University of Oxford
Intermediate Social Statistics: Lecture One

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Course Requirements

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- Eight Lectures

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- Five Classes

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- Three Homework Exercises (40 percent of mark)

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- Final Exam (60 percent of mark)

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Today's Lecture: Overview

- Theory

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- Hypotheses and measurement

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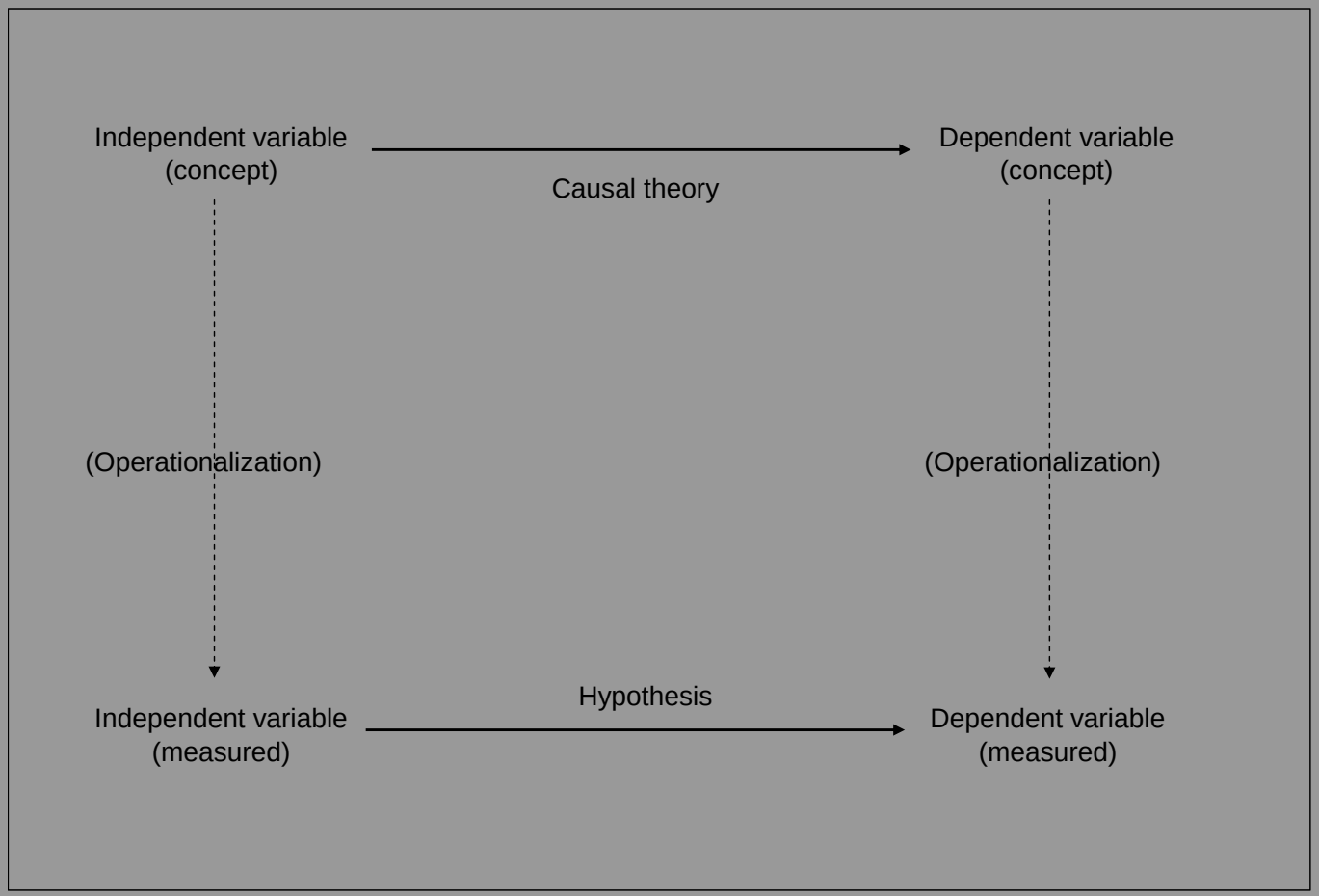
- A **theory** is a tentative conjecture about the causes of some phenomenon of interest.
- A **hypothesis** is a theory-based statement about a relationship that we expect to observe.

The relationship between a theory and a hypothesis



Rules of the road for social science research

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- Pursue both generality and parsimony

Where do theories come from?

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- The role of deductive reasoning (or “formal theory”)

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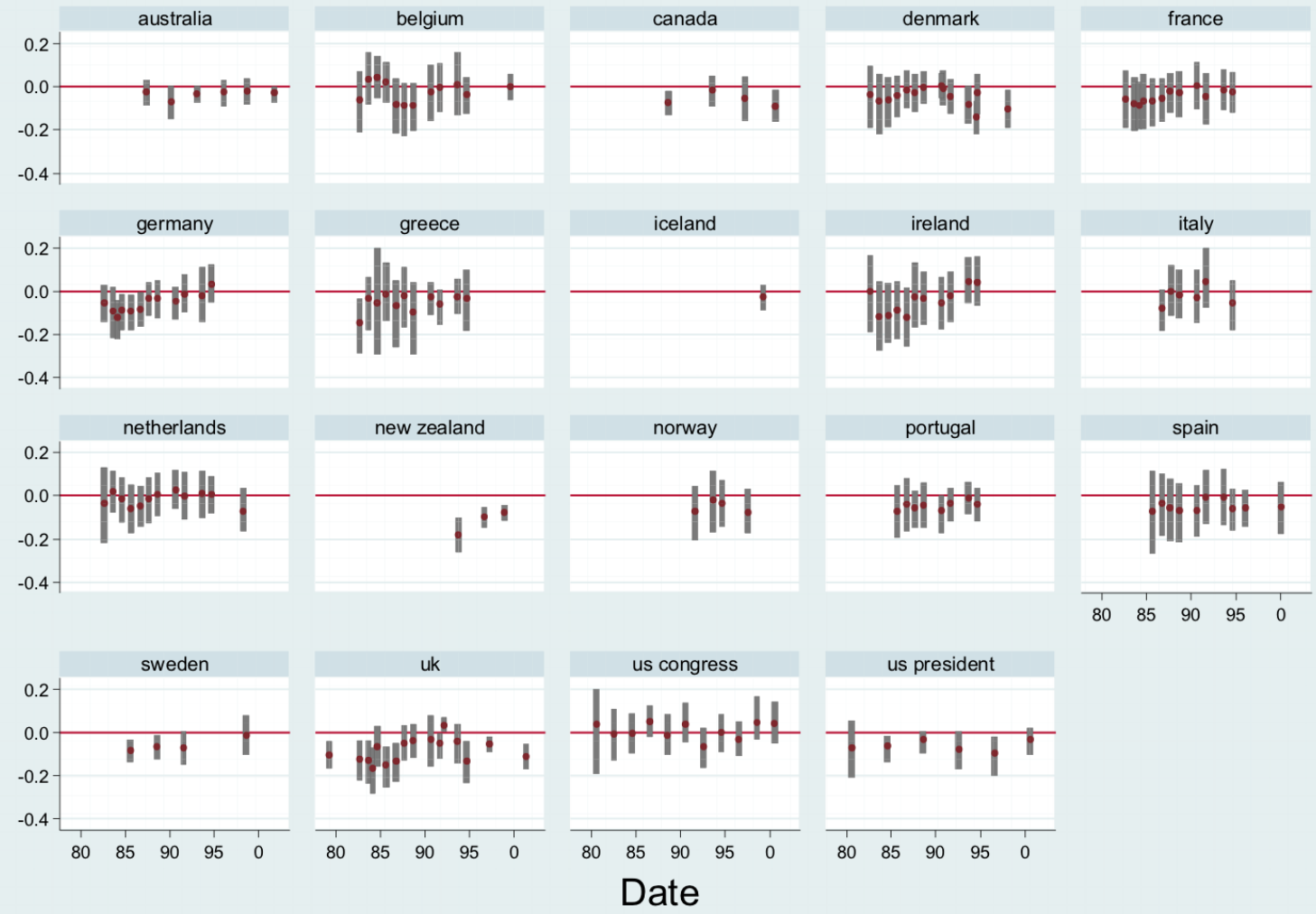
- Example from my research – the Economic Vote



Note: One Greek upper confidence interval is truncated

Measurement problems in the social sciences

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  - Calorie consumption

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- The bathroom scale

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- Robert Dahl: “contestation” and “participation.”
- The best-known is the Polity IV measure: annual scores ranging from -10 (strongly autocratic) to +10 (strongly democratic) for every country on earth from 1800 - 2004.

Measuring democracy, part 2

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- The Polity IV measure of democracy has four components:
  - Regulation of executive recruitment
  - Competitiveness of executive recruitment
  - Openness of executive recruitment
  - Constraints on chief executive

Measuring democracy, part 3

- Example of expert coding scale for “regulation of executive recruitment,”:

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- +3 = regular competition between recognised groups

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- Countries that have regular elections between groups that are more than ethnic rivals will have higher scores.

Cronbach's Alpha: Measure of Scale Reliability

Measure of internal consistency - how closely related a set of items are as a group

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is a function of the number of test item (N), the average covariance among the items ($\bar{c}$), and the average variance of all items ($\bar{v}$)

$$\alpha = \frac{N * \bar{c}}{\bar{v} + (N - 1) * \bar{c}} \tag{1}$$

Some Stata Code

```
clear
cd "/Users/raymondduch/Dropbox/IS_2011/Data_sets/"

use "/Users/raymondduch/Dropbox/IS_2011/Data_sets/ESS_measurement_class1.dta"
keep cntry trstprl trstlgl trstplc trstplt trstprt trstep trstun weight

****TRUST IN THE POLITICAL SYSEM
*two factor example

global trust trstprl trstlgl trstplc trstplt trstprt trstep trstun
des $trust // 0-10 scale

pwcorr $trust [aw=weight], sig

alpha  $trust , item
```

Reliability of Trust in Political System Scale

```
. ****TRUST IN THE POLITICAL SYSEM
. *two factor example
.
. global trust trstprl trstlgl trstplc trstplt trstprt trstep trstun

. des $trust // 0-10 scale

              storage  display     value
variable name   type   format      label      variable label
------------------------------------------------------------------------------
trstprl         byte   %8.0g       LABC       Trust in country's parliament
trstlgl         byte   %8.0g       LABC       Trust in the legal system
trstplc         byte   %8.0g       LABC       Trust in the police
trstplt         byte   %8.0g       LABC       Trust in politicians
trstprt         byte   %8.0g       LABC       Trust in political parties
trstep          byte   %8.0g       LABC       Trust in the European Parliament
trstun          byte   %8.0g       LABC       Trust in the United Nations
```

Item Correlations

```
.
. pwcorr $trust [aw=weight], sig

             |  trstprl  trstlgl  trstplc  trstplt  trstprt   trstep   trstun
-------------+---------------------------------------------------------------
     trstprl |   1.0000
             |
             |
     trstlgl |   0.6667   1.0000
             |   0.0000
             |
     trstplc |   0.5463   0.7039   1.0000
             |   0.0000   0.0000
             |
     trstplt |   0.6628   0.5449   0.4744   1.0000
             |   0.0000   0.0000   0.0000
             |
     trstprt |   0.6299   0.5195   0.4343   0.8498   1.0000
             |   0.0000   0.0000   0.0000   0.0000
             |
      trstep |   0.4695   0.4055   0.3289   0.5217   0.5344   1.0000
             |   0.0000   0.0000   0.0000   0.0000   0.0000
             |
      trstun |   0.4133   0.3960   0.3767   0.4795   0.4809   0.7513   1.0000
             |   0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
             |
```

Cronbach's Alpha

```
. alpha  $trust , item

Test scale = mean(unstandardized items)
```

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
trstprl	53362	+	0.8324	0.7536	3.673209	0.8762
trstlgl	53318	+	0.8074	0.7150	3.696197	0.8809
trstplc	54187	+	0.7497	0.6330	3.861636	0.8908
trstplt	53703	+	0.8475	0.7831	3.754276	0.8735
trstprt	53397	+	0.8310	0.7622	3.806338	0.8762
trstep	47932	+	0.7350	0.6330	3.964784	0.8900
trstun	48363	+	0.7325	0.6233	3.93814	0.8915
Test scale					3.814613	0.8979

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Determine the dimensionality of these underlying latent variables

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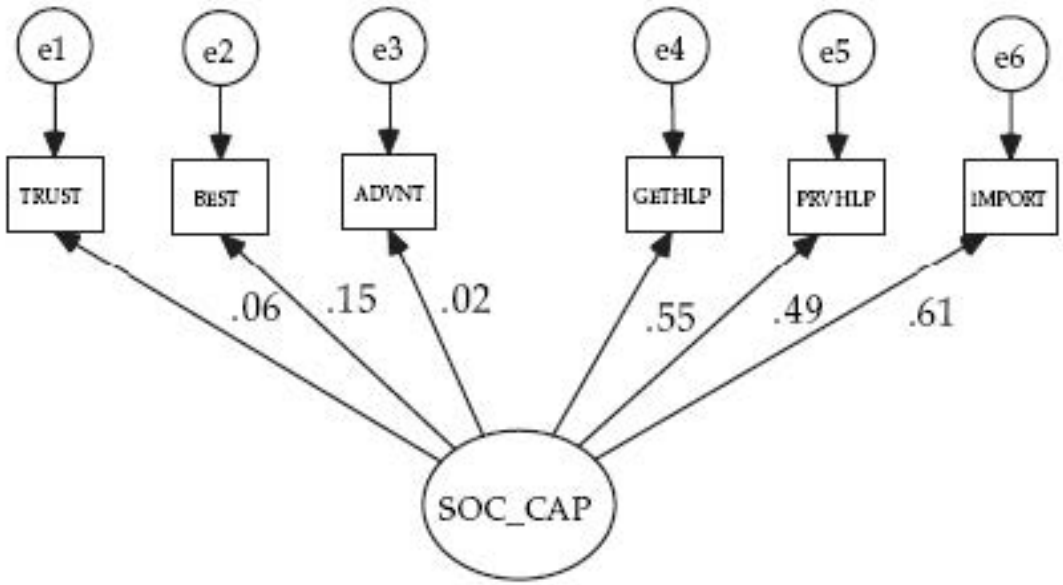
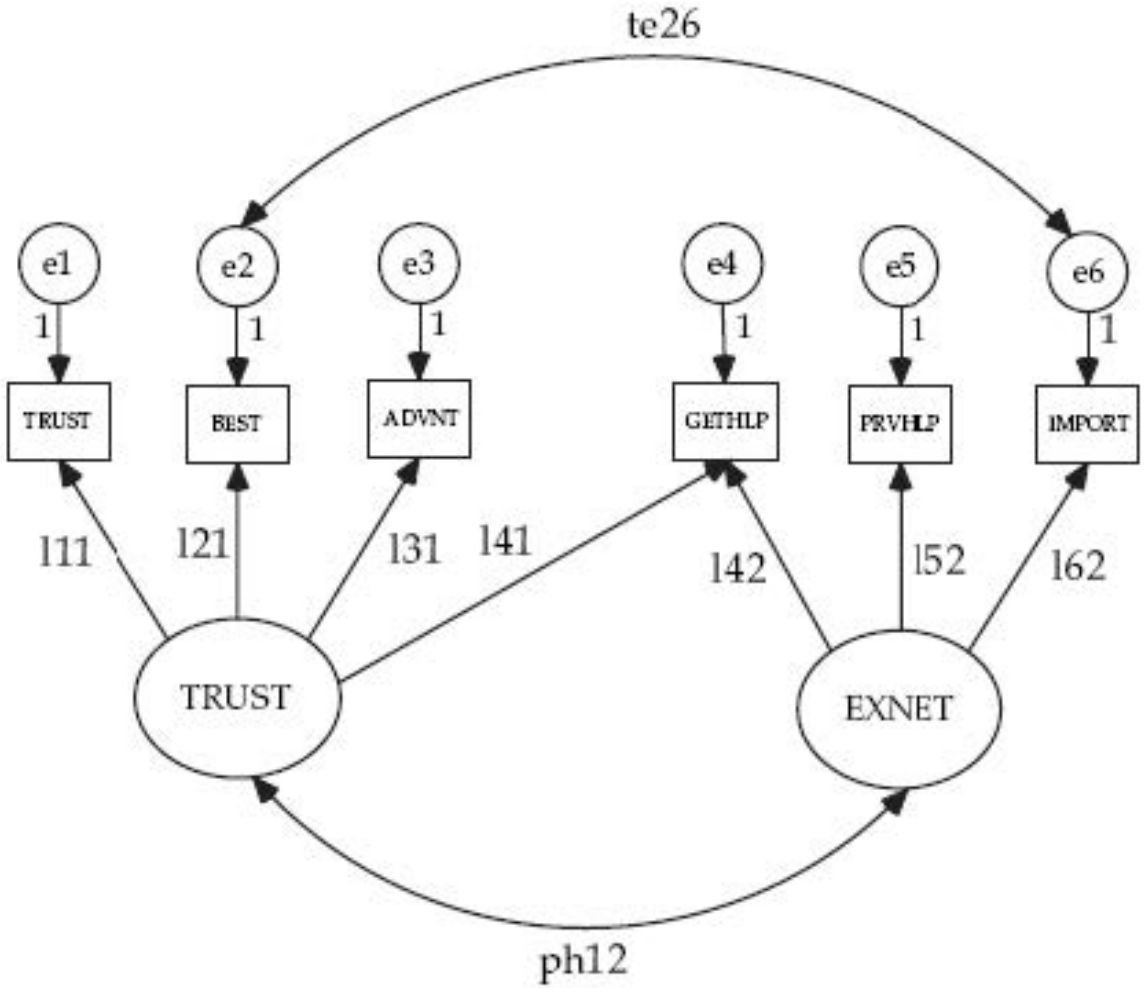
Recover measures of these underlying latent variables

Figure 1. Measurement model for social capital – a single factor model (standardised solution)



Chi-square = 214.294 (9 df), p=.000
GFI=.937, BIC=319.918, RMSEA=.144

Figure 2. Measurement model for social capital – two factors solution



Factor Loadings on the Unobserved Factors

Consider a survey with i respondents who answer j survey questions

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Factor analysis posits that x_{ij} is a combination of p unobserved factors, each written using the Greek letter ξ

$$x_{ij} = \lambda_{j1}\xi_{i1} + \lambda_{j2}\xi_{i2} + ... + \lambda_{jp}\xi_{ip} + \delta_{ij} \quad (2)$$

λ are factor loadings

Factor Loadings on the Unobserved Factors

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δ_{ij} is measurement error

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Some More Stata Code

```
clear
cd "/Users/raymondduch/Dropbox/IS_2011/Data_sets/"

use "/Users/raymondduch/Dropbox/IS_2011/Data_sets/ESS_measurement_class1.dta"

factor $trust [aw=weight], pcf
rotate // varimax to produce orthogonal factors
predict trust1 trust2
pwcorr trust1 trust2 [aw=weight], sig // no correlation
*trust in EP and UN have much higher scores on factor 2
```

Factor Analysis of Trust in Political System Items

```
. factor $trust [aw=weight], pcf
(sum of wgt is   4.6914e+04)
(obs=45155)

Factor analysis/correlation                       Number of obs    =     45155
    Method: principal-component factors           Retained factors =         2
    Rotation: (unrotated)                         Number of params =        13

    ------------------------------------------------------------------------------
        Factor  |   Eigenvalue   Difference        Proportion   Cumulative
    ------------+-----------------------------------------------------------------
        Factor1 |      4.24868      3.24066            0.6070       0.6070
        Factor2 |      1.00803      0.28532            0.1440       0.7510
        Factor3 |      0.72270      0.34281            0.1032       0.8542
        Factor4 |      0.37989      0.11811            0.0543       0.9085
        Factor5 |      0.26178      0.02687            0.0374       0.9459
        Factor6 |      0.23491      0.09090            0.0336       0.9794
        Factor7 |      0.14401            .            0.0206       1.0000
    ------------------------------------------------------------------------------
    LR test: independent vs. saturated:  chi2(21) = 2.1e+05 Prob>chi2 = 0.0000
```

Factor Loadings

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Uniqueness
trstprl	0.8182	-0.2303	0.2776
trstlgl	0.7828	-0.4055	0.2228
trstplc	0.7112	-0.4431	0.2979
trstplt	0.8516	-0.0036	0.2748
trstprt	0.8350	0.0480	0.3005
trstep	0.7323	0.5475	0.1639
trstun	0.7085	0.5406	0.2058

Factor Scores

```
. predict trust1 trust2
(regression scoring assumed)

Scoring coefficients (method = regression; based on varimax rotated factors)

    ---------------------------------
       Variable |  Factor1   Factor2
    ------------+--------------------
        trstprl |  0.29475  -0.04882
        trstlgl |  0.40122  -0.18648
        trstplc |  0.41261  -0.22581
        trstplt |  0.15483   0.12735
        trstprt |  0.11863   0.16375
         trstep | -0.22131   0.52508
         trstun | -0.22114   0.51622
    ---------------------------------
```

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- Bear in mind that establishing causal relationships between variables is not at all akin to hunting for DNA evidence like some episode from a television crime drama.
- Social reality does not lend itself to such simple, cut-and-dried answers.
- Is there a "best practice" for trying to establish whether X causes Y?

The four causal hurdles

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- Is there a credible causal mechanism that connects X to Y?

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- Is there covariation between X and Y?

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- Is there a credible causal mechanism that connects X to Y?
- Is there covariation between X and Y?
- Could Y cause X?
- Is there some **confounding variable** Z that is related to both X and Y, and makes the observed association between X and Y **spurious**?

But what if we don't cross that fourth hurdle?

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- Since the main goal of science is to establish whether causal connections between variables exist, then failing to control for other causes of Y is a potentially serious problem.
- Statistical analysis should not be disconnected from issues of theory (model) and research design.

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- Lets explore three generic strategies

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- if between measurings the group that was exposed (called the test group) has changed relative to the control group, ascribe this to the effect of the independent variable (X) on the dependent variable (Y)

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- if test group change is different than control group change ascribe this difference to the independent variable (X)

Table: Some Research Designs

Type	Graphic Representation
Observation with no control group	Test group: M * M
Natural experiment no pre-measurement	Test group: * M Control: M
Natural experiment	Test group: * M Control: M
True experiment	Test group: R M * M Control: RM M