PSYC1111 – Measuring Mind and Behaviour

THE SCIENTIFIC METHOD

LECTURE 1 – INTRODUCTION TO THE SCIENTIFIC METHOD

Availability Heuristic: A 'rule of thumb' for estimating probabilities based on the ease with which instances or occurrences can be brought to mind

The Scientific Progress

- Make an observation and form a hypothesis
- Hypothesis – prediction about the effect of one variable on another
- Test the hypothesis
- Analyse the data
- If our evidence supports the hypothesis we can make a conclusion. If NOT then we update or discard the hypothesis
- We need to complete this cycle many times and then we can from a theory

Determinism: There is some underlying systematic order to many phenomena in the universe

Parsimony: When you have competing hypotheses that are equally good at predicting the results, the hypothesis with the fewest assumption should be selected. Simpler explanations are better. In extreme circumstances this is obvious.

Empiricism: claims must be supported by systematic and well-collected evidence

Testability: Theories and hypotheses should be testable

- You should be able to devise some test or observable event based on the theory/hypothesis
- You should be able to put forth some empirical evidence to support a hypothesis or theory
- **Verificationism:** You need to be able to confirm that a theory/hypothesis is "true"

Falsifiability: A good theory or hypothesis is therefore both verifiable and falsifiable, and we should seek to falsify our theories

Operationalisation: Operationalising variables allows you specify exactly what you mean in your hypothesis/theory

- It allows for the variable to be measured/quantified
- It also allows you to indirectly define unobservable variables

LECTURE 2 – PSEUDOSCIENCE

SCIENCE: WHAT ARE WE TRYING TO DO?
Existence: Does X or Y exist?
Relationship: Does X co-vary with Y?
Causation: Does X cause Y?

The Scientific Method

- The scientific method will not tell you what is "true" or whether something has been "proven"
  - The scientific method is a process
  - Nothing is set in stone, it can always be changed if new evidence compels us to do so.
- It is an interactive process
  - Scientists discuss their ideas with other scientists and publish their work in peer-reviewed journals
  - Published work is not guaranteed to be "correct" but it has passed a number of checks to increase your confidence in its accuracy and meaning
- Good science should always be clear. Unnecessarily vague and unclear theories hide vagueness, misunderstanding and are not useful.

Peer Review

- The system of scientific publishing is difficult and rigorous
- You don't try to falsify your own findings but the system is designed to find ways to falsify your research
- You must produce good findings and have experts agree that the experiment is valid

Why Trust Science?
It works. In the past, reliance on different non-systematic and metaphysical approaches to understanding the world did not work. For example, modern medicine:

- The efficacy of modern medicine to prevent you from dying after losing a limb
- Older traditions had limited success e.g. using herbs on wounds
  - Wearing masks to block smells during the plague
- Attempts at treating people were mostly guesswork
- Modern germ theory – Louis Pasteur experimentally tested methods of killing micro-organisms

PSEUDOSCIENCE

What is Pseudoscience?
Examples of pseudoscience include Astrology, Phrenology, Crystal healing, Extra sensory perceptions (ESP), Homeopathy, chiropractic, leeching.

How do we differentiate Science from Pseudoscience?
Science and pseudoscience can be similar in subject matter (physics, chemistry, biology and medicine) and aims (Description, Prediction and Explanation).

The point of difference between the two arises in the methodology used in science (Observations, relationships between variables and experiments). Some pseudoscience uses scientific methodology and techniques but is usually employed poorly. Also, Pseudoscience does not change when sufficient evidence suggests that it is wrong.

Two Main Factors

- The term pseudoscience does not refer to a different kind of research, it refers to science and thinking that has been flawed and refuses to change
- Normally this involves one or both of these factors:
  1) Flawed/biased evidence – observations or experiments
  2) Resistance to change or let go of failed ideas/theories/hypotheses

EXAMPLES OF PSEUDOSCIENCE:

1. **<u>Astrology</u>** is the ancient art of predicting future events in the world based on the position of the stars and planets
   - Horoscopes are readings of the position of the planets and stars at the time of birth and using these to predict the personality and the future events of an individual
   - ***Theory:*** there is a causal relationship between astronomical phenomena and events in the human world. Common argument: the moon
   - ***History:*** Astronomy and Astrology were intertwined until the 17th Century
     - The original systems placed the Earth at the centre of the galaxy (and universe) with the planets and stars orbiting around the Earth in perfect circles
     - The Ancient Greeks proposed the circles because they were mathematically beautiful and seemed to be the divine property of the Gods/beings that ruled the planets/stars
     - Medieval rulers would have a court astrologer/astronomer who took careful measurements of the positions of the astral bodies (astronomy) and then used these to predict the future for the ruler or kingdom.
   - Now we know the fundamental assumptions not tenable
     - Geocentric -> heliocentric
     - Perfect circles -> ellipses
   - So, surely the beliefs around astrology (based on this model) should be dropped?
   - **Carlson (1985)** carried out a double-blind test of astrology which was designed to meet the requirements of the scientific and astrological community
     - Volunteers provided information for natal charts and completed the California Personality Inventory (CPI)
     - 28 astrologers were given 1 natal chart to determine the horoscope and then 3 personality descriptions. They had to choose which of the 3 personalities belonged to the horoscope. If they were guessing they would have 1/3 chance of getting it right.
     - <u>Results:</u> Astrologers performed at chance levels!
     - Maybe the astrologers weren't too confident about their predictions?
     - They measured confidence for each prediction from 1-10 (low-high). These ratings did not correspond to their accuracy i.e. They were just as likely to be correct with both high and low confidence

- Important Features of this study include:
  - Clear research question
  - Clear hypothesis and interpretation of different outcomes
  - **Double-blind study:** Both the experimenters and the astrologers did not know who the personality profiles belonged to or their birth information. This removes the possibility of correct answers being given away by accident

NOTE: A double blind study is where both the participant and the experimenter are unaware of the conditions. E.g. Randomised drug trial Both the Doctor and patient do not which drug they are receiving

Why do people believe astrology? The P. T. Barnum effect: Horoscopes are written in a very general and vague manner. It is easy to apply these to any situation or person

Why do We need Double Blind Studies?

- The importance of Double blind studies is evidently portrayed in the example of Clever Hans the counting horse?
  - Clever Hans: The Horse that could do math problems!
  - The owner was equally amazed at the skills of Clever Hans
  - Reality: The owner was unintentionally giving the horse subtle clues
- You need double blind studies because of the Observer-Expectancy Effects which is that you can influence the outcome of experiment because of your expectation of your outcomes.

2. Homeopathy

- Homeopathy based on the principle of "let like cure like"
- Samuel Hahnemann (1755-1843) developed medicine. He found that substances that produced symptoms in a healthy person could be used to treat those symptoms in a sick person
- Law of Similars
- For example, we all know that cutting raw onions can result in stinging, watery eyes. When onion is prepared as a homeopathic remedy, it can be used to treat hay fever that manifests itself with similar symptoms."

Homeopathy: how does it work?

- ***Claim:*** dilution makes the medicine stronger
- ***Practice:*** make a low concentration liquid, then dilute. Repeat dilution. Normally homeopathic dilutions involve a 10^{60} fold dilution
- So if the homeopath started with a 1 mole solution (overestimation) then the final dilution is 1037 fold higher than Avogadro's number
  - The likelihood that 1 molecule of the original substance (e.g. caffeine) is present in the final solution is very very very small.
- The likelihood of 1 molecule is too low. So how do Homeopath's claim that the dilution works if it doesn't contain the actual substance anymore?
- The water it was mixed in retains a "memory" of the substance!

- We have to valuate these claims:
  - Water has memory
  - Greater dilution increases its potency
  - Homeopathy works

- Homeopathy: Water has memory
    - Originally proposed by a scientist in 1988 and published in a high ranking scientific journal: J. Benveniste et. al. Nature 333: 816–818.
    - However, methodologically flawed and it was published with an editorial that pointed out the numerous laws of physics and chemistry that are violated if this were true
    - Principle of parsimony/Occam's razor
        - If we accept that water has "memory" the idea does not account for a large amount of experimental data that current physics and chemistry can account for
        - Doesn't mean it is wrong, but in the absence of extra-ordinary and strong evidence, we shouldn't accept the idea
        - Further, controlled experiments failed to replicate the findings so we should not accept it
    - The claim does not stand up to scientific methods. No studies have replicated the finding and we cannot accept the claim then as valid.
- Homeopathy: Greater dilution increases the potency
    - So every time you reduce the concentration of the chemical it becomes stronger
    - Logically, this form of reasoning leads to very confusing predictions e.g. If you refill an empty beer bottle with water you would get really drunk from drinking the water!
- Homeopathy: It works
    - What kind of evidence is normally put forward to support the efficacy of homeopathy?
    - Normally argued that a homeopathic remedy is tailored to the individual so it makes it hard to compare to other types of medicines that are "one size fits all"
    - So, one way of looking at the efficacy is through Testimonials.
    - What is wrong with testimonials? They involve a single person, so any effects could be random and not generalizable to the population
    - *Biased Sampling:* you only see the testimonials for the people that it worked on! You never see negative testimonials so you don't know if it failed to work most people!
        - This is the reason why studies using large numbers of participants are needed, to avoid only reporting instances where things worked.
        - It is also important scientific practice to use random sampling i.e. a random group of people that are representative of the population
        - Otherwise you may have a large group of people that have a systematic bias e.g. if they are all believers in the efficacy of homeopathy

How do you compare homeopathy with "no treatment"?

- Can't just have a group that don't receive anything. However a group that doesn't receive anything will tell you about natural/spontaneous remission of symptoms
- You need a Placebo group: A group that thinks it is getting a treatment but does not • Give them a pill with nothing in it
    - Hope the placebo pill doesn't have a "memory" of things it has touched

- Why a Placebo? Because people can report feeling better if they think they have been treated (Placebo effect).

STATISTICS

LECTURE 1 – DESCRIPTIVE STATISTICS

Statistics: Art and Science of Dealing with Data

- Sets of mathematical equations used to analyse what is happening in the world around us.
- Tell us any trends in what happened in the past and can be useful in predicting what may happen in the future.
- Collection of procedures and principles for gaining and analysing information to educate people and help them mak e better decisions when faced with uncertainty.

Statistics is necessary in fulfilling the first two goals of psychological research. That is, to measure and describe AND to explain and predict.

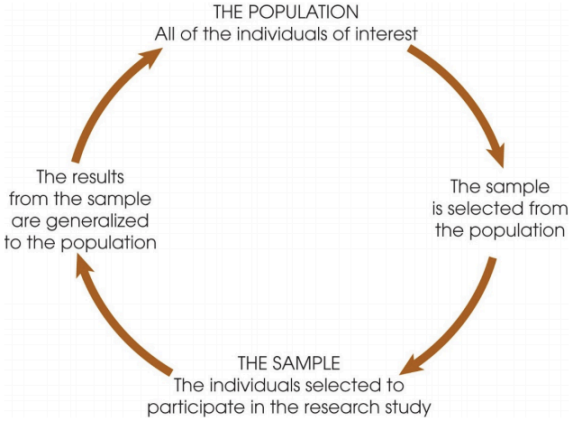
NOTE: The third goal is to apply and control

Descriptive Statistics

- Methods for organizing and summarizing data.
    - For example, tables or graphs are used to organize data, and descriptive values such as the average score are used to summarize data.
- A descriptive value for a population is called a ***parameter*** and a descriptive value for a sample is called a ***statistic***.

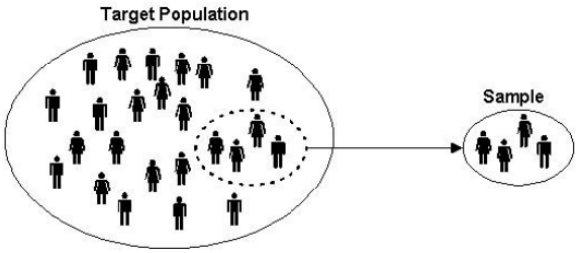
Inferential Statistics

Methods for using sample data to make general conclusions (inferences) about populations.



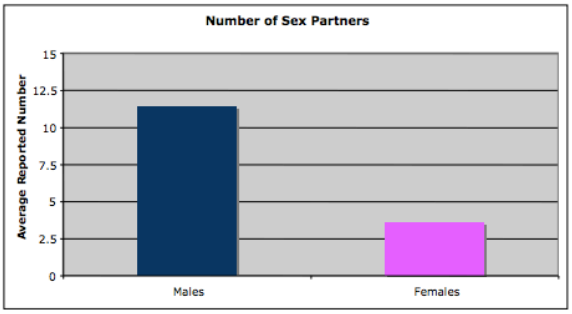
Population and Sample

- The entire group of individuals is called the ***population***
- Usually populations are so large that a researcher cannot examine the entire group. Therefore, a sample is selected to represent the population in a research study. The goal is to use the results obtained from the sample to help answer questions about the population.



E.g. What is the average number of sex partners in population of adults between 18-65 age?
In this example, the sample includes 600 males and 600 female participants

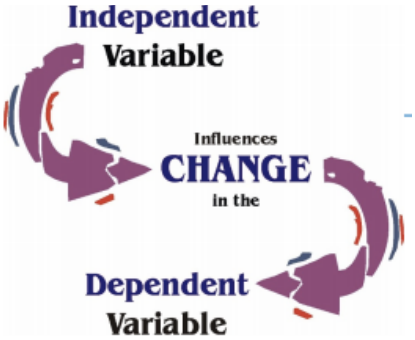
1) **Descriptive statistics describe data sets**: extract representative characteristics of the group(s) being observed.



	Males	Females
Average	11.38	3.61

Variables

- A variable is a characteristic or condition that can change or take on different values.
- Most research begins with a general question about the relationship between two variables for a specific group of individuals.



Qualitative vs. Quantitative Variables

- **Qualitative variables:**
  - Sometimes called *categorical;*
  - Attributes of the variable fall into discrete categories;
    - *(e.g. gender, favorite color, country of birth)*

- **Quantitative variables:**
  - Attributes of the variable are assigned values that can be anywhere within a range;
    - *(e.g. age, weight, height, IQ, speed of driving)*

Discrete

Data are comprised of indivisible units, represented by whole numbers:

-number of children

-errors on a true/false test

For example, you can't have 0.5 children .....

Continuous

Data involve numbers which can be divided an infinite number of times.

For example, if you have driven 2km, to reach the 3rd km you have to pass through all fractional parts of the next km.

MEASUREMENT SCALES

Nominal Scale (Identity)

- Used for categorical (not continuous) variables;
- Any case can be placed in one and only one category.
- Numbers at this level of measurement are arbitrary – they act as labels, they are there instead of names (nominal)
- Numbers indicate:
  - Sameness or difference;
  - numbers don't indicate size or order

Examples: