



Analysis of Psychological Data

Lab 11. What Makes Factorial ANOVA Special: Main Effect and Interaction Effect

Ihnwhi Heo (iheo2@ucmerced.edu)

Quantitative Methods, Measurement, and Statistics

Website: <https://ihnwhiheo.github.io>

Office: <https://ucmerced.zoom.us/j/2093557522> (Friday 1:30 - 3:30 pm)



What are we going to do?

Recap to give you a big picture

Main effect

Interaction effect

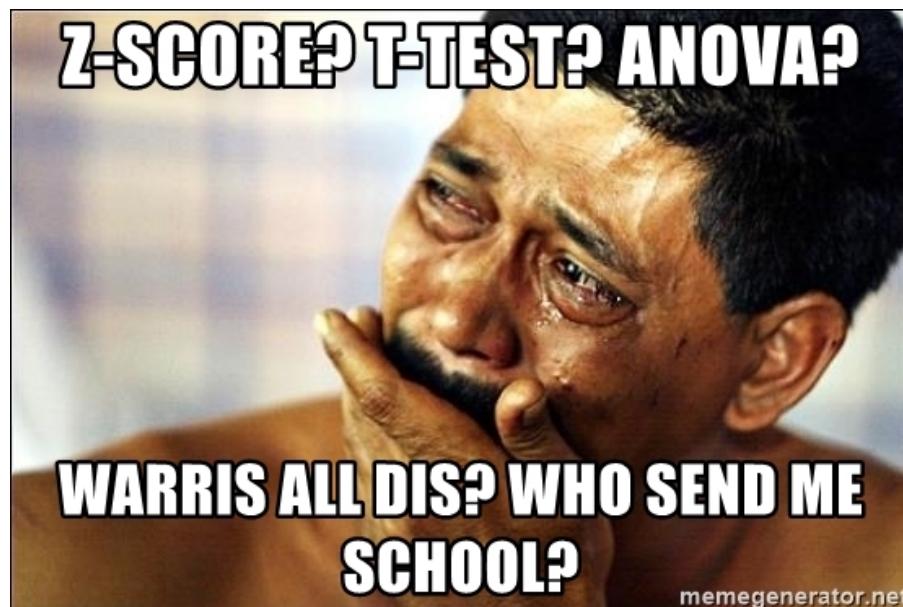
Do it together



Factorial ANOVA

Big idea

Goal is to compare the means of the dependent variables across different categories of the independent variables





Factorial ANOVA

N-way (or N-factor) ANOVA (# of factors)

There are N independent variables (IVs = factors = grouping variables)

$N = 1 \rightarrow$ One-way ANOVA = ANOVA with 1 IV
 \rightarrow One hypothesis

$N = 2$ or more \rightarrow Factorial ANOVA \rightarrow Start to consider interactions
 \rightarrow Multiple hypotheses



Factorial ANOVA

Two-way ANOVA

→ null hypothesis H_0 : Nothing is going on. No effect (no difference)!

H_0 : IV1 does not have a significant effect on DV

= Group means on DV across levels in IV1 are not different

H_0 : IV2 does not have a significant effect on DV

= Group means on DV across levels in IV2 are not different

H_0 : Interaction between IV1 and IV2 does not have a significant effect on DV



Factorial ANOVA

Two-way ANOVA

→ alternative hypothesis H_1 : Something is going on. There is an effect!

H_1 : IV1 has a significant effect on DV

= Group means on DV across levels in IV1 are different

H_1 : IV2 has a significant effect on DV

= Group means on DV across levels in IV2 are different

H_1 : Interaction between IV1 and IV2 has a significant effect on DV



Effect

Wait... we have been using a word **effect** a lot...

Null hypothesis (no effect), alternative hypothesis (there is an effect), effect size...

Let me ask you: What is an effect in statistics?



Effect

Intuitively, effect means '**differences**' in statistics!

Null hypothesis → no effect → no difference

Alternative hypothesis → there is an effect → there is a difference

Effect size → How big our differences are



Effect

Main effect and interaction effect are also about 'differences'!

Remember, ANOVA is all about comparing means...

Working example

Two-way ANOVA where two factors are school type and region

Dependent variable: Happiness

School type (UC Merced and Merced College) & Region (California and Massachusetts)



Main effect

Mean differences across the levels of a single factor

An effect of a single factor averaged across levels of the other factors

Whether there are mean differences in happiness between UC Merced and Merced College
(or between California and Massachusetts)

Differences in marginal means

N-way ANOVA → There are N main effects

Two-way ANOVA → Two main effects!



Main effect

Mean differences across the levels of a single factor

An effect of a single factor averaged across levels of the other factors

Differences in marginal means

	UC Merced	Merced College	Mean
California	20	10	
Massachusetts	10	8	
Mean			



Main effect

Mean differences across the levels of a single factor

An effect of a single factor averaged across levels of the other factors

Differences in marginal means

	UC Merced	Merced College	Mean
California	20	10	$(20+10)/2$
Massachusetts	10	8	$(10+8)/2$
Mean	$(20+10)/2$	$(10+8)/2$	$(20+10+10+8)/4$



Main effect

Mean differences across the levels of a single factor

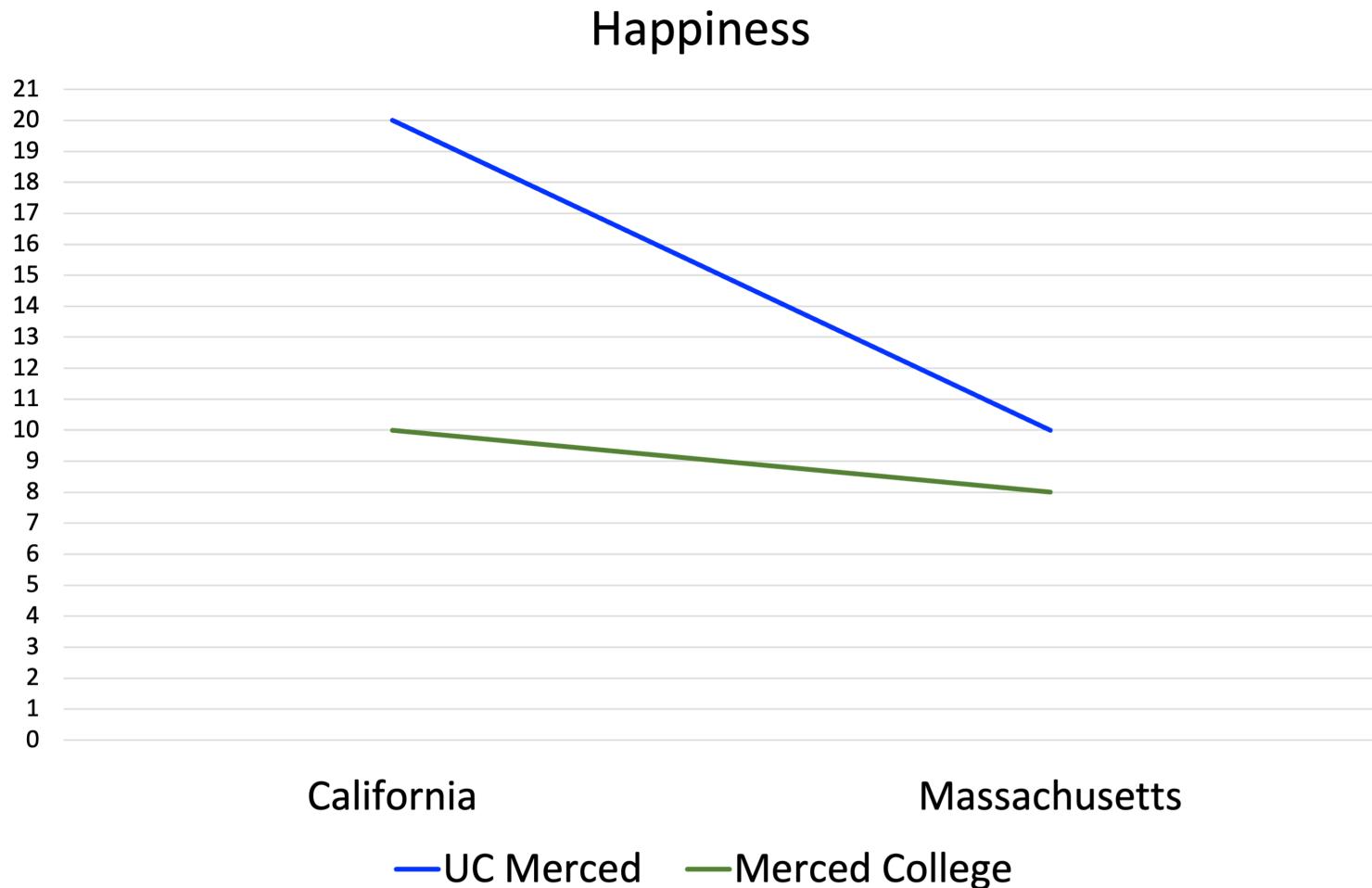
An effect of a single factor averaged across levels of the other factors

Differences in marginal means

	UC Merced	Merced College	Mean
California	20	10	15
Massachusetts	10	8	9
Mean	15	9	12



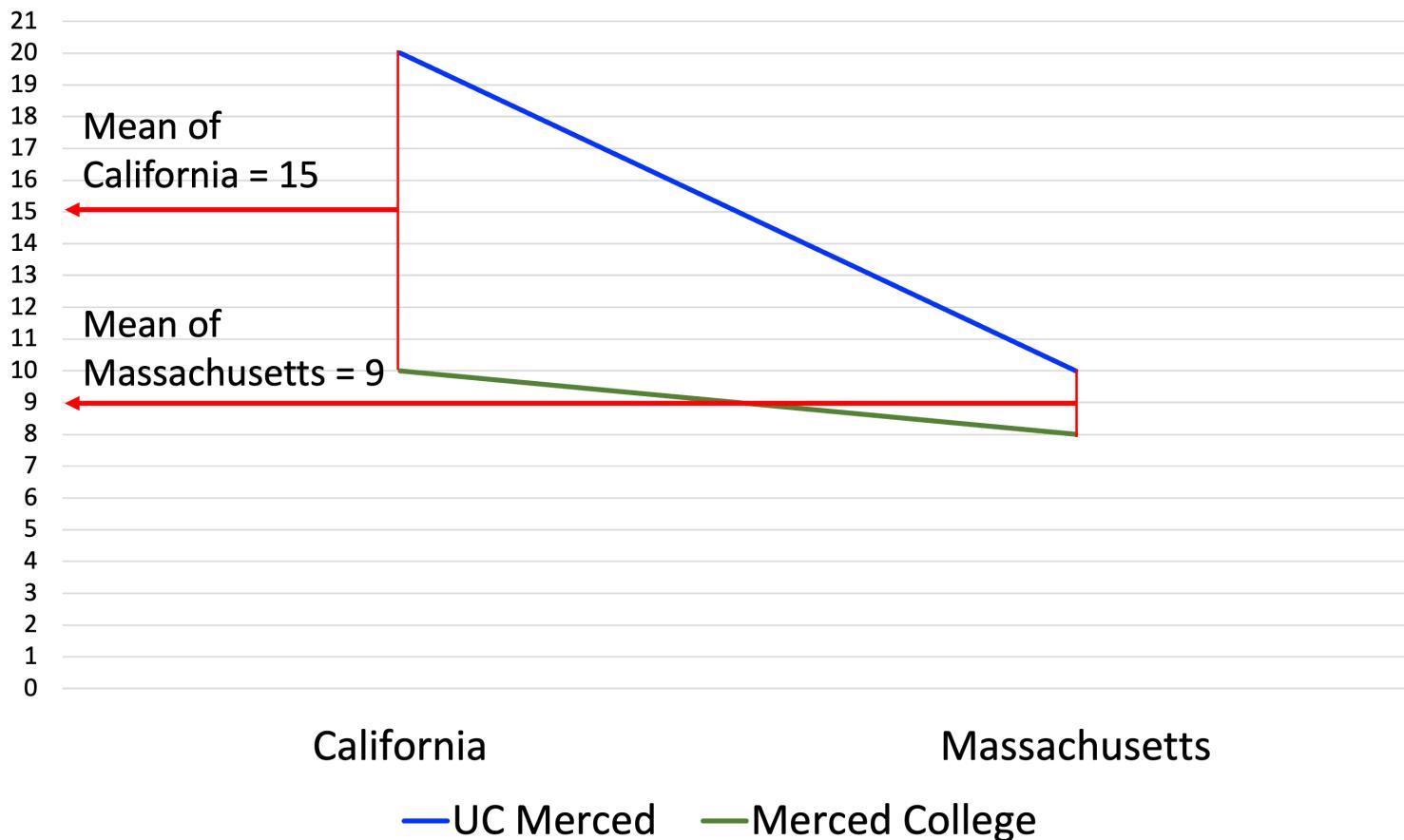
Main effect





Main effect

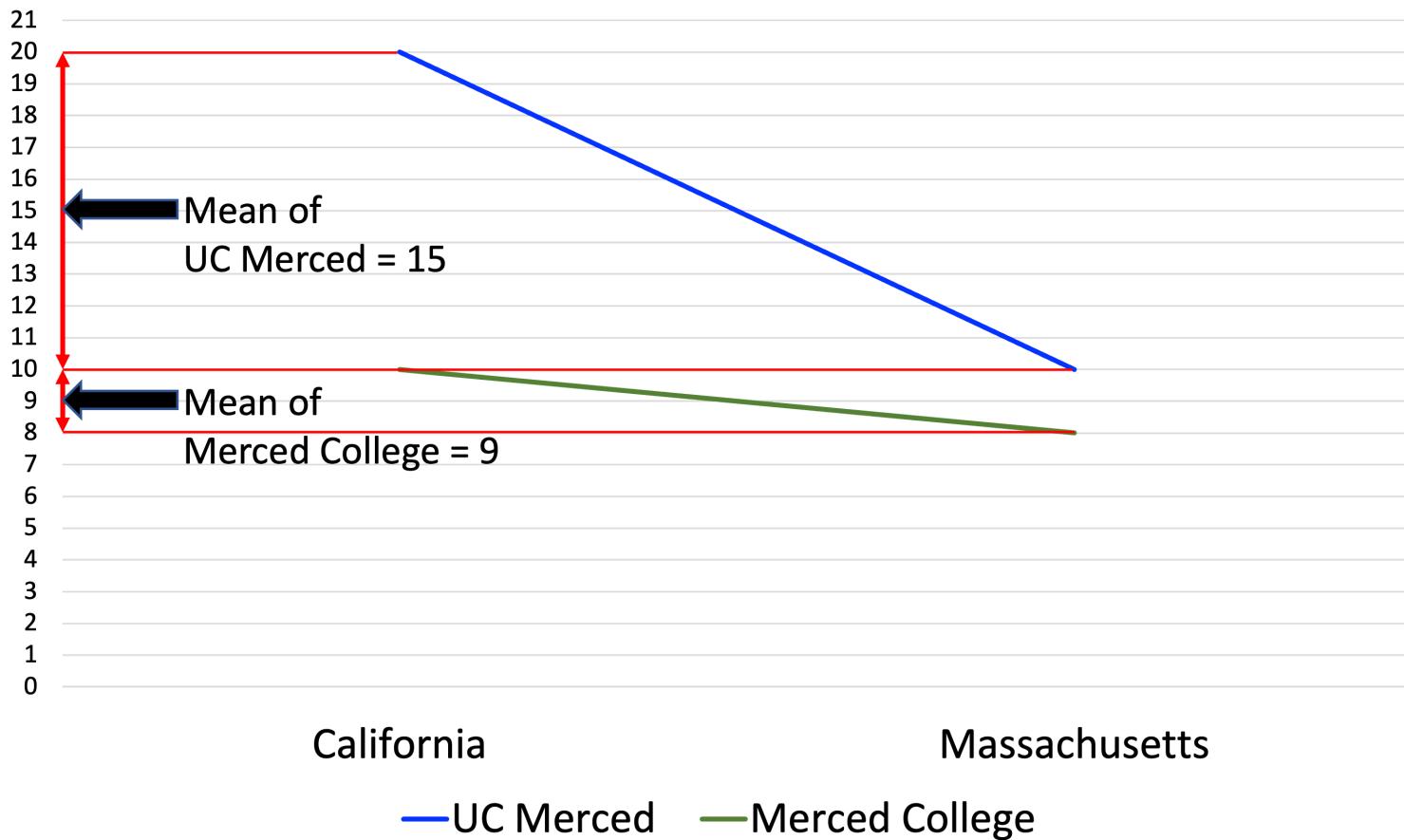
Happiness: Main Effect of Region





Main effect

Happiness: Main Effect of School Type





Interaction effect

If an effect of a single factor differs across levels of the other factors

Mean differences at each level of one factor change across the levels of the other factors

Whether the mean differences in happiness between two levels of school type (or region) change across the levels of region (or school type)

Differences in differences → unparalleled lines

N-way ANOVA → There are $2^N - N - 1$ interaction effects

Two-way ANOVA → One interaction effect!



Interaction effect

If an effect of a single factor differs across levels of the other factors

Mean differences at each level of one factor change across the levels of the other factors

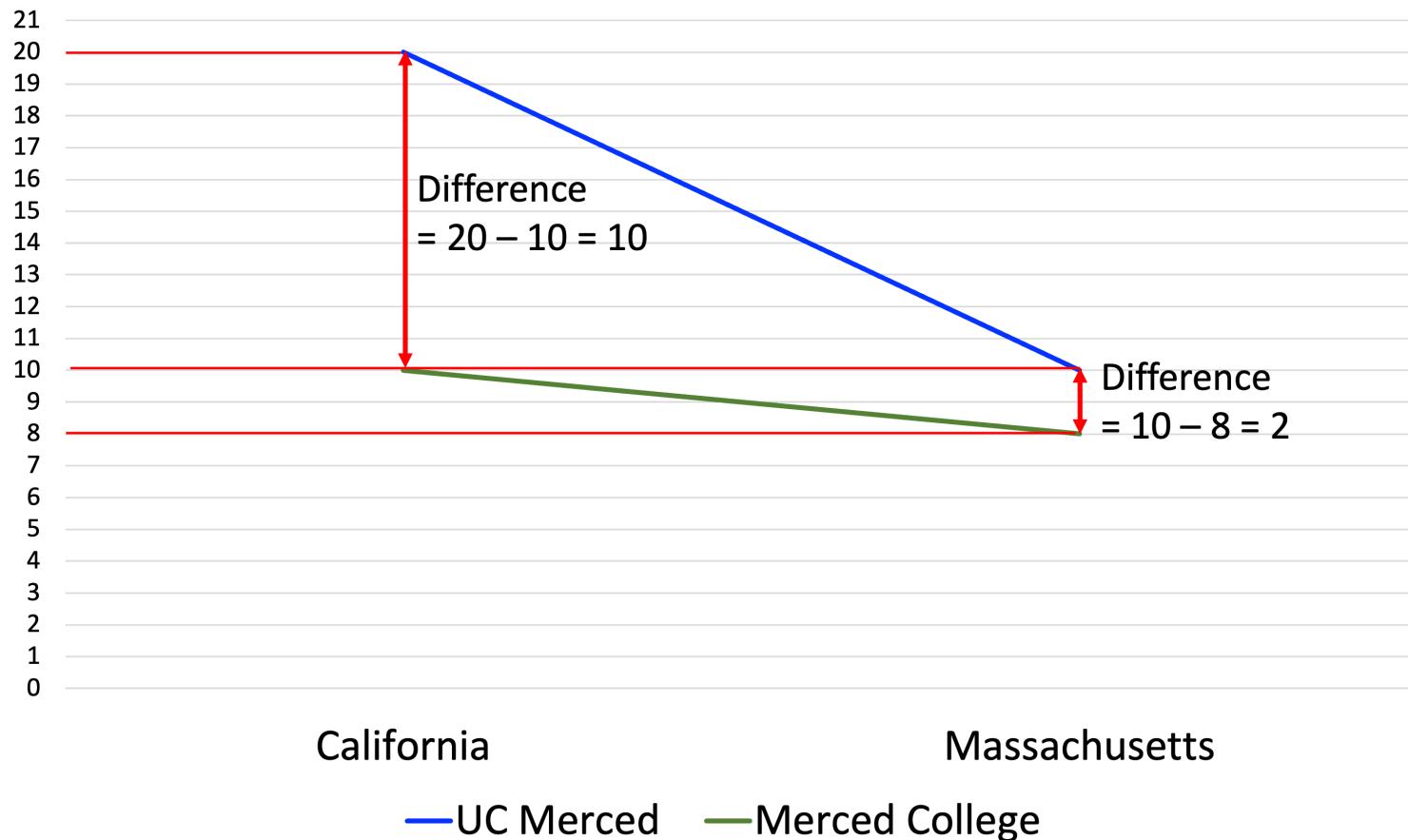
Differences in differences → unparalleled lines

	UC Merced	Merced College	Mean
California	20	10	15
Massachusetts	10	8	9
Mean	15	9	12



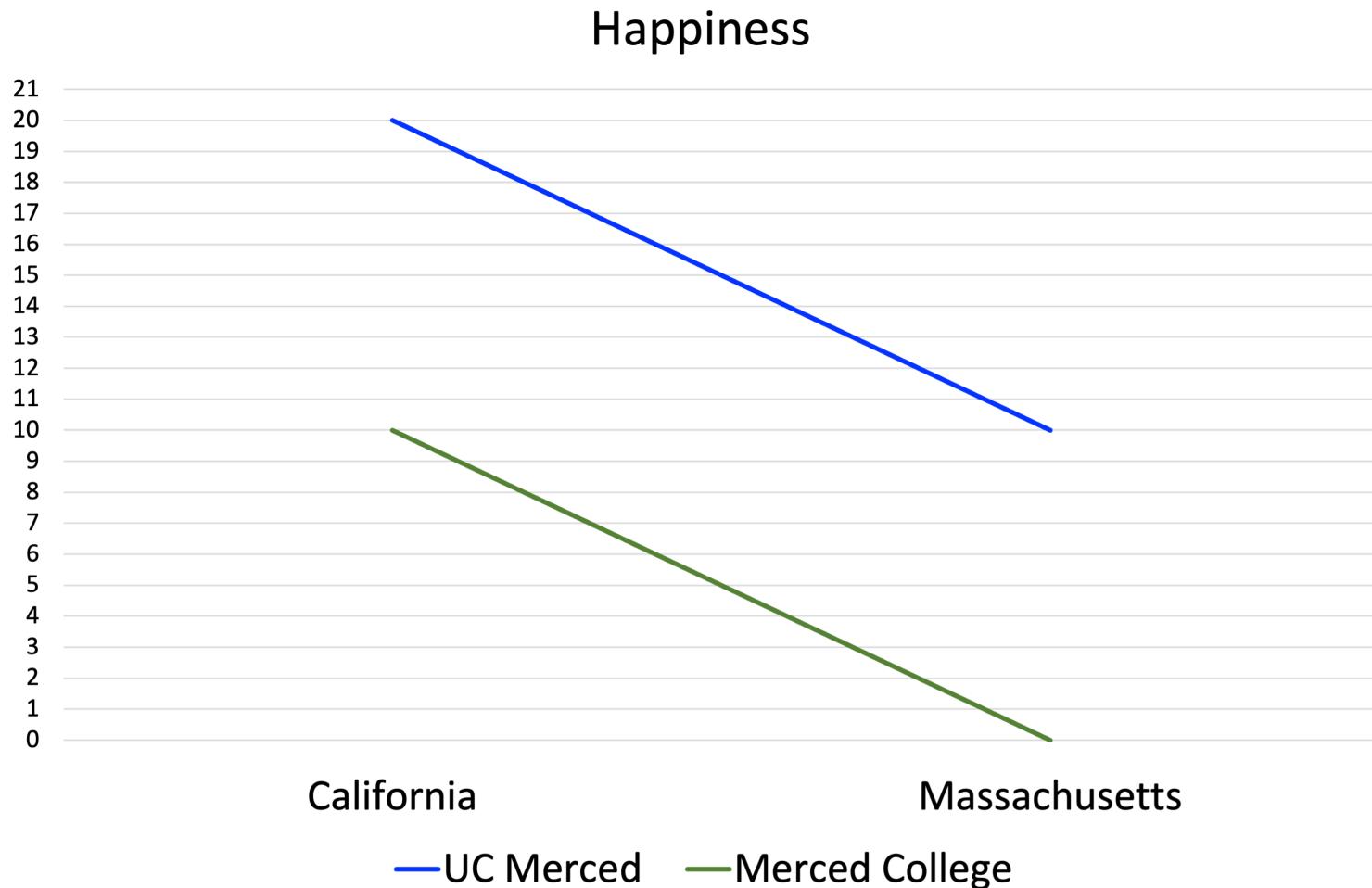
Interaction effect

Happiness: Interaction Effect



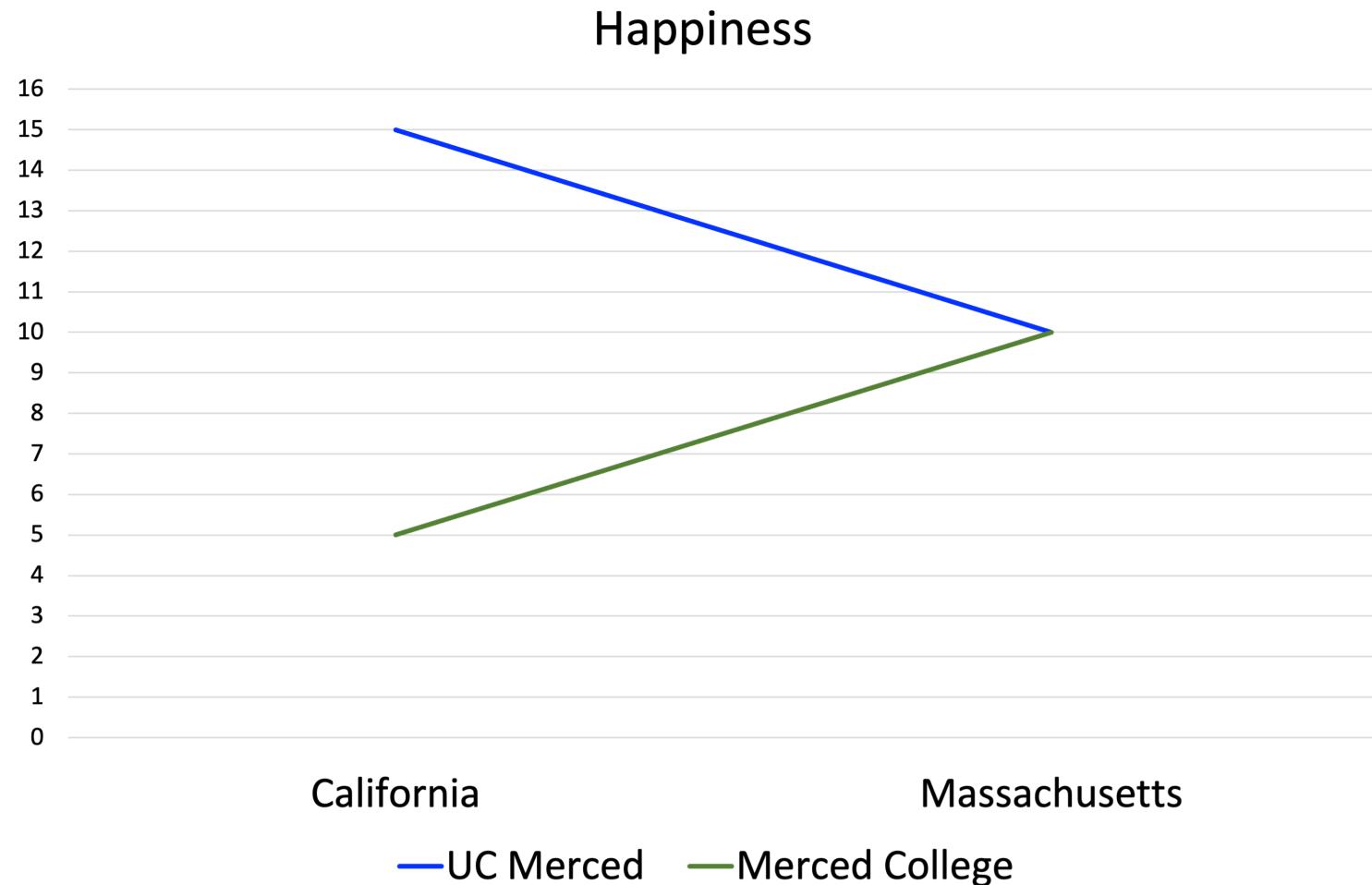


Do it together (Example 1)



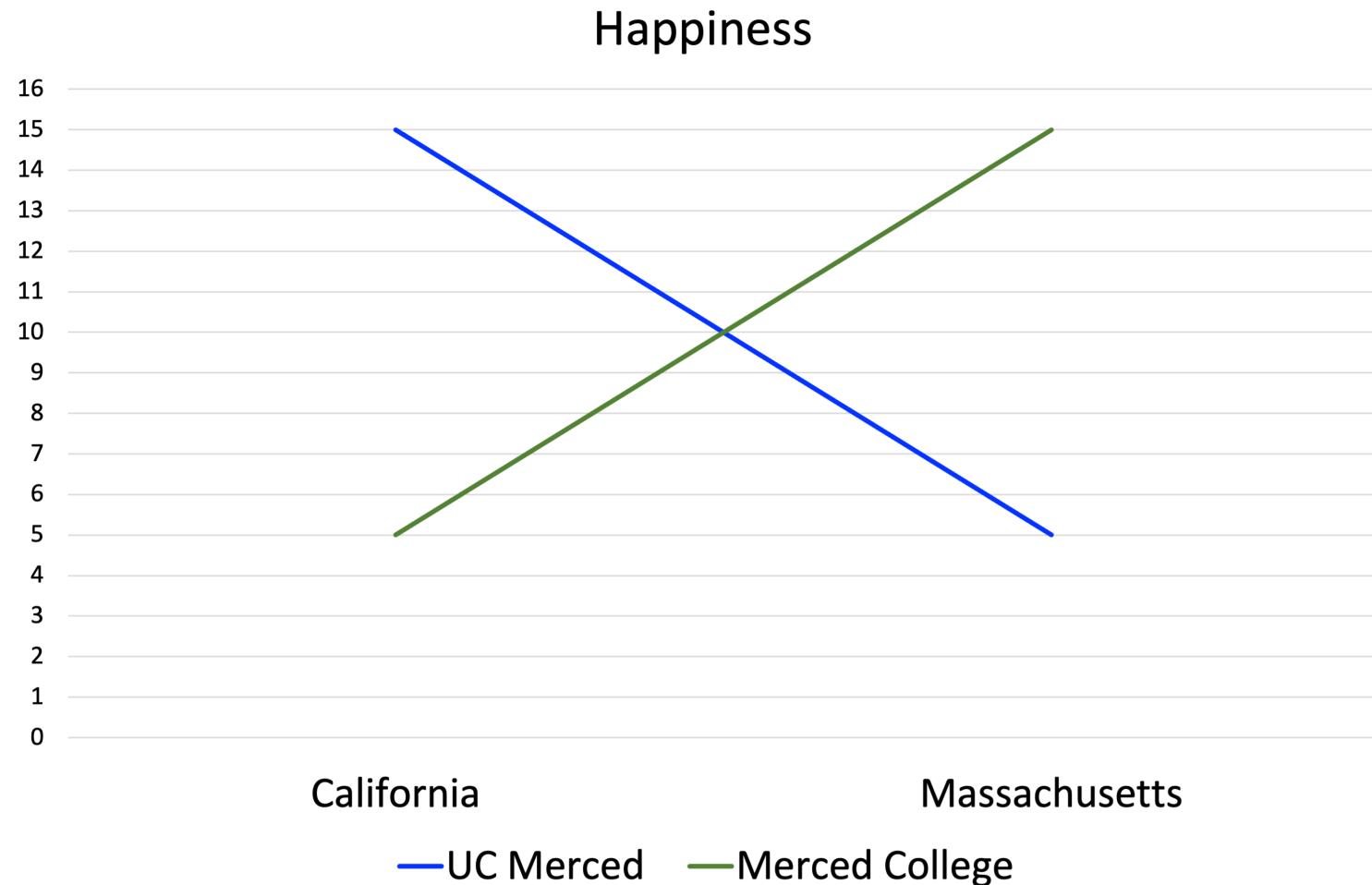


Do it together (Example 2)





Do it together (Example 3)





Do it together (Example 4)





Do it together

Answer key

Example	Main Effect of Region	Main Effect of School Type	Interaction Effect
1	O	O	X
2	X	O	O
3	X	X	O
4	O	X	X



Note

Whenever we say there are whether main effect or interaction effect, this does not necessarily mean these effects are statistically significant

It is enough for us to suspect there might be

To check statistical significance

→ p -value < α → Observed F value > Critical F value



Before you close...

Any questions or comments?

Shoot emails to iheo2@ucmerced.edu



Have a nice weekend!

