psyc3010 lecture 12

<u>This week:</u>

(1) PSYC3010 - overview
(2) A bit on logistic regression
(3) T-VALS
(4) Discussion of exam and distribution of practice exam
(5) Interconnections between ANOVA and regression [2nd part of lecture – optional / advanced]

Howell ch 16 p. 604-617

last week: mixed anova

(1) what have we “added” in 3010 from 2010?

course overview

PSYC2010

- designs involving one factor or one predictor

PSYC3010

- designs involving **multiple** factors, predictors, or categorical variables

PSYC2010

- one-way between-subjects ANOVA
- one-way within-subjects ANOVA

PSYC3010

- **factorial ANOVA**
- between-subjects
  - 2-way
  - 3-way
- within-subjects
- mixed
- blocking (and ANCOVA)

PSYC2010

- bivariate correlation and regression

PSYC3010

multiple regression

- standard
- hierarchical
  - as control technique
  - assessing categorical variables
  - assessing moderation

The purpose of statistics

- To understand the shape of the data
- To **understand** **meaningful** **questions** and **assess** **meaningless** **ranting**
  - "Women mature faster than men" "Men are stronger"
    - What's the standard deviation? Is the difference reliable - Is it even going to be significant in the population?
    - What's the effect size? What portion of the variance in the data does gender account for?
    - What are other factors associated with gender to control for (e.g., via ANCOVA)? [ANOVA is not causation!]
    - What other factors might moderate this effect? (interactions!)

The purpose of statistics

- Meaningful ?s and meaningless ranting
  - The wealthier you are, the happier you are!
    - Is that relationship reliable, is it significant in the population?
    - What is the effect size?
    - What other factors might need to be controlled for? [Correlation is not causation!]
    - What other factors might moderate this effect? (interactions!)
    - Is this really a linear effect ?
- To read psych articles, need to know statistics – now you can read most & understand them
- more broadly, it’s difficult to understand human variability meaningfully without understanding what variability and differences are and are not.

when do you use which analysis?

Need to consider the type of variables:
independent (predictor) and dependent (criterion).

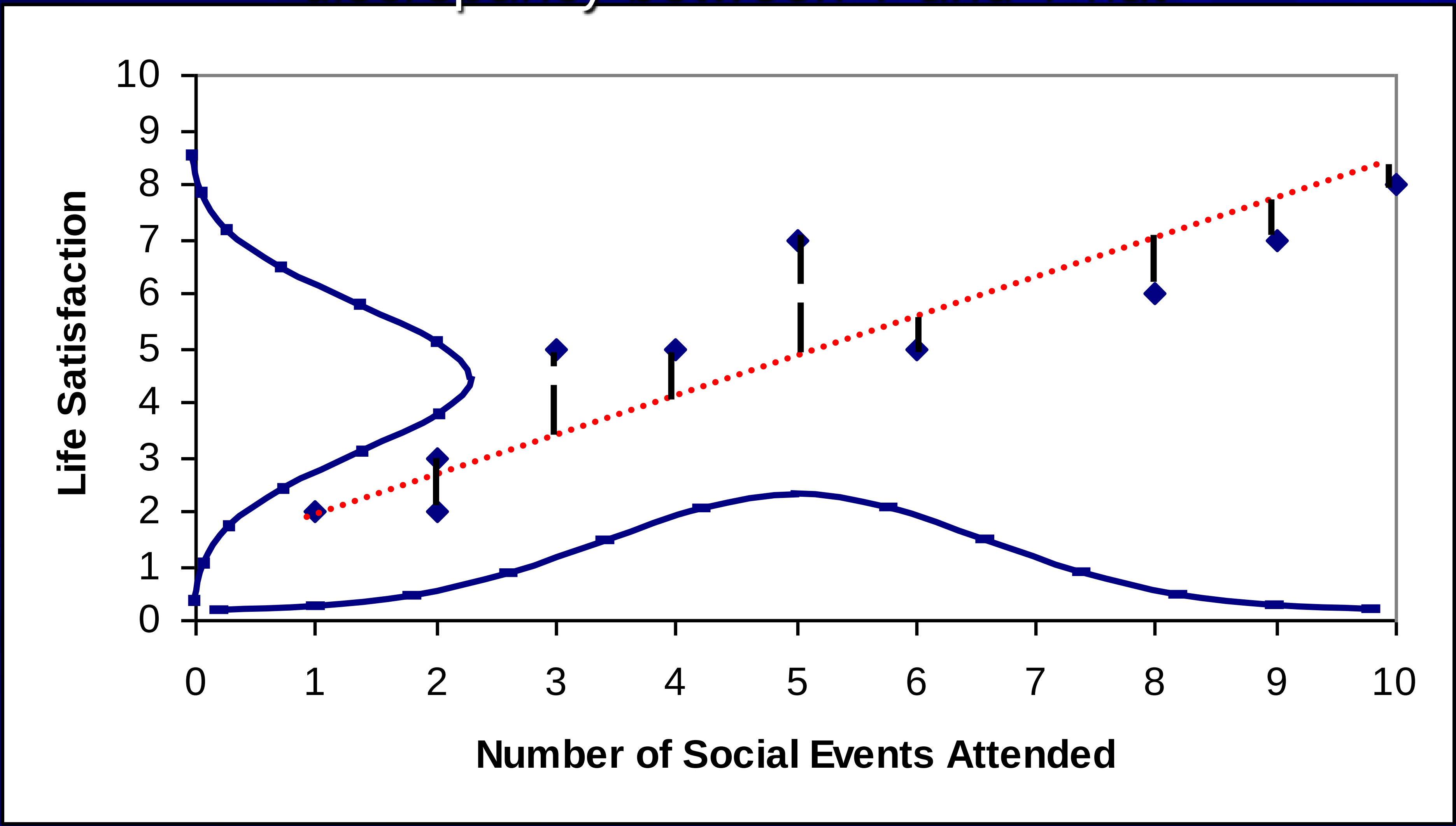
Predictors	Criterion	Method
Categorical	Continuous	ANOVA; MR
Categorical & Continuous	Continuous	MR
Continuous	Continuous	MR
Continuous	Categorical	Logistic Regression
Categorical	Categorical	Log-linear Analysis

(2) A bit on logistic regression

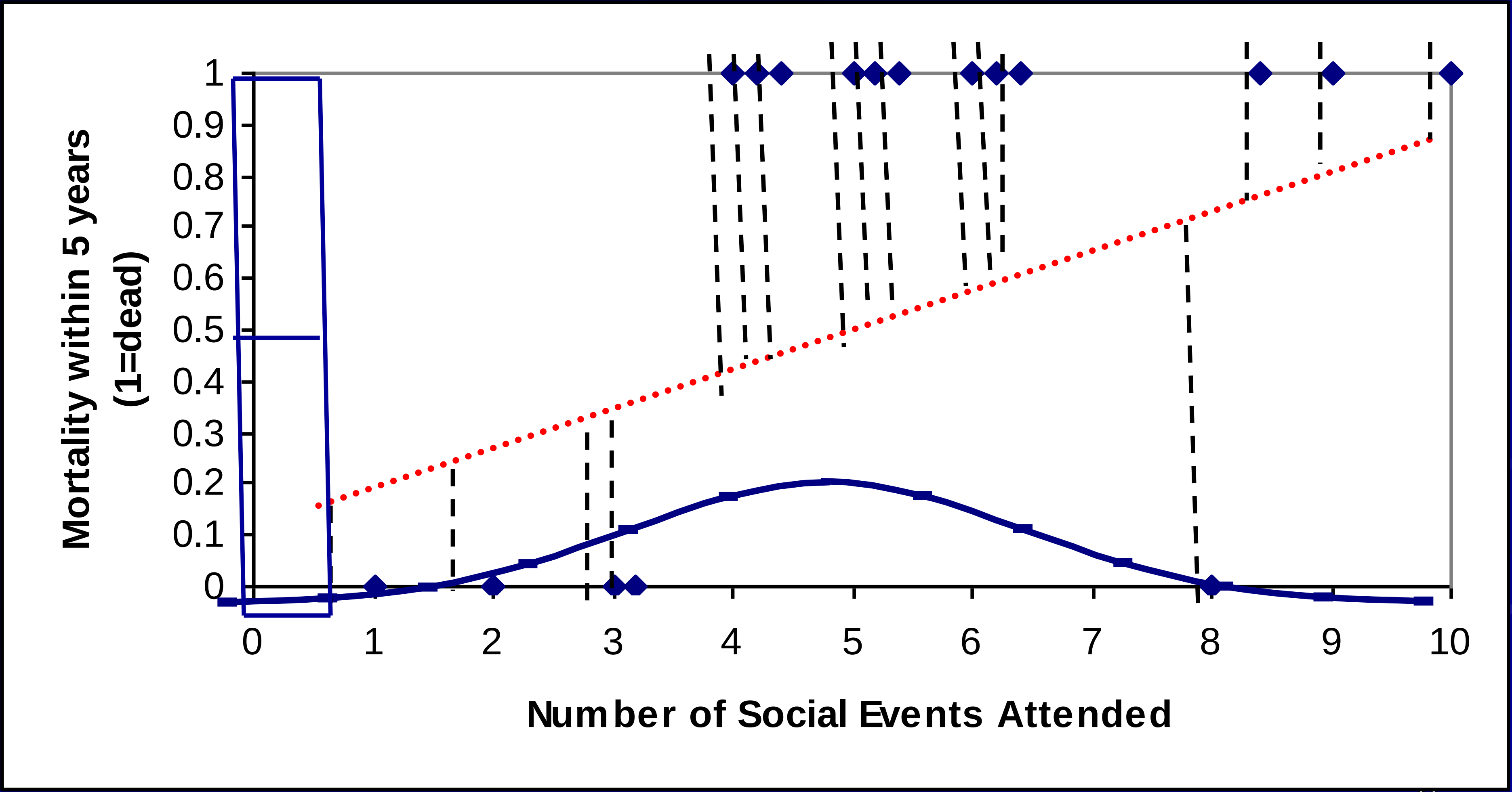
If all our acts are conditioned behaviour, then so are our theories: yet your behaviourist claims his is objectively true.

-- W. H. Auden

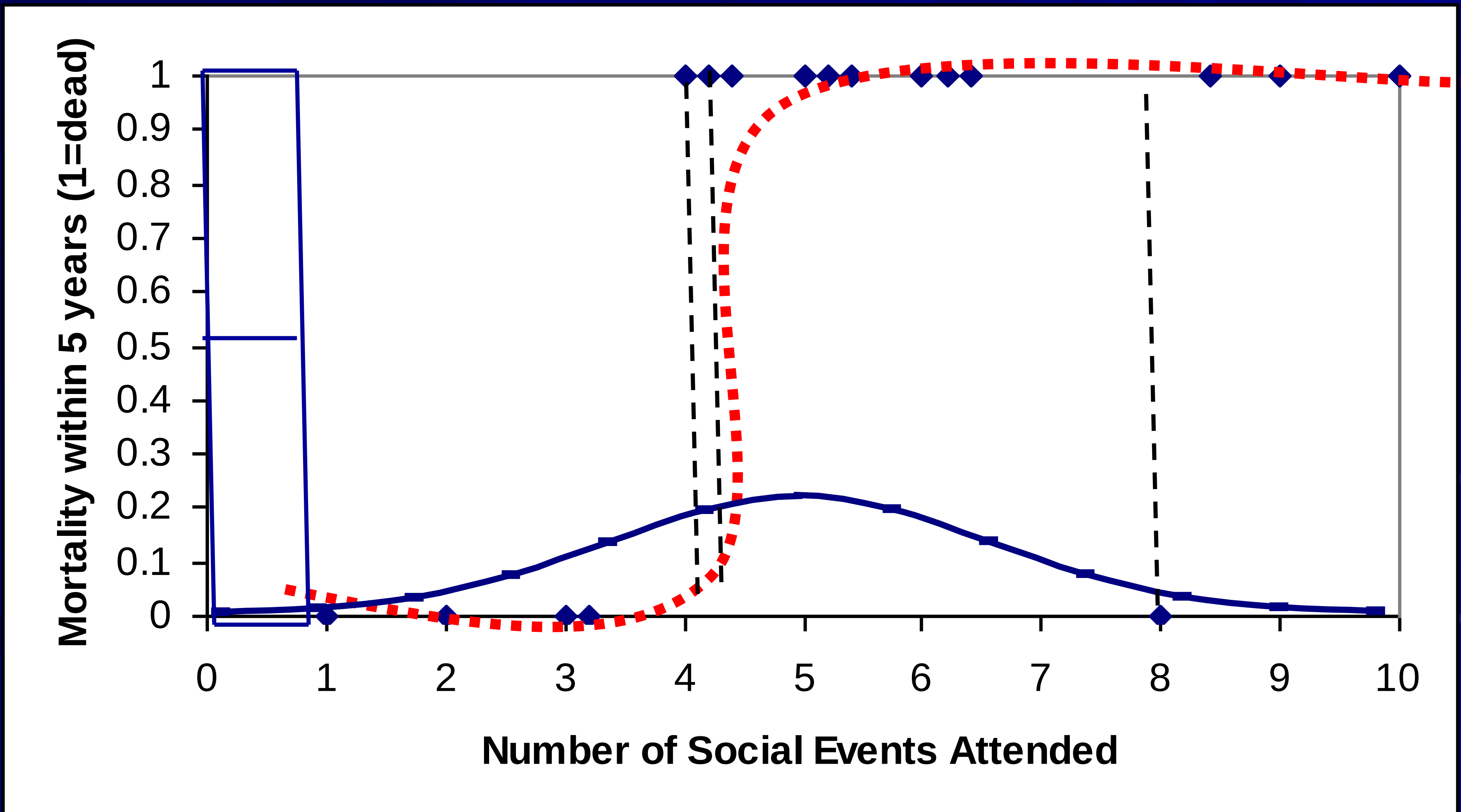
Multiple regression = continuous IVs and DVs, each normally distributed. We fit the data with a linear model – the straight line minimising the discrepancy between Y and Y hat



Logistic regression = continuous IVs and categorical (0, 1) DV. Obviously (a) Y is not normally distributed and (b) a straight line fits this data poorly.



Accordingly we fit the data with a logistic model – the S-shape curve (a.k.a., sigmoidal curve) that best predicts whether an observation will be in one group (0) versus another (1).



Conceptual similarities: Interpreting logistic R2 and R2 change

- In SPSS for logistic regression, you get R2 estimates labelled Cox & Snell R2 and Nagelkerke R2
  - These are two ways of understanding the "variance" in dichotomous (0, 1) DVs
  - No convention exists regarding which to report - C&S is the more conservative one, and Nagelkerke is more liberal – at the moment Nagelkerke R2 is more common.
- Hierarchical logistic regression can be performed
  - SPSS will output C&S and N R2 for each model but you need to subtract the later R2 from earlier to get R2 change / block
- R2 and R2 change are tested with chi-square (χ^2) tests, not F-tests, but structure of write-up = identical
- Both X2 for model and for block are reported,
- R2 change must be calculated by hand from the output.

E.g. output and write-up

Logistic Regression

Block 0: Beginning Block

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.235	.143	2.673	1	.102	.791

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	.856	2	.652
	Block	.856	2	.652
	Model	.856	2	.652

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	269.553[a]	.004	.006

a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	c_age	-.026	.034	.613	1	.434	.974
	ec_women(1)	-.171	.313	.298	1	.585	.843
	Constant	-.118	.260	.204	1	.651	.889

a. Variable(s) entered on step 1: c_age, ec_women.

"A hierarchical logistic regression was conducted predicting whether or not participants took political action from demographic factors (Block 1) and attitude strength (Block 2). Table 1 describes the means, standard deviations, and intercorrelations. The entry of the demographics did not increase the variance accounted for, Nagelkerke R^2 = .01, X^2 (2) = 0.86, p = .652 [snip]

Block 2: Method = Enter

E.g. output and write-up

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	14.475	1	.000
	Block	14.475	1	.000
	Model	15.331	3	.002

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	255.078[a]	.075	.100

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

"However, the entry of attitude strength in Block 2, significantly increased the variance accounted for, Nagelkerke R^2 change = .09, X^2 (1) = 14.48, $p < .001$. [snip] The final model accounted for only 10% of the variance in action however, X^2 (3) = 15.33, $p = .002$.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	c_age	-.045	.035	1.622	1	.203	.956
	ec_women(1)	-.054	.327	.028	1	.868	.947
	atstr_sc	.404	.110	13.439	1	.000	1.498
	Constant	-1.073	.379	8.015	1	.005	.342

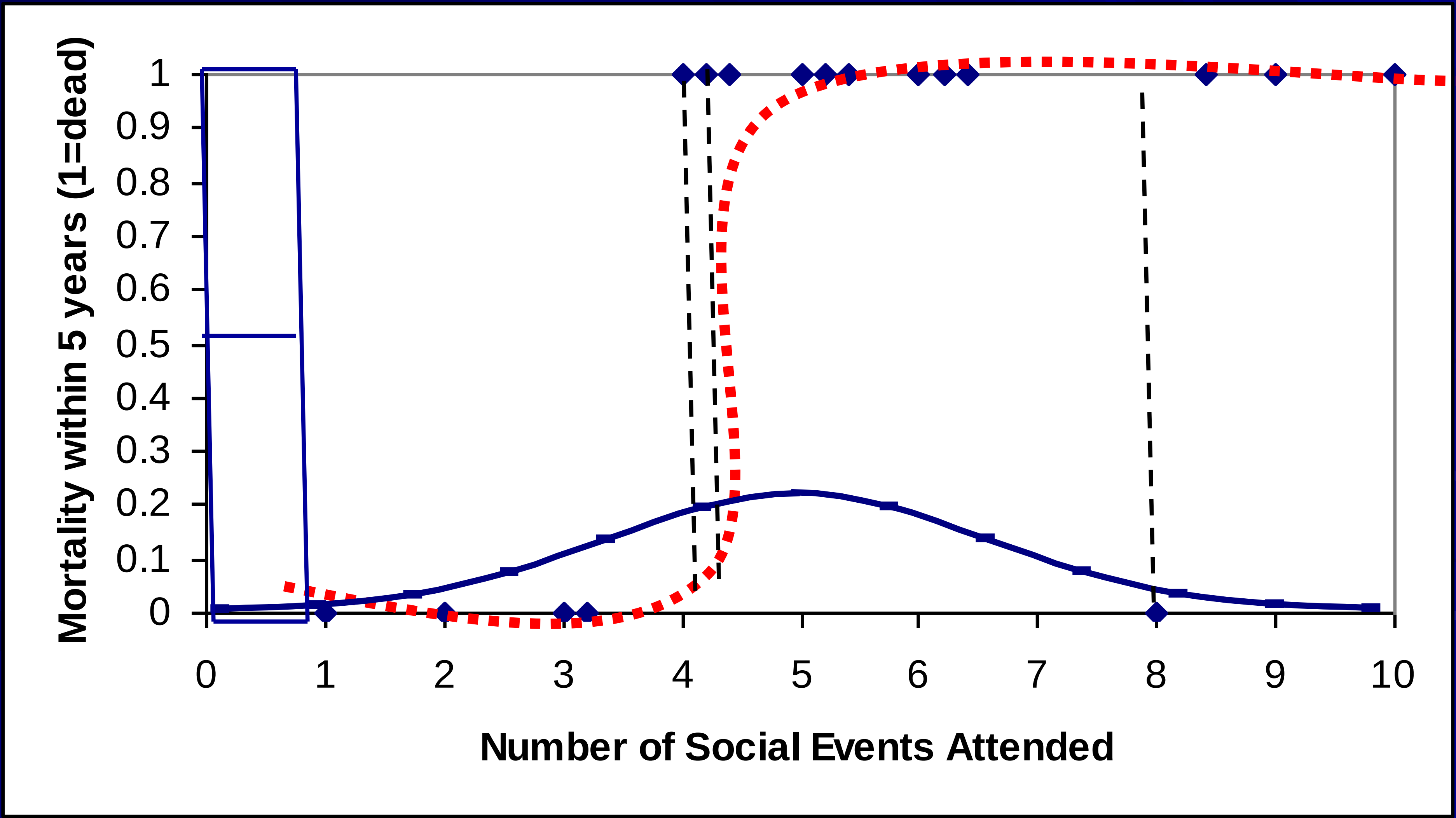
a. Variable(s) entered on step 1: atstr_sc.

Note: the the difference between 2LL in this model (255.078) and the first model (269.553) equals the chi-square value (14.475). Some reviewers prefer reporting 2LL over R^2

How should we like it were stars to burn
With a passion for us we could not return?
If equal affection cannot be
Let the more loving one be me .

-- W. H. Auden

Return to the data…



Interpreting logistic coefficients

- Error = still deviations from the (s-shaped) line but now involve misclassification (e.g., predicted dead when is in fact alive) – instead of being normally distributed, errors also trend towards 0,1 distribution
- Instead of describing and reporting unstandardised coefficients, report Exp(B). This coefficient is tested with a Wald test not a t-test, but structure of write-up is same.
- Exp(B) coefficients don't describe the 1 unit change in DV given 1 unit change in IV – they describe change in odds of being (1) compared to (0) for every unit increase in IV
  - Exp(B) = 1.00 – no change in likelihood of dead within 5 years for every 1 more social events
  - Exp(B) = 2.50 – likelihood of being dead within 5 years increases by 2.5 times (or increases by 250%) for every 1 more social events attended
  - Exp(B) = .80 – likelihood of death within 5 years increases by .8 times (but much more useful to say decreases by 20% [1-.8 = .2]) for every 1 more social events attended

E.g. output and write-up

Logistic Regression

Block 0: Beginning Block

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.235	.143	2.673	1	.102	.791

Block 1: Method = Enter

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Variables in the Equation

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	ec_women(1)	-.171	.313	.298	1	.585	.843
	Constant	-.118	.260	.204	1	.651	.889

a. Variable(s) entered on step 1: c_age, ec_women.

"A hierarchical logistic regression was conducted predicting whether or not participants took political action from demographic factors (Block 1) and attitude strength (Block 2). Table 1 describes the means, standard deviations, and intercorrelations. The entry of the demographics did not increase the variance accounted for, Nagelkerke R^2 = .01, X^2 (2) = 0.86, p = .652, **and inspection of the coefficients revealed that neither age nor gender was significantly linked to action, Wald tests < .30, *ps*> .584.**

Block 2: Method = Enter

E.g. output and write-up

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	14.475	1	.000
	Block	14.475	1	.000
	Model	15.331	3	.002

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	255.078[a]	.075	.100

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

"However, the entry of attitude strength in Block 2, significantly increased the variance accounted for, Nagelkerke R^2 change = .09, $X^2(1) = 14.48$, $p < .001$. **Specifically, on a scale from 0 to 5, every additional unit of attitude strength increased the likelihood of political action by 150%, Exp(B) = 1.50, Wald = 13.44, *p* < .001.** The final model accounted for only 10% of the variance in action however, X^2 (3) = 15.33, *p* = .002."

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	c_age	-.045	.035	1.622	1	.203	.956
	ec_women(1)	-.054	.327	.028	1	.868	.947
	atstr_sc	.404	.110	13.439	1	.000	1.498
	Constant	-1.073	.379	8.015	1	.005	.342

a. Variable(s) entered on step 1: atstr_sc.

- Logistic regression is seen quite often, e.g.:
  - clinical psychology (what factors predict becoming schizophrenic, recurrence of depression?)
  - social (predict attending rally, getting divorced?)
  - org psych (predict quitting the firm / being promoted?)
- Occasionally other statistics are reported but the above would serve in a journal article at the moment.
- Also can have multiple categories on DV
  - Use multinomial logistic regression
- So worth knowing
- Field spells it all out rather nicely and goes thru SPSS
- Covered in Howell section 15.14 (5^{th} & 6^{th} ed)
- But not assessed on exam!
- Also note: on course outline this week's reading and extra tutorial exercise is Log linear (Howell chpt 17) but we won't get around to covering this so feel free to ignore (as psychs you will come across logistic regression far more frequently)

(3) T-VALS

Knowing artists, you think you know all about Prima Donnas:
boy!, just wait till you hear scientists get up and sing.

-- W. H. Auden

(4) Exam Info

Structure of the exam

- **40 multiple-choice questions**
  - 1 mark each; content spread across the 11 content lectures
- **2 short answer questions**
  - 10 marks each; content focuses on key themes of the course: factorial ANOVA (within, between, and/or mixed) and multiple regression (standard, hierarchical, and/or moderation)
  - Each short-answer question has a bonus question worth 1 mark (so in theory could score 11/10) – take a punt if you have time
- **2 hours working time + 10 mins perusal**
  - Pace yourself
- **formula sheet included**
  - does not include DF calculations
  - up on Blackboard now (see "practice exam questions" link)

content of exam

→ **primarily conceptual**

- moving between research questions, design, and hypotheses
- partitioning variance
- understanding of linear models
- understanding of error terms
- interpretation of statistics
  - description of results (e.g., F and p values provided)
  - no SPSS output
- calculating degrees of freedom

preparing for the exam

revise the lecture notes

- everything you need to know for the exam can be found in the 12 lectures

read the readings

- readings (and tute exercises) will help to consolidate and clarify this material

complete the practice questions

- the practice exam (web handouts) and extra practice questions (tute workbook, web handouts) are representative of the kinds of questions you will have to answer

think about what might be asked on the exam

- the exam content MC questions are more or less evenly spread across the lectures
- The short answer questions target key themes of course – factorial ANOVA (between/ within / mixed) and regression

Important Examination Information. **Candidates are reminded of the following:**

- Double-check the examination timetable to ensure you have the correct date, time and venue for your examination.
- Be at the examination room at least 15 minutes before the scheduled start time.
- Bring your University Identity Card to the examination room. Your identity card must be prominently displayed on your desk. The University will conduct identity checks. You may not be permitted to sit the examination if you do not have your student ID card with you.
- You are not permitted to have a mobile telephone on your person during an examination. Please be aware that the use of mobile phone detectors has recently been introduced for examination rooms.
- Do not bring anything such as books, notes, calculators etc into the examination room unless they are specifically permitted for that examination and are listed on the examination cover sheet; (Candidates found in possession of unauthorised items in an examination will be liable to investigation for misconduct.)
- Bring pens, pencils, rulers, erasers etc. Do not attempt to take your own scrap paper or post-it notes into the examination room.
- When you enter the examination venue, sit at the seat number given to you on entry to the exam room.
- No food or drinks, other than a small clear bottle of still water with the label removed, can be taken into the examination room.
- Leave all personal property, other than writing and drawing instruments in the area specified by the Invigilator. Please note these items are left at the candidate’s own risk.
- Do not bring into the examination room, any item which may cause a disturbance to others, for example an audible alarm watch.

Practice exam

- 10 MC questions, 2 short answer
- Answers will be discussed in tutes this week

(5) Interconnections between ANOVA and regression

…multivariate methods…

Factorial ANOVA

between/within & mixed

Multiple Regression

ANOVA

& **t-tests**

between/within

Bivariate

(simple)

correlation

experimental vs. correlational research

this is what many will tell you about the differences between anova vs correlational designs:

- **Anova designs**
  – the only research strategy in which causation can be inferred - the factor can be said to "cause" changes in DV
  – this is because the IV is manipulated

- **correlational research**
  – can not be used to infer causality
  – this is because variables are not manipulated -- just measured

experimental vs. correlational research

this is <u>misleading</u> because:

it is confuses ***research*** methodology (PSYC3042) with ***statistical*** methodology (PSYC3010), and it assumes that the benefits of experimental research transfer automatically to anova

- the differences between experimental and correlational research involve random assignment to levels of IV vs observation of natural / measured levels of IV
- These have ***NOTHING*** to do with the differences between anova and regression, which involve partitioning variance between factors and within versus between a regression line and observations
- ANOVA can be carried out statistically with regression analyses; t-tests can be carried out with correlations
- All of these statistical techniques are generalisations of one underlying model, the general linear model (GLM)

The General Linear Model

What is it?

$$X_{ijk} = \mu + \alpha_j + \beta_k + \alpha\beta_{jk} + e_{ijk}$$

$$X_{ij} = \mu + \alpha_j + \pi_i + e_{ij}$$

$$Y = b_1X + b_2Z + b_3XZ + c + e$$

The General Linear Model

What is it?

→ a system of linear equations which can be used to model data

← quite similar to the T1000:

- *powerful!*
- *versatile!*
- *can execute a range of operations!*
- *can take on a variety of appearances!*
- *provides the basis for just about every parametric statistical test we know* *(OK, weak link there…)*

Read Cronbach, 1968 for more

he closed his eyes
upon that last picture, common to us all,
of problems like relatives gathered
puzzled and jealous about our dying.

-- W. H. Auden, "In Memory of Sigmund Freud"

magic tricks!

it is fairly easy to show that:

1. a t-test is a correlation
2. factorial anova is a standard regression problem
3. ancova is a hierarchical regression problem
4. interactions in anova are identical to those in MMR

correlation and the t-test

- you may have heard of a *point-biserial* correlation (Howell p. 297-305)
- this is a special case of correlation where one of the variables is dichotomous (e.g., gender) and the other is continuous (e.g., height)
- the other name for a *point-biserial* correlation is an *independent samples t-test*

Females	Males
150	165
160	170
165	180
155	175

Heights of males and females – this is how we are used to seeing the data laid out when we are doing hand calculations for t-test

Gender	Height
1	150
1	160
1	165
1	155
2	165
2	170
2	180
2	175

but we know that SPSS would prefer that we lay the data out like this

hmmm…looks familiar…

so let's run our t-test…

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
HEIGHT	Equal variances assumed	.000	1.000	-3.286	6	.017
	Equal variances not assumed			-3.286	6.000	.017

$t(6) = 3.29$, $p = .017$

now run as a correlation…
(just as if we had two continuous variables)

Correlations

		GENDER	HEIGHT
GENDER	Pearson Correlation	1	.802*
	Sig. (2-tailed)	.	.017
	N	8	8
HEIGHT	Pearson Correlation	.802*	1
	Sig. (2-tailed)	.017	.
	N	8	8

*. Correlation is significant at the 0.05 level (2-tailed).

$r = .802$, $p = .017$, $r^2 = .643$

p value is the same as in t-test

re-run as an anova…
(to get estimates of effect size)

Tests of Between-Subjects Effects

Dependent Variable: HEIGHT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	450.000[a]	1	450.000	10.800	.017	.643
Intercept	217800.000	1	217800.000	5227.200	.000	.999
GENDER	450.000	1	450.000	10.800	.017	.643
Error	250.000	6	41.667			
Total	218500.000	8				
Corrected Total	700.000	7				

a. R Squared = .643 (Adjusted R Squared = .583)

$F(1,6) = 10.8$, $p = .017$, $\eta^2 = .643$

→ **p value is again the same**

→ **partial η2 = r2** (from previous slide)

→ **F** (i.e., 10.8) **= t2** (i.e., 3.292)

now run as a regression…
(just for the sake of comparison)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.802[a]	.643	.583	6.45497

a. Predictors: (Constant), GENDER

R^2 = partial ε^2 = r^2

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	450.000	1	450.000	10.800	.017[a]
	Residual	250.000	6	41.667		
	Total	700.000	7			

a. Predictors: (Constant), GENDER

b. Dependent Variable: HEIGHT

F and p are the same…

$R^2 = .643$, $F(1,6) = 10.8$, $p = .017$

an additional slide to consolidate structural models

First to help interpretation re-run MR using dummy coding (female = 1 male = 0) Can use structural model to calc means:

Group Statistics

	gender	N	Mean	Std. Deviation	Std. Error Mean
height	male	4	172.5000	6.45497	3.22749
	female	4	157.5000	6.45497	3.22749

From t-test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	172.500	3.227		53.447	.000
	gender	-15.000	4.564	-.802	-3.286	.017

a. Dependent Variable: height

From regress

$Y_{hat} = a + B_1X_1$

So, for men (coded as zero), Y hat = 172.50 – (15.00*0) = 172.50

And for women (coded as one), Y hat = 172.50 – (15.00*1) = 157.50

explanation

- a t-test, or an anova between two groups, is just a special case of correlation,
  – which in turn is just a special case of regression,
  – which is a representation of the General Linear Model
- SPSS did the same* thing in all four analyses – it just presented the output in different ways

*(strictly speaking, bivariate correlations and t-tests are not executions of the GLM – they are calculated using ‘shortcuts’ that achieve the same basic results)

hierarchical regression and ancova

- in ancova our goal was to remove the effects of a covariate before examining our treatment effect
- in hierarchical regression, the idea was to examine the contribution of a set of variables at step 2 after accounting for prediction at step 1
  - as it turns out, both are basically doing the same thing!

let's go back to our height data – and include ***age*** as a covariate:

data is laid out how we would for an ancova or a hierarchical regression

Sex	Age	Height
1	16	150
1	18	160
1	17	165
1	17	155
2	16	165
2	17	170
2	18	180
2	17	175

first run as an ancova …

Tests of Between-Subjects Effects

Dependent Variable: HEIGHT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	606.250[a]	2	303.125	16.167	.007	.866
Intercept	47.690	1	47.690	2.543	.172	.337
AGE	156.250	1	156.250	8.333	.034	.625
GENDER	450.000	1	450.000	24.000	.004	.828
Error	93.750	5	18.750			
Total	218500.000	8				
Corrected Total	700.000	7				

a. R Squared = .866 (Adjusted R Squared = .812)

for gender, $F(1,5) = 24.00$, $p = .004$

this is the effect after controlling for age

now run as hierarchical regression…

Model Summary

Model	R	R Square	Change Statistics				
			R Square Change	F Change	df1	df2	Sig. F Change
1	.472[a]	.223	.223	1.724	1	6	.237
2	.931[b]	.866	.643	24.000	1	5	.004

a. Predictors: (Constant), AGE

b. Predictors: (Constant), AGE, GENDER

$Fch(1,8) = 24.00$, $p = .004$

this is the effect after controlling for age

Minor diffs in output

there are some <u>minor</u> differences in presentation:

- in our ancova we are given $\eta^2 = .828$ but in regression the R^2ch was .643
- η^2 actually corresponds to the squared partial correlation for gender → $.91^2 = .828$

Coefficients[a]

Model		Standardized Coefficients	t	Sig.	Correlations	
		Beta			Partial	Part
1	(Constant)		.725	.496		
	AGE	.472	1.313	.237	.472	.472
2	(Constant)		.976	.374		
	AGE	.472	2.887	.034	.791	.472
	GENDER	.802	4.899	.004	.910	.802

a. Dependent Variable: HEIGHT

Minor diffs in output

- in our ancova the test for age is given as $F(1,5) = 8.33$, $p = .034$
- this actually corresponds to the test of the coefficient for age in the full model at step 2:
  - *remember* $t^2 = F$ ($2.887^2 = 8.33$)

Coefficients[a]

Model		Standardized Coefficients	t	Sig.	Correlations	
		Beta			Partial	Part
1	(Constant)		.725	.496		
	AGE	.472	1.313	.237	.472	.472
2	(Constant)		.976	.374		
	AGE	.472	2.887	.034	.791	.472
	GENDER	.802	4.899	.004	.910	.802

a. Dependent Variable: HEIGHT

explanation

- ancova and hierarchical regression achieve the same broad purpose
- some minor differences in the output simply reflect defaults which have been programmed into SPSS
  - e.g., as effect sizes have only recently become emphasised for anova, these don’t line up as you would expect with the ones for regression, but the link is in there somewhere!

interactions – MMR vs anova

- testing interactions in anova and MMR look incredibly different
  - this is just because they have different histories
  - essentially they are doing the same thing

2 categorical variables

- going back to our height data, let's say we wanted to examine the interaction between maternal diet and gender in the prediction of height…
  - factor A is gender (M/F)
  - factor B is maternal diet (healthy, unhealthy)

(N = 16)

anova – the way we know…

Tests of Between-Subjects Effects

Dependent Variable: HEIGHT

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	950.000[a]	3	316.667	8.444	.003
Intercept	435600.000	1	435600.000	11616.000	.000
GENDER	625.000	1	625.000	16.667	.002
DIET	100.000	1	100.000	2.667	.128
GENDER * DIET	225.000	1	225.000	6.000	.031
Error	450.000	12	37.500		
Total	437000.000	16			
Corrected Total	1400.000	15			

a. R Squared = .679 (Adjusted R Squared = .598)

$F\,(1,12) = 6.00,\ p = .031$

MMR…

- in our MMR lecture we talked briefly about categorical variables in MMR – they can get a bit tricky
- but with dichotomous variables it is dead easy
  - enter additive effects (gender and diet) at step 1
  - interaction term (gender*diet) at step 2….

MMR…

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Significance F Change
1	.720[a]	.518	.444	7.20577	.518	6.981	2	13	.009
2	.824[b]	.679	.598	6.12372	.161	6.000	1	12	.031

a. Predictors: (constant) DIET, GENDER…

b. Predictors: (constant) DIET, GENDER, INT…

$Fch\ (1,12) = 6.00,\ p = .031$

implications

- the GLM has been behind the scenes for just about all of the statistical methods examined in PSYC3010
- we stick to a lot of these conventions about when to use ANOVA instead of regression for practical reasons
- by understanding the common links through all these analyses we can be less rigid in our use of these tools
- here are some of the comparisons we can make

hypothesis testing

- in **anova** we test the hypothesis that our manipulations have had a significant effect on our DV

  ***H_0*: $\mu_1 = \mu_2 = \mu_3$**
  - the null hypothesis – no differences among treatment means

  ***H_1*: the null hypothesis is false**
  - the alternative hypothesis – there is at least one difference among treatment means

- in **regression** we test the hypothesis that our predictors are accounting for a significant amount of variance in our criterion

  ***H_0*:** the relationship between the criterion and the set of predictors is zero

  ***H_1*:** the relationship between the criterion and the set of predictors is <u>not</u> zero

variance partitioning

- in **anova** we want to partition the total variance out into effects and error terms
  - ***main effects*** and ***interactions*** compared to ***error***
  - the goal is to attribute a ***significant*** and ***substantial*** proportion of variance in our DV to our effects

- in **regression** we want to model our data by finding the line/plane of best fit, i.e., the one that minimises errors of prediction
  - the model can then be described in terms of ***additive effects*** and ***interactions,*** which are compared to ***error***
  - the goal is to explain a ***significant*** and ***substantial*** proportion of variance in our criterion as possible

effect size

- in **anova** we can quantify the amount of the total variance which each effect accounts for
  - eta-squared *(sample estimate)*
  - omega-squared *(population estimate)*

- in **regression** we can quantify the amount of variance that our model accounts for
  - R^2 *(sample estimate)*
  - R^2 adjusted *(population estimate)*
  - sr^2 *(importance of individual predictor)*

complex relationships

- in **anova** we can test for 2-way or 3-way interactions (and beyond!)
  - the effect of factor A on the DV changes over levels of factor B
  - follow-up these with simple effects – i.e., examine the effect of A on the DV at each level of B

- in **regression** we can test for 2-way or 3-way interactions (and beyond!)
  - the relationship between X and Y varies over values of Z
  - follow-up these with simple slopes – i.e., examine the relationship between X and Y at high and low conditional values of Z

increasing power

- in **anova** we can employ a number of statistical and methodological techniques:
  - blocking on a concomitant factor
  - remove individual differences (i.e., use a within-subjects design)
  - include a covariate (i.e., use ancova)

- in **regression** we also have some similar techniques at our disposal:
  - partial the effect of another variable out first (i.e., use hierarchical regression - similar to ancova)
  - improve measurement (e.g., measure subjects with most reliable measures – i.e., higher alpha)

The multivariate universe:

- Before 3010:
  - Single explanations
  - Barely grasp difference between correlations and group differences
  - Tendency to rely too much on p-values
- After 3010:
  - Multiple explanations
  - Explanations that interact, or are inter-related
  - Variables considered jointly so you can see interactions and inter-relationships explain more than considering each alone
  - Strong understanding of correlations and group differences
  - Understanding key idea of effect sizes

In the tutes:

- This week: Practice exam

In future :

- Consult times for me for the exam will be Friday November 7th 11am-12 and 1-2pm or by appointment
  - – Not available on weekends – please go through materials & ask questions ahead of time!
- Every effort will be made to post the A2 marks online by Friday November 7th, although this cannot be guaranteed