Theory in Experimental Designs

Danilo Freire

7th August 2023

Causality and experiments

- As researchers, we are interested in research questions about how the world works.
- There are a number of different types of questions that we may want to answer.
  - **Descriptive questions**: Descriptions of a given phenomena: e.g., "*how do bureaucrats allocate their time across different tasks?*"
  - **Causal questions**: Questions about *how* X affects Y: e.g., "*Does providing vocational training to migrants improve their economic integration in the receiving country?*"
- Then we can move on to questions about why? $\rightarrow$ i.e., knowing the effect of a cause is necessary before moving on to understanding the causes of an effect.
- (Next session: more on about what we mean by causality and how experiments give us leverage to make causal claims.)

Theory

- What is the phenomenon we want to explain?
  - **Our outcome** (we are going to call it **Y**)
- Does the cause we theorize lead to observing changes in Y?
  - **Our treatment** (in the context of experiments) (we are going to call it $\mathcal{T}$)
- What is the theory of change?
- We are ultimately interested in how **two theoretical concepts are related**, measured by **observed variables** $\mathcal{T}$ (our treatment) and Y (our outcomes)

Why is theory important?

- Our theory allows us to:
- Derive **observable implications** (hypotheses) that we test in the real world.
- **Separate two completely unrelated experiments** with identical empirical properties for Y and $\mathcal{T}$
  - For example, we could have two identically sized experiments with the same treatment assignment, the same observed outcomes, but with significantly different underlying theories.

From theory to research design

- We then need to connect what we are interested in to what we observe in the real world $\rightarrow$ **operationalization** of theoretical concepts.
- How are we going to *measure* our outcomes? How are we going to *manipulate* the cause of interest?
- This close link between theory and research design helps us interpret the results of our experiment.

Measurement

- Measurement is the link between a researcher's theory and an (experimental) research design.
- Measurement then follows from our theory of the way you think the world works and how our treatment manipulates that world.
- The ideal case is direct measurement of the phenomenon of interest with no error. But this is generally not possible.
- We are often only able to measure indicators connected to the underlying phenomenon of interest.

Let's consider the example from our experiment practicum

- What is the outcome of interest (Y)?
- What is the cause of interest ($\mathcal{T}$)?
- What can be a theory that yields to this experimental design?
- What can be the main hypothesis?

Measuring treatments

- **Can we directly manipulate $\mathcal{T}$?** (underlying treatment concept of interest)
  - Ethical, logistical and other types of considerations can limit our ability to manipulate all of the indicators of $\mathcal{T}$.
  - At best, we may be able to change **some of its indicators**.
  - We design a treatment, **T**, to do so.
- **How does T relate to $\mathcal{T}$?**
  - But T can be manipulating other things (bundled treatments).
- **Did everyone receive T?**
  - Measure compliance.

Thinking about the treatment from the practicum...

- What could be underlying treatment concept ($\mathcal{T}$)?
- What was the actual treatment (**T**)?
- What dimensions of $\mathcal{T}$ does **T** manipulate?
- What else can **T** be manipulating? What is the "bundle" of **T**?

Thinking about the treatment from the practicum. . .

- Now think of yourselves as the researchers.
- In pairs or groups of three:
  - Generate hypothesis on the direction of expected average effect
  - Generate hypothesis on potential heterogeneous effects
  - Generate expected effect size
  - Discuss theories behind the hypothesis and expected effect size, with emphasis on the importance of theory
  - Other ways of measuring the outcome or mode of administering the treatment?

Measuring outcomes

- As social scientists, we cannot directly observe the true value of the outcome concept for most of the outcomes we are interested in.
- Examples:
  - Correct answers to problems (indicators) for underlying mathematical aptitude (the actual phenomenon).
  - Days without food (indicators) for hunger (the actual phenomenon).
  - Reports of bribes (indicators) for corruption (the actual phenomenon).
- Moreover, the underlying outcome concept may be even under debate (e.g., democracy).
- If our indicators don't measure the underlying concept that we're interested in, then we may not be able to learn very much, even if we have an otherwise very sound experiment.

Back to our experiment practicum...

- What items are designed to measure our theoretical outcome of interest (**Y**)?
  - Any concerns about this operationalization?
  - Other possible ways to measure Y?

Things to consider

- Problems with measurement can lead you to draw incorrect causal inferences from your study (systematic error, more bias).
- Noisy measurement reduces power (random error, less precision) [discussing this on Thursday].
- Data collection often takes up a very large portion of the time and financial resources available in the project budget.
- New data can be a useful research output in its own right and an important foundation for future research. Data is a public good!

To wrap up

- As researchers, we have theories about how the world works.
- Some of these theories imply causal statements, and we can use experiments to test them empirically (i.e., with the data we observe from the real world).
- Measurement connects theory and research design.
- We observe real-world indicators of the broader theoretical concepts we are interested in.

Questions?

- Your questions are most welcome!