2. The Target Trial

Ian Lundberg
Cornell Info 6751: Causal Inference in Observational Settings
Fall 2022

25 Aug 2022

Responding to feedback

- Questions

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  - More intuition, examples, then notation

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  - Problem set due Monday, but office hours TTh
    - Ed Discussion

Logistics

- Problem Set 1 is due on Monday at 5pm on Canvas
- We are getting one or more TAs

Feedback & Logistics

From Tuesday's reading

Randomized experiments: Two key benefits
- Exchangeability
- Precise questions

Group Exercises

General discussion

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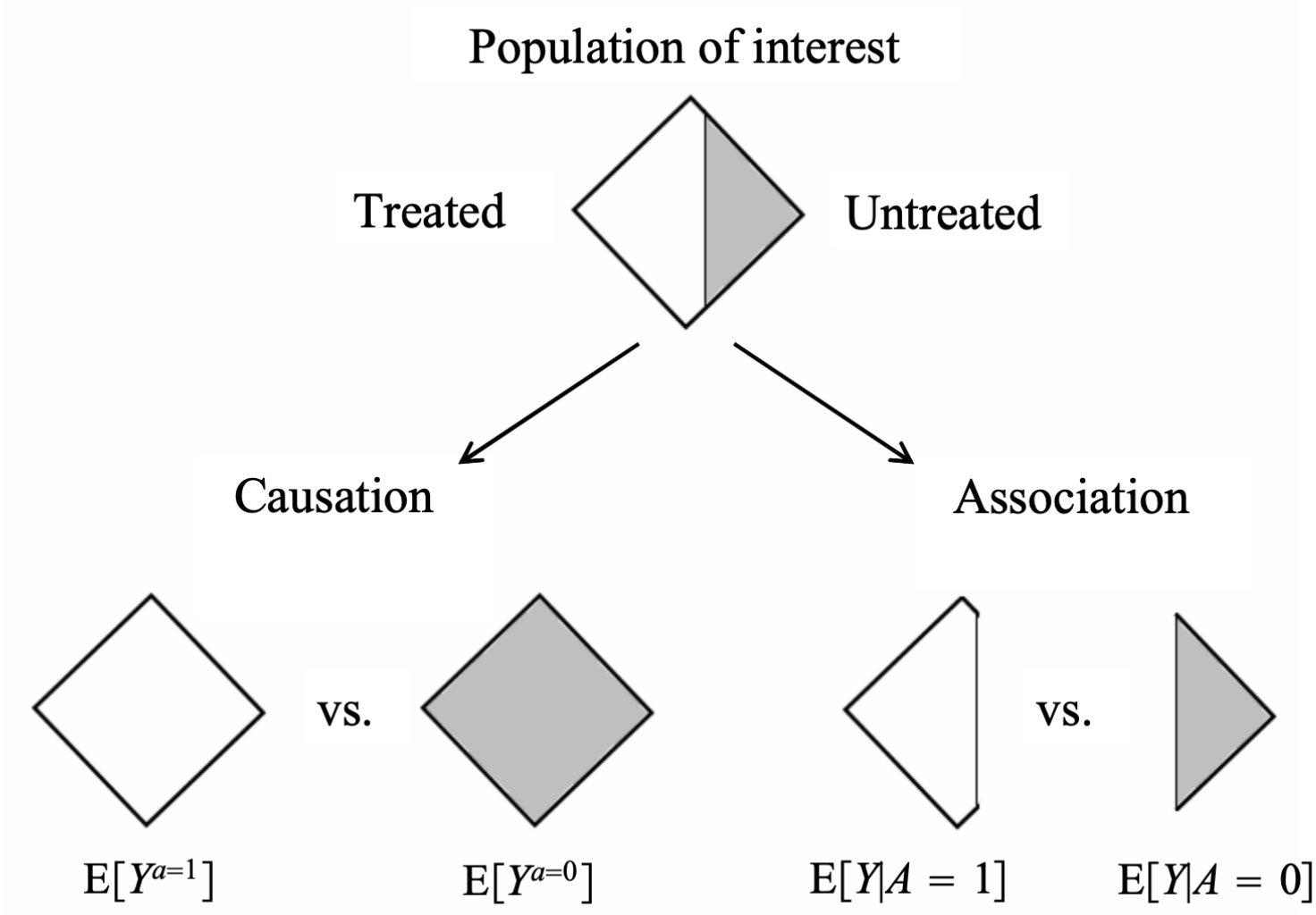
Revisit a figure from Tuesday's reading



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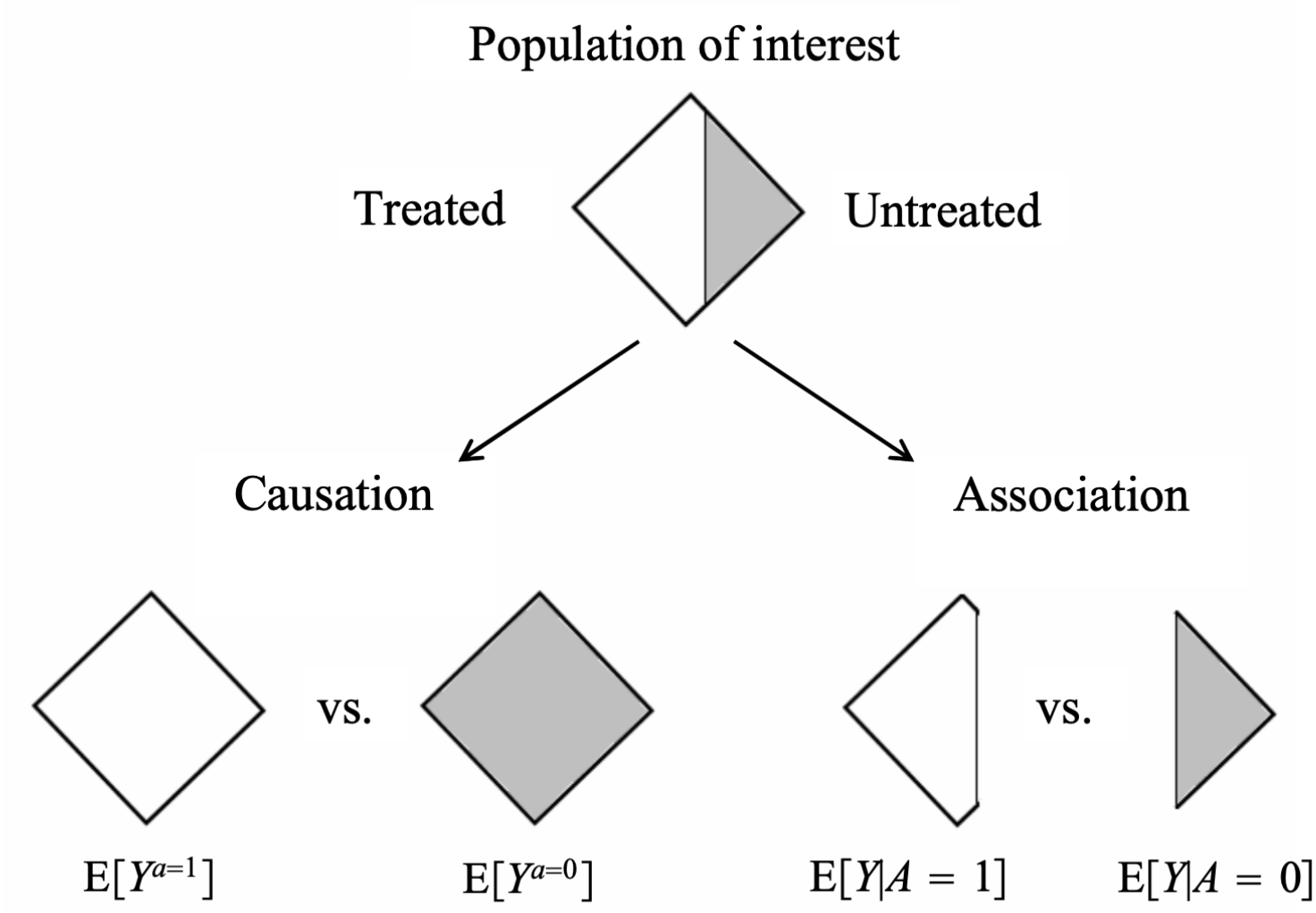

Question: What if a coin flip assigned units to the white or gray?

The white and gray are **exchangeable**

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We will discuss this key idea in three ways:

- By an experimental procedure
- By a science table
- By a mathematical statement of independence

Exchangeability: By an experimental procedure

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Flip a coin

Two groups of people: heads and tails

Exchangeability: By an experimental procedure

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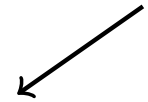
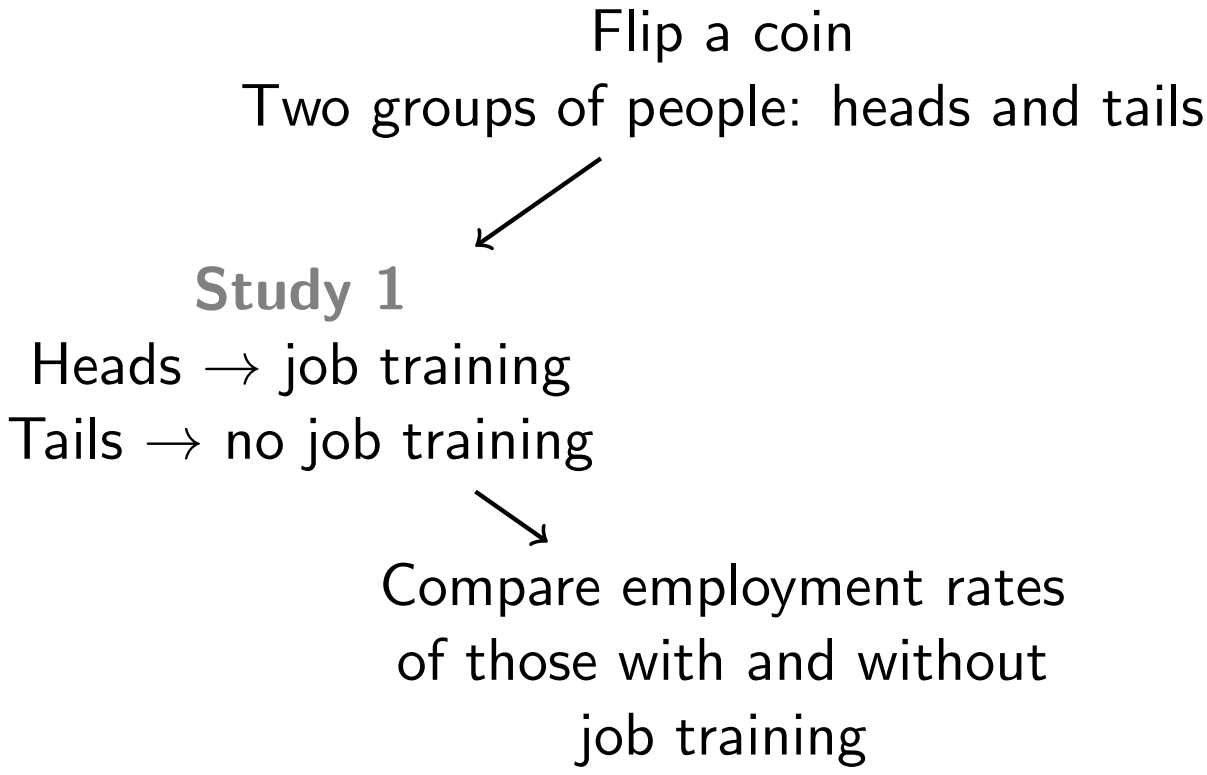


Study 1

Heads $\rightarrow$ job training

Tails $\rightarrow$ no job training

Exchangeability: By an experimental procedure



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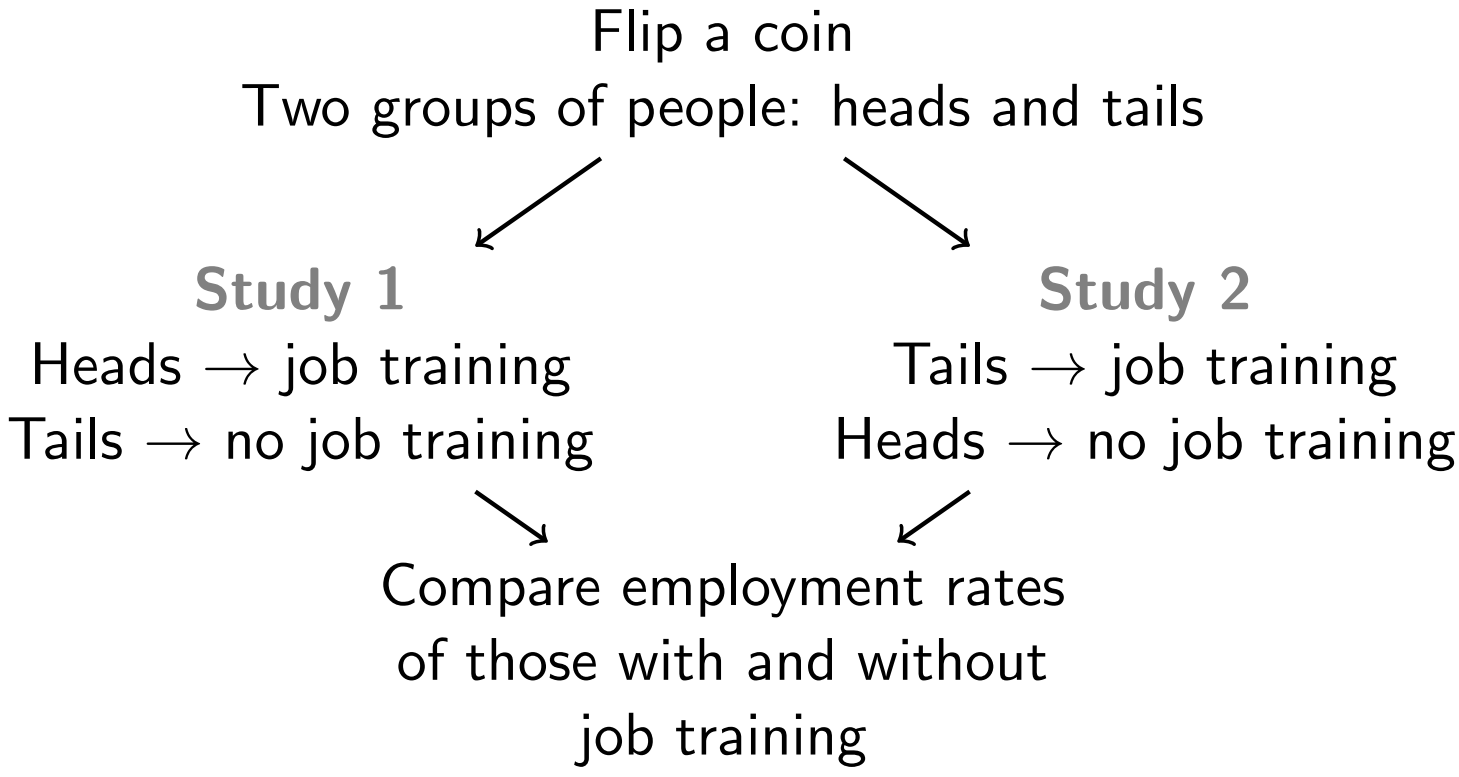

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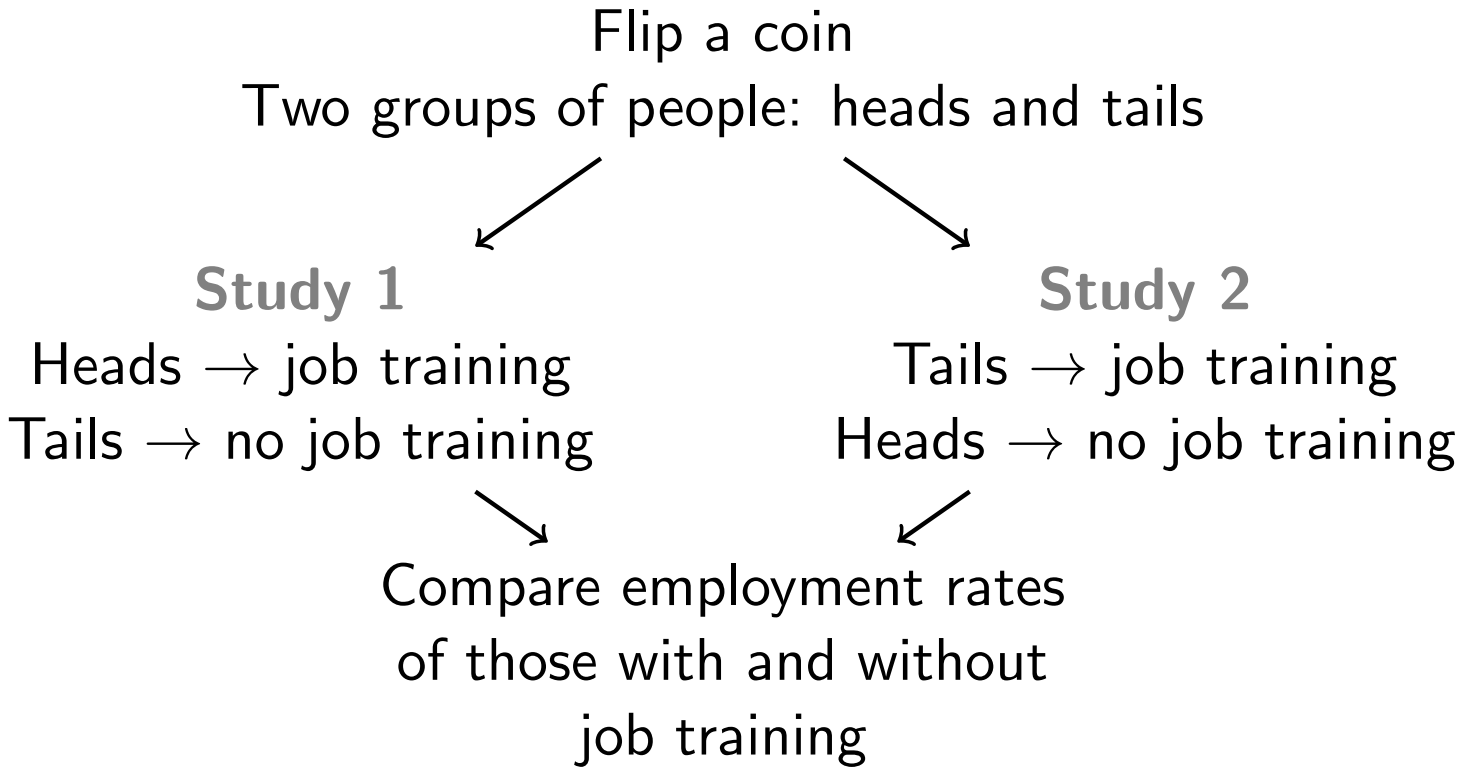

Question: Are both studies valid?

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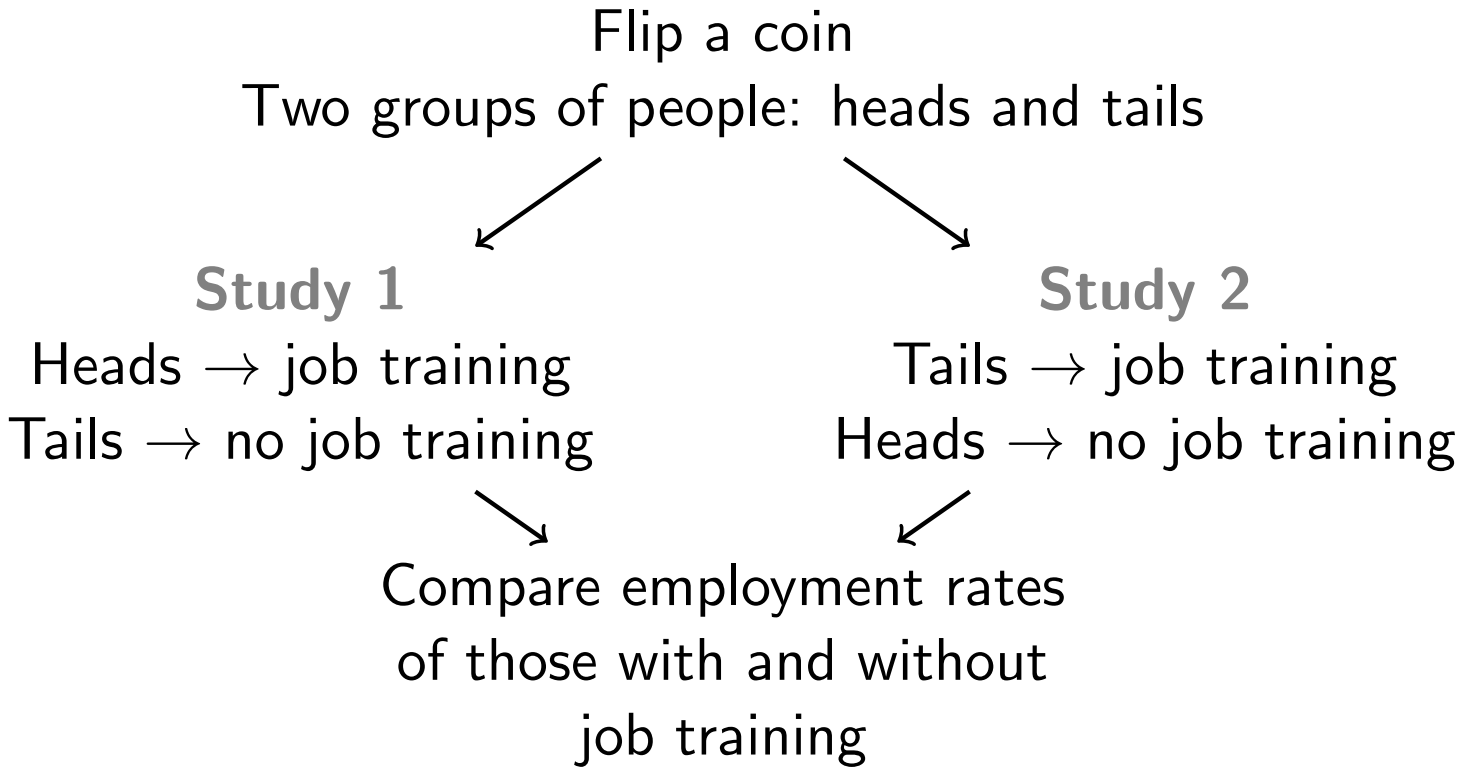

Question: Are both studies valid?

Yes. The (H/T) groups are **exchangeable**.
Any statistical pattern between (H/T) and employment
can only arise from the causal effect of job training

Exchangeability[1]: In a Table

- Treatment A: Job training or no job training
- Outcome Y: Employed or jobless

	Outcome With Job Training	Outcome Without Job Training
Person 1	Employed	Employed
Person 2	Employed	Employed
Person 3	Employed	Jobless
Person 4	Employed	Jobless

[1] See Hernán and Robins 2.1

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Exchangeability[2]: In Math

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- But A tells us nothing about and $Y^{\texttt{Job training}}$

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  - The coin flip A is unrelated to which kind of person one is

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In math:

$$A \perp\!\!\!\perp Y^a \qquad \text{for all } a$$

In words:
The treatment A is independent
of the potential outcomes Y^a
for all treatment values a

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Experiments are great because exchangeability holds by design.

Experiments are great because exchangeability holds by design.

But they are also great for other reasons.

Phase 3 Clinical Trial of Investigational Vaccine for COVID-19 Begins

Multi-Site Trial to Test Candidate Developed by Moderna and NIH

July 27, 2020

[3]Published 27 July 2020. https://www.niaid.nih.gov/news-events/phase-3-clinical-trial-investigational-vaccine-covid-19-begins

The Moderna trial[4]: What do we like about this design?

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- "Trial volunteers will receive two intramuscular injections approximately 28 days apart."

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- "Trial volunteers will receive two intramuscular injections approximately 28 days apart."
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The Moderna trial[5]: What do we like about this design?

Person 1

Person 2

Person 3

Person 4

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The Moderna trial[5]: What do we like about this design?

	Treatment
Person 1	mRNA-1273
Person 2	Saline
Person 3	Saline
Person 4	mRNA-1273

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The Moderna trial[5]: What do we like about this design?

	Treatment	Outcome Under mRNA-1273	Outcome Under Saline
Person 1	mRNA-1273	Healthy	?
Person 2	Saline	?	Healthy
Person 3	Saline	?	Hospitalized
Person 4	mRNA-1273	Healthy	?

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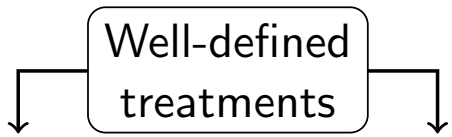

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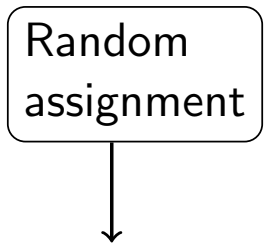

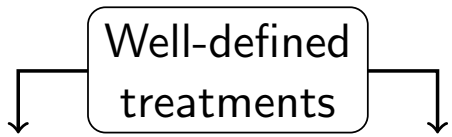

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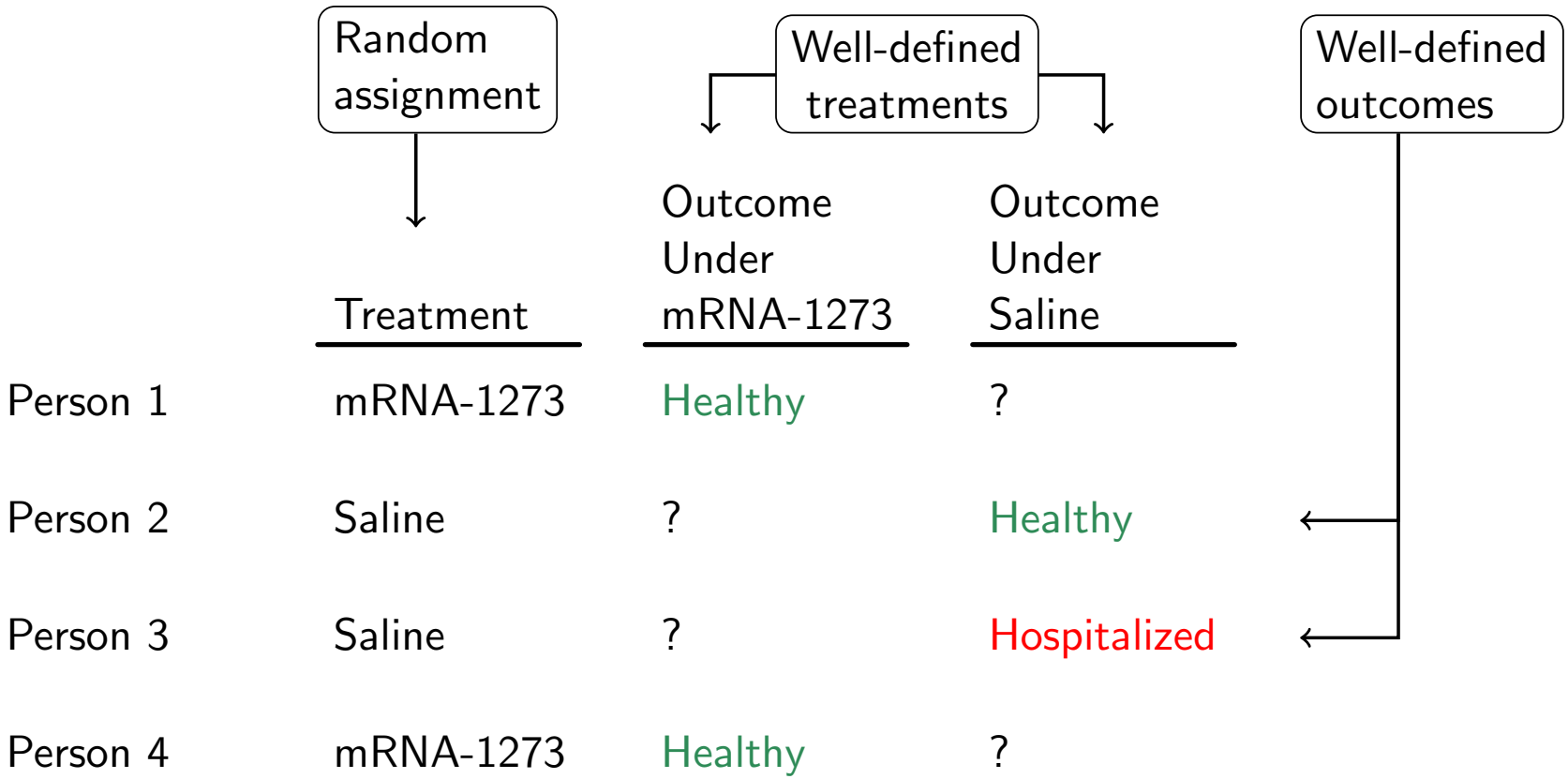

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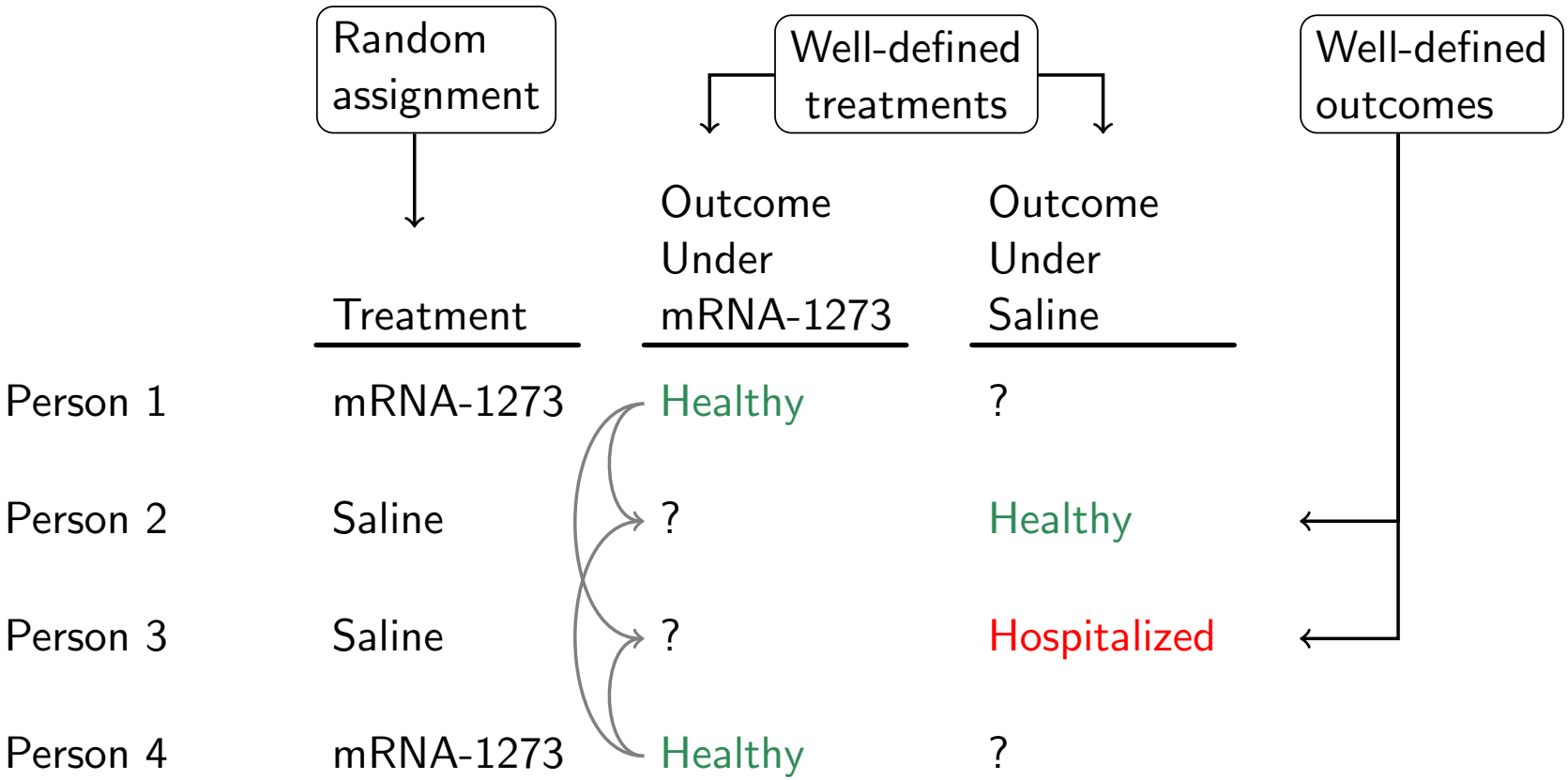

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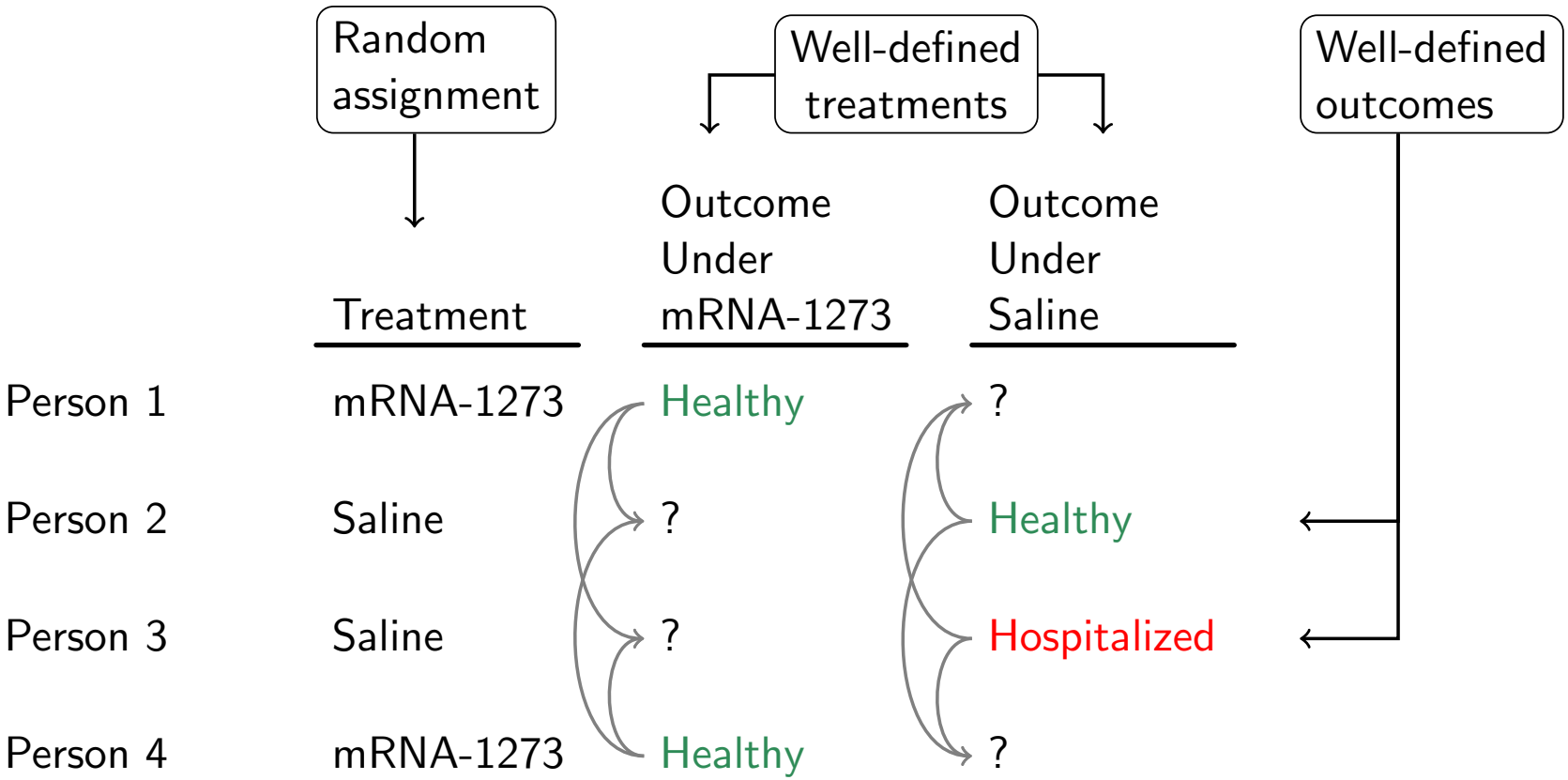

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- Eligibility criteria clear

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The Moderna trial[6]: What do we like about this design?

- Eligibility criteria clear
- Blinded
- Defined follow-up period

[6] Published 27 July 2020. https://www.niaid.nih.gov/news-events/phase-3-clinical-trial-investigational-vaccine-covid-19-begins

The Moderna trial[6]: What do we like about this design?

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- Eligibility criteria clear
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- Defined follow-up period
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- Randomized assignment

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- Pre-registered hypotheses

[6] Published 27 July 2020. https://www.niaid.nih.gov/news-events/phase-3-clinical-trial-investigational-vaccine-covid-19-begins

Media Advisory Wednesday, December 30, 2020

Peer-reviewed report on Moderna COVID-19 vaccine publishes

Data from Phase 3 clinical trial confirm vaccine is effective.

7

[7] https://www.nih.gov/news-events/news-releases/peer-reviewed-report-moderna-covid-19-vaccine-publishes

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Part 1) Design a randomized trial

This page had links to Google docs for 8 groups to work on the exercise (see exercise on next slides)

Odd numbered groups

You are a medical researcher focused on high blood pressure. Your research points toward a new drug—MiraclePill—which you believe will cause lower blood pressure in patients who are at risk (you are the expert, so you can define this). You aren't sure of the correct dosage: you think somewhere between 0 and 100 mg per week.

How would you design a randomized trial to assess MiraclePill?

1. What is the intervention?
2. What is the outcome?
3. What is the follow-up period between treatment and outcome?
4. Who is the target population?
5. How are unit-level quantities aggregated to a population-level summary?

Even numbered groups

You are a social scientist focused on the underrepresentation of women in computer science at the BA level. You develop a new mentorship program to connect entering first-year women computer science majors with recent women Cornell alumni from CS. The alumni agree to meet one-on-one with the first-year undergraduates a couple times a year. You want to randomize some element of this program in order to test its effectiveness.

How would you design a randomized trial to assess the mentorship program?

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2. What is the outcome?
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Observational evidence

Scroll down to Part 2

Odd numbered groups

Another medical researcher comes to you with observational evidence. "I had 100 people in my office today. 50 of them tell me they take MiraclePill 100mg once per week. The other 50 tell me they do not take MiraclePill. Average blood pressure was lower for those who take MiraclePill."

What do you say to this researcher? How is their evidence different from your target trial?

Even numbered groups

Another social scientist comes to you with observational evidence. "Today I was at a gathering of women Cornell alumni from the CS and English departments. I went around and asked them if they ever engaged with CS alumni during college. 75% of the CS graduates said yes, but only 10% of the English graduates said yes. I think engaging with alumni is key to persistence in CS."

What do you say to this researcher? How is their evidence different from your target trial?

Hypothetical target trial

Scroll down to Part 3

Odd numbered groups

A researcher (with whom you may disagree) says to you: "Coming to office hours frequently causes student success in the classroom."

Your task is to create the details that would make this observational claim specific. What is the target trial?

1. What is the hypothetical intervention?
2. What is the outcome?
3. What is the follow-up period between treatment and outcome?
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Even numbered groups

A researcher (with whom you may disagree) says to you: "Single parenthood causes poverty. If poor women would marry, then they would no longer be poor."

Your task is to create the details that would make this observational claim specific. What is the target trial?

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In an observational study, you cannot randomize.

[8] Hernán, M. A., & Robins, J. M. (2016). Using big data to emulate a target trial when a randomized trial is not available. American Journal of Epidemiology, 183(8), 758-764.

In an observational study, you cannot randomize.

But you can do all the other things[8]

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Let me know what you are thinking

tinyurl.com/CausalQuestions

Office hours TTh 11am-12pm and at
calendly.com/ianlundberg/office-hours
Come say hi!