

Overview of Course

- Lecturers
 - Dr Peter Bibby
 - Dr Eamonn Ferguson
- Course
 - Part I - Anova and related methods (Semester 1)
 - Part II - Issues relating to 'field work' and its statistical analysis (Semester 2)
- Assessment
 - A single 3 hr examination in the Semester II examination period
- Related Courses
 - All modules offered within the School of Psychology will be understood better if the data and the statistical analyses that underpin psychological research are understood.
 - The practicals module will rely in part of the statistics that you learn in this module and the statistical knowledge you acquired in the first year.

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1

Overview of Lecture

- Designing Experiments
- Control in Experimentation
- Statistical Hypotheses
- Errors in Hypothesis Testing

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2

Designing Experiments

- Experimentation begins by formulating a number of research hypotheses.
- Translate the different research hypotheses into a set of treatment conditions and the selection of an appropriate experimental design within which to embody the different treatment conditions
- Different treatments are administered to different groups of subjects or to the same subjects in different orders and performance on some response measure is observed and recorded.

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3

Independent and Dependent Variables

- The treatment variable is commonly known as an independent variable and the measure is known as the dependent variable.
 - An independent variable is the variable that is manipulated
 - drug or placebo
 - The dependent variable is the response measure which is manipulated on the basis of the independent variables
 - blood sugar levels

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4

Quantitative, Qualitative & Classification Independent Variables

- There are three kinds of independent variables:
 - Quantitative variables are variables that represent variation in amount (e.g. amount of drug, loudness of noise).
 - Qualitative variables represent variations in kind or type (e.g. teaching strategy).
 - Classification variables systematically vary characteristics which are intrinsic to the subjects of the experiment (e.g. age, sex, IQ, species, word type, etc.)

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5

Nuisance Variables

- Nuisance variables are potential independent variables which if left uncontrolled could exert a systematic influence on the different treatment conditions.
 - Several researchers running the same experiment might produce an experimenter effect.
 - The time of day could have an influence.
 - The kind of subject selected can effect the influence of the independent variables.
- If we do not control for these differences in experimental situation, we might have a confounding variable in the experiment.

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6

Dependent Variables

- Once we have designed an experiment and have produced an experimental hypothesis then we need to decide upon the specific details of the experiment.
- The idea is to select a measure that will "capture" the hypothesised differences.
- The measure that is adopted is known as the dependent variable.
- We hypothesise that the observed data will be somehow dependent on the nature of the independent variable.

Control in Experimentation

- Consider an experiment where the data is collected by running the experiment simultaneously in two different laboratories:
 - The two labs are identical in every respect except that the temperature for each room cannot be controlled.
 - Temperature variations may lead to systematic variations in the performance on a task.
- Randomly allocating different treatment conditions to the rooms gives an equally likely "chance" that different random temperatures will be associated with the different treatment means.

Completely Randomized Designs

- The completely randomized design is characterized by the fact that the subjects are randomly assigned to serve in one of the treatment conditions.
 - This is also known as a between subjects design since any differences in behaviour observed among the treatment conditions are based on differences between different groups of subjects.

Randomized Block Designs

- Randomized block design uses blocks of subjects who are matched closely on some relevant characteristic.
- A common procedure is to treat a subject as a 'block', wherein the subject serves in all the treatment conditions of an independent variable.
 - When subjects complete all the treatment conditions this type of design is commonly referred to as a repeated measures design or a within subjects design.

Statistical Hypotheses.

- The Null Hypothesis
- The Alternative Hypothesis
- Deciding to Accept or Reject the Null Hypothesis.
- Errors in Hypothesis Testing.
- Juggling Type I and Type II Errors

Statistical vs Research Hypotheses.

- A research hypothesis is a fairly general statement about the assumed nature of the world that gets translated into an experiment.
- Statistical hypotheses consist of a set of precise hypotheses about the parameters of the different treatment populations.

Statistical Hypotheses

- Two statistical hypotheses are usually stated
 - The Null Hypothesis
 - The Alternative Hypothesis
- These are mutually exclusive or incompatible statements about the treatment parameters

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13

The Null Hypothesis

- The null hypothesis is the statistical hypothesis which will be tested. It is often symbolized as H_0 .
- The function of the null hypothesis is to specify the values of a particular population parameter (usually the mean) in the different treatment populations (symbolized as μ_1 , μ_2 , μ_3 and so on).
- The null hypothesis typically chosen gives the same value to the different populations such that
 - $H_0: \mu_1 = \mu_2 = \mu_3 = \text{etc.}$
- This is the same as saying that no treatment effects are present in the population.

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14

The Alternative Hypothesis

- If the parameter obtained from the treatment groups are too deviant from those specified by the null hypothesis, H_0 , then the null hypothesis is rejected in favour of the other statistical hypothesis, called the alternative hypothesis, H_1 .
- Usually the alternative hypothesis states simply that the values of the parameter in the different treatment populations are not all equal. Specifically,
 - H_1 : not all μ 's are equal.

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15

Deciding to Reject the Null Hypothesis or not.

- A decision to reject H_0 implies an acceptance of H_1 , which in essence, constitutes support of our original research hypothesis.
- On the other hand, if the parameter estimates are reasonably close to those specified by the null hypothesis, H_0 is not rejected.

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16

Deciding to Reject the Null Hypothesis.

- There is a problem with the way in which the null hypothesis and alternative hypotheses are set up.
- For the null hypothesis
 - All μ 's are equal
- For the alternative hypothesis
 - All μ 's are not equal.
- These are statements at the level of the population means. However all we have are sample means.

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17

Deciding to Reject the Null Hypothesis

- We have to adopt a criteria for rejecting the null hypothesis.
- We do this by calculating test statistics based on the properties of the F-distribution.
- The value we adopt is called the significance level and is referred to as α (alpha).
- The value for α that we usually adopt in psychology is 0.05.

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18

Errors in Hypothesis Testing.

- The procedures we follow in hypothesis testing do not guarantee that a correct inference will be drawn.
- Whenever we make a decision about the Null Hypothesis we can make a mistake.
- There are two basic kinds of errors:
 - Type I Error
 - Type II Error

Type I Error

- Reality
 - Null Hypothesis is true
 - Alternative Hypothesis is false
- Decision
 - Reject the Null Hypothesis
 - Accept the Alternative Hypothesis

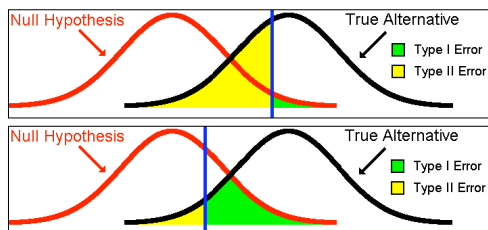
Type II Error

- Reality
 - Null Hypothesis is false
 - Alternative Hypothesis is true
- Decision
 - Fail to reject the Null Hypothesis
 - Reject the Alternative Hypothesis

Summary of Type I & II Errors

		Reality	
		H_0 is true	H_0 is false
Decision	Reject H_0	Wrong Type I	Correct
	Fail to reject H_0	Correct	Wrong Type II

Trading off Type I and Type II Errors



Juggling Type I and Type II Errors

- Most of the time we do statistical analyses we are trying to juggle Type I and Type II errors.
- Generally, if it is important to discover new facts, then we may be willing to accept more Type I errors.
- On the other hand if it is important not to clog up the literature with false facts then we might be more willing to accept more Type II errors.