Letter to the Editor: A Response to Robinson (2016)

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Robinson (2016) expresses concern regarding appropriate error terms for experiments in which animals are nested within pen and treatment is applied to pen. Robinson (2016) identifies the issue by presenting alternative definitions of experimental unit—that commonly accepted, “The experimental unit is the smallest unit to which an individual treatment is imposed” and an alternative, “the smallest unit in which an individual treatment can be measured.” The latter is more commonly denoted in the statistical literature as the “sampling unit.”

The difference between the two can be illustrated by an example in which 2 treatments are randomly applied across 5 pens per treatment with 20 cows in each pen. A blood sample is collected from each cow, divided between 2 tubes, and each tube is assayed in triplicate. The number of sampling units in this experiment is $3 \text{ assay repetitions} \times 2 \text{ sample repetitions} \times 20 \text{ cows per pen} \times 5 \text{ pens per treatment} \times 2 \text{ treatments}$, totaling 1,200 sampling units. The number of experimental units is 10, the number of pens randomized to treatment. When determining the effect of treatment, the difference between treatment means must be considered relative to the variation among the pens, not variation among cows or among duplicate blood samples or trip-

licate assays. Those repetitions within pens improve the precision of estimation of the pen means and increase statistical power, but the inference of the statistical test applies to the pen.

In his example, Robinson (2016) correctly notes that using variation among cows, rather than variation among pens, as the error term for treatment does not invariably increase the chance of finding statistical significance. When pen is not a significant source of variation, there should be little difference between using variation among cows versus variation among pens as the error term; however, when variation among pens is important, using variation among cows as the error term is likely to cause an incorrect rejection of the null and an improper conclusion. St-Pierre (2007) discusses alternative approaches in detail.

REFERENCES

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