CPSY 501: Advanced Statistics

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Instructor: Dr. Sean Ho
TA: Marci Wagner

cpsy501.seanho.com

- ***No food/drink in the computer lab, please!***

- ***Please pick-up:***
  - ***Syllabus***
  - ***HW 1***
  - ***Project Handout***

- ***Please fill out sign-in sheet***

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Outline for today

- Welcome, devotional, introductions
- Administrative details: syllabus, schedule
  - MyCourses, SPSS, textbook
- Stats review:
  - Purpose, research questions
  - Linear models
  - Correlation, Spearman's ρ, χ^2, t-test
- Data Analysis Project, HW Assignment 1
  - Marci's SPSS tutorials

Stats review: purpose

- What is the purpose of statistical analysis in counselling psychology research?
  - → Research questions!
- Statistics allows us to (1) pose new questions and (2) answer them – decision-making tool
  - Is an effect/relationship real? How strong?
- Possible limitations, assumptions:
  - Danger of extreme reductionism
  - Neutrality of observation, objectivity
  - Looking at groups, not individuals

Cycles in statistical analysis

- Formulate research question
- Data prep: input errors/typos, missing data, univariate outliers
- Explore variables: IV, DV, descriptives
- Model building: choose a model based on RQ
- Model testing: are assumptions met?
  - If not, either clean data or change model
  - May need to modify RQ!
- Run final model and present results

Research question: example

- RQ: are men taller than women?
  - Is this relationship real? How strong is it?
- What are the variables? IV/DV? Level of meas?
  - IV: gender (dichot), DV: height (scale)
  - Levels of measurement: categorical, ordinal, scale (interval, ratio)
- What type of test should we use?
  - Independent samples: *t*-test
- Limitations/assumptions of this test?

Model-building process

- Operationally define a phenomenon: variables
- Measure it (collect data)
- Build a model: verify data meet assumptions and input data into model
- Draw conclusions and/or predictions about the phenomenon in the “real world” population
    - e.g., if child A holds 2 apples, B:6 apples, and C:1, how many apples is a child most likely to have?
    - Individual vs. group

Statistical model: example

- RQ: does self-esteem correlate with school performance?
- Measure: questionnaire and marks
- Choose model: correlation
- Assumptions! Measures, procedures, model
- Make conclusions: based on assumptions
    - Objectivity, individual vs. group,
    - Linearity is a big assumption!

Linear modelling

- A linear model is a straight "line" that best fits the observed data
  - Minimizes error (least-squares) of model
- Use analytic techniques to derive the equation of the linear model directly from the data, or
- Use optimization techniques to try to find the line that maximizes the goodness of fit between model and data:
  - Test statistic = (variance due to model) / (due to error)

Linear modelling: summary

- Statistics are used to build models of psychological phenomena out of observations gathered from specific samples of individuals
- The most common type of statistical model is linear – straight “line” (or plane, or hyperplane, …) that minimizes distance from model to data
- The adequacy of the model to explain the data can be calculated through test statistics
  - If there is a poor fit, the model may need to be revised, or to consider additional confounding variables

Linear modelling: limitations

- What if vars are not related in a linear way?
- Many common procedures (some ANOVA, some regression) depend strongly on linearity
    - If linearity is violated, results are only very approximate
    - Even non-parametric models are often approximations using group patterns
- Reifying models: “correct” the data to better fit the assumptions of the model!
- Examples of psychological phenomena vars that are related non-linearly?

Linear Correlation

- A measure of the strength of the linear relationship between two variables
- Relies on measuring covariance between vars
  - When one var deviates from mean, does the other var also deviate?
  - Does it deviate in the same direction?
- Correlation is a value between -1 and +1
  - Close to +1: positive relationship
  - Close to -1: negative relationship
  - Close to 0: no relationship

Measuring correl: Pearson's *r*

- The most common way to measure correlation is Pearson's product-moment correlation coefficient, named *r*:
- Requires parametric data
    - Indep obs, scale level, normally distrib!
- Example: ExamAnxiety.sav
    - Measured anxiety before exam,
      time spent reviewing before exam, and
      exam performance (% score)

Pearson's correlation coeff

Name of Correlation Statistic

Significance Value (p)

Correlations

		Exam performance (%)	Exam Anxiety	Time spent revising
Exam performance (%)	Pearson Correlation	1	-.441**	.397**
	Sig. (1-tailed)		.000	.000
	N	103	103	103
Exam Anxiety	Pearson Correlation	-.441**	1	-.709**
	Sig. (1-tailed)	.000		.000
	N	103	103	103
Time spent revising	Pearson Correlation	.397**	-.709**	1
	Sig. (1-tailed)	.000	.000	
	N	103	103	103

**. Correlation is significant at the 0.01 level (1-tailed).

Each variable is perfectly correlated with itself!

Spearman's Rho (ρ or r_s)

- Another way of calculating correlation
- Non-parametric: can be used when data violate parametricity assumptions
- No free lunch: loses information about data
- Spearman's works by first ranking the data, then applying Pearson's to those ranks
- Example (grades.sav):
  - grade on a national math exam (GCSE)
  - grade in a univ. stats course (STATS)
  - coded by “letter” (A=1, B=2, C=3, ...)

Spearman's Rho (ρ or r_s): ex

Name of Correlation Statistic

Correlations

			Statistics Grade	GCSE Maths Grade
Spearman's rho	Statistics Grade	Correlation Coefficient	1.000	.455*
		Sig. (1-tailed)	.	.011
		N	25	25
	GCSE Maths Grade	Correlation Coefficient	.455*	1.000
		Sig. (1-tailed)	.011	.
		N	25	25

*. Correlation is significant at the 0.05 level (1-tailed).

Sample Size

The correlation is positive

Chi-Square test (χ^2)

- Evaluates whether there is a relationship between 2 categorical variables
- The Pearson chi-square statistic tests whether the 2 variables are independent
- If the significance is small enough ($p<\alpha$, usually $\alpha=.05$), we reject the null hypothesis that the two variables are independent (unrelated)
  - i.e., we think that they are in some way related.

t-Tests: comparing two means

- Moving beyond correlational research…
- We often want to look at the effect of one variable on another by systematically changing some aspect of that variable
- That is, we want to manipulate one variable to observe its effect on another variable.
- *t*-tests are for comparing two means
- Two types of application of *t*-tests:
  - Related/dependent measures
  - Independent groups

Related/dependent *t*-tests

- A repeated measures experiment that has 2 conditions (levels of the IV)
- the <u>same subjects</u> participate in both conditions
- We expect that a person's behaviour will be the same in both conditions
  - external factors – age, gender, IQ, motivation, ...
    – should be same in both conditions
- Experimental Manipulation: we do something different in Condition 1 than what we do in Condition 2 (so the only difference between conditions is the manipulation the experimenter made)
  - e.g., Control vs. test

Independent samples *t*-tests

- We still have 2 conditions (levels of the IV), but different subjects participate in each condition.
- So, differences between the two group means can possibly reflect:
  - The manipulation (i.e., systematic variation)
  - Differences between characteristics of the people allotted to each group (i.e., unsystematic variation)
  - Question: what is one way we can try to keep the 'noise' in an experiment to a minimum?

t-Tests

- *t*-tests work by identifying sources of systematic and unsystematic variation, and then comparing them.
- The comparison lets us see whether the experiment created *considerably* more variation than we would have got if we had just tested the participants w/o the experimental manipulation.

Example: dependent samples

- “Paired” samples *t*-test
- 12 ‘spider phobes’ exposed to a picture of a spider (**picture**), and on a separate occasion, a real live tarantula (**real**)
- Their **anxiety** was measured at each time (i.e., in each condition).

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Paired samples *t*-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Picture of Spider	40.0000	12	9.29320	2.68272
	Real Spider	47.0000	12	11.02889	3.18377
Pair 2	Picture of Spider	40.0000	12	9.29320	2.68272
	Real Spider	47.0000	12	11.02889	3.18377

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Picture of Spider & Real Spider	12	.545	.067
Pair 2	Picture of Spider & Real Spider	12	.545	.067

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Example: paired *t*-Tests

Degrees of Freedom (in a repeated measures design, it's N-1)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Picture of Spider - Real Spider	-7.00000	9.80723	2.83110	-13.23122	-.76878	-2.473	11	.031
Pair 2	Picture of Spider - Real Spider	-7.00000	9.80723	2.83110	-13.23122	-.76878	-2.473	11	.031

Standard Deviation of the pairwise difference

Standard error of the differences b/w subjects' scores in each condition

SPSS uses df to calculate the exact probability that the value of the 't' obtained could occur by chance

The probability that 't' occurred by chance is reflected here

Example: indep samples *t*-test

Used in situations where there are 2 experimental conditions – and different participants are used in each condition

Example: SpiderBG.sav

- 12 spider phobes exposed to a picture of a spider (picture); 12 different spider phobes exposed to a real-life tarantula
- Anxiety was measured in each condition

Group Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Anxiety	Picture	12	40.0000	9.29320	2.68272
	Real Spider	12	47.0000	11.02889	3.18377

Summary Statistics for the 2 experimental conditions

(N1 + N2) - 2 = 22

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Anxiety	Equal variances assumed	.782	.386	-1.681	22	.107	-7.00000	4.16333	-15.6342	1.63422
	Equal variances not assumed			-1.681	21.385	.107	-7.00000	4.16333	-15.6486	1.64864

Parametric tests (e.g., *t*-tests) assume variances in the experimental conditions are ‘roughly’ equal.

If Levene’s test is sig., the assumption of homogeneity of variance has been violated

Significance (*p*-value): 0.107 > α=.05, so there is no significant difference between the means of the 2 samples

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Data Analysis Project

- Half of this course is your semester-long data analysis project:
  - Find suitable existing data
  - Propose a new statistical analysis of it
  - Get approval by Research Ethics Board
  - Go through "spiral" of statistical analysis
  - Write it up in an APA-style manuscript
- Groups of up to 3 people
  - Can also be done individually
  - Let me know when you have your group

Project step 1: Finding data

- It must be existing data – you are not allowed to collect data for this course! (nor do you have time to)
  - No simulated (made-up) data
- Minimum sample size: 50
- Minimum of 3 variables (2 IV, 1 DV)
- Analysis: multiple regression or ANOVA
  - Non-parametric alternatives w/permission
- Possible sources: your own data, faculty members, CPSY dept thesis data, publicly available / government data (WHO, NIH, etc.)

Dataset description: due 2Oct

- Written description of the dataset you will be using and the particular variables you consider
- Preliminary explorations of the data
  - Descriptives, histograms, boxplots, etc.
  - Upload annotated SPSS output *.spv
- APA manuscript style not needed, but please format it neatly in a document
  - e.g., not a short email or Facebook msg!
- Upload (1) write-up, and (2) SPSS output to myCourses

Project step 2: Proposal/meeting

- Written proposal of the particular analysis you plan to do on the dataset
  - Old data, but new analysis
  - State specific research questions
  - Check sample size is sufficient (GPower3)
  - Anticipate possible problems, plan
- Book an appointment with me (Neu 5) by 9Oct
  - All team members there
  - Send me your proposal >24hrs before
  - Bring/email your dataset on USB stick

Project step 3: REB (due 16Oct)

- Approval by TWU Research Ethics Board is required before any new analysis may be done!
  - Cursory exploration as in dataset description and proposal is okay
- You are not allowed to start your new analysis until you get REB approval
- Use the “Analysis of Existing Data” form
- You need written permission from the original owner of the data
  - For CPSY theses, the faculty supervisor
  - None needed for publicly available data

Project step 4: Manuscript

- The focus is to demonstrate your statistical knowledge, not to deal with the subject area in question
  - It's okay if you don't find groundbreaking results for all of counselling psychology
  - Methodology and statistics will be more detailed than a “real” research paper
- Full APA manuscript format is required!
  - Include tables/figures
- Max length 15 pages + annotated SPSS output

HW Assignment 1: Stats review

- Four homework assignments over the semester will give you practice on the concepts in lecture
- HW assignment 1 (due 25Sep, in two weeks):
  - Review of undergrad statistics
  - Practice with SPSS
- Download from our website: “Assignments”
  - Assignment: HW1-Review.doc
  - SPSS Dataset: AttnDefDis-1.sav

Practice reading for next week

- For practice, try reading this journal article, focusing on their statistical methods: see how much you can understand
- Missirlian, et al., "*Emotional Arousal, Client Perceptual Processing, and the Working Alliance in Experiential Psychotherapy for Depression*", Journal of Consulting and Clinical Psychology, Vol. 73, No. 5, pp. 861–871, 2005.
- Download from website, under today's lecture

For discussion next time:

- What research questions do the authors state that they are addressing?
- What analytical strategy was used, and how appropriate is it for addressing their questions?
- What were their main conclusions, and are these conclusions warranted from the actual results /statistics /analyses that were reported?
- What, if any, changes/additions need to be made to the methods to give a more complete picture of the phenomenon of interest (e.g., sampling, description of analysis process, effect sizes, dealing with multiple comparisons, etc.)?

SPSS tutorials by Marci

- Our TA, Marci, has graciously agreed to do tutorials on getting started with SPSS
  - After class today, in Wong Centre
    - Just tag along with her
  - Next week (Tue/Wed?)