

Moderators and Mediators

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CPSY 501
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Please download:

- *Peattie2.sav*
- *ExamAnxiety.sav*

Outline for today

■ Moderators

- Assessment: test if we have moderation
- Interpretation
- Example: Peattie marital satisfaction dataset

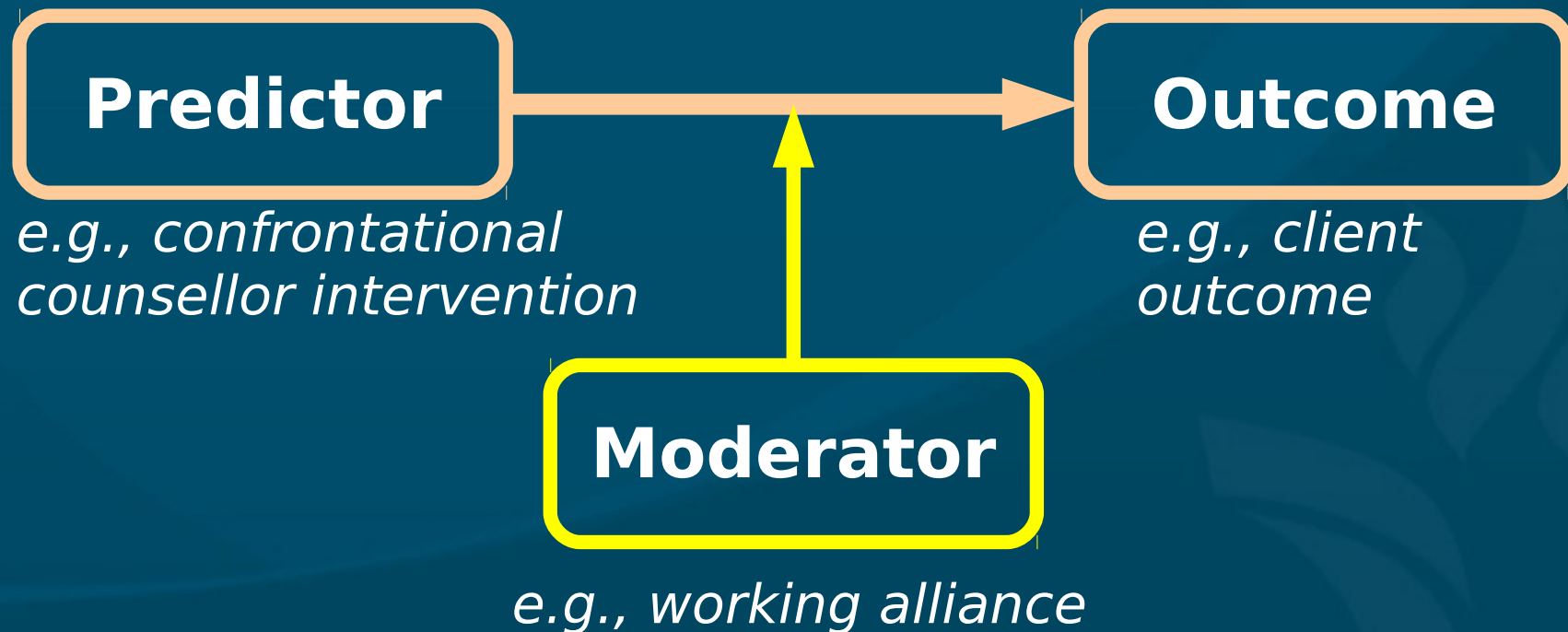
■ Mediators

- Assessment
- Example: Exam Anxiety toy dataset
- Interpretation
- MacArthur model

■ Journal article: Missirlian, et al.: Regression

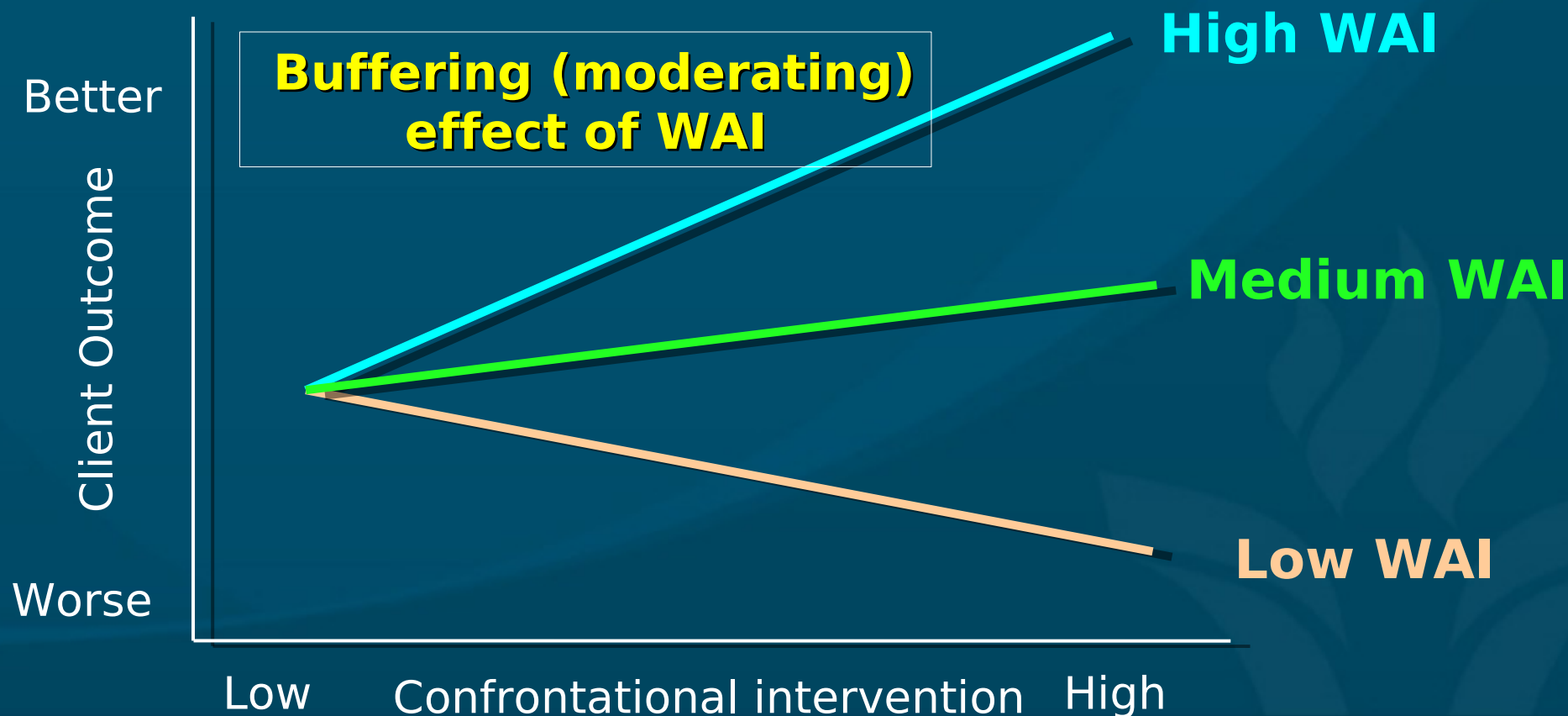
Moderators in Regression

- 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: $IV - (IV \text{ mean}) \rightarrow IV_ctr$
- Create the interaction term:
 - Compute: $IV_ctr * Mod_ctr \rightarrow IVxMod$
- 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				
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
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>

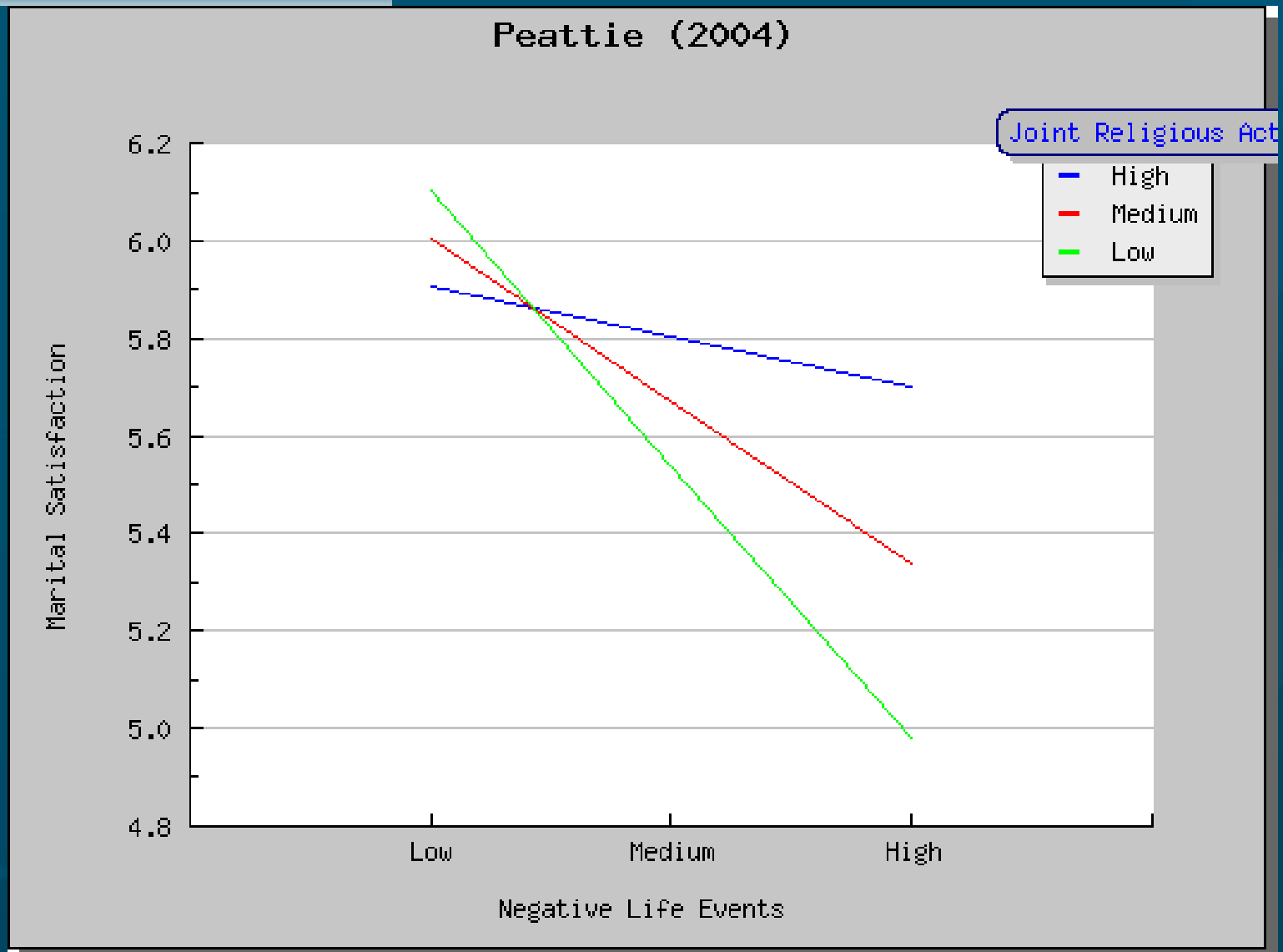
Peattie: Using ModGraph

- 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

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■ Mediators

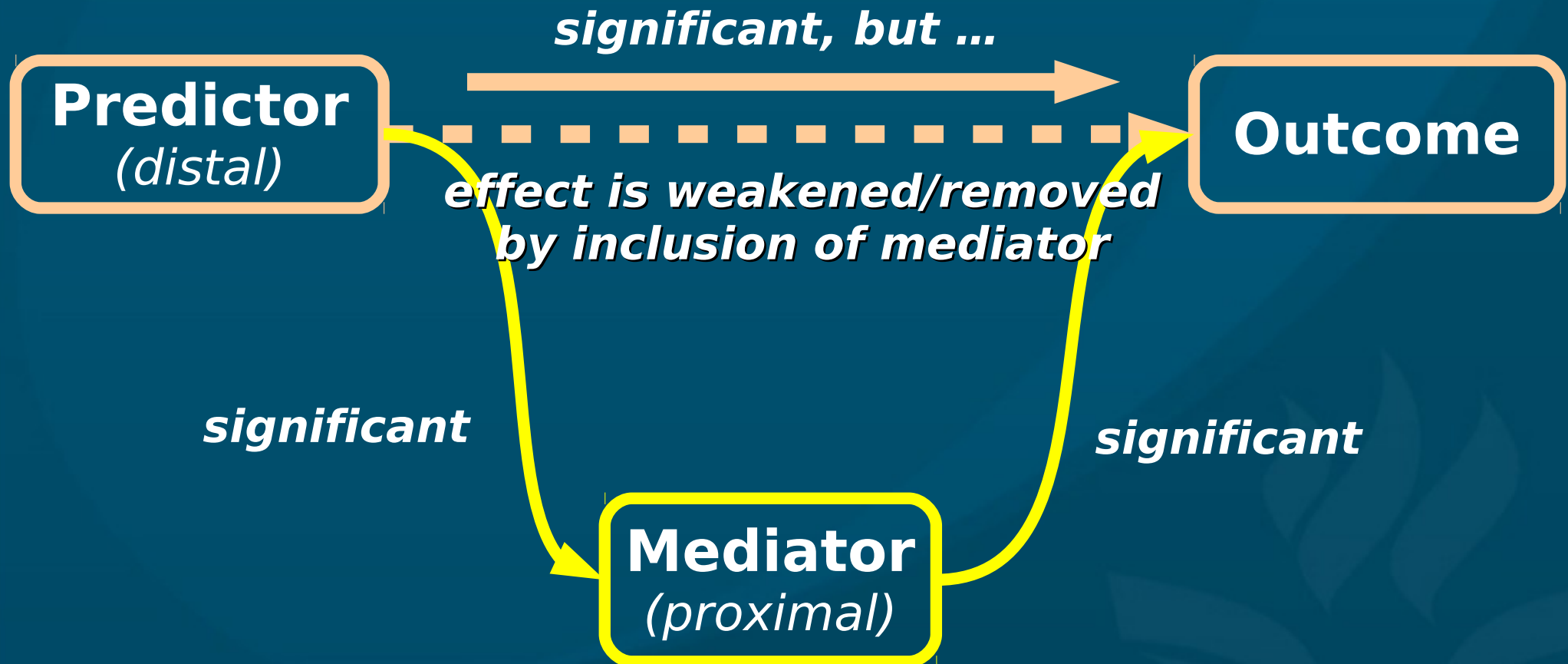
- Assessment
- Example: Exam Anxiety
- Interpretation
- MacArthur model

■ 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

				Change Statistics			
Model	R	R Square	Adjusted R Square	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

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
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	F Change	Change Statistics			Sig. F Change
					df1	df2		
1	.709 ^a	.503	.498	102.233	1	101		.000

a. Predictors: (Constant), Time Spent Studying

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	Beta	t	
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**

Model Summary

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

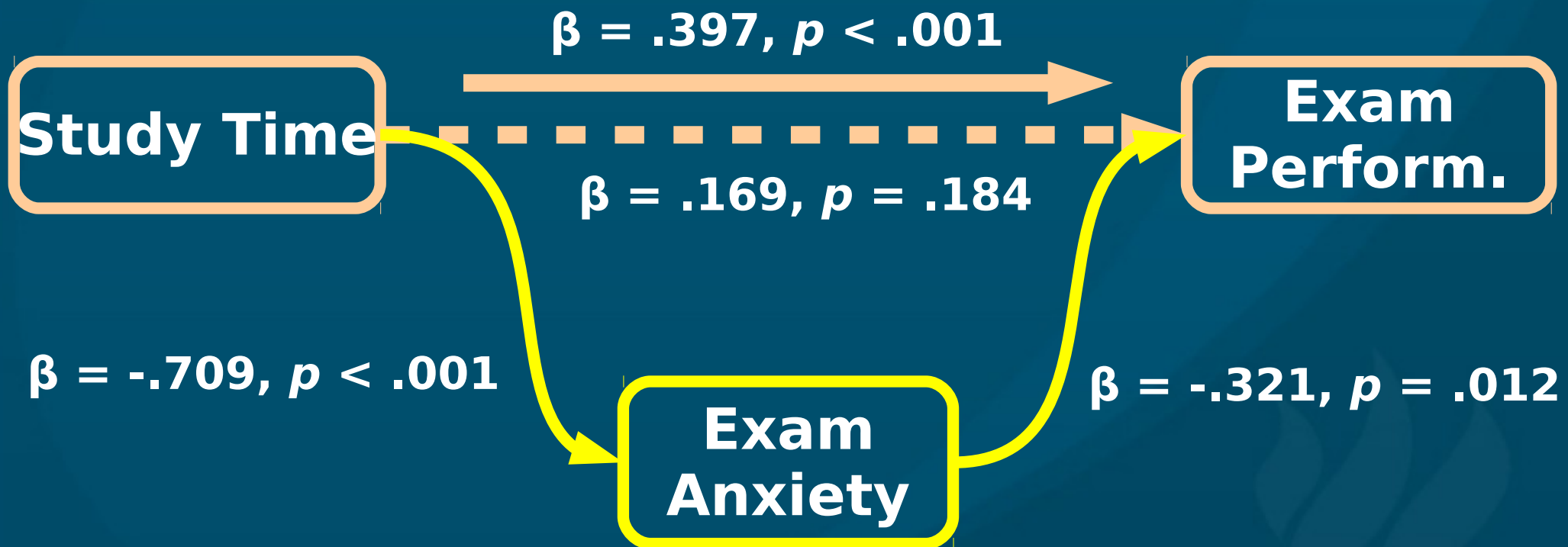
a. Predictors: (Constant), Exam Anxiety, Time Spent Studying

Coefficients^a

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
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 $IV \rightarrow Med \rightarrow DV$
- B+K explicitly **tests** the $IV \rightarrow Med$ 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

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- 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 recruited 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

Variable	Pretreatment				Posttreatment			
	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?