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Lecture 2 Statistics/Overview of Experimental Design

- Scientific Research needs to be hypothesis driven
- Exam - data given, need to formulate hypothesis
- **Acute- short term exposure**
- **Chronic - long term exposure**

1 Identifying Keywords
Look for:
- Important keywords
- Supplementary keywords
- Irrelevant words
- Words on issues to be excluded from your answer

2 One or more general hypotheses which explains the claim
- Keep in mind you will need measurable outcomes to be tested

3 Consider underlying physiological mechanisms -> expand on them

Manipulation Hypothesis
5 essentials
- **Independent variable:** What you're going to change e.g. caffeine
- **Dependent variable:** What you're measuring e.g. blood pressure
- **Mechanism:** Must be measurable e.g. increased cardiac output
- **Species:** e.g. humans, rodents
  - Response in humans may be v. different in rodents
  - May need to be more specific e.g. athletes
- **Direction:** Increased, decreased NOT ALTERED

Aim vs Hypothesis
- **Aim**
  - Investigate
  - Describe
  - Characterise
  - "The aim of this study is to…"
  - e.g. investigate the chronic effect of caffeine in humans
- **Hypothesis**
  - More descriptive
  - "The hypothesis associated with this study is…

4 What approach would you take to the investigation?
- ~~Asking the subjects to complete a questionnaire~~
  - Might lie
- A minimum number of subjects (20) is preferable b/c wide genetic variability in people
- No point in having extra subjects
- Best approach
  - Measure heart rate and bp of 40 subjects (20 caffeine, 20 placebo) for three months, then repeat measurements
- Subjects may need some time without caffeine to eliminate previous effects

5 Would animal or human studies, or both, be appropriate?

- Ideally, use human subjects (if ethical)
- Criteria for choosing subjects
  - Health
  - Age
  - Strain
- Availability, numbers, cost

6 Cells, tissues, or whole organisms?

- What else can you find out from cells or tissues that you cannot from a whole organism?
  e.g. record directly from neurones in the brain
- Invasive procedures needed to target particular cells in whole organisms?

7 What controls would be appropriate in your experiments?

- The control group and the treatment group should be the same except for one variable
- Human and/or animal subjects
- **Serial controls: Same subjects used as their own control**
  - Alternate b/w caffeine and placebo
- **Parallel controls: Different control subjects from experimental subjects**
  - But same characteristics
- Important characteristics of control and treatment groups
  - Gender
  - Age
  - Diet
  - Fitness
  - Health
- Prefer same total numbers, same number of different types

8 How would you choose the number of experimental tissues/ subjects?

- 10/20 subjects are usually a reasonable number of subjects in physiological experiments
- Must consider cost and feasibility in a real world

9 What issues are important in the experimental protocol?

- **Time of Day:** Changes in bp and heart rate
  - Experiment and controls done @ same time of day?
- **Duration of experiment:** Chronic (days, weeks, months?) or acute (short-term)
  - Must eliminate acute effects
    e.g. can't measure straight after taking caffeine. Must wait for it to be cleared by the body
  - Long-term experiments, can make multiple measurements e.g. once a day to follow development
  - Basal (resting) measurements must be done on subjects who have not had caffeine for a period of time

10 What are the ethical considerations?

- What limitations might these impose on your experimental design?
  - Invasive procedures, surgery, drugs injections
  - Side effects?
  - Pain? Discomfort? Stress? Harm?
- Restrict to a room for the duration?
- Informed consent for volunteers

11 Does your experimental design adequately test your hypothesis?

- Would the results either
  - Refute your hypothesis OR
  - Provide support for your hypothesis

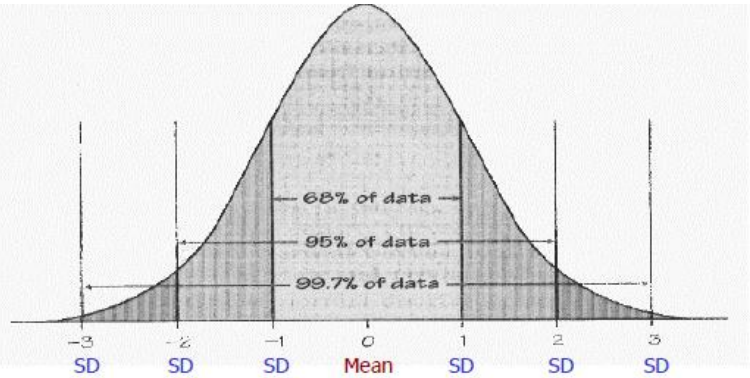
Statistical Terms

- **Mean:** average
- **n:** number of samples or subjects
- **Standard deviation (SD):** measure of the spread of a distribution/measure of sample variability
- **Standard error of the mean:** standard deviation of all of the mean values

$$\mathrm{SEM} = \frac{\mathrm{SD}}{\sqrt{\mathrm{n}}}$$

Normal Distribution

- Density Curve which describes the shape of the shape of the distribution
- 68-95-99.7 rule
  - **68%** of observations fall within **1 std dev** of the mean
  - **95%** of observations fall within **2 std dev** of the mean
  - **99.7%** of observations fall within **3 std dev** of the mean



T-test

- Assume that prac results fall within the normal distribution
- Perform statistical test based on normal distribution
  - ∴ Test whether two samples are statistically the same
- Use T-test to determine the p-value - probability of a false positive
- **If p-value is smaller than 0.05: Results are statistically significantly different**
- **If p-value is larger than 0.05: Results are NOT statistically significantly different**
- Lower p-value= more confident that samples from the two groups are significantly different (not a false positive)