

## Randomization, Replication, and Control

The main idea behind experiments is not difficult: we want treatment groups to be identical in all respects other than the treatment. If that were known to be true, then any response differential must be due to the treatments. All the principles below serve that overarching purpose.

"**Control**" is, collectively, all the efforts we make to get the units to be and behave the same. We might, for example, restrict ourselves to one type of tiger shrimp to reduce the variability that naturally comes from different shrimp types. We might feed all our rabbits the same amount of the same food. Etc.

"**Replication**" is using more than one unit in each treatment group. Recognizing that there is inherent variability among units that we can't always control, we need to be able to see how much variability in all of the responses is inherent, and how much is coming from treatments. We love to see lots of variability in responses across different treatments, while simultaneously seeing very little variability between units that got the same treatment. (We want "signal" louder than "noise".) But note that without replication, we cannot know how much variability there would be between units that got the same treatment. With only one observation per treatment, who knows whether differences in responses are due to treatments, or whether treatments have no effect at all and all variability is just what we'd normally see anyway.

"**Randomization**" is crucial because we now see we need multiple units in each treatment group, but we still want the treatment groups to be as similar as possible in every way except for the treatment--that remains the primary goal. Random allocation of units to treatment groups doesn't guarantee that treatment groups will be the same as one another, but it comes fairly close, and it gives us a way to probabilistically estimate the chances that an observed response differential could have been due to just chance.

Finally, something that also serves the purpose of trying to make treatment groups similar to one another in all respects other than the treatment:

"**Blocking**" is a special way of trying to force the treatment groups to be similar to one another. By blocking, you guarantee that some (presumably) influential factor that can't be controlled for can at least be equally represented in all treatment groups. (There's a little more to it than that, but that's basically the idea.)