Psychology Research Methods (Introductory) – Week 1

Part 1 – Learning Objectives:

- Understand the difference between population and sample
- Distinguish between parameters and statistics
- Distinguish between descriptive and inferential statistics

Population vs Sample

- Population: "the entire collection of events in which you are interested" (Howell, p. 2)
- All individuals that you are interested in studying
- Sample: A subset of individuals selected from the entire population

If you're interested in doing a study comparing males and females on anxiety levels, the entire population would be all males and all females.

But because we can't access the entire population for a study, we recruit a sample from that population.

Research questions are generally phrased at the population level, but the studies are normally just conducted on a sample drawn from that population.

Example

- A psychologist wants to determine whether a motivational program is effective in improving performance in Australian office workers.
- Population? Every Australian office worker
- Problem – not feasible, and not sure if it works yet
- Solution – select a **sample** from the population
- Sample – e.g., 100 workers from each state

The view then would be to infer the effects of the motivational program on the sample to the population; if it works in this particular sample, then we have evidence that it might be effective at the population level.

Parameter vs Statistic

- **Parameter:** characteristic of the **p**opulation
- Example: average income of all Australian office workers
- **Statistic:** characteristic of the **s**ample
- Example: measure the age of the 100 depressed patients

A parameter is any value that we obtain that is characteristic of the population; any score that we get from a population. Census data allows us to access the whole population.

If we were interested in studying all university students but we could only get the 200 people that come to the first seminar to do a survey, and we got the average score from that sample then the average would be a statistic.

Two main types of statistics

The scores obtained are raw scores, but we can convert each of them into a standard score.

What is the z-score corresponding to X = 5? This would be the same as asking, how many standard deviations above the mean is a score of 5?

5 – 3.6/1.67 = 0.84

A self-esteem score of 5 is 0.84 standard deviations above the mean – almost a full standard deviation above the mean.

The z-score allows us to compare scores (e.g. anxiety) that have been obtained using another metric (e.g. scale from 0 – 50 instead of 0 – 10); can convert that score into a z-score and directly compare them. If a person has a higher z-score for anxiety than he does for self-esteem, then he is relatively higher on anxiety compared to self-esteem for that sample. So the scores with z- are directly comparable.

Scores = 5 1 3 4 5
Mean = 3.6
SD = 1.67

Z-scores = 0.84 – 1.56 – 0.36 0.24 0.84
Mean = 0
SD = 1

All scores in standard deviation units. This results in a 'standard normal distribution' – Mean = 0, and SD = 1.

The z-scores tell you the extent to which each score is above or below the mean in terms of standard deviations.

Probability and 'area under the curve'

- Z-score for X = 115, Mean = 100, SD = 15
- The area under the normal curve distribution is determined by consulting the tables of the standard normal distribution (Appendix z)

IQ test – Mean = 100, SD = 15

What is the probability of scoring 115 or more on this test? This is the same question as, what proportion of the population score 115 or more on this test? So, proportion and probability are equivalent, and so we can use the concept of the normal distribution to help us answer this research question.

The first step in answering this research question is to standardise the score, which means converting it to a z-score.

What is the z-score for a value of 115 given a mean of 100 and a standard deviation of 15?

115 – 100/15 = 1

The score of 115 is 1 standard deviation above the mean.

Z = –3 (55) – 2 (70) – 1 (85) 0 (100) + 1 (115) + 2 (130) + 3 (145); z-scores with raw scores in brackets

What proportion of the population score 115 or more?

The proportion of the normal curve above 115 is 0.1587, correspondent to a z-score of 1. 0.1587 is the area of the curve under the whole curve i.e. distribution. This area is known as the smaller portion, while the remaining area would be called the larger portion. This proportion can be converted into a percentage by multiplying it by 100 = 15.87.

The probability of someone scoring 115 on this test is 15.87%.

- There are two free choices – once the expected frequencies for two of the categories have been decided upon, the frequency for the third is automatically determined

Category A	**Category B**	**Category C**
10	10	? (10)

- Thus, df = C – 1
- The entire set must equal N

When there are large differences between the observed and expected frequencies, the value of the chi-square will be large, whereas when observed and expected frequencies are similar, the value of the chi-square will be smaller. Therefore, the chi-square statistic will negate the null hypothesis, the higher it is.

There is a critical value of 5.99 for 2 degrees of freedom under a proportion of .05; this is the minimum value the chi-square statistic needs to be for in order for the finding to be statistically significant. The observed chi-square was 9.8, which is well above 5.99, which reflects that this finding is statistically significant.

- If our observed chi-square value is *greater* than the critical value, then we can reject the null hypothesis
- Since observed > critical we can reject the null hypothesis
  - The **observed** frequencies differed significantly from those **expected** by the null hypothesis (i.e., chance)
- We have statistical evidence that the three brands of lemonade were not preferred equally
  - **A chi-square goodness of fit test revealed a significant difference in preferences across the three brands of lemonade $\chi 2$ (2) = 9.8, $p < .05$**

Since the observed chi-square value is greater than the critical chi-square value, we can reject the null hypothesis; we can say that there's a difference across the three categories.

The greater the chi-square value, the greater the likelihood that there is less than .05% of a chance of expecting it.

Part 2 – Learning Objectives:

- Understand the concept of a contingency table and how to calculate the expected cell frequency
- Calculate and interpret the chi-square statistic for a two-way classification study

Two-Way Classification: Contingency Tables

- Two variables – allows us to answer more complex research questions
- Are the two variables **independent** of one another? (chi-square test of independence)
- Is one variable *contingent* on another?

This allows us to answer more complex research questions; for example, we can ask, whether or not, the two variables are independent of one another, or are they contingent on one another.

- New variable in the lemonade preference study:
  - Gender
- Now we can ask:
  - Is the preference for the different brands of lemonade **independent of gender**? Or

Smoking example using pooled variance

- Two groups: Smokers (n = 12) and non-smokers (n = 27)
- DV – mean anxiety scores (0 – 20)
- Smokers (mean = 15.31, s = 4.42)
- Non-smokers (mean = 12.19, s = 3.28)

1. Calculate pooled variance

Two groups:

Smokers (**n = 12**)
Non-smokers (**n = 27**)
DV – mean anxiety scores (0 – 20)
Smokers (mean = 15.31, **s = 4.42**)
Non-smokers (mean = 12.19, **s = 3.28**)

pooled variance = (group 1 sample size – 1) X variance for group 1 + (group 2 sample size – 1) X variance for group 2 / group 1 sample size + group 2 sample size – 2

= (12 – 1) X 19.54 + (27 – 1) X 10.76 / 12 + 27 – 2

= 11 X 19.54 + 26 X 10.76 / 37

= 214.94 + 279.76 / 37

= 494.7 / 37

= 13.37

2. Calculate *t*-statistic

t = group 1 mean – group 2 mean / square root of (pooled variance / group 1 sample size + pooled variance / group 2 sample size)

= 15.31 – 12.19 / square root of (13.37 / 12 + 13.37 / 27)

= 3.12 / square root of (1.11 + 0.50)

= 3.12 / square root of 1.61

= 3.12 / 1.27

= 2.46

t (37) = 2.46, $p < 0.05$

Critical value for $t(37)$ of 0.05 is 2.02; values that exceed this reflect statistical significance.

Given that it does exceed the critical value of 2.02, we would get a statistic of 2.45 less than 5% of the time; rare enough to reject the null hypothesis.

Example data

- A research psychologist was interested examining personality differences between Ecstasy users and non-users
  - Sensation-seeking

Psychology Research Methods (Introductory) – Week 7

Part 1 – Learning Objectives:

- Understand what is meant by prediction
- Understand what is meant by intercept and slope
- Use a regression equation to predict a value for *y*

What is regression?

- When two variables are correlated, we can use scores on one variable to *predict* scores on the other
- Bivariate vs multiple regression
- Predictor variable = independent variable
- Predicted (criterion) variable = dependent variable
- The DV is 'predicted' by the IV
- The stronger the correlation, the more reliable the prediction

Pearson correlation

- Degree and direction of the relationship between two variables
- The degree to which data points form a straight line
- Scatterplots

Regression lines

- Line of best fit

1. Makes the relationship between the two variables easier to see.
2. Identifies the 'centre'' of the relationship (simplified description).
3. Can be used for **prediction**.

- Prediction

Prediction of *Y* on the basis of *X*

Predict negative mood (*Y*) on the basis of anxiety (*X*)

If a person scored 8 on anxiety, what would be their predicted negative mood score?

Approx. 6

Regression

- Regression is a statistical procedure for determining the equation of that line
- Uses that line (related to correlation) to predict one variable from the other
  - Predict negative mood/stress from trait anxiety
- We can predict by just knowing one of the variables (e.g. anxious personality)

Post-hoc Tests – Week 9

Post-hoc comparisons

- Post-hoc comparisons are analyses undertaken after a significant ANOVA is revealed, to explore where the difference in the data is

Type 1 error rate

- The type 1 error rate is equal to your significance level, or alpha
- When you are saying that something is statistically significant, you are saying that there is less than 5% chance that these findings would have occurred even when there is no difference. But, there is still a 5% chance of making an error. This is your Type 1 error rate. There is a 5% chance that you will say there is a statistically significant difference, when in fact, there is none.
- Why are Type 1 errors relevant to post-hoc testing?
- When we conduct post-hoc tests, we are conducting additional analyses. Every time we conduct an analysis, there is a 5% chance of making a Type 1 error. The more analyses we conduct, the greater the chance of making at least one Type 1 error.

Family-wise error rate

- E.g., if we conduct 4 analyses, each at the .05 level, the overall chance of making at least one Type 1 error is:

$$\text{alpha}_{fw} = 1 - (1 - \text{alpha})^{c}$$

- Where alpha is your rejection level, and c = the number of comparisons you make
- So, with an alpha level of .05, and comparisons to be done, our error rate is:
- $\text{alpha}_{fw} = 1 - (1 - .05)^4$
- $\text{alpha}_{fw} = 1 - (1 - .95)^4$
- $\text{alpha}_{fw} = 1 - 0.815$
- $\text{alpha}_{fw} = 0.185$
- This means that the overall chance of making a Type 1 error is .185, or 18.5% - too high
- This value of 0.185 is our 'familywise error rate'
- It is the probability of making at least 1 Type 1 error across our series (or family) of comparisons
- This value takes into account the fact that with each additional analysis performed, there is an increased probability of making a Type 1 error

Per-comparison rate

- By contrast, the per-comparison rate is just the alpha level you set for each individual analysis
- You (the researcher) subjectively determine the alpha level. The standard is .05
- You can change it if you wish

Familywise vs per-comparison error rate

- Familywise error rate = overall chance of making a Type 1 error over a series of analyses
  - Takes into account per-comparison error rate

	of one variable from the other is not perfect (some error between actual Y values and predicted values) standard deviation of Y (square root of (1 – coefficient of determination)) • *confidence limits*: using standard error, we can calculate 95% confidence limits on the predicted value; the larger the standard error, the wider the confidence interval predicted value ± (critical t-value)(standard error)
ANOVA	• ANOVA = analysis of variance; analysing the variance between different groups to see if there is a significant difference between their group means, ANOVA can test differences between *more* than two groups (t-test can only do two) Gender: male and female (t-test), Age: young, middle-aged, old (ANOVA) • Within group variance and between group variance • *Variance between groups*: difference in scores that are due to the fact that participants are in different groups • *Variance within groups*: difference in scores that are due to the fact that there are individual differences and measurement error • ANOVA tests whether the difference between groups is larger than can be explained by the individual differences within groups; if the difference between groups is larger than the differences within groups, then we can reject H_0 • *ANOVA assumptions*: homogeneity of variance (variances of each group should be spread equally around the mean), normality (for each group of data, there is a normal distribution of scores around the mean), independence of observations (each observation, or each score, should be independent of the others; if scores are related to each other, then the differences between scores are not random) If assumptions are violated, you can still run an ANOVA, but you must be cautious in your interpretation (large sample sizes overcomes violation of assumptions) • *ANOVA sources of error*: individual differences, measurement error, error variance (variability between people in the same treatment) • *Difference between groups can only be due to*: effect of the treatment & chance • *F-statistic*: generated to reflect the proportion of the variance between groups to the variance within the groups variance between groups/variance within groups • ANOVA compares whether the difference between the treatment means (numerator) is greater than the difference expected by chance (denominator); *denominator* is referred to as error variance as it represents uncontrollable, random factors, *numerator* also contains error – the difference between