Towards More Efficient Use of Animals in Research

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The Problem

You are probably using more animals than necessary in your research. Commonly, when we wish to carry out an experiment, we decide on the number of subjects to use based upon 3 things

- How many subjects there are *available* to use,
- The *cost* to us or to the animals of the test procedure,
- Some intuitive feeling about how many are *necessary* in order to make our decision.

Estimating usually overestimates the number of subjects needed because humans are not good judges of probability. So how do we decide on how many animal we need without overestimating?

A Solution

One advance over just guessing at the number of animals to use would be to do a Power Analysis. But a Power Analysis 'fixes' the estimated subject numbers.

Sequential Sampling techniques were developed by quality-control engineers (Pyzdek, 1989) and are rarely used by behavioural researchers. These techniques are more powerful in that fewer subjects are required in order to arrive at a decision with the same degree of certainty (Edwards, 1986). Using it often reduces the number of subjects needed, *especially in the case when the size of the effect turns out to be greater than you had predicted*. Such economy is possible because the decision as to the total number of animals needed to test is updated as *each* animal's data is collected and evaluated.

Tools Needed

Two things are needed to use *Sequential Sampling*:

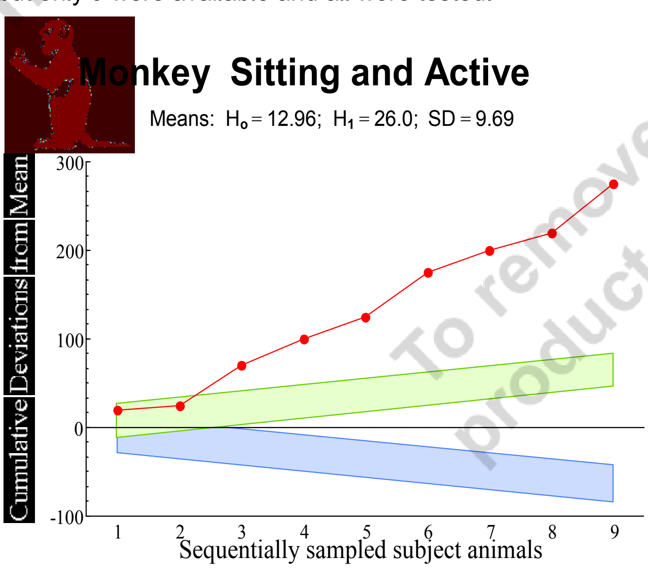
- To know the mean and variability of your population, and size of the effect you consider to be "important";
- Be able to test your subjects one or a few at a time.

The information about population parameters and effect size is normally available from the literature, from control data, or can be estimated. *Statistical Sampling* (and Power Analysis) is simple to use and readily available in one computer statistics package STATISTICA™ by StatSoft Inc©. If you have an effect size greater than expected, then you can more-economically do experi-ments using many fewer subjects than other methods.

Enter the parameter values (very top of Figure 1) into the computer and the statistical package produces a plot as illustrated in green and blue. You then enter the data (red line) from each animal sequentially. When the plot goes outside either path, significance has been achieved, testing can be stopped, and a decision made about your hypothesis. Data rising above the ascending green path indicates you've produced a significant increase (below the descending blue path means a decrease), hovering around the zero base-line denotes 'no effect' resulting from the experimental manipulation. If the plot remains within a path, you can conclude that your design is not powerful enough to detect an effect.

An Example

Would providing caged monkeys with a box of wood-shavings increase the time spent being active (research is illustrated in UFAW, 1990). Before the provision of the 'forage box', monkeys spent 13% of the day 'sitting & active' (13 = value for H_0; standard deviation = 9.7). For it to be worthwhile (size of effect), I estimated the forage box would have to at least double the time active (that is the value for H_1 = 26%) at $p = 0.05$ (two-tailed). Before the study, I estimated that I would need about 20 monkeys to get a reliable effect, but only 9 were available and all were tested.



In fact the box of wood-shavings (Figure Above) trebled the time spent sitting but active, up to 42% of the daytime. Had I used *Sequential Sampling* procedures, I would only have had to test 3 monkeys before reaching significance (see data in **red** in Figure Left) and able to conclude that the forage box was reliably increasing activity a worthwhile amount. Application of a Power Analysis indicated that I would have needed to test 5.7 subjects.

In sum, my estimate was that 20 animals were needed, a Power Analysis calculated I should test 6; had I used *Sequential Sampling* procedures, I would only have needed to test 3. That is an 84% reduction in the number of animals from the initial estimate, a 66% reduction from what was in fact used, and 50% of that suggested by a Power Analysis.

When you want to reduce animal numbers to the lowest number possible, especially when test procedures are aversive, *Sequential Sampling* is a more ethical alternative, when it can be used.

References

Edwards, HP (1986) Sequential experimentation, or count your chickens as they hatch. In: *The Fascination of Statistics*, Ed. RJ Brook. Marcel Dekker: New York.
Pyzdek, T. (1989) *What Everyone Should Know about Quality Control.* Marcel Dekker: New York.
UFAW (1990) *Environmental Enrichment: Advancing Animal Care* [video]. (Available from Universities Federation for Animal Welfare, 8 Hamilton Close, South Mimms, UK, EN6 3QD)