Chapter 5 Pseudoreplication

Answers to additional self-test questions

Q5.1 The book argues that if we were surveying the food preferences of different nationalities, then using five members of one family as five independent measurements of the food preferences of the nationality of that family would not be statistically valid. Explain the reasoning behind this in your own words.

Five members of one family have shared experiences that they do not share with other members of their nationality. For example, it may be that the mother does almost all of the cooking and is particularly terrible at cooking rice. If this is true then we might expect that all family members report a low preference for rice dishes. Alternatively, it might be that because one family member is allergic to pulses, family meals never contain pulses and so, again, we might expect all family members to report low preferences for dishes containing pulses. The family as a whole may have had a very memorable family holiday in India, as a result of which all family members report a high preference score for Indian dishes.

Q5.2 Are there any variables you can think of where you might be able to justify using members of the same family as independent subjects?

It is very difficult to think of a variable where shared genetic inheritance and shared previous experience do not influence results. Even something like 'favourite colour' could be affected by genetics or by a relative's unusual fashion sense. Perhaps something like aspects of fingerprint might be alright. However, in general we can assume that family members are almost never independent sample units.

Q5.3 Define independence of data points in your own words.

Independent data points are measurements taken from subjects that are unrelated (that is they are not genetically related and do not experience the same conditions for factors that might influence the thing you are measuring). If the measured value from one subject affects your expectation of the measured value (from the range of possible measured values) of another subject then the two are not independent. In a set of subjects no individual should be more closely related (in the sense used above) to some other individuals in the set than to others.

Q5.4 Give an example of your own that helps to explain the statistical concept of independence.

If we are interested in comparing weight gain across puppies of two different breeds of dog, two pups from the same litter would not be independent data points. These pups share 50% of their genes, and are probably being fed by the same mother and kept together in the same accommodation. All these factors might reasonably be expected to affect growth rate.

Q5.5 If you were carrying out a survey, would a husband and wife count as independent data points?

It depends what you are measuring in the survey. If the survey is about how good people consider their marriage to be, then they would not be independent because they share the same marriage. If the survey was about attitude to housework, then they would not be independent because this is a subject that they have likely discussed together often. However, if the survey is about how many siblings people have, or the experience of their early years at school (or other issues related to the time before they met), then it might be reasonable to consider then as independent samples. *Whether or not two subjects are independent depends on what you are measuring.*

Q5.6 The book discusses pseudoreplication through a shared enclosure with reference to a study of behavioural enrichment in chimpanzees. Is there any way you can usefully study enrichment if you truly only have access to one enclosure?

Absolutely; you simply have periods of time when the enrichment materials are available interspersed with periods of time when they are not, and a comparison can be made between the two different treatment conditions. The key is that the results really only give you evidence of how these enrichment materials affected this one chimpanzee group, and you should be very cautious about how you generalize these results to captive chimpanzee groups more generally. If you only want to improve the welfare of one particular group, this is not such a big problem.

Q5.7 In the book, female zebra finches are given a choice between a dummy male with a bright beak on one side of their cage and one with a duller beak on the other side; which side of the cage should the brighter-beaked male be placed in?

The side should be determined randomly independently for each female, say by coin-toss, otherwise you introduce preferences for side as a confounding factor. Such preferences are

plausible if one side is perhaps brighter or further way from the door, or any one of a number of reasons.

Q5.8 Consider a jury of 12 people in terms of statistical independence.

The 12 people are not independent; they are asked not to talk to each other about the trial but are required to come to a consensus decision at the end of the trial. The intention is not that the jurors are independent; they must discuss and seek to persuade those of opposing views until a consensus can be reached. They have a strong imperative to reach a consensus, because then they can go home and get on with their lives. The reason for having a large jury is to relieve the burden of such grave decision making on any one individual, and to lessen the effect of an aberrant individual who may have views very divergent from society's norms.

Q5.9 In the experiment on the behaviour of crickets as a function of temperature, the book warns about keeping all the crickets at one temperature in one incubator and all the crickets at the other temperature treatment in another single incubator. Explain why.

If you find a difference in behaviour between the crickets from the two incubators, this could be because the two incubators are at different temperatures, but it could be due to any other difference that might occur between the incubators and that could potentially affect behaviour. Maybe one is in direct sunlight and one is not, or one is nearer a noisy extractor fan than another, or one has a strong smell from residue of a previous experiment. There will always be such potential confounding factors. Thus, you must use more than two incubators and randomize incubators to treatments. If you truly only have two incubators (or one!) then the same incubator must be used repeatedly with different temperature treatments, but care must be taken to avoid introducing time as a confounding factor.

Q5.10 Explain the difference between a longitudinal study and a cross-sectional study by means of an example.

Both are means of looking at the effect of age or experience. Imagine we wanted to look at how employees' view of how good their employer is changes with how long they have been with that employer. A cross-sectional study takes a cross-section of people with different levels of experience at a given moment in time. That is, we spend a day or two interviewing people, and we ask each person how long they have worked for the employer and how they would rate how good their employer is (relative to other employers) on a 0–5 scale. We

would then look for a correlation across individuals between these two measures. A longitudinal study follows people over time. In this case we recruit people into our study exactly as before, but we return two years later, and four years later, and six years later, and ask those same people (if they are still there) how they now rate their employer. We can then look for effects of years of employment by making comparisons within individuals, rather than across individuals in a cross-sectional study.