Outline

• Experimental method in psychological research
• ‘True’ experiments and importance of random allocation
• ‘Quasi’-experiments
• Alternatives to random allocation: systematic ways to control for nuisance variables

Experiments

Experiments – involve the manipulation of a variable of interest (independent variable or treatment) and the measurement of the effect this has on another variable of interest (dependent variable) with the aim of establishing causality. (Other research approaches include correlational and observational/descriptive approaches.)

Experimental design – protocol for data collection with the aim to establish causality between treatment and changes in the dependent variable; a key consideration is how participants are allocated to treatment conditions.

‘True’ experiments – involve full control of the experimenter over allocation and scheduling of the treatment; in psychology and social sciences, ‘true’ experiment is often meant to refer to protocols involving random allocation of participants to treatments.

Random allocation

• Every participant has an equal chance of being allocated to any condition.
  • Purpose is to spread any potentially confounding differences (‘nuisance variables’) between participants evenly across treatment conditions; i.e. to minimise systematic differences other than the treatment.
  • Random allocation aids in isolating the causal effects of the treatment on the dependent variable (by removing systematic influence of nuisance variables/threats to internal validity).
  • Particularly important where potential nuisance variables are difficult to identify.
  • Procedures for random allocation may involve using a draw to allocate participants to conditions or using a random number generator.

What is the purpose of random allocation of participants to treatment conditions?

a) Practically
b) Increase of statistical power
c) Control for nuisance/confounding variables
d) Increase in external validity
Exercise

What’s wrong with the following experiment?

A final year project student wants to examine how caffeine affects performance on a memory test. All participants were asked not to consume caffeinated drinks within 24 h before the test. The first 15 participants to come to the department were given a cup of caffeinated coffee before the memory test. The next 15 participants to come to the department were given a cup of decaffeinated coffee before the memory test. The test performance of each group was used as dependent variable.

What’s wrong with this experiment?

a) Nothing.

b) Allocation of participants to groups.

c) Sample size.

d) Both b) and c).

‘Quasi’-experiments

• Research procedure that aims to establish causal effect between an independent variable and variations in a dependent variable, but where there is no full control over the allocation of participants to the different levels of the independent variable.

• The lack of random allocation is typically considered the demarcation from ‘true’ experiments in many areas of psychology, such as social and educational psychology.

• The lack of random allocation poses a key threat to internal validity, as it increases the risk that group/conditions may systematically differ with respect to factors other than the independent variable.

Which of the following is a key threat to internal validity in a pre-post test (O X O) design?

a) Compensatory rivalry

b) History

c) Maturation

d) Both b and c

Some common ‘quasi’-experimental designs

Nomenclature:  X = a treatment    O = observation/measurement ...

• One group pre-post test design

O X O

• Non-equivalent control group design

O X O

• Interrupted time-series design

Counterbalancing

In within-subjects designs, the confounding effects of nuisance variables, such as testing order, can be countered by balancing them across the different levels of the independent variable.

Examples:

1. Counterbalancing of testing order across two conditions A and B: One half of the subjects is first tested in condition A, then in B; the other half is first tested in B, then in A. So, any difference in the dependent variable between conditions A and B cannot be accounted for by testing order.

2. Latin Square Designs: used when there are more than 2 conditions.
   - N conditions, A, B, C, . . ., N, can be arranged such that each condition occupies each rank in the testing order equally.
   - To do this, sequences of A to N are arranged in a Latin Square consisting of N columns and N rows, with each row and each column containing each condition exactly once, e.g. for three conditions A to C:
     - A B C
     - B C A
     - C A B
   - Then, the same number of participants is allocated to each of the different testing orders specified by the different rows (i.e. the number of participants must be a multiple of the different testing orders, which equals the number of conditions).

Systematic approaches to control for nuisance variables

- Blocking
- Matching
- Counterbalancing

Matching

Groups are matched/comparable with respect to specific individual difference (e.g., education; sex; age; pre-treatment performance; smoking status) to minimise the influence of this nuisance variable on the dependent variable: in a matched-subjects/matched case-control design, every participant is directly compared with another participant who is matched according to a relevant nuisance variable. Compare: http://www.bmj.com/content/309/6962/1598

Example: Differences in hippocampal size between depressed and control subjects (YL Sheine et al., 1994, Proc Nat Acad Sci USA 90:3908-3913)

Counterbalancing

Exercise

a) Work out the testing sequences for an experiment with five conditions A, B, C, D and E according to a Latin Square design to avoid confounding effects of testing order.

b) Which numbers of participants may, in principle, be suitable for such a Latin Square design: 5, 10, 12, 15, 35, 36, 40, 99, 10 000
In a nutshell

• Aim of the experimental approach is to establish causal relationships between an independent variable (‘treatment’, ‘manipulation’) and a dependent variable.

• A key consideration in experimental design are nuisance variables or third factors that may lead us to falsely conclude a causal relationship between independent and dependent variables.

• One key approach to control for nuisance variables is random allocation to treatments; alternatives include blocking, counterbalancing and matching.

• In psychology and social sciences, random allocation is often considered the demarcation criterion between ‘true’ experiments and ‘quasi’-experiments.

Suggested reading

A book on research methods, for example:

Further specialised reading


Some questions for revisions

• What are the key features differentiating the experimental approach from correlational and observational research approaches in psychology?
• In general:
  How can we ensure the internal validity of our research (i.e., that any changes observed in our dependent variables are due to changes in our independent variable, rather than other factors)?
• More specifically:
  - What is the purpose of random allocation?
  - Are there alternatives to random allocation? Consider pros and cons.