DIFF-IN-DIFF I

PMAP 8521: Program Evaluation for Public Service

October 21, 2019

Fill out your reading report on iCollege!

PLAN FOR TODAY

Quasi-experiments

Interactions and regression

Two wrongs make a right

Analyzing DDs

QUASI-EXPERIMENTS

RCTs are great!

Super impractical to do all the time though!

QUASI-EXPERIMENTS

You can't always randomly assign people to do things

So let other people (or the government, or nature) do it

QUASI-EXPERIMENTS

Quasi-experiment = a situation where you, as researcher, did not assign people to treatment/control

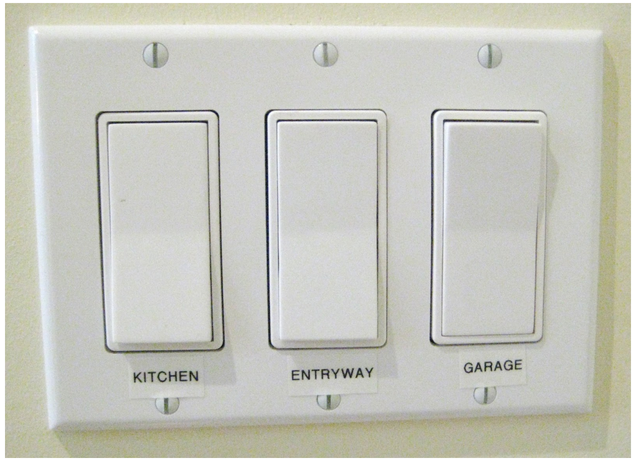
External validity

Selection

INTERACTIONS AND REGRESSION

SLIDERS AND SWITCHES

$$\hat{\text{happiness}} = \beta_0 + \beta_1 \text{life expectancy} + \epsilon$$



$$\begin{aligned}\hat{\text{happiness}} = \beta_0 + \beta_1 \text{Europe} + \beta_2 \text{Latin America} + \\ \beta_3 \text{MENA} + \beta_4 \text{North America} + \\ \beta_5 \text{South Asia} + \beta_6 \text{Sub-Saharan Africa} + \epsilon\end{aligned}$$

```r
model_life_school_region <-
  lm(happiness_score ~ life_expectancy + school_enrollment + region,
     data = world_happiness)
```

term	estimate	std_error	statistic	p_value
intercept	-2.821	1.355	-2.083	0.04
life_expectancy	0.102	0.017	5.894	0
school_enrollment	0.008	0.01	0.785	0.435
regionEurope & Central Asia	0.031	0.255	0.123	0.902
regionLatin America & Caribbean	0.732	0.294	2.489	0.015
regionMiddle East & North Africa	0.189	0.317	0.597	0.552
regionNorth America	1.114	0.581	1.917	0.058
regionSouth Asia	-0.249	0.45	-0.553	0.582
regionSub-Saharan Africa	0.326	0.407	0.802	0.425

$$\widehat{\text{happiness}} = \beta_0 + \beta_1 \text{life expectancy} + \beta_2 \text{school enrollment} + \\ \beta_3 \text{Europe} + \beta_4 \text{Latin America} + \beta_5 \text{MENA} + \\ \beta_6 \text{North America} + \beta_7 \text{South Asia} + \beta_8 \text{SSA} + \epsilon$$

INDICATORS & INTERACTIONS

Indicators (dummies)

Change in **intercept** for specific group

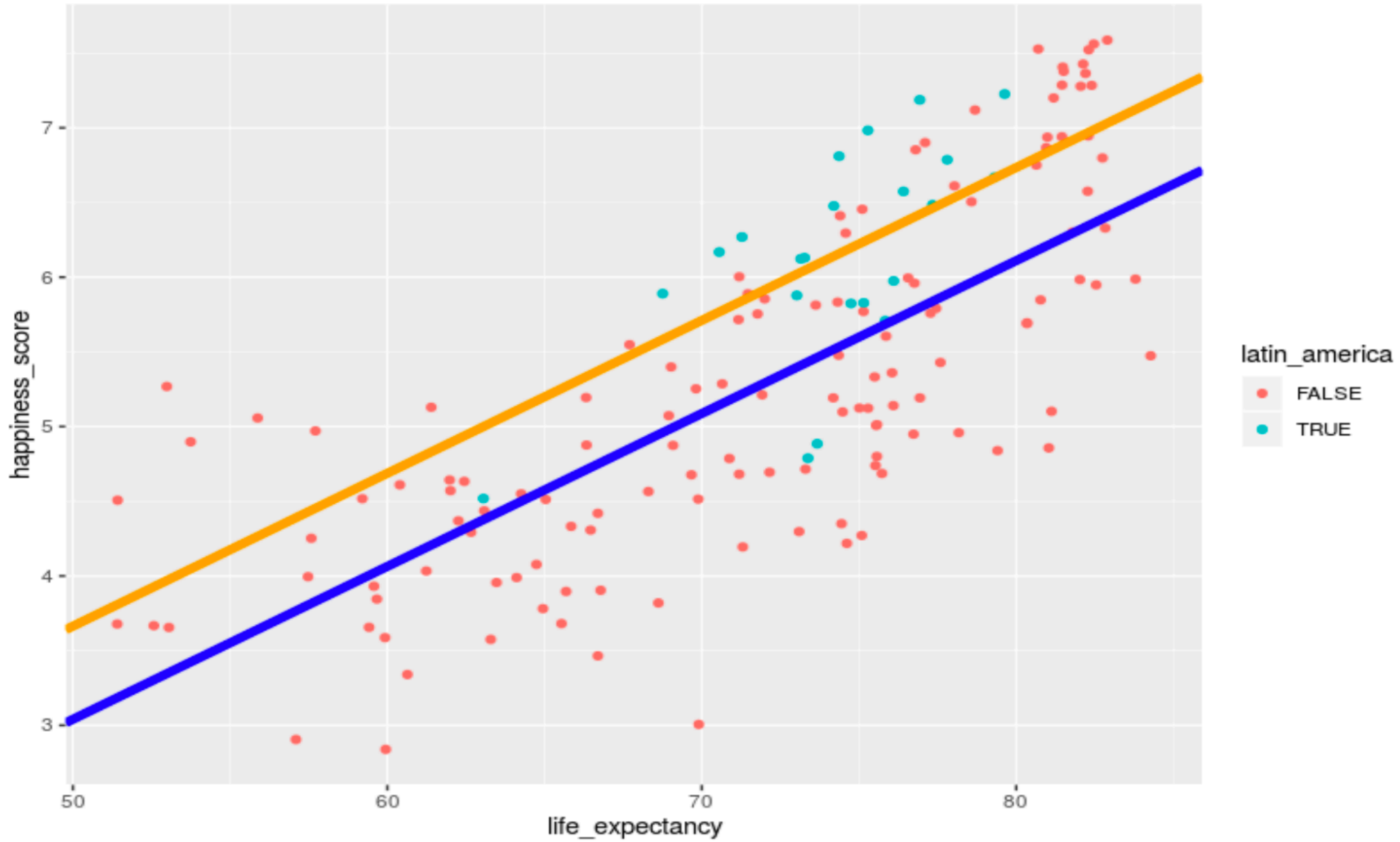
Interactions

Change in **slope** for specific group

```r
model_life_la <-
  lm(happiness_score ~ life_expectancy + latin_america, data = world_happiness)
```

term <chr>	estimate <dbl>	std.error <dbl>	statistic <dbl>	p.value <dbl>
(Intercept)	-2.0770858	0.536773852	-3.869573	1.613712e-04
life_expectancy	0.1023494	0.007449708	13.738707	1.954881e-28
latin_americaTRUE	0.6234255	0.172757872	3.608666	4.171373e-04

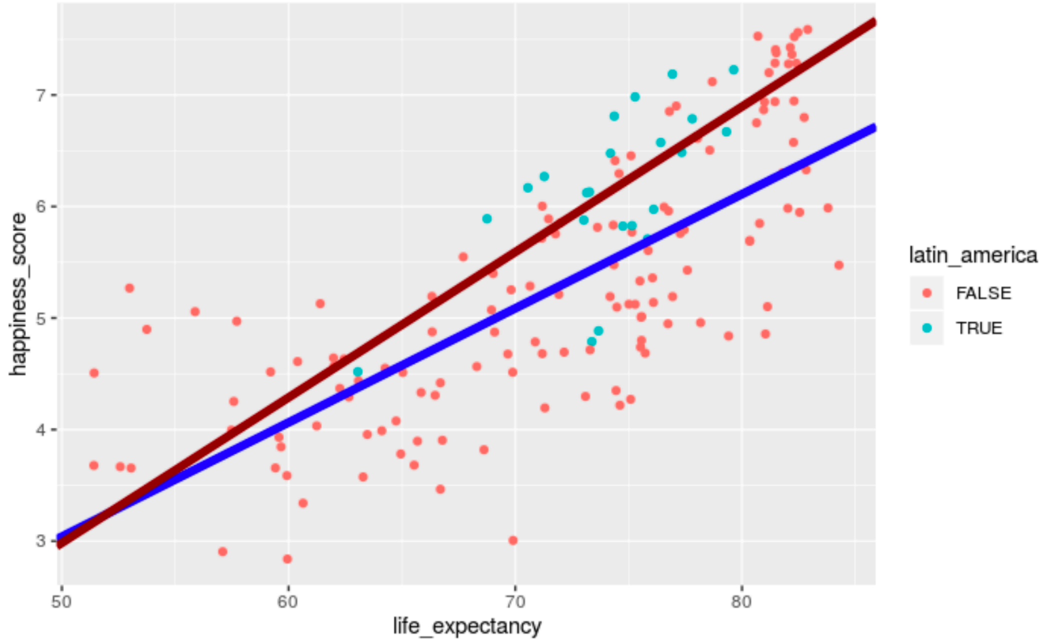
3 rows



```r
model_life_la_int <-
  lm(happiness_score ~ life_expectancy + latin_america +
                     (life_expectancy * latin_america), data = world_happiness)
```

term <chr>	estimate <dbl>	std.error <dbl>	statistic <dbl>	p.value <dbl>
(Intercept)	-2.01948544	0.545386030	-3.7028551	2.983292e-04
life_expectancy	0.10154408	0.007570767	13.4126556	1.649813e-27
latin_americaTRUE	-1.51554651	3.364657434	-0.4504311	6.530456e-01
life_expectancy:latin_americaTRUE	0.02884127	0.045307973	0.6365606	5.253749e-01

4 rows



Is there a discount when combining cheese and chili?

What is the cheese effect?

What is the chili effect?

What is the chili × cheese effect?

TWO WRONGS MAKE A RIGHT

RAISING THE MINIMUM WAGE

What happens if you raise the minimum wage?

Economic theory says there should be fewer jobs

New Jersey in 1992

$4.25 → $5.05

BEFORE VS. AFTER

Average fast food jobs in NJ

Before: 20.44

After: 21.03

Δ: 0.59

Does this show the causal effect?

TREATMENT VS. CONTROL

Average fast food jobs in states

PA_{after}: 21.17

NJ_{after}: 21.03

Δ: −0.14

Does this show the causal effect?

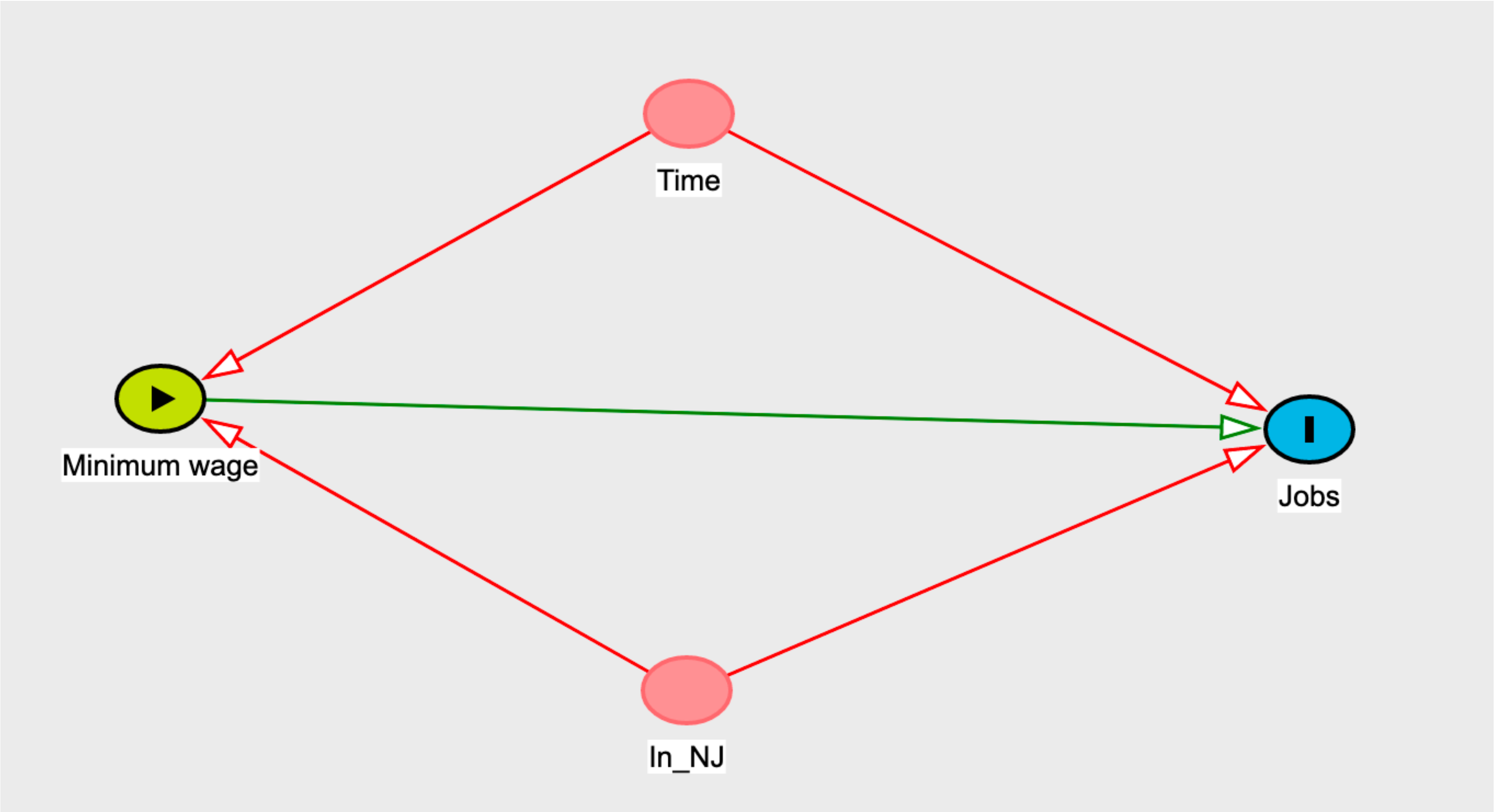
PROBLEMS

Comparing only before/after

Impossible to know if growth happened because of treatment or just naturally

Comparing only treatment/control

Impossible to know if any changes happened because of natural growth


Time
Minimum wage
Jobs
In_NJ

	Pre mean	Post mean
Treatment	A (not yet treated)	B (treated)
Control	C (never treated)	D (never treated)

	Pre mean	Post mean	Δ (post−pre)
Treatment	A (not yet treated)	B (treated)	B−A
Control	C (never treated)	D (never treated)	D−C

Growth!

	Pre mean	Post mean
Treatment	A (not yet treated)	B (treated)
Control	C (never treated)	D (never treated)
Δ (trtmt−ctrl)	A−C	B−D

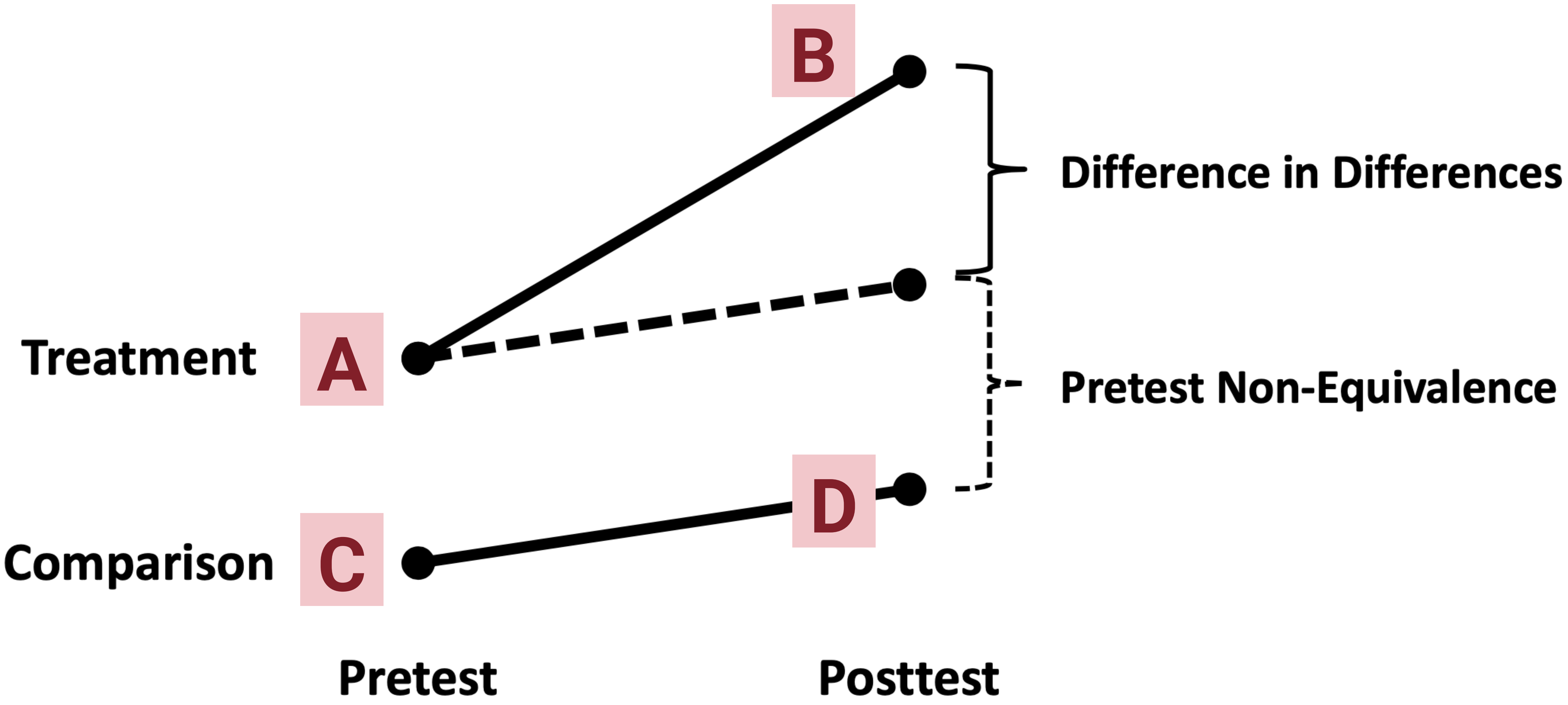
Within-group effects

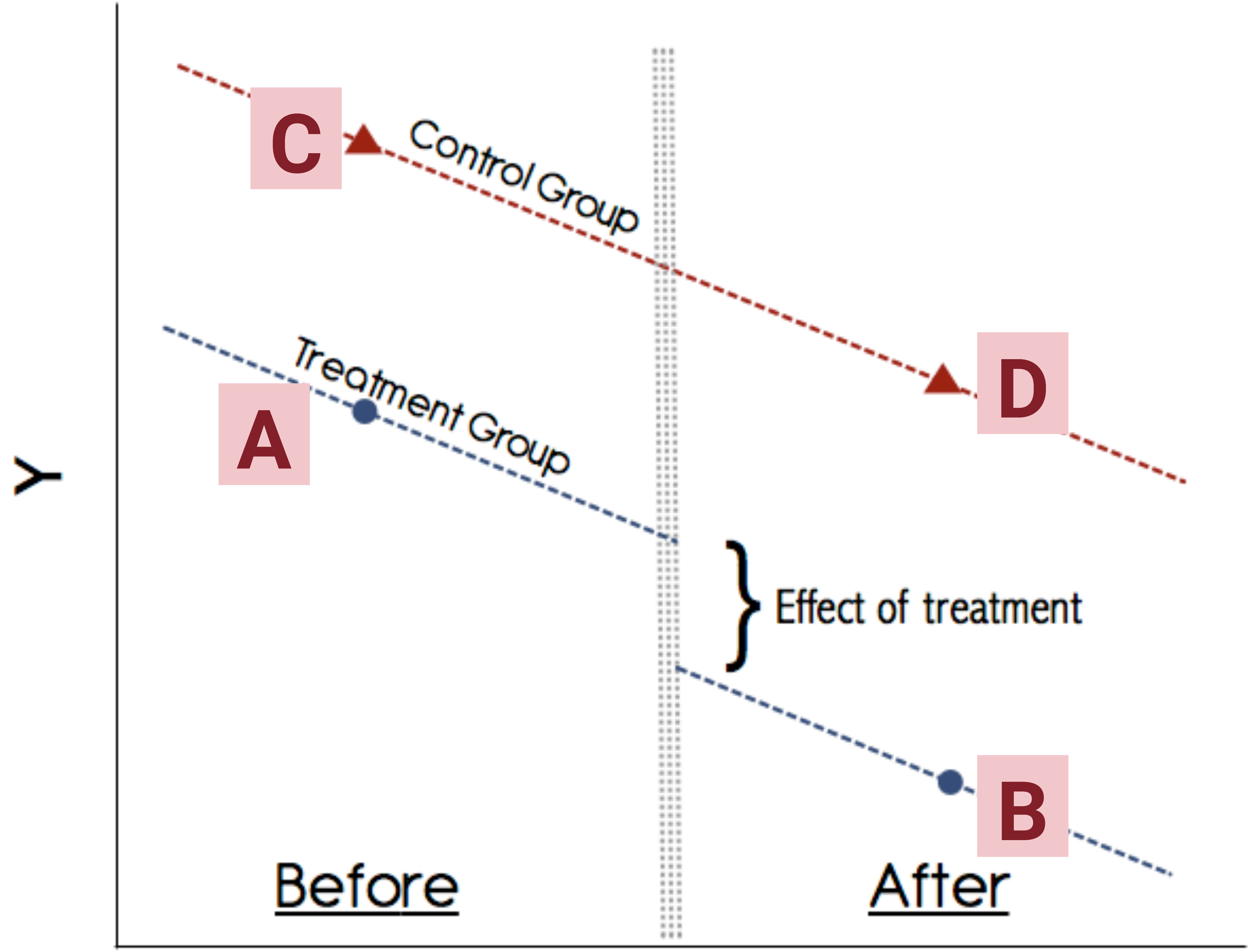
	Pre mean	Post mean	Δ (post−pre)
Treatment	A (not yet treated)	B (treated)	B−A
Control	C (never treated)	D (never treated)	D−C
Δ (trtmt−ctrl)	A−C	B−D	(B−A) − (D−C)

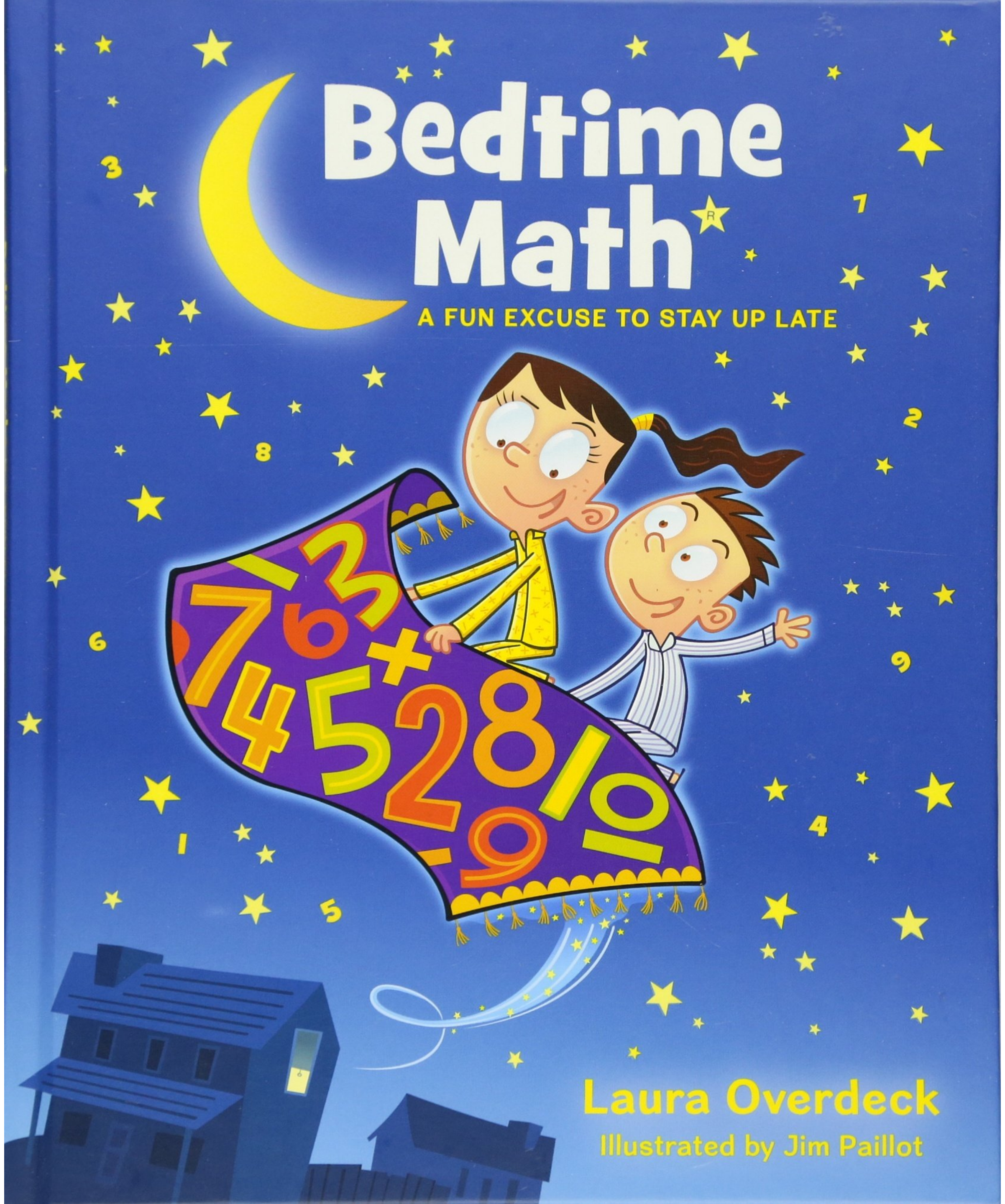
Growth of treatment – growth of control (DiD!)

$$
\begin{aligned}
\mathrm{DD} =& (\bar{x}_{\text{treatment, post}} - \bar{x}_{\text{treatment, pre}}) \\
& - (\bar{x}_{\text{control, post}} - \bar{x}_{\text{control, pre}})
\end{aligned}
$$

	Pre mean	Post mean	Δ (post−pre)
NJ	A 20.44	B 21.03	B−A 0.59
PA	C 23.33	D 21.17	D−C −2.16
Δ (trtmt−ctrl)	A−C −2.89	B−D −0.14	(0.59) − (−2.16) = 2.76


B
Difference in Differences
Treatment
A
Pretest Non-Equivalence
D
Comparison
C
Pretest
Posttest


C
Control Group
Treatment Group
A
D
Y
Effect of treatment
B
Before
After

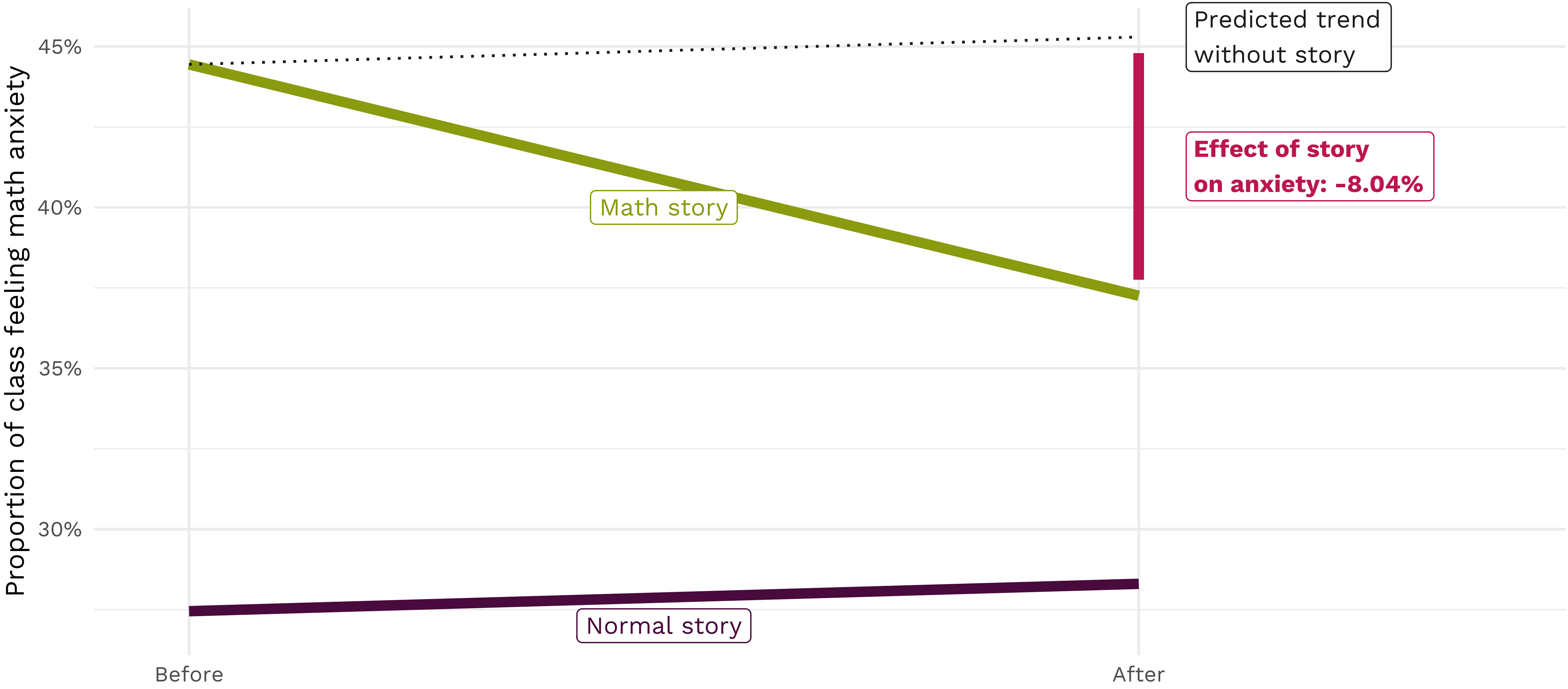

Bedtime Math
A FUN EXCUSE TO STAY UP LATE
Laura Overdeck
Illustrated by Jim Paillot

	Pre mean	Post mean	Δ (post−pre)
Math story	A	B	B−A
Normal story	C	D	D−C
Δ (trtmt−ctrl)	A−C	B−D	(B−A) − (D−C) =

R time!

Reading a story about math reduces math anxiety

Experiment in four 4th grade classes



Finding all the group means is tedious though!

What if there are other backdoors to worry about?

Regression to the rescue!


HOT DOGS
PLAIN $2.00
CHEESE $2.35
CHILI $2.35
CHILI CHEESE $2.70

$$
\begin{aligned}
Y_{it} = & \alpha + \beta \ \text{Group}_i + \gamma \ \text{Time}_t + \\
& \delta \ (\text{Group}_i \times \text{Time}_t) + \epsilon_{it}
\end{aligned}
$$

```r
model <- lm(outcome ~ group + time + group * time)
```

Group = 1/TRUE if treatment

Time = 1/TRUE if after

$$Y_{it} = \alpha + \beta \ \text{Group}_i + \gamma \ \text{Time}_t + \delta \ (\text{Group}_i \times \text{Time}_t) + \epsilon_{it}$$

```
model <- lm(outcome ~ group + time + group * time)
```

α = Mean of control, pre-treatment

β = Increase in outcome across groups

γ = Increase in outcome across time

δ = Difference in differences!

$$Y_{it} = \alpha + \beta \text{ Group}_i + \gamma \text{ Time}_t + \delta \text{ (Group}_i \times \text{Time}_t) + \epsilon_{it}$$

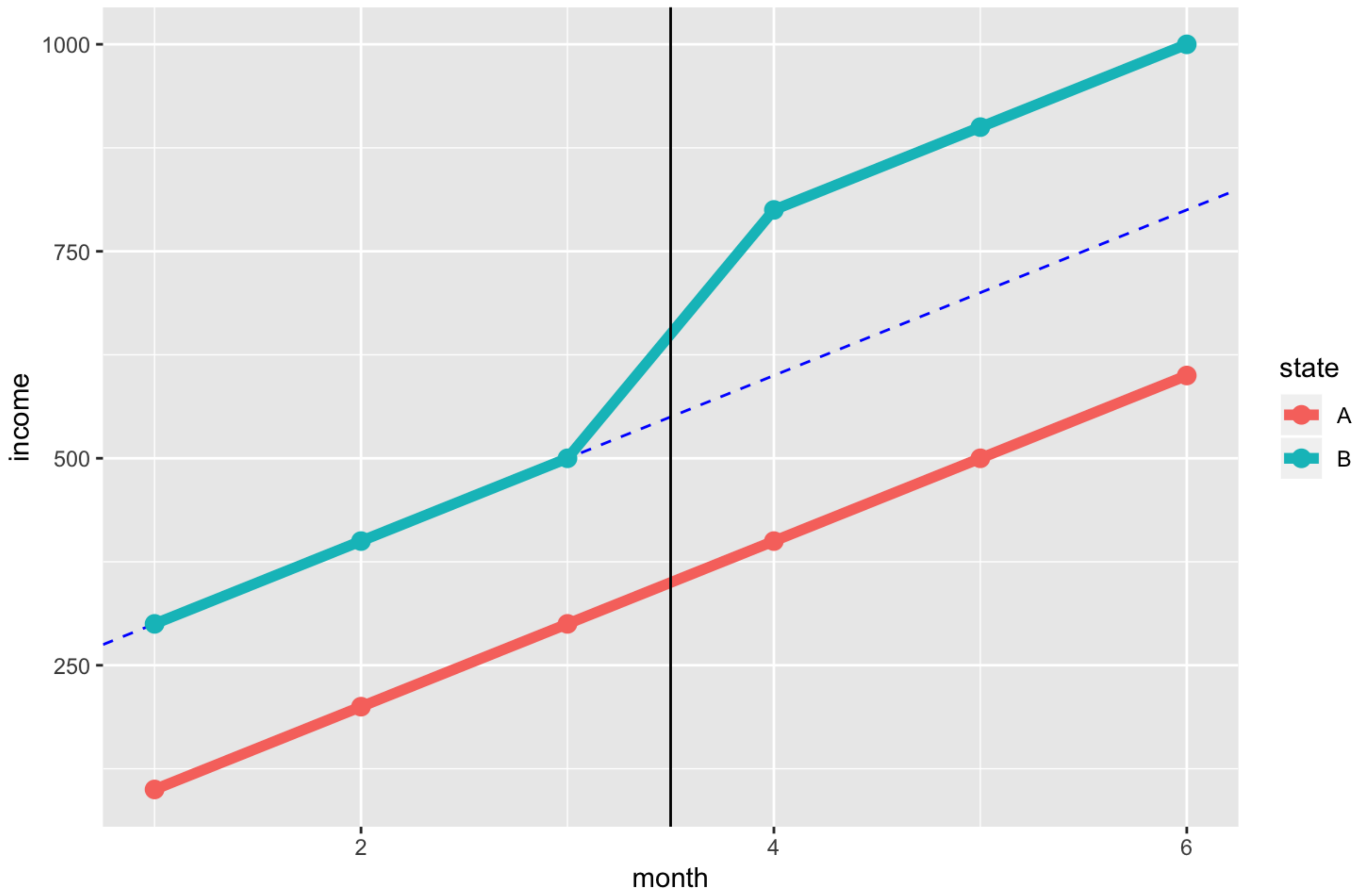
	Pre mean	Post mean	Δ (post-pre)
Treatment	α	α + γ	γ
Control	α + β	α + β + γ + δ	γ + δ
Δ (trtmt-ctrl)	β	β + δ	δ

ANALYZING DDS

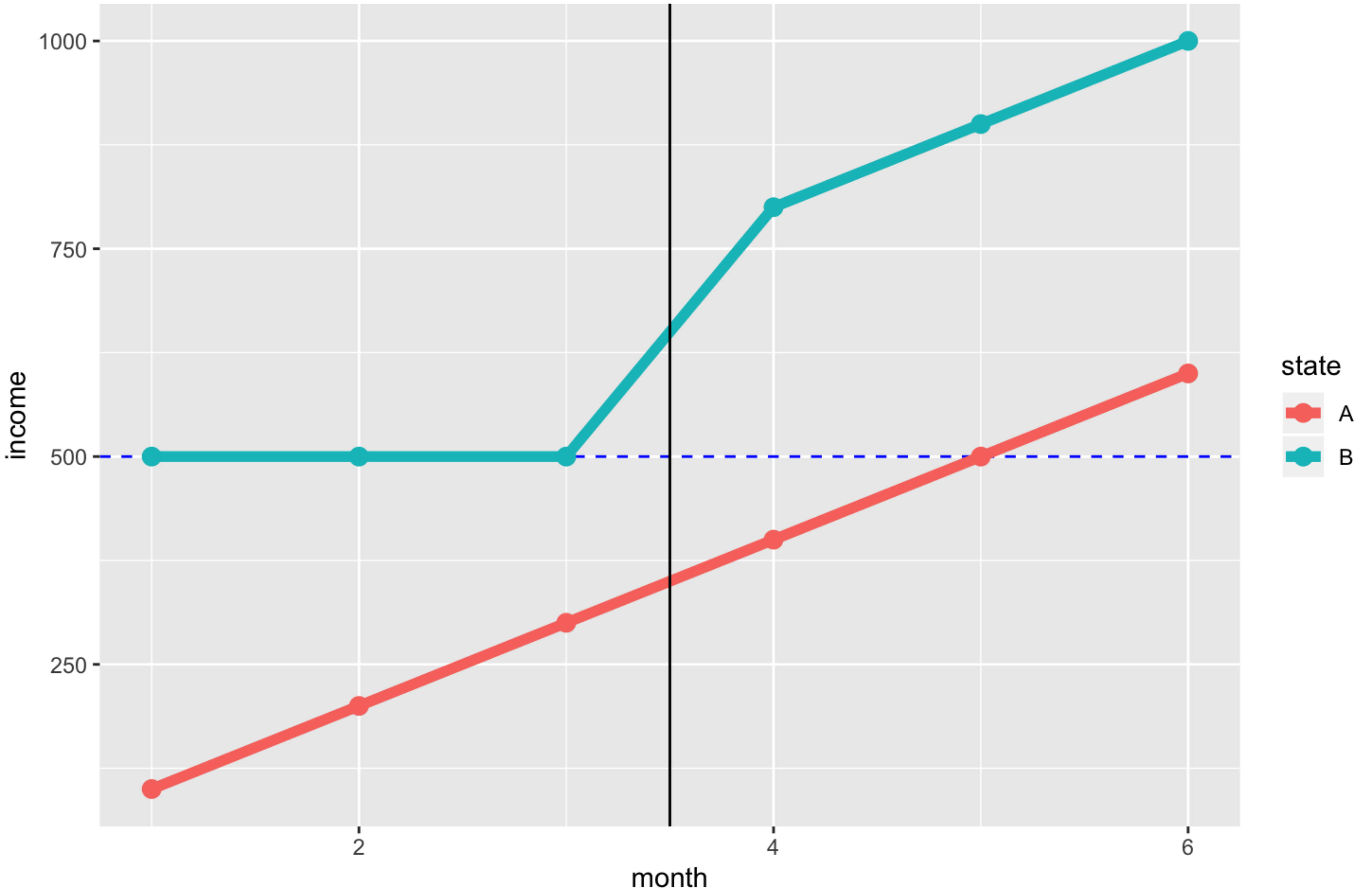
ASSUMPTIONS

Parallel trends

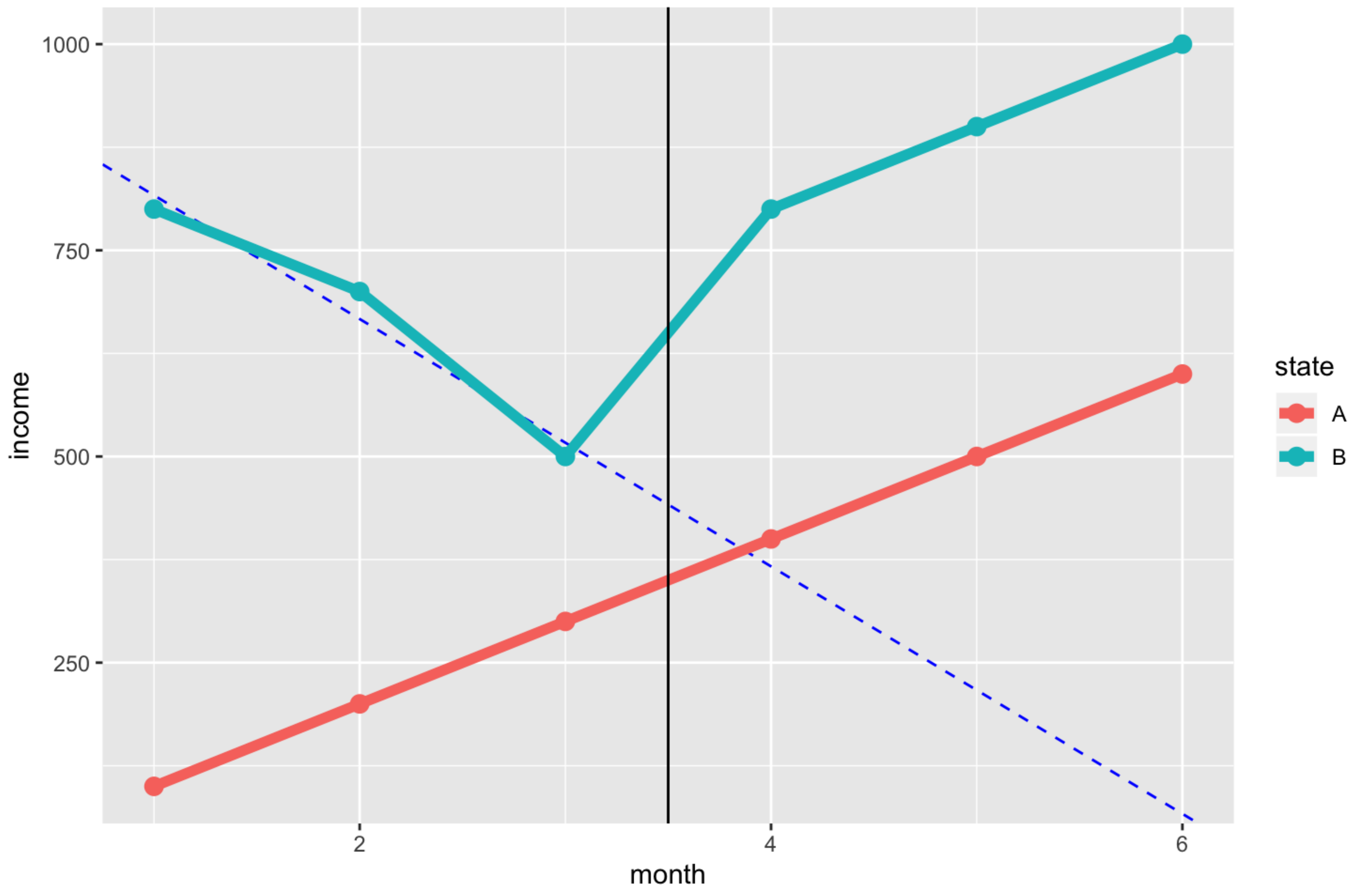
Treatment and control might have different values at first, but we assume treatment group would have changed like control in absence of treatment



1000
750
500
250
income
2
4
6
month
state
A
B



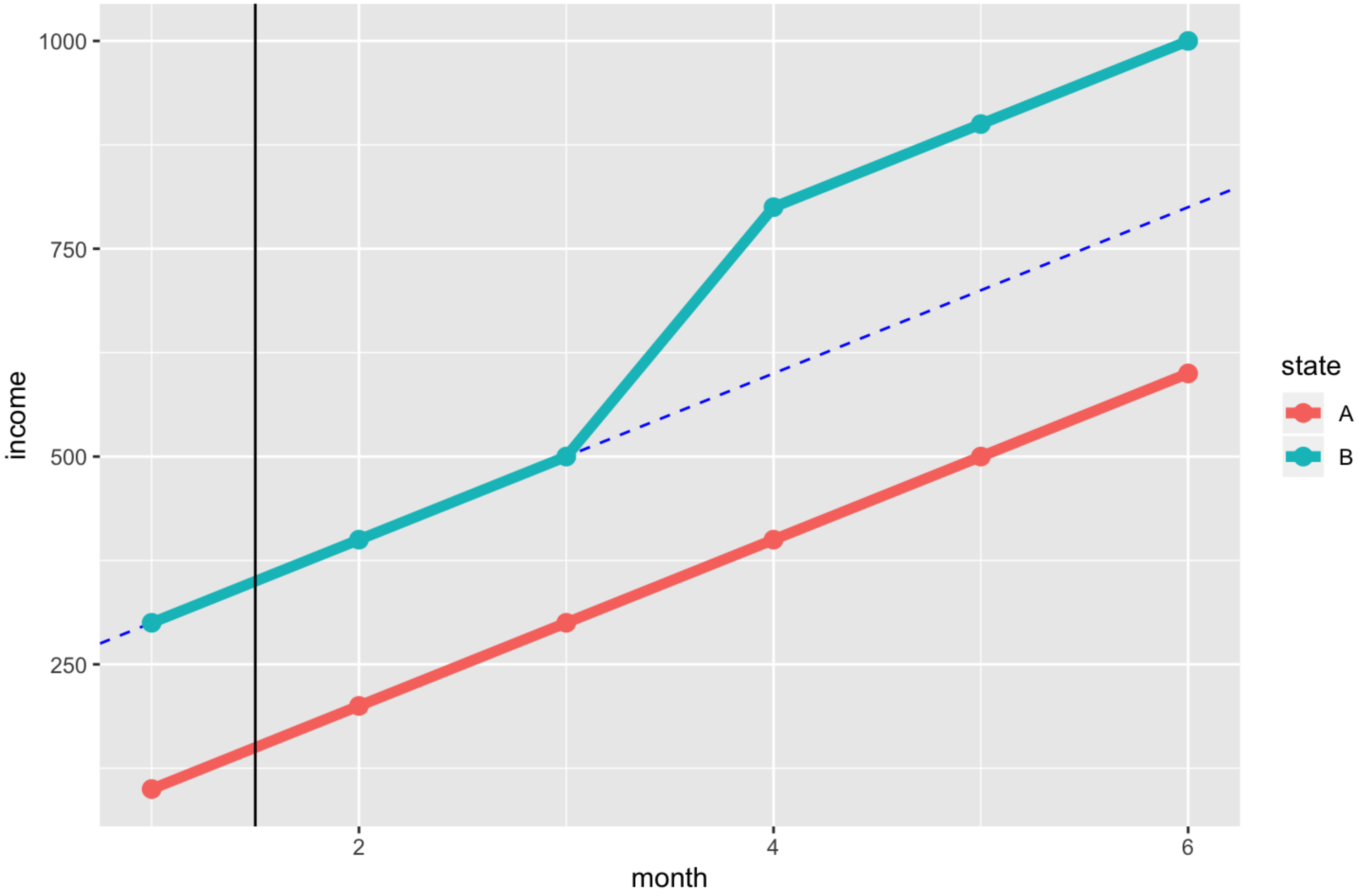
1000
750
500
250
income
2
4
6
month
state
A
B


1000
750
500
250
income
2
4
6
month
state
A
B

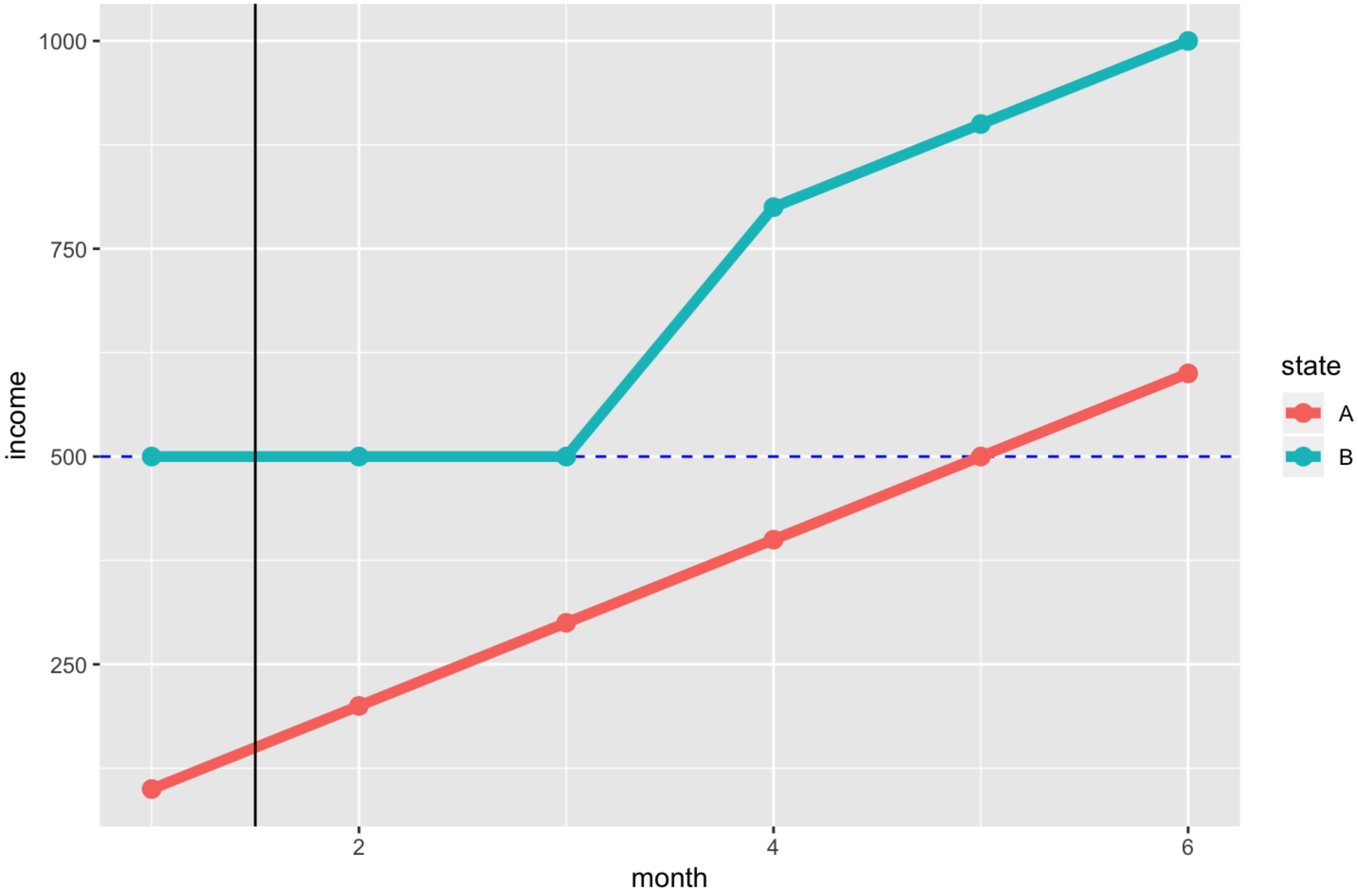
ASSUMPTIONS

Parallel trends

Check by pretending the treatment happened earlier.
If there's an effect, there's an underlying trend.



1000
750
500
250
income
2
4
6
month
state
A
B


1000
750
500
250
income
2
4
6
month
state
A
B

Gotta catch'em all! Pokémon GO and physical activity among young adults: difference in differences study

Katherine B Howe,[1,2] Christian Suharlim,[3] Peter Ueda,[4,5] Daniel Howe, Ichiro Kawachi,[2] Eric B Rimm[1,6,7]

[1]Department of Epidemiology, Harvard TH Chan School of Public Health, Boston, MA, USA

[2]Department of Social and Behavioral Sciences, Harvard TH Chan School of Public Health, Boston, MA, USA

[3]Center for Health and Decision Science, Department of Health Policy and Management, Harvard TH Chan School of Public Health, Boston, MA, USA

[4]Department of Global Health and Population, Harvard TH Chan School of Public Health, Boston, MA, USA

[5]Clinical Epidemiology Unit, Department of Medicine, Solna, Karolinska Institutet, Sweden

[6]Department of Nutrition, Harvard TH Chan School of Public Health, Boston, MA, USA

ABSTRACT

OBJECTIVE

To estimate the effect of playing Pokémon GO on the number of steps taken daily up to six weeks after installation of the game.

DESIGN

Cohort study using online survey data.

PARTICIPANTS

Survey participants of Amazon Mechanical Turk (n=1182) residing in the United States, aged 18 to 35 years and using iPhone 6 series smartphones.

MAIN OUTCOME MEASURES

Number of daily steps taken each of the four weeks before and six weeks after installation of Pokémon GO, automatically recorded in the "Health" application of the iPhone 6 series smartphones and reported by the participants. A difference in difference regression model was used to estimate the change in

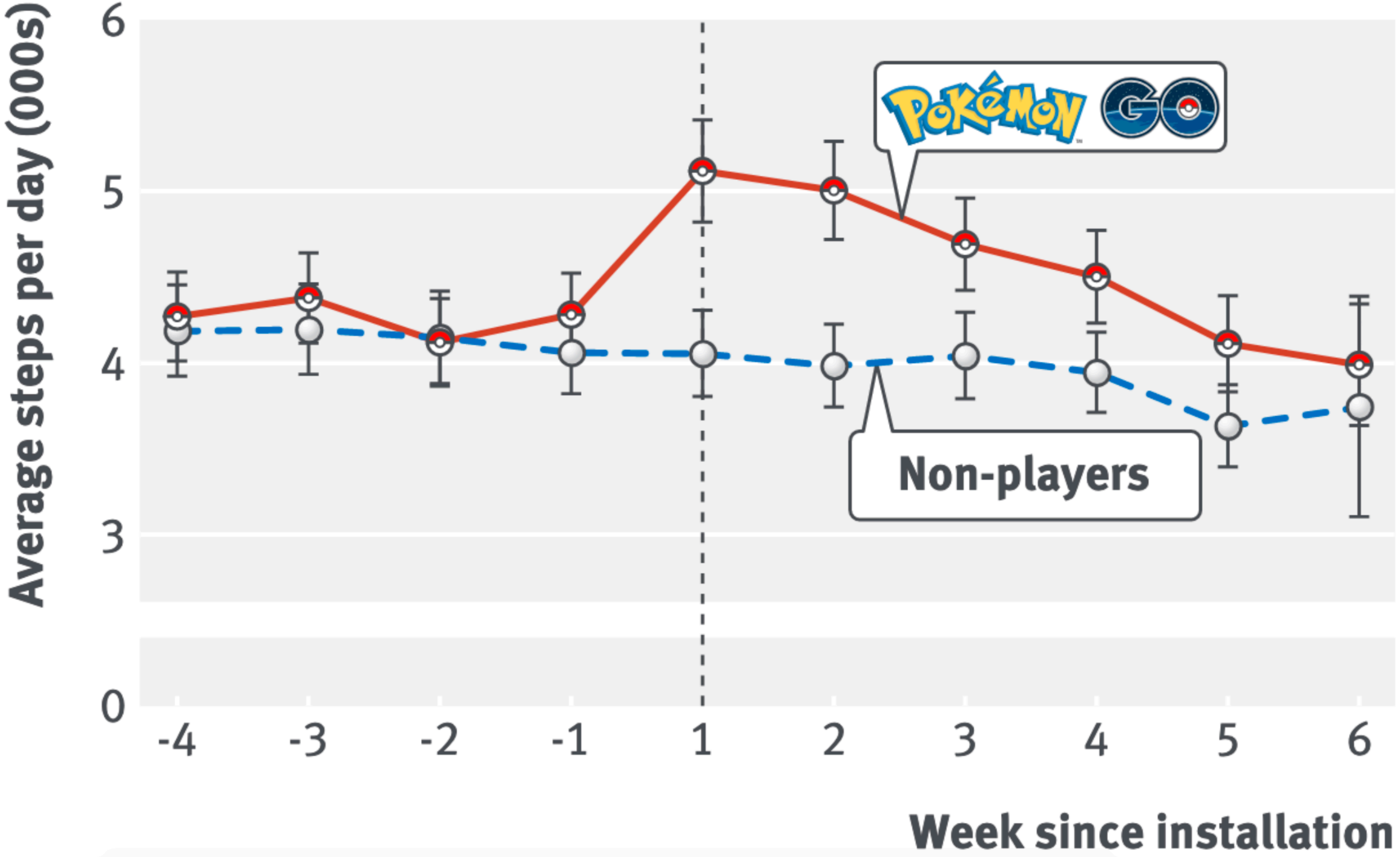
CONCLUSIONS

Pokémon GO was associated with an increase in the daily number of steps after installation of the game. The association was, however, moderate and no longer observed after six weeks.

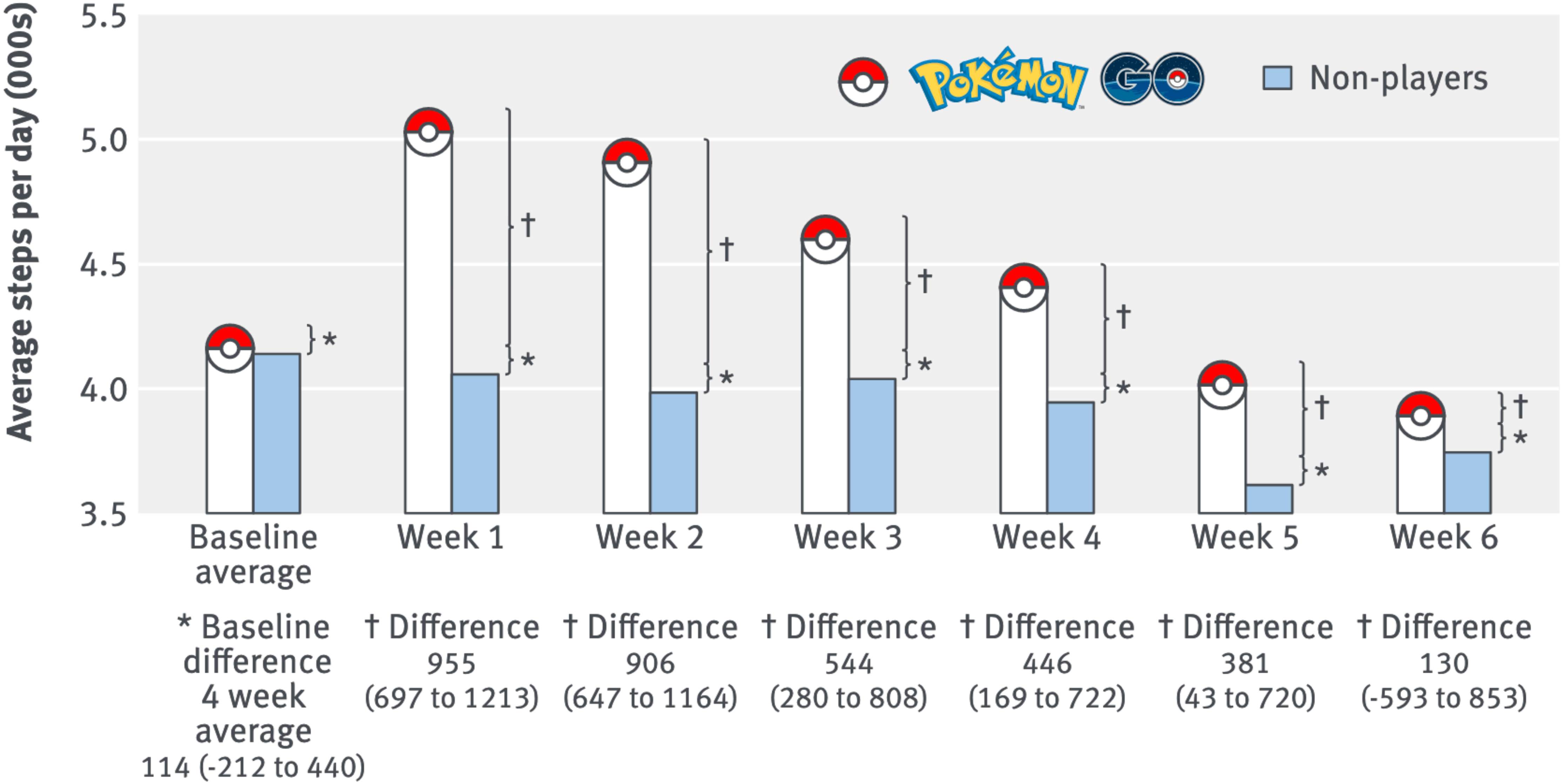
Introduction

Pokémon GO is an augmented reality game in which players search real world locations for cartoon characters appearing on their smartphone screen. Since its launch in July 2016, the game has been downloaded over 500 million times worldwide.

Games that incentivise exercise might have the potential to promote and sustain physical activity habits.[1 2] Because walking is encouraged while playing, Pokémon GO has been suggested to increase physical activity and improve public health, but these claims have been based on anecdotal evidence.[3-5]



Average steps per day (000s)
6
5
4
3
0
Pokémon GO
Non-players
-4
-3
-2
-1
1
2
3
4
5
6
Week since installation


Average steps per day (000s)
5.5
5.0
4.5
4.0
3.5
Pokémon GO
Non-players
Baseline average
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
* Baseline difference 4 week average 114 (-212 to 440)
† Difference 955 (697 to 1213)
† Difference 906 (647 to 1164)
† Difference 544 (280 to 808)
† Difference 446 (169 to 722)
† Difference 381 (43 to 720)
† Difference 130 (-593 to 853)

R time!