Longitudinal Causal Inference in Psychology

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1. What is Causal Inference (Potential Outcomes) in longitudinal Settings?

2. Can we do that in psychological research?

What is Causal Inference (Potential Outcomes) in longitudinal Settings?
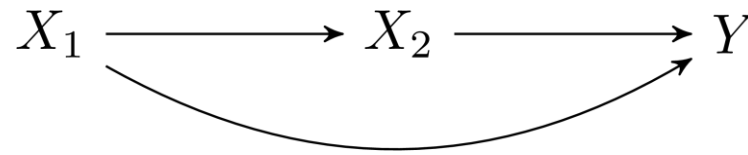
X_t

Y

Potential Outcome:

$$Y_i^x \qquad (1)$$

Individual Causal Effect:

$$Y_i^{x=1} - Y_i^{x=0} \qquad (2)$$

Average Treatment Effect (ATE):

$$E[Y^{x=1}] - E[Y^{x=0}] \qquad (3)$$

Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies. Journal of Educational Psychology, 66(5), 688–701. https://doi.org/10.1037/h0037350

What is Causal Inference (Potential Outcomes) in longitudinal Settings?

$$X_1 \longrightarrow X_2 \longrightarrow Y$$

X_t: Smartphone Usage

Y: Sleep quality

What is Causal Inference (Potential Outcomes) in longitudinal Settings?

$$X_1 \longrightarrow X_2 \longrightarrow Y$$

X_t

Y
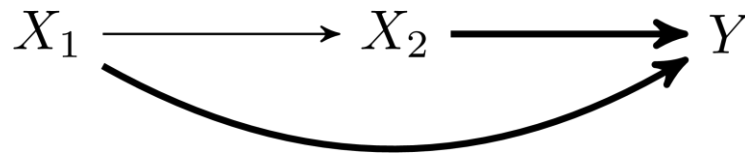
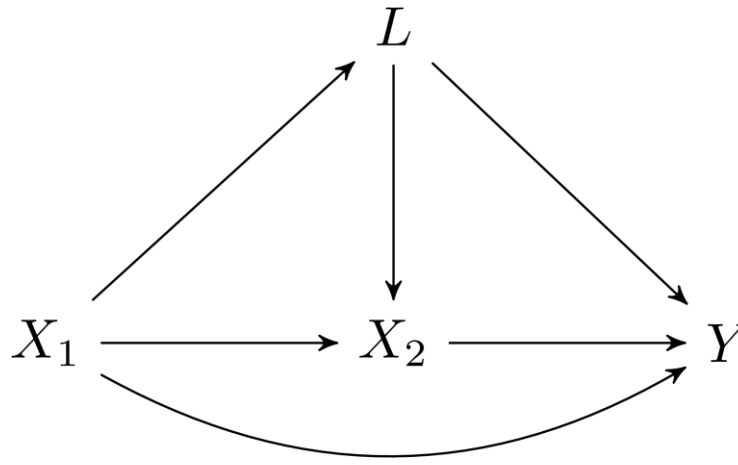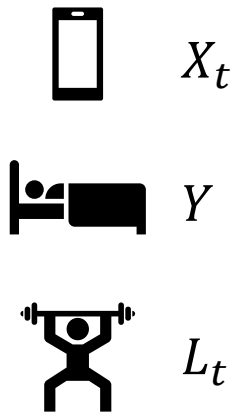A Potential Outcome is defined under multiple interventions:

$$Y^{x_1, x_2}$$

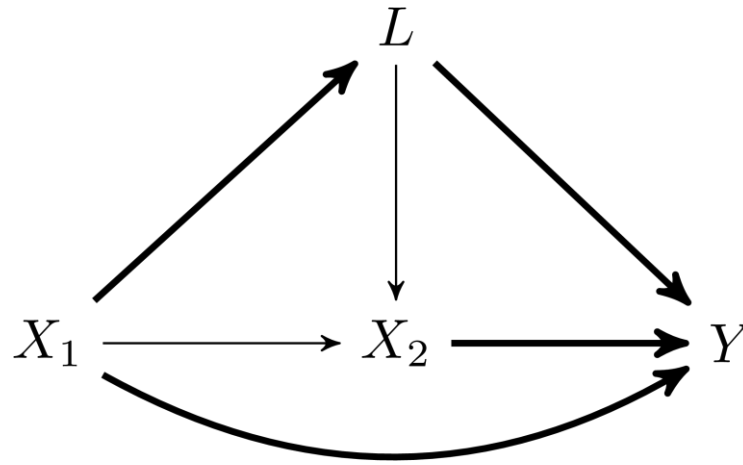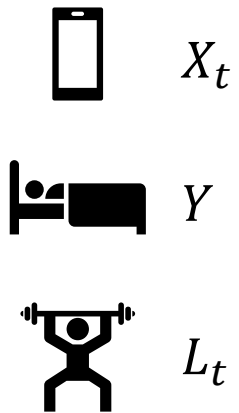The contrast of two Potential Outcomes is then the *joint effect*:

$$Y^{x_1=1, x_2=1} - Y^{x_1=0, x_2=0}$$

$$Y^{x_1=1, x_2=0} - Y^{x_1=0, x_2=0}$$

Longitudinal Causal Inference:
It's complicated...

X_t

Y

L_t

Longitudinal Causal Inference:
It's complicated...

📱 X_t

🛏️ Y

🏋️ L_t

How to identify joint effects?

1. Experiment
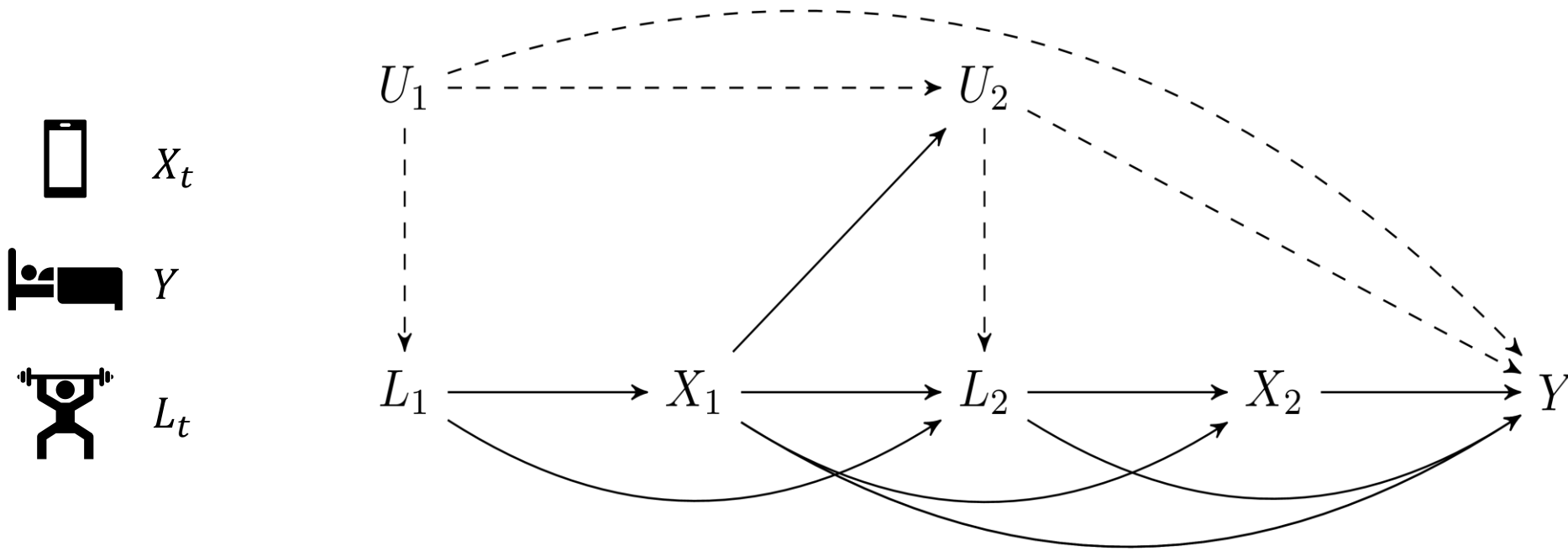   1. X_t is randomized at every time point t
   2. Or: a full strategy is randomized ($x_1 = 1, x_2 = 1$)
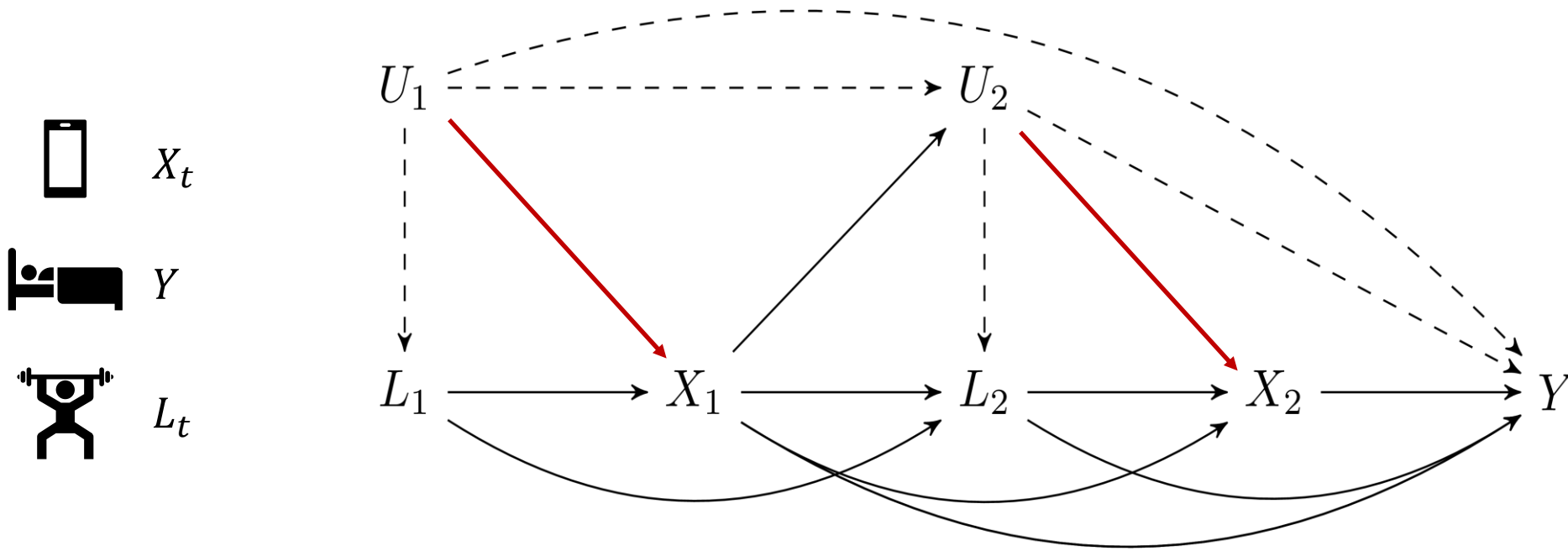
2. Observational Study: Confounder adjustment
   ➢ If we know the relevant „reasons" for X_t, we can adjust for them

1. What is Causal Inference (Potential Outcomes) in longitudinal Settings?

2. Can we do that in psychological research?
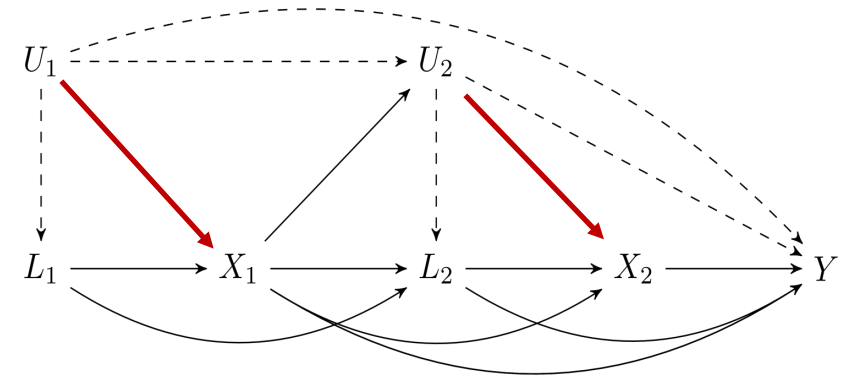
What do we need to identify joint effects?

What do we need to identify joint effects?

When are variables independent in psychology?

1. Randomization
2. **Information Restriction**

Gelman, A. (2011). Causality and Statistical Learning. American Journal of Sociology, 117(3), 955–966. https://doi.org/10.1086/662659

When are variables independent in psychology?

1. If X is self-selected, U is not measureable

2. If X is assigned by a person **based on information**, it *cannot* be influenced by unobservables
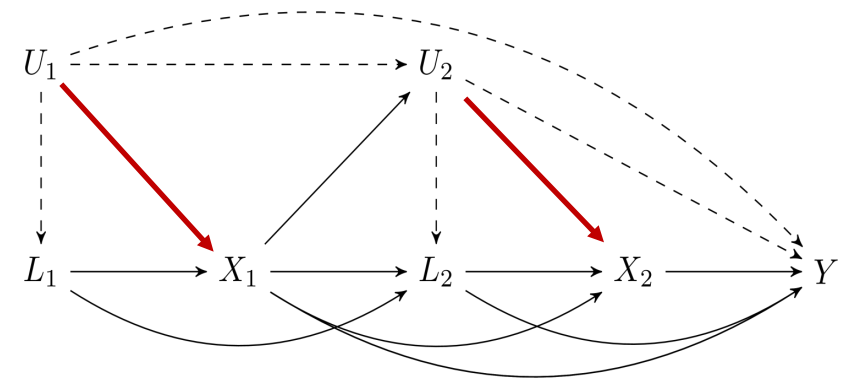
Who assigns X based on observables L?

1. Doctors
X = Treatment
L = Biomarker
Y = Health

2. Psychotherapists
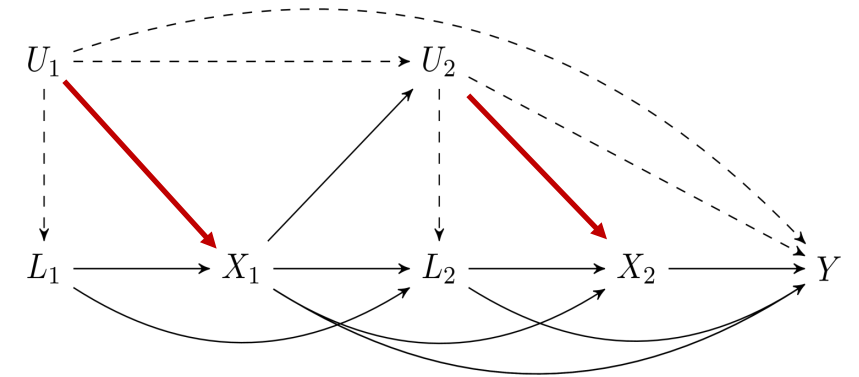X = Treatment
L = Questionnaire
Y = Mental Health

3. Teachers
X = Extra Classes
L = Grades
Y = Passing the course

Summary

- Causal Inference is applicable in longitudinal settings
- Causal Inference is possible without full randomization

- Psychology needs clever research designs
- Leverage Information Restriction

Furthermore…

- SEM (path analysis) relies on unrealistic assumptions
- g-Methods from epidemiology rely on more reasonable assumptions

Junker, L., Schoedel, R., & Pargent, F. (2025). Towards a Clearer Understanding of Causal Estimands: The Importance of Joint Effects in Longitudinal Designs with Time-Varying Treatments. https://doi.org/10.31234/osf.io/zmh5a

Thank you!