Moderators and Mediators

REB forms due!
Please download:
- ***Peattie2.sav***
- ***ExamAnxiety.sav***

15 Oct 2010
CPSY 501
Dr. Sean Ho
Trinity Western University

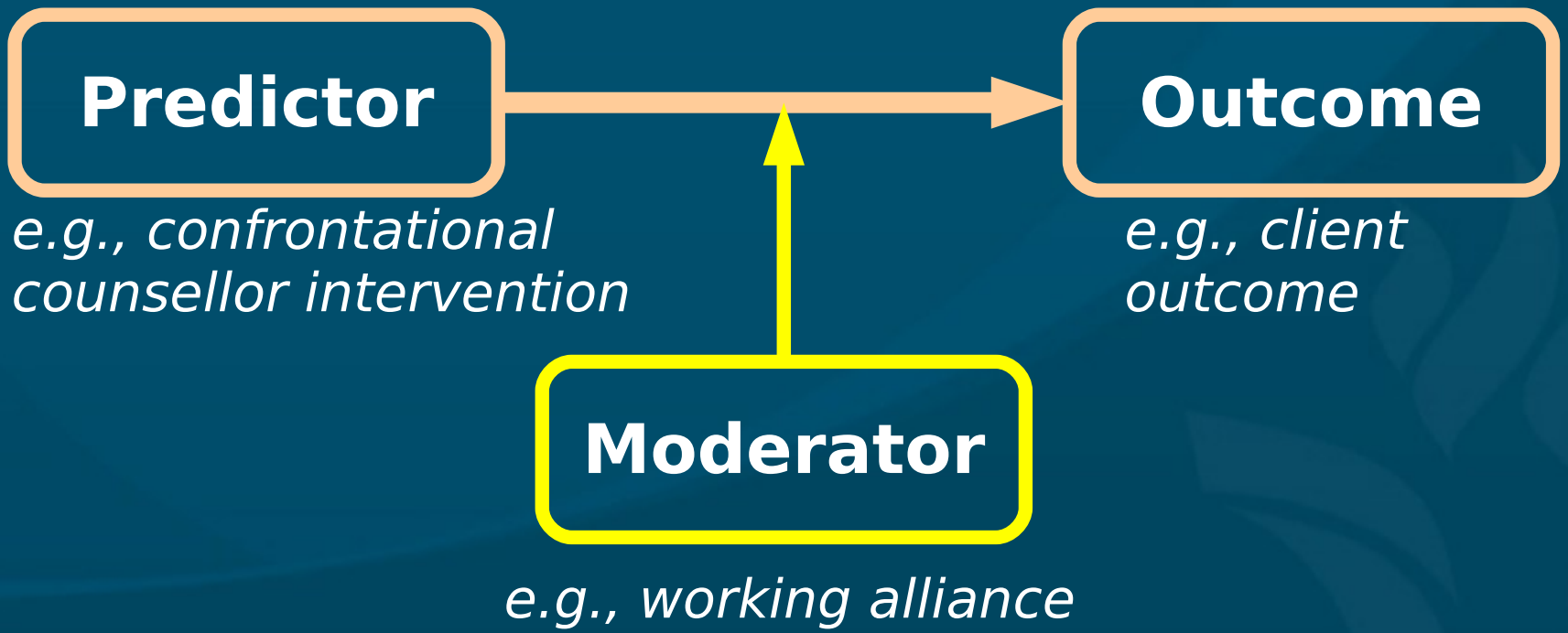
TRINITY WESTERN UNIVERSITY

Outline for today

- Moderators
  - Assessment: test if we have moderation
  - Interpretation
  - Example: Peattie marital satisfaction dataset
- Mediators
  - Assessment
  - Example: Exam Anxiety toy dataset
  - Interpretation
  - MacArthur model
- Journal article: Missirlian, et al.: Regression

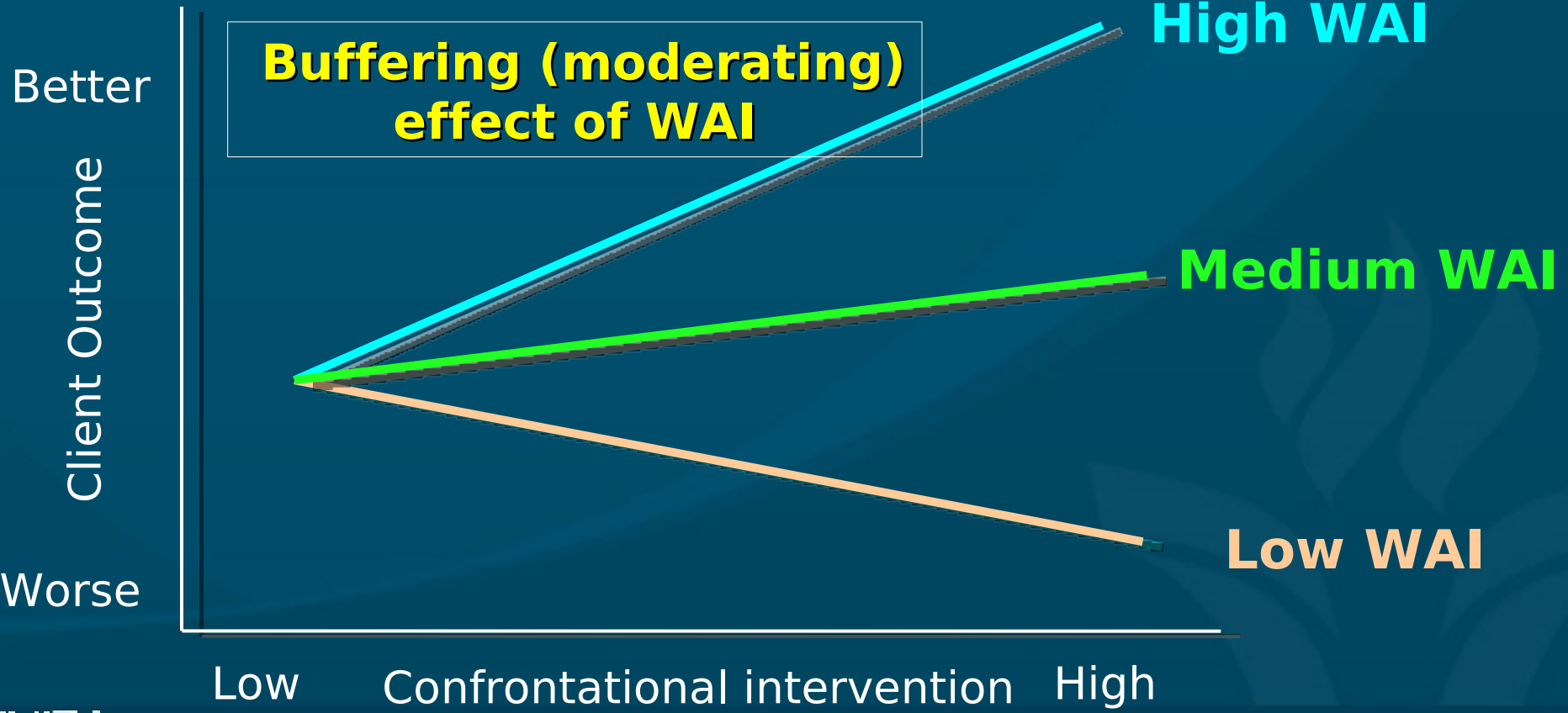
Moderators in Regression

- Definition: A moderator is a variable that interacts with the predictors and the outcome, changing the degree or direction of relationship



Effect of moderation

- Does the level of working alliance moderate the effect of confrontational counsellor intervention on client outcome?



Asking good RQs

- RQ1: Does working alliance moderate client outcome?
  - No good: moderation requires at least three variables: IV, DV, and Mod
- RQ2: Does working alliance moderate the relationship between confrontational intervention and client outcome?
  - IV: confrontational intervention
  - DV: client outcome
  - Mod: working alliance

Regression vs. ANOVA

- We can test for moderation in either a regression or ANOVA model:
- Regression: scale-level IV and Mod
- ANOVA: categorical IV and Mod

- Remember that regression and ANOVA are really two sides of the same coin: both are general linear model
- Today we'll focus on moderators in regression
  - Assume IV, Mod, and DV are all scale-level

Testing for Moderation

- Centre the predictor and moderator:
  - Compute: IV – (IV mean) → IV_ctr
- Create the interaction term:
  - Compute: IV_ctr * Mod_ctr → IVxMod
- Run regression model:
  - Centred predictor and centred moderator go in blocks in normal order
  - Interaction term goes in a subsequent block
- If the interaction term is significant, you have a moderator (common in CPSY research!)

Interpreting Moderators

- If we have moderation, the main effects (effects of each variable by itself) must be reinterpreted
- The presence of a moderating effect indicates that the relationship between the predictor and the outcome variable is different for different kinds of people (as defined by the moderator)
- Theory is needed to determine how to interpret the interactions.
- Analytically, we need to graph the interaction to understand what is going on.

Example: Peattie, 2004

- Birgitte Peattie's thesis on marriage, stress, & sanctification.
  - Dataset: Peattie2.sav
- RQ: Do joint religious activities buffer the effect of negative life events on marital satisfaction?
  - DV: Marital Satisfaction (Mar_sat)
  - IV: Negative Life Events (NLE, stress)
  - Mod: Joint Religious Activities (JRA)
- Buffering: high levels of a "buffer" weaken the impact of stress
  - → interaction!

Preparing Variables

(1) Centre predictor (NLE)

- First calculate the mean: Analyze → Descrip.
- Transform → Compute: NLE – 5.1250
  Target Variable: NLE_ctr

(2) Centre moderator (JRA) (but *don't* centre DV!)

(3) Create interaction term

- Multiply centred predictor and moderator:
- Transform → Compute: NLE_ctr * JRA_ctr
  Target Variable: NLE_x_JRA

Testing Moderation in Regr.

- Analyze → Regression → Linear:
- Dependent: Mar_sat
  - Block 1: centred predictors: NLE_ctr
  - Block 2: centred moderators: JRA_ctr
  - Block 3: Interaction term(s): NLE_x_JRA
- Statistics: R^2 change, Part/Partial, Collinearity, Durbin-Watson
- Save: Standardized Resid., Cook's, Leverage
- Plots: ZPRED vs. ZRESID, ZPRED vs. SRESID

Peattie Data: Model Summary

- If the interaction term is significant, we have moderation

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.335[a]	.112	.104	1.39996	.112	13.911	1	110	.000
2	.350[b]	.122	.106	1.39834	.010	1.256	1	109	.265
3	.391[c]	.153	.130	1.37987	.031	3.937	1	108	.050

a. Predictors: (Constant), NLE_Cent

b. Predictors: (Constant), NLE_Cent, JRA_Cent

c. Predictors: (Constant), NLE_Cent, JRA_Cent, NLE_JRA_Int

d. Dependent Variable: Marital Satisfaction

Peattie: Coefficients Table

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.601	.132		42.338	.000
	NLE_Cent	-.120	.032	-.335	-3.730	.000
2	(Constant)	5.600	.132		42.385	.000
	NLE_Cent	-.108	.034	-.302	-3.195	.002
	JRA_Cent	.105	.093	.106	1.121	.265
3	(Constant)	5.672	.135		41.925	.000
	NLE_Cent	-.081	.036	-.224	-2.220	.028
	JRA_Cent	.088	.092	.089	.952	.343
	NLE_JRA_Int	.037	.019	.195	1.984	.050

a. Dependent Variable: Marital Satisfaction

ModGraph: Moderation Tool

- Paul Jose's ModGraph tool:
  - Helps us visualize the moderating relationship: how the PV predicts the DV depending on the level of the Mod

- Jose, P.E. (2008). *ModGraph-I: A programme to compute cell means for the graphical display of moderational analyses: The internet version, Version 2.0.* Victoria University of Wellington, Wellington, New Zealand.

http://www.victoria.ac.nz/psyc/paul-jose-files/modgraph/modgraph.php

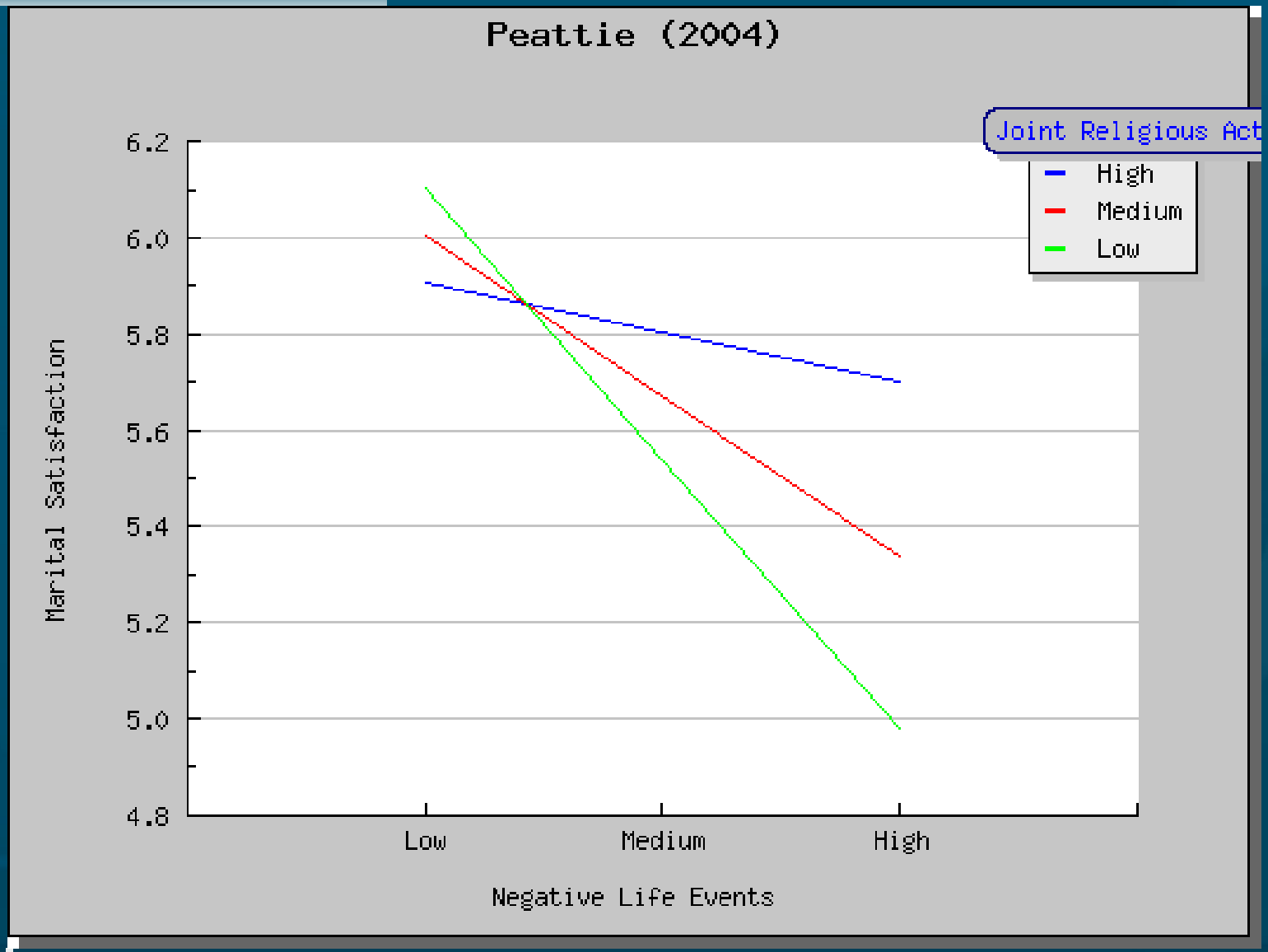
Peattie: Using ModGraph

- Select "Continuous Moderator": Data Entry
- Chart Labels:
  - Title: "Peattie (2004)"
  - X-axis (IV): "Negative Life Events"
  - Y-axis (DV): "Marital Satisfaction"
  - Moderator: "Joint Religious Activities"

ModGraph: Data Entry

- All B values (unstandardized slopes) should come from the full (last) regression model!
- Main effect:
  - B=-.081, mean=0 (centred), SD=4.1157
- Moderating:
  - B=.088, mean=0 (centred), SD=1.4979
- Interaction term and constant:
  - B=.037
  - Constant: 5.672

ModGraph: Results



Interpreting Interactions

- Slope of IV regression lines differs for various levels of the moderating variable
- Peattie study example:
  - In general, negative life events have a negative impact on marital satisfaction,
  - However, joint religious activities weaken this negative relationship

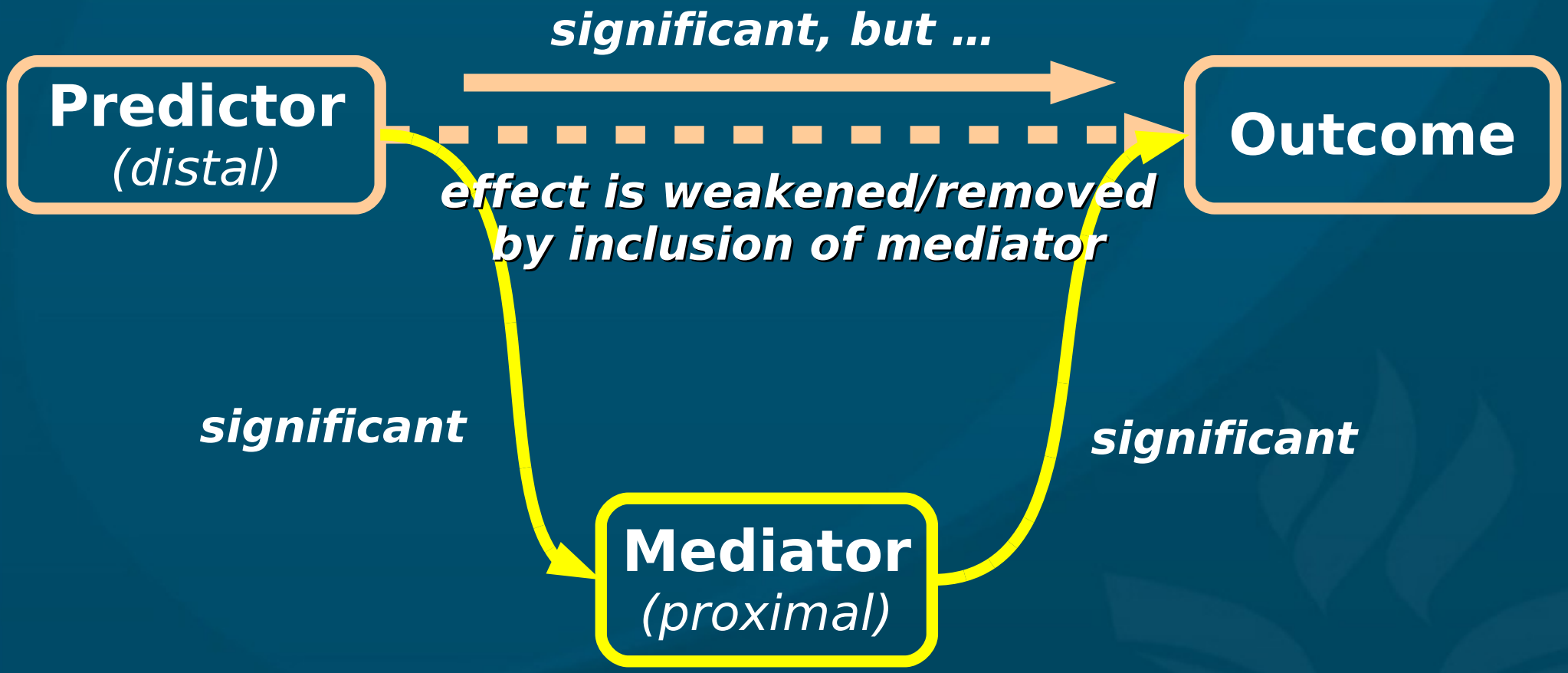
Outline for today

- Moderators
  - Assessment: test if we have moderation
  - Interpretation
  - Example: Peattie marital satisfaction dataset
- Mediators
  - Assessment
  - Example: Exam Anxiety
  - Interpretation
  - MacArthur model
- Journal article: Missirlian, et al.: Regression

Mediators: Definition

- A mediator is a "generative mechanism" by which a predictor influences an outcome var:
  - IV has a significant relationship with DV,
  - Med has sig. relshp. with both IV and DV, but
  - When Med is included in the model, the relationship between IV and DV disappears
- Partial mediation: if the IV-DV relationship is merely weakened rather than disappearing
- Theory must support placing the mediator "between" the IV and DV in some sense

Mediators: Block diagram



Examples of mediators

- Predictor: Childhood trauma
  - Mediator: Depression
  - Outcome: Eating psychopathology
- Predictor: Disease severity
  - Mediator: Intrusiveness of illness
  - Outcome: Psychological distress
- Predictor: Therapy program
  - Mediator: Catharsis, problem solving, ...
  - Outcome: Psychological well-being
- Others?

Testing for Mediators

- Are all three variables significantly correlated?
- Is there a relationship to mediate?
  - Run regression without the mediator: sig.?
- Is there a relationship between IV and Med?
  - Run a simple regression with IV as predictor and Med as outcome: is it significant?
- Back to the original regression model, include the mediator in the model (in the same block as the predictor)
  - Keep any other predictors as-is in the model

Example: Exam Anxiety

- Dataset: ExamAnxiety.sav
  - (Toy dataset from the textbook)
- RQ: does exam anxiety mediate the relationship between studying time and exam performance?
  - IV: time spent studying
  - Med: exam anxiety
  - DV: exam performance
- First check if all three are correlated:
  - Analyze → Correlate → Bivariate

ExamAnxiety: Correlations

Correlations

		Time Spent Revising	Exam Performance (%)	Exam Anxiety
Time Spent Studying	Pearson Correlation	1.000	.397**	-.709**
	Sig. (2-tailed)		.000	.000
	N	103	103	103
Exam Performance (%)	Pearson Correlation	.397**	1.000	-.441**
	Sig. (2-tailed)	.000		.000
	N	103	103	103
Exam Anxiety	Pearson Correlation	-.709**	-.441**	1.000
	Sig. (2-tailed)	.000	.000	
	N	103	103	103

**. Correlation is significant at the 0.01 level (2-tailed).

ExamAnxiety: Main effect

- Next, we check to see if there is a main effect between study time and exam performance
  - If not, then there is no relationship to be mediated!
- Analyze → Regression → Linear:
  - Dependent: Exam Performance
  - Block 1: Time Spent Revising
  - If we had any other predictors (including other moderators), we'd include them according to their blocks

Main effect: Results

Model Summary

Model	R	R Square	Adjusted R Square	Change Statistics			
				F Change	df1	df2	Sig. F Change
1	.397[a]	.157	.149	18.865	1	101	.000

a. Predictors: (Constant), Time Spent Studying

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	45.321	3.503		12.938	.000
	Time Spent Studying	.567	.130	.397	4.343	.000

a. Dependent Variable: Exam Performance (%)

ExamAnxiety: IV to Med

- Now we must evaluate the relationship between the predictor and the mediator:
- Analyze → Regression → Linear:
  - Dependent: Exam Anxiety
  - Block 1: Time Spent Revising
  - For this side analysis, we don't need any other variables, just simple regression

Predictor to Mediator: Results

Model Summary

Model	R	R Square	Adjusted R Square	Change Statistics			
				F Change	df1	df2	Sig. F Change
1	.709[a]	.503	.498	102.233	1	101	.000

a. Predictors: (Constant), Time Spent Studying

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	87.668	1.782		49.200	.000
	Time Spent Studying	-.671	.066	-.709	-10.111	.000

a. Dependent Variable: Exam Anxiety

ExamAnxiety: Full Model

- Finally, we run the full regression model, now including the mediator in the same block as the predictor:
- Analyze → Regression → Linear:
  - Dependent: Exam Performance
  - Block 1: Time Spent Revising, Exam Anxiety
  - Any other predictors/moderators would be included according to plan
- See if the mediator is significant in the model, but the predictor is now no longer significant

Full Model: Output

Model Summary

Model	R	R Square	Adjusted R Square	Change Statistics			
				F Change	df1	df2	Sig. F Change
1	.457[a]	.209	.193	13.184	2	100	.000

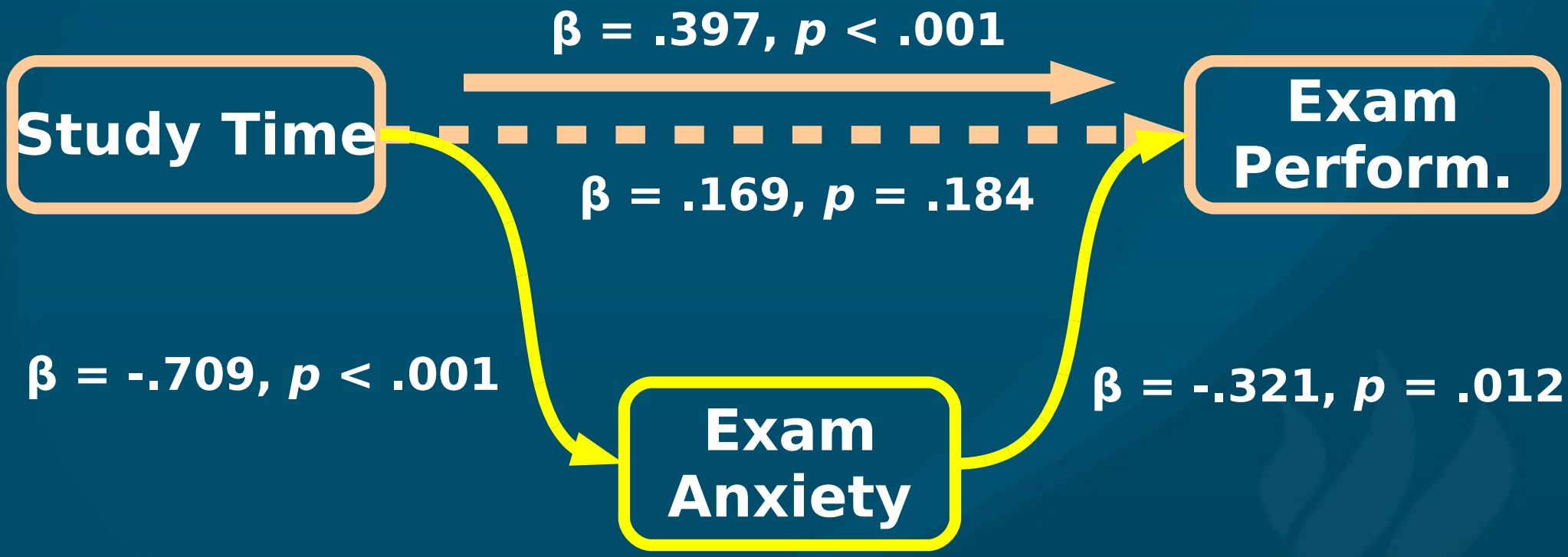
a. Predictors: (Constant), Exam Anxiety, Time Spent Studying

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	87.833	17.047		5.152	.000
	Time Spent Studying	.241	.180	.169	1.339	.184
	Exam Anxiety	-.485	.191	-.321	-2.545	.012

a. Dependent Variable: Exam Performance (%)

ExamAnxiety: Block Diagram



- Study time influences exam performance indirectly, via the mediator of exam anxiety
- Report *p*-values and effect sizes (β, R^2)

MedGraph: mediation tool

- Paul Jose's MedGraph:
  - Tool to visualize the mediation relationship
  - http://www.victoria.ac.nz/psyc/paul-jose-files/medgraph/medgraph.php
- Sobel test: one way to check partial mediation
  - Kristopher Preacher and Andrew Hayes
  - http://people.ku.edu/~preacher/sobel/sobel.htm
  - May have problems with power

Interpreting Mediators

- Conclude that what appeared to be a real relationship between the predictor and outcome is actually an indirect relationship, and due to the mediator variable.
- Report:
  - Relationships (β, R^2) between the predictor and the outcome variable before and after the mediator is entered into the model
  - Relationships between the mediator and predictor, and between mediator and outcome variable (in the final model)

Moderation or Mediation?

- Does the level of dyadic coping employed by a couple change the impact that emotional expression has on a couple's stress level?
- Is the relationship between quality of relationships and depression best understood by considering social skills?
- Does psychotherapy reduce distress by its ability to inspire hope in clients?

- The rules of thumb for discerning between moderation and mediation are somewhat fluid!

MacArthur Model

- The current definitions and procedures for assessing moderation and mediation are largely due to Baron and Kenny (1986)
- MacArthur model is a more general approach:
  - Is IV correlated with DV? (can be ok if not)
  - Is Med correlated with DV? (try Spearman)
  - Show that the effect of IV on DV can be explained at least in part by Med:
    can use linear regression or other means
  - If interaction of IV*Med significantly predicts DV, this can be evidence of mediation, too

MacArthur vs. Baron+Kenny

- Both rely on prior theory to tell us temporal sequencing of IV → Med → DV
- B+K explicitly tests the IV → Med relationship
  - MacArthur relies on temporal sequencing
- MacArthur tests for interaction of IV*Med on DV
  - B+K does not test interaction (moderation)
- B+K adopts assumptions of linear regression (e.g., parametricity, linearity)
  - MacArthur is flexible to other non-param. methods: even correlation can be Spearman

Further Reading

- The original Baron+Kenny paper:
  - Baron, R. M., & Kenny, D. A. (1986). *The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations.* Journal of Personality and Social Psychology, 51, 1173-1182.
- Comparison of B+K to MacArthur model:
  - Kraemer, H. C., Kiernan, M., Essex, M., & Kupfer, D. J. (2008). *How and why criteria defining moderators and mediators differ between the Baron & Kenny and MacArthur approaches*. Health Psychology 27, S101–S108.
- Checklist for moderators / mediators:
  - Assessing Mediators and Moderators.doc

Outline for today

- Moderators
  - Assessment: test if we have moderation
  - Interpretation
  - Example: Peattie marital satisfaction dataset
- Mediators
  - Assessment
  - Example: Exam Anxiety
  - Interpretation
  - MacArthur model
- Journal article: Missirlian, et al.: Regression

Journal Article: Missirlian, et al.

- Missirlian, T. M., Toukmanian, S. G., Warwar, S. H., & Greenberg, L. S. (2005). *Emotional Arousal, Client Perceptual Processing, and the Working Alliance in Experiential Psychotherapy for Depression.* Journal of Consulting and Clinical Psychology, 73(5), 861-871.
- We skimmed this before; now we can understand it more fully!
- RQ: "…client emotional arousal, perceptual processing, and the working alliance, together, would be a better predictor of therapy outcome than any one of these variables alone"

Methodology

- Participants: 32 of 500 individuals recurited met criteria for inclusion – screened to ensure mild to moderate levels of depression (no comorbid dx, no Axis-II dx, no medications, not receiving treatment elsewhere)
- Method: participants were randomly assigned to 1 of 11 possible therapists to complete between 14 and 20 manualized sessions
- Depression (BDI) was measured pre-treatment
- 4 outcome measures were collected at 3 phases (early, middle, late) in the therapeutic process

IVs: Therapeutic Processes

- Emotional Arousal: Two independent and blind raters used video tape + transcript to rate on the Client Emotional Arousal Scale-III
- Perceptual Processes: Two other independent judges watched the same tapes, rating on Levels of Client Perceptual Processing (from 'recognition' at one end to 'integration' at other)
- Working Alliance: Clients completed (self-rated) the Working Alliance Inventory at the end of each session.

DVs: Therapeutic Outcomes

- Depression: Beck Depression Inventory (BDI)
- Self-esteem: Rosenberg Self-Esteem Scale (SES)
- Stress due to Interpersonal Sources: Inventory of Interpersonal Problems (IIP)
- Psychopathology: Global Symptom Index (GSI) of the Symptom Checklist-90 (SCL-90)

Analysis Method?

- What kind of a design are we working with?
  - Longitudinal: Correlations between variables observed over time
  - Procedure: Manualized therapy for clients with depression
  - Measures: Coding of transcripts of therapy sessions (arousal, perceptions) and some self-report measures (BDI, WAI)
- A series of hierarchical regression analyses test the predictive ability of the three therapeutic process measures in relation to the four outcome measures.

Correlation: Check Assumptions

- NO perfect multicollinearity: no perfect linear relationship between two or more predictors
- Linearity: Assume the relationship we're modelling is a linear one

Table 2

Pearson Product–Moment Correlations on Pretreatment and Posttreatment Outcome Measures and Process Measures by Time

	Pretreatment				Posttreatment			
Variable	BDI	RSE	IIP	SCL-90-R	BDI	RSE	IIP	SCL-90-R
Early								
Arousal	−.06	.14	−.14	.08	−.36*	.20	−.17	−.24
LCPP	−.18	−.02	−.15	.00	−.35*	.09	−.34	−.51**
WAI	.03	.27	−.07	.23	−.20	.39*	−.07	−.29
Middle								
Arousal	.16	.04	−.19	.01	−.56**	.33	−.27	−.60**
LCPP	−.13	−.05	−.22	−.04	−.54**	.17	−.48**	−.80**
WAI	.03	.08	.03	.24	−.42*	.29	−.18	−.38*
Late								
Arousal	.15	−.11	.13	.07	−.36*	.09	−.12	−.36*
LCPP	−.01	.03	−.02	.24	−.44*	.21	−.37*	−.66**
WAI	−.05	.02	.24	.33	−.50**	.20	.02	−.33

Note. $N = 32$. Arousal = modal arousal; LCPP = Levels of Client Perceptual Processing (high); WAI = Working Alliance Inventory; BDI = Beck Depression Inventory; RSE = Rosenberg Self-Esteem Scale; IIP = Inventory of Interpersonal Problems; SCL-90-R = Symptom Checklist–90–Revised.
* $p < .05$. ** $p < .01$.

Results: Mid-Therapy

Arousal' adds only marginal Unique improvement over Perceptual Processes

Table 3

Summary of Hierarchical Regression Analysis for Middle Therapy Variables Predicting Depressive Symptomatology at Therapy Termination

Variable	R_{total}	R_{change}	R^2_{total}	R^2_{change}	F_{change}	*df*	β
Step 1							
BDI (pre)	.093	−.093	.009	.009	0.25	1, 29	−.093
Step 2							
BDI (pre)		−.026					−.026
Middle arousal	.550	−.542	.303	.294	11.81	1, 28	−.546**
Step 3							
BDI (pre)		−.101					−.105
Middle arousal		−.289					−.343†
Middle LCPP	.637	−.321	.406	.103	4.69	1, 27	−.383*
Step 4							
BDI (pre)		−.100					−.104
Middle arousal		−.235					−.304
Middle LCPP		−.297					−.363†
Middle WAI	.642	−.077	.412	.006	0.26	1, 26	−.093

Note. $N = 31$. Pre = pretreatment; BDI = Beck Depression Inventory; LCPP = Levels of Client Perceptual Processing (high); WAI = Working Alliance Inventory.
† $p < .07$. * $p < .05$. ** $p < .01$.

- Emotional Arousal & Perceptual Processes significantly increased prediction for Depression

Results: Late-Therapy

LCPP adds only 'marginally significant' unique improvement over WAI

Table 4

Summary of Hierarchical Regression Analysis for Late Therapy Variables Predicting Depressive Symptomatology at Therapy Termination

Variable	R_{total}	R_{change}	R^2_{total}	R^2_{change}	F_{change}	*df*	β
Step 1							
BDI (pre)	.093	−.093	.009	.009	0.25	1, 29	−.093
Step 2							
BDI (pre)		−.100					−.100
Late LCPP	.454	−.444	.206	.197	7.00	1, 28	−.444*
Step 3							
BDI (pre)		−.119					−.119
Late LCPP		−.270					−.292†
Late WAI	.585	−.368	.342	.136	5.57	1, 27	−.399*

Note. $N = 31$. Pre = pretreatment; BDI = Beck Depression Inventory; LCPP = Levels of Client Perceptual Processing (high); WAI = Working Alliance Inventory.
† $p < .10$. * $p < .05$.

- Adding Working Alliance on top of Perceptual Processing improved prediction of depressive symptoms (explaining 34% of the variance)

Limitations? Future work?

- Small sample size (n=32): limited power
  - But don't dismiss results simply because of "marginal significance" – look at effect size
- Homogenous sample:
  selecting for only mild to moderate depression doesn't mirror the reality of the clinical world
- Self-report inventories for outcome measures:
  influenced by "demand characteristics"?
- Later regression models are built
  based on results of earlier regression tests:
  inflated "experiment-wise" Type-I error?