CPSY 501: Advanced Statistics

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

10 Sep 2010
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- *Please pick-up:*
  - *Syllabus*
  - *Project Handout*
  - *HW 1*

TRINITY WESTERN UNIVERSITY

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,
    - Comparing means (*t*-test): RM vs. groups
- Data Analysis Project, HW Assignment 1
    - Kafui'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 interpret 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?
  - Levels of measurement: categorical, ordinal, scale (interval, ratio)
  - IV: gender (dichot), DV: height (scale)
- 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?
- How do we measure / gather data?
  - 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, 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

Correlation is positive

Chi-Square test (χ^2)

- Evaluates whether there is a relationship between two categorical variables
- The Pearson chi-square statistic tests whether the two 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 same subjects participate in both conditions
- We expect that a person's behaviour will be the same in both conditions
  - External factors kept same in both:
  - e.g., Age, gender, IQ, motivation, …
- Experimental Manipulation: we change the environment between the two conditions:
  - 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 – i.e., different groups
- So, differences between the two group means might 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 without the experimental manipulation.

Example: dependent samples

- SpiderRM.sav
- "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).
- What are the variables? IV/DV?
- Is the predictor a grouping variable or a repeated-measures variable?

Example: paired *t*-Tests

Degrees of freedom (=N–1 for repeated measures)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference 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 pairwise differences between conditions

Standard error of the pairwise differences

Probability that the given value of 't' might have occurred by chance

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 both groups

$$(N_1 + N_2) - 2 = 22$$

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	-15.63422	1.63422
	Equal variances not assumed			-1.681	21.385	.107	-7.00000	4.16333	-15.64864	1.64864

t-test is parametric: assumes variances in both groups are similar

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

Significance (*p*-value): $> \alpha = .05$, 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
  - Email me 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! (no time!)
  - No simulated (made-up) data
- Minimum sample size: 50
- Minimum of 3 variables (2 IV, 1 DV)
- Analysis: multiple regression or ANOVA
  - Non-parametric only with permission
- Possible sources: your own data, faculty members, CPSY dept thesis data, publicly available / government data (WHO, NIH, etc.)

Dataset description: due 1Oct

- Written description of the dataset you will be using and the particular variables you consider
- Preliminary explorations of the data
  - Descriptives, histograms, boxplots, etc.
  - Include as figures in your write-up
- APA manuscript style not needed, but please format it neatly in a document (Word, etc.)
- Upload your document to myCourses
  - One person can submit for whole group

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 8Oct
  - All team members there
  - Send me your proposal >24hrs before
  - Upload or bring your dataset on USB key

Project step 3: REB (due 15Oct)

- 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

- Focus is to demonstrate statistical analysis, 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
- Due Sat 18 Dec at noon

HW Assignment 1: Stats review

- Four homework assignments over the semester will give you practice on the concepts in lecture
- HW assignment 1 (due 24Sep, in two weeks):
  - Review of undergrad statistics
  - Practice with SPSS
- Download from our website: "Assignments"
  - Assignment: HW1-Review.html
  - SPSS Dataset: HW1-ADD.sav

Practice reading for next week

- For practice, try reading this journal article, focusing on their statistical methods
- 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
- Much of it you might not understand, but see how much you can get!

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?
- How might you adjust the methods for a more complete picture of the phenomenon of interest (e.g., sampling, description of analysis process, effect sizes, handling multiple comparisons)?

SPSS tutorials by Kafui

- Our TA, Kafui, has graciously agreed to do tutorials on getting started with SPSS
  - If there is interest, at 4pm Tues or next Fri in the Wong Centre (is there interest?)
- Kafui.Sawyer@mytwu.ca