping ability:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Gender** | **Height** |  | **Name** | **Gender** | **Height** |  | **Name** | **Gender** | **Height** |
| Anna | female | 61 |  | Kyle | male | 71 |  | Patrick | male | 70 |
| Audrey | female | 67 |  | Mary | female | 66 |  | Peter | male | 69 |
| Barbie | female | 63 |  | Matt | male | 73 |  | Russ | male | 68 |
| Brad | male | 70 |  | Michael | male | 71 |  | Shawn | male | 67 |

1. Take 12 index cards, and write each subject’s name on a different card. Shuffle the cards and randomly deal out 6 for the strength shoe group and 6 for the ordinary shoe group. Record the names assigned to each group in this table, along with their gender and height:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Strength Shoe Group** | | |  | **Ordinary Shoe Group** | | |
| **Name** | **Gender** | **Height** |  | **Name** | **Gender** | **Height** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |

1. Calculate and report the proportion of men in each group. Also subtract these two proportions (taking the strength shoe group’s proportion minus the ordinary shoe group’s proportion).

*Strength shoe group proportion of men:*

*Ordinary shoe group proportion of men:*

*Difference in proportions (strength – ordinary):*

1. Calculate and report the average height in each group. Also subtract these two averages (taking the strength shoe group’s average minus the ordinary shoe group’s average).

*Strength shoe group average height:*

*Ordinary shoe group average height:*

*Difference in averages (strength – ordinary):*

1. Are the two groups identical with regard to both of these variables? Are they similar?

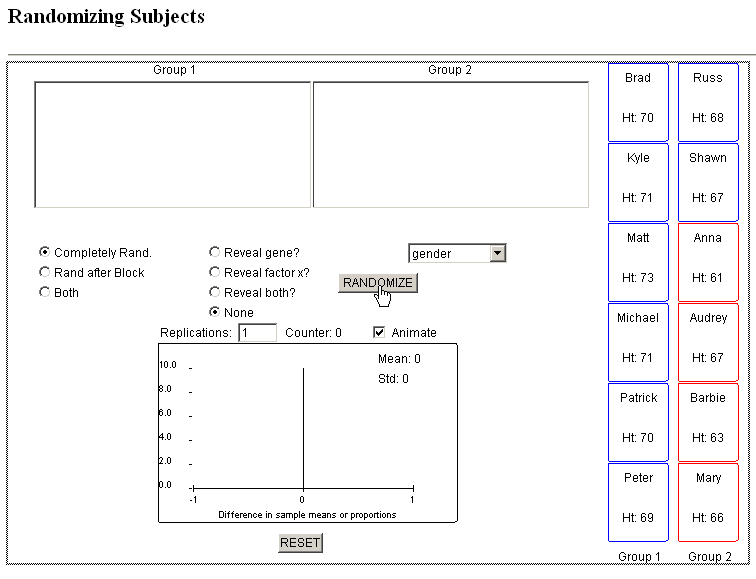
* Combine your results with those of your classmates by adding your two differences to the plots on the whiteboard.

1. Sketch a plot of the *differences in proportions* *of men*.
2. Sketch a plot of the *differences in average heights*.
3. Where are these distributions centered? Explain why this indicates that the random assignment is effective.

Now you will explore properties of random assignment further by using a web applet to repeat this random assignment process many more times.

**Randomization of Subjects applet**

* Go to <http://www.rossmanchance.com/applets>. On the right hand side of the page, you should see a link for *Randomization of Subjects.* Click on that link.
* You should see a card for each subject on the right hand side of the applet with the person’s height recorded and gender color-coded (Males = blue and Females = red).
* Click Randomize, and the applet will randomize the 12 subjects between the two groups.
* Click Show Tables to see the lists of names in the plots in the top part of the window.



1. Use the Randomization of Subjects applet to randomize (randomly assign) the 12 subjects to groups (see instructions in margin). Report the proportion of men in each group and the difference in proportions for this particular random assignment outcome.
2. Click Randomize again. Did you get the exact same assignment of subjects to groups? Is the difference in proportions of men the same as before?
3. Predict what the plot of differences in proportions will look like if you examined the distribution of the difference in proportions of men for many random assignments of the subjects into groups. In particular, where do you think that distribution will be centered? Explain.

**Running Many Trials of the Randomization applet**

* Click Reset, change the number of replications to 200.
* Uncheck the Animate box.
* Click the Randomize button. The applet will display the distribution of the 200 differences in proportions of men between the two groups.

1. Run 200 trials of the simulation. Where is this distribution centered? Is this what you predicted?
2. Does random assignment always balance out the gender variable exactly between the two treatment groups in each randomization? Explain.
3. Does it tend to balance out the gender variable in the long run, after many trials? Explain.

**Changing to Another Summary Measure**

* Use the pull-down menu to change *gender* to *height*. The applet now displays the distribution of 200 differences in average heights between the two treatment groups.

1. Comment on the distribution of difference in height (see instructions in margin for changing summary measure information). Be sure to address whether or not random assignment tends to balance out the heights between the two groups, and explain the evidence for your conclusion.

Now suppose that there are two more variables related to jumping ability that you had not considered or could not measure. These variables that were not measured are called *confounding variables*.

1. Would you expect random assignment to balance out these variables between the two treatment groups as well? Explain.

**Displaying Information for the Unrecorded or Unseen Variables**

* Click Reveal Both, and the applet reports values for a categorical genetic trait and a quantitative x factor.
* Using the pull-down menu, select each of these in turn.

1. Comment on what the plots reveal about whether or not random assignment is effective for unrecorded or unseen variables (see instructions in margin for displaying unrecorded or unseen variables).
2. Suppose you ended up with a random assignment that included only one person with the gene assigned to group A. Would you be convinced something went wrong with the random assignment process? Explain based on your output from the previous problem.
3. Suggest a value for the difference between the two sample means of the “X-variable” that would convince you that something had gone wrong with the random assignment process. That is, how large would that difference need to be for you to be convinced that something other than “chance” created such an extreme difference between the two groups? Explain your choice.
4. Now suppose you conduct this random assignment and find that the strength shoe group jumps substantially farther, on average, than the ordinary shoe group. Would you be comfortable concluding that the strength shoes caused the increased jumping distance? Explain how you would argue that no confounding variable was responsible.
5. In general, if you have a randomized experiment, would you be comfortable making cause-and-effect conclusions based on the result?

1. Cook, S. D., Schultz, G., Omey, M. L., Wolf, M. W., & Brunet, M. F. (1993). Development of lower leg strength and flexibility with the strength shoe. *American Journal of Sports Medicine*, *21*, 445-448. [↑](#footnote-ref-1)