Blocking

If we’re interested in testing a single factor (one-way ANOVA) in an experiment, then within-group variation is our enemy: The higher the within-group variation, the less sensitive our F test is to between-group variation. (See why?)

It is therefore good if the individuals can be grouped into “blocks” that are similar on some separate measurement that we feel might be related to the response variable. By doing this, we reduce the variability within each block.

This creates a second factor—a blocking factor—and as a result we have 2-way ANOVA instead of 1-way ANOVA:

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>230.81</td>
<td>115.41</td>
<td>17.86</td>
<td>0.000</td>
</tr>
<tr>
<td>Block</td>
<td>1</td>
<td>2253.44</td>
<td>2253.44</td>
<td>348.80</td>
<td>0.000</td>
</tr>
<tr>
<td>Error</td>
<td>14</td>
<td>90.45</td>
<td>6.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>2574.70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Think about how the table changes if the block effect is not included.

The important analogy to draw is with paired data in a t procedure: Blocking is like pairing.
Two-way ANOVA: Generating data

There are three ways we might generate data for a two-way ANOVA:

1.) A randomized block design: Blocks are chosen, consisting we hope of similar individuals. Within each block, individuals are assigned to treatments at random.

Example: Case study 13.1.1

2.) A completely randomized design: We have two factors of interest, and individuals are assigned to levels of each treatment at random.

Example: The Blood-brain barrier dataset of Problem 13.15

3.) Observational study: Rather than being assigned to levels of the factors, each individual’s factor levels already exist before the study begins.

Example: The Nature-Nurture dataset of Problem 13.18

As usual, we may make causal inferences from randomized studies but not observational studies.