Toward Understanding Contradictory Methods for Reducing Selection Bias in Longitudinal Analyses

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Outline

- 2 types of gain scores yield different β's
- Lord's paradox
- Counterfactuals implied by the null H_0 of the 2 gain-score analyses
- ANCOVA assumptions and Lord's paradox

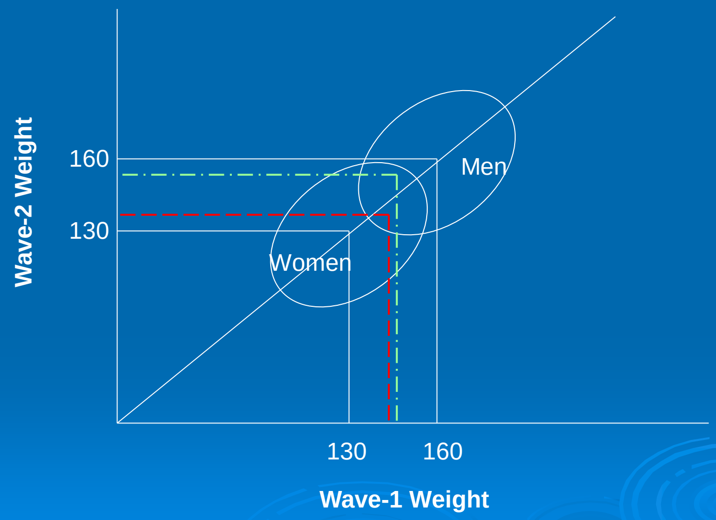
Two Controls for Selection Bias

- Simple gain: $Y_2 – Y_1$
  - Repeated measures ANOVA
  - Linear growth model
  - Differences in differences
- Residualized gain: $Y_2 | Y_1$
  - Predicting Y_2 controlling for Y_1
  - ANCOVA
  - Cross-lagged panel models

2 Control Methods: Often Contradictory Results

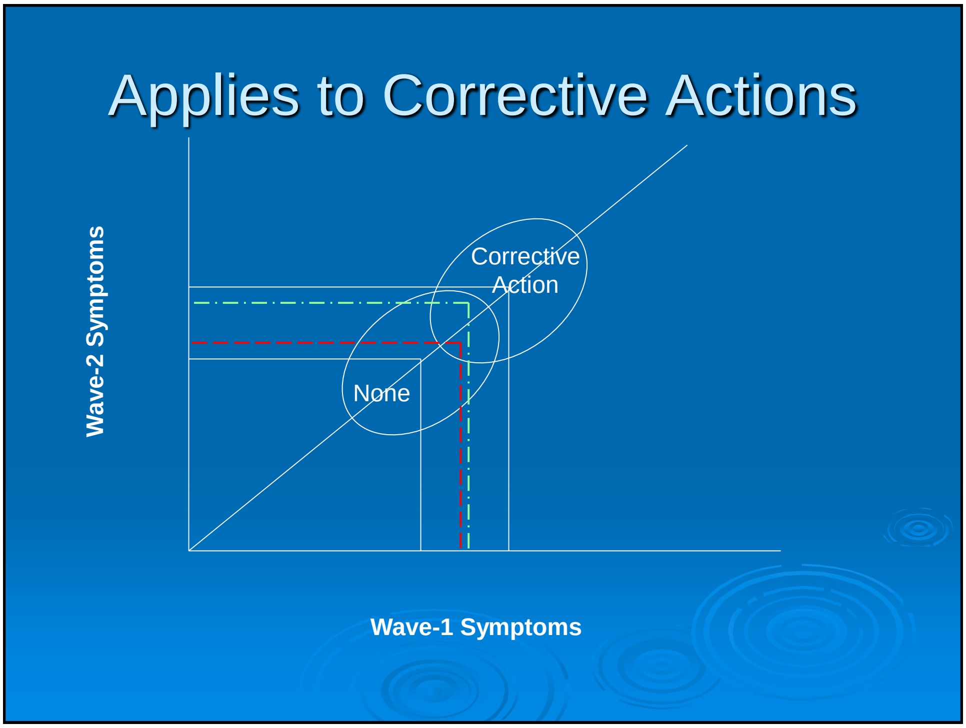
- Lord's paradox

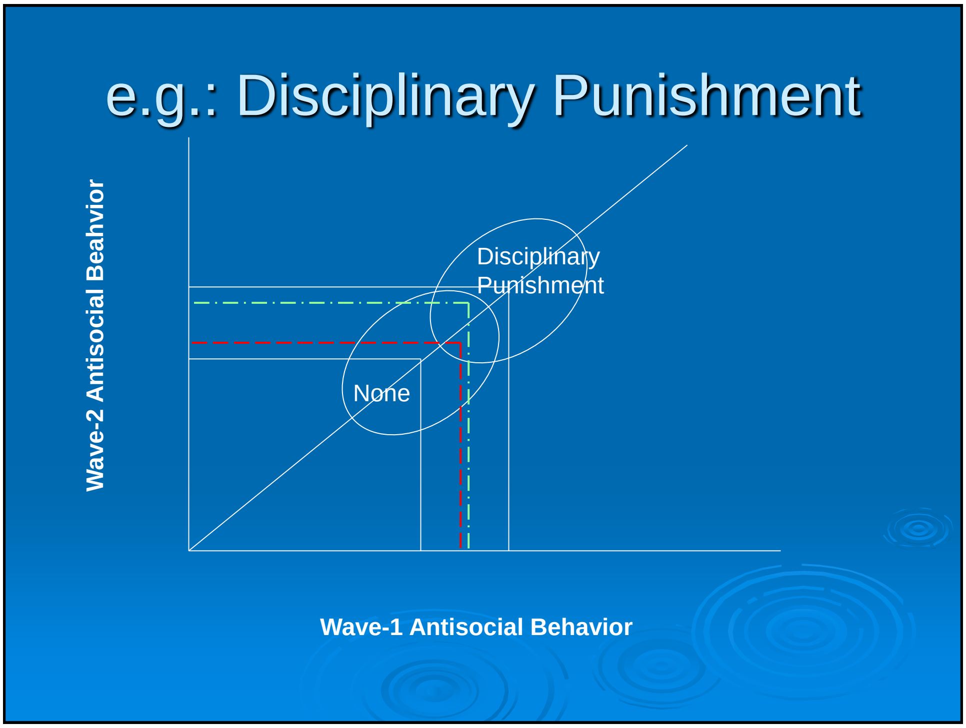
Lord's Paradox



Differing Conclusions

- Simple change: (solid line)
  - No sex difference in change
  - Mean *within-person* change
- Residualized change (dashed lines)
  - For any W1 weight, predicted W2 weight has men > women
  - Bias in direction of pre-existing differences (relative to simple change)


Applies to Corrective Actions
Wave-2 Symptoms
Corrective Action
None
Wave-1 Symptoms


e.g.: Disciplinary Punishment
Wave-2 Antisocial Beahvior
Disciplinary Punishment
None
Wave-1 Antisocial Behavior

Opposite Biases for 2 Gain Scores:

- Age: 4 or 5 years old at Wave 1
- *N* = 1464 (Canadian NLSCY)
- 2 outcomes:
  - Antisocial
  - Hyperactivity
- 2-wave & 4-wave analyses(CLPM & LGM)
  -- Larzelere, Ferrer, et al. (2010)

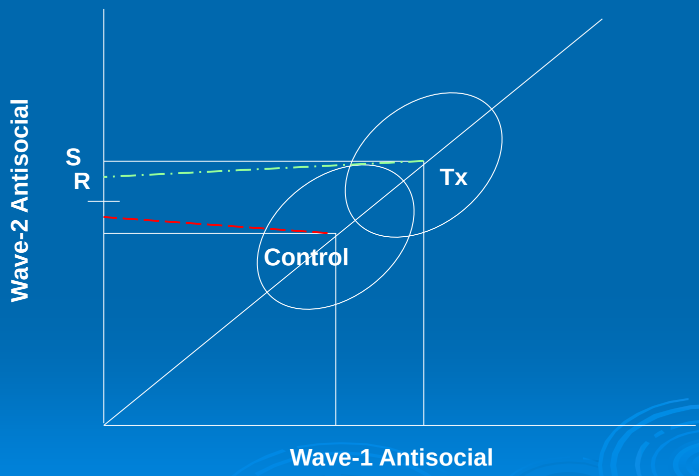
Larzelere, Ferrer, et al. (2010)

- 4 corrective parental actions
  - Physical punishment
  - Nonphysical punishment
  - Scolding or yelling
  - "Hostile-ineffective" (perceived behavioral difficulty)
- 2 corrective actions by professionals
  - Psychotherapy visits
  - *Ritalin*

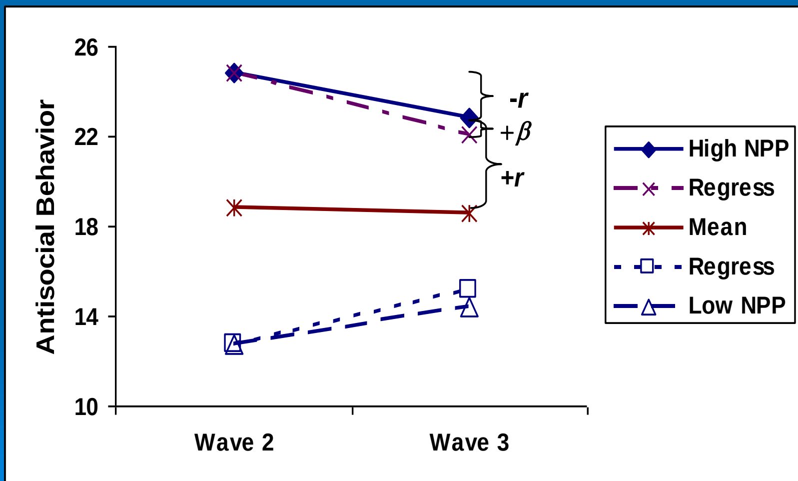
Results for Corrective Actions

- Residualized change – all “effects” detrimental
  - Longitudinal net-effects – 10 of 14
  - Cross-lagged latent analysis – 3 of 14, 4 marginally (p < .10)
- Simple gains – all “effects” beneficial
  - r with later gain – 4 of 14, 2 marginally
  - Growth curve – 5 of 14

Counterfactuals: Simple (S) & Residualized (R) Change



Counterfactuals for 3 Analyses

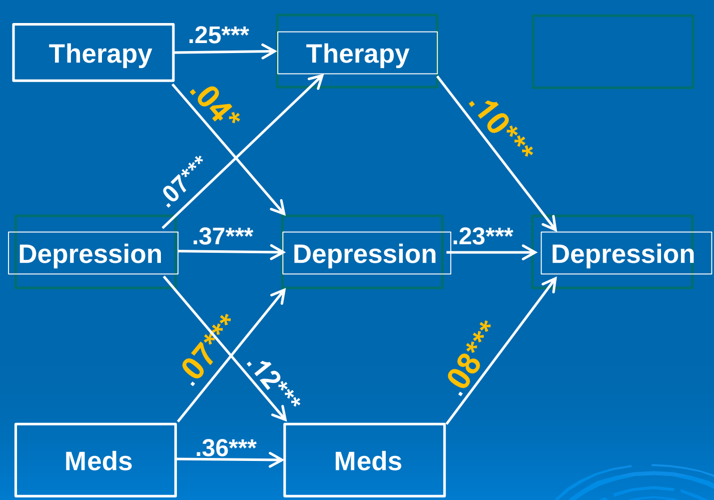


Counterfactuals Implied by Null H_0 for Two Types of Change

- Simple change: $Y_2 = 0X + Y_1$
  - Counterfactual in null H_0 = no change
- Residualized change: $Y_2 = 0X + \beta_1 Y_1$
  - Counterfactual in null H_0= regression of group means toward grand mean, estimated by β_1

2 Methods Have Opposite Biases for Professional Tx's

- Treatments for depression
  - Meds for depression
  - Therapy for depression
- Fragile Families data
  - Mostly unmarried; 20 USA cities
  - Waves 1-5: Ages 0, 1, 3, 5, & 9
  - Mom depression: 2 stem Q's, 6 symptom Q's
  - Therapy or medication for depression?



2-Step Linear Growth Model

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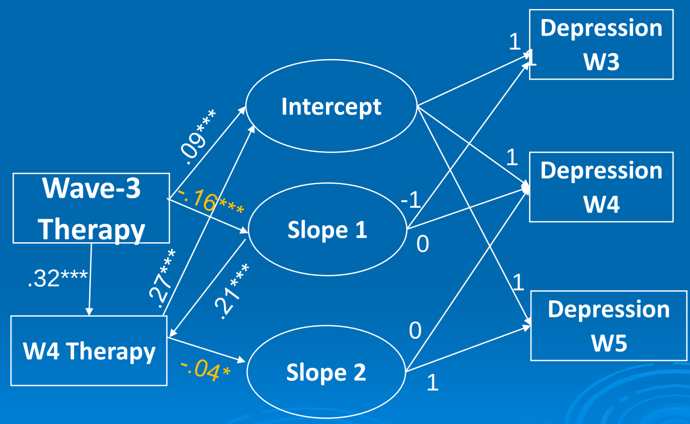

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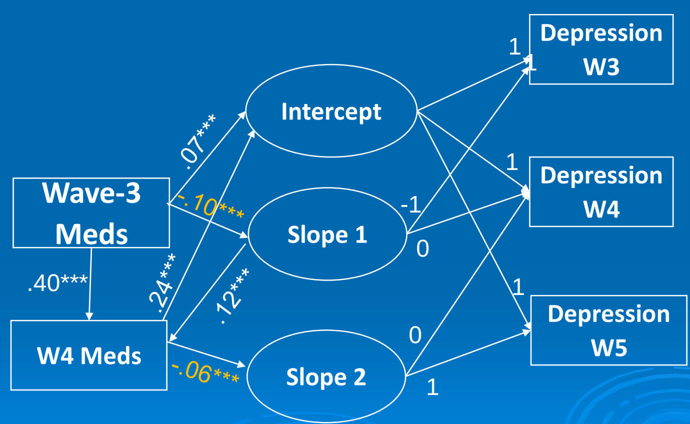
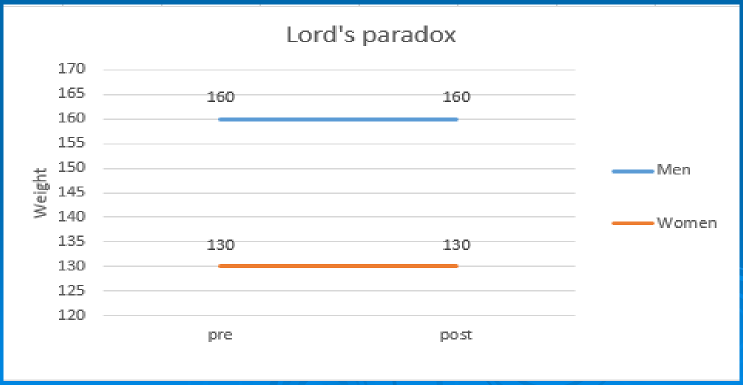


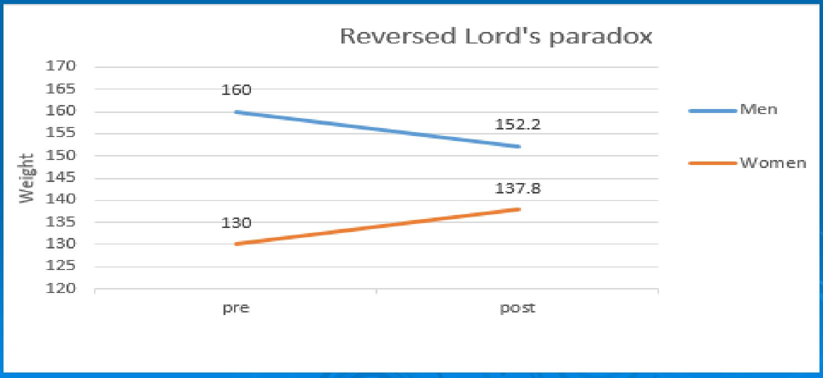
Simulated Lord's Paradox

- Means: 130 & 160; *SD* = 15
- Null H_0: No-Tx effect re simple gain scores



Simulated Reversed Lord's Paradox

- Ms: 130, 160, post: 137.8, 152.2; *SD* = 15
- Null H_0: No-Tx effect re ANCOVA



Mean Results (1000 Repl's)

Lord's Paradox		
	ANCOVA	DIFFS-IN-DIFFS
Predicted Sex Diff in Weight	-15.6***	-.02

Reversed Lord's Paradox		
	ANCOVA	DIFFS-IN-DIFFS
Predicted Sex Diff in Weight	.02	15.61

ANCOVA assumptions

- NID (0, e^2) residuals
- Homogeneous variance
- Homogeneous stability *r*'s
- Equal group pretest means!
  - Within-group stability *r* estimates shrinkage of means from pre- to post-test
- Linearity of regression

Simulation Results on Paradox Varying Distribution, Slope, and Standard Deviation

Normality	***SD*(g)**	***SD*(b)**	***Corr*(g)**	***Corr*(b)**	**y0(g)**	**y0(b)**	**y1(g)**	**y1(b)**	***d***	b_1
	Data settings				Simulated results					
Pretest means are different: mean of girls' pretest weight (130), mean of boys' pretest weight (160)										
Assuming the simple gain score null H_0 is correct, setting mean of girls' posttest weight to 130, & mean of boys' posttest weight to 160										
Yes	5	15	0	0.48	130.01	160.00	129.99	159.99	0.00	-17.05***
Yes	15	15	0	0.48	130.02	160.00	129.98	159.99	-0.03	-22.81***
Yes	5	15	0.48	0	130.01	160.01	130.00	159.99	0.01	-28.54***
Yes	15	15	0.48	0	130.02	160.01	129.99	159.99	-0.01	-22.79***
Yes	5	15	0.48	0.48	130.01	160.00	130.00	159.99	0.00	-15.60***
Yes	**15**	**15**	**0.48**	**0.48**	**130.02**	**160.00**	**129.99**	**159.99**	**-0.02**	**-15.60*** **
No	5	15	0	0.48	85.00	92.50	82.00	88.00	1.50	-5.98***
No	15	15	0	0.48	85.00	92.50	82.01	88.00	1.50	-5.97***
No	5	15	0.48	0	85.00	92.50	82.00	88.00	1.51	-5.99***
No	15	15	0.48	0	85.00	92.50	82.00	88.00	1.51	-5.97***
No	5	15	0.48	0.48	85.00	92.50	82.00	88.00	1.50	-5.97***
No	15	15	0.48	0.48	85.00	92.50	82.00	88.00	1.50	-5.96***
Assuming the ANCOVA null H_0 is correct by setting means of girls' and boys' posttest weights to those predicted by slope of 0.48										
Yes	5	15	0.48	0.48	130.00	160.01	137.80	152.20	15.61***	0.05
Yes	**15**	**15**	**0.48**	**0.48**	**129.99**	**160.01**	**137.80**	**152.20**	**15.61*** **	**0.02**
No	5	15	0.48	0.48	85.00	92.50	83.56	86.44	4.63	-2.86
No	15	15	0.48	0.48	84.99	92.50	83.56	86.44	4.63	-2.84

slope

SD

Normality

Simulation Results on Paradox Varying Distribution, Slope, and Standard Deviation

Normality	***SD*(g)**	***SD*(b)**	***Corr*(g)**	***Corr*(b)**	**y0(g)**	**y0(b)**	**y1(g)**	**y1(b)**	***d***	b_1
	Data settings				Simulated results					
Pretest means are the same: mean of girls' pretest weight (145), mean of boys' pretest weight (145)										
Assuming the null H_0 is correct while setting the means of girls' and boys' posttest weights to 145 with slope coefficient of 0.48										
Yes	5	15	0.48	0.48	145.00	145.01	145.00	145.00	0.01	0.00
Yes	15	15	0.48	0.48	144.99	145.01	145.00	145.00	0.01	0.00
No	5	15	0.48	0.48	88.75	88.75	85.00	85.00	0.01	0.00
No	15	15	0.48	0.48	88.74	88.75	85.00	85.00	0.01	0.00
Assuming alternative H_A is correct, setting the mean of girls' posttest weight to 130 & the mean of boys' posttest weight to 160										
Yes	5	15	0	0.48	145.01	145.00	129.99	159.99	-30.00***	-30.00***
Yes	15	15	0	0.48	145.02	145.00	129.98	159.99	-30.03***	-30.02***
Yes	5	15	0.48	0	145.01	145.01	130.00	159.99	-29.99***	-30.00***
Yes	15	15	0.48	0	145.02	145.01	129.99	159.99	-30.01***	-30.01***
Yes	5	15	0.48	0.48	145.01	145.00	130.00	159.99	-30.00***	-30.00***
Yes	15	15	0.48	0.48	145.02	145.00	129.99	159.99	-30.02***	-30.01***
No	5	15	0	0.48	88.75	88.75	82.00	88.00	-6.00*	-5.99***
No	15	15	0	0.48	88.75	88.75	82.01	88.00	-6.00*	-5.99***
No	5	15	0.48	0	88.75	88.75	82.00	88.00	-5.99*	-5.99***
No	15	15	0.48	0	88.75	88.75	82.00	88.00	-5.99*	-5.99***
No	5	15	0.48	0.48	88.75	88.75	82.00	88.00	-6.00*	-5.99***
No	15	15	0.48	0.48	88.75	88.75	82.00	88.00	-6.00*	-5.99***

Note: $^*p < .05$. $^{***}p < .0001$

Normality – normal distribution, *SD* – standardized deviation, *Corr* – correlation between pretest and posttest, (b) – boys, (g) – girls, y0 – pretest weight, y1 – posttest weight, *d* – CHANGE approach, b_1 – ANCOVA approach.

The first bold font is Lord's paradox and the second bold font is Lord's paradox reversed.

Variations in Pre- and Post-Test Means

- Differences in effect size is f(pre-test mean difference, stability *r*)
- $b_x - d = (1 - r_{pst,pre})\ (\bar{y}_{Tx,pre} - \bar{y}_{Cntl,pre})$
  - Assumes homogeneous variances
    - Tx and control
    - Pre-test and post-test
- Some combinations in "Table 3": contrasting signs, some $p < .05$

Conclusions

- Lord's paradox related to violation of ANCOVA assumption of independence of covariate & Tx
  - Artificial equating of pre-tests may not help
    - Group-centered ANCOVA = simple gain scores
    - Homogenous groups & matching = ANCOVA
- Best option? Justifying null H_0
  - Plausibility? Differs for antisocial & wt gain
  - Predicting Tx diffs in 2+ pre-test waves

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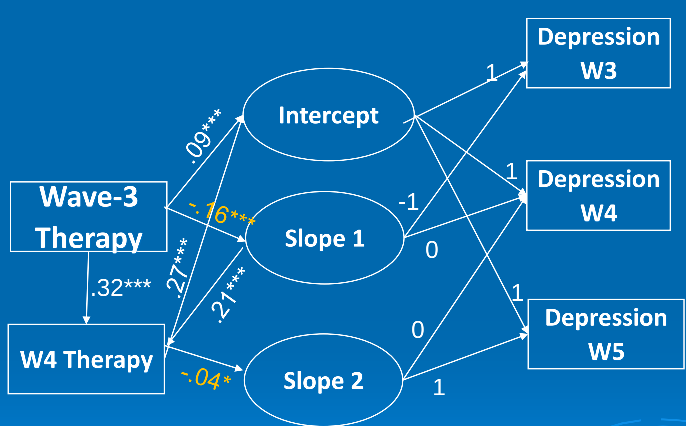
Extra Slides Not Used

Meta-Analytic *r*'s & β's: Effect of Spanking on Externalizing

	$r(y_1, x)$	$r(y_2, x)$	$r(y_1, y_2)$	$\beta(y_2 x.y_1)$	$\beta((y_2 - y_1)x)$
Spanking	.20	.16	.46	.07***	-.04*

- 2 β's have opposite signs
- Same pattern after reversing occasions
  - β = .05 & β = –.05, *ps* < .01
- Larzelere et al. (in press) *Child Development*



Mean *r*'s & β's for Antisocial

	$r(y_1, x)$	$r(y_2, x)$	$r(y_1, y_2)$	$\beta(y_2 x.y_1)$	$\beta((y_2 - y_1)x)$
Hostile-ineff	.49	.35	.56	.09	-.15
Disc tactics	.27	.20	.56	.05	-.07
Tx & *Ritalin*	.11	.13	.56	.07	.02

- 2 β's have opposite signs
  - (except corrective actions by professionals, which became non-significant)

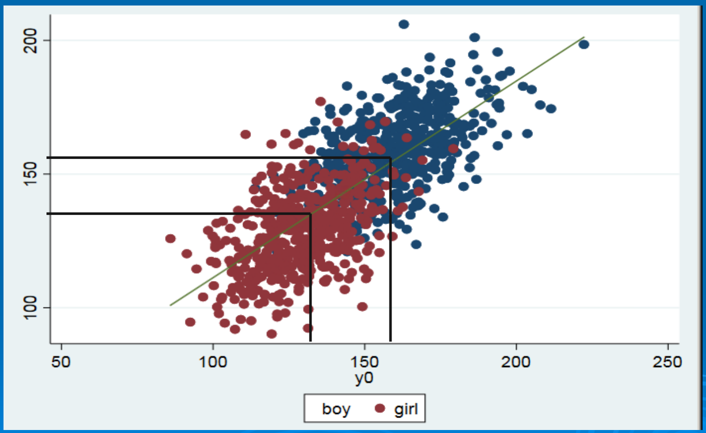
Counterfactual for Tx to Beat

- Simple Changes (Gains)
  - Any improvement in Tx group
- Residualized Changes (Gains)
  - More improvement than regression toward grand mean

Simulate Lord's Paradox

- Repeated Measures ANOVA
- Counterfactual in Null H_0:
  - No Tx effect: Tx & Control = in simple change
    - Mean Y_{Tx} – Mean Y_{Ctl} same on post- & on pre-test
- ANCOVA (fits reversed Lord's paradox)
- Counterfactual in Null H_0:
  - No Tx effect: Group means regress toward grand mean from pre- to post-test
    - Mean Y_{Tx} – Mean Y_{Ctl} shrinks from pre- to post-

Simulated Lord's Paradox



Reversed Lord's Paradox