Friedrich-Alexander-Universität
Technische Fakultät

Machine Learning
Data Analytics

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# Human Computer Interaction

## Chapter 6: Evaluation

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# Overview



Machine Learning and Data Analytics Lab (MaD) in Erlangen

# Experimental Design

# How do experiments look like?

NIHS laboratory, © Nestlé: https://www.flickr.com/photos/nestle/8144370795 (CC BY-NC-SA 2.0)

# Are men with scars attractive?

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Hypothesis: Negative Impact of Scarring.
**How would you design such an experiment?**

- **147 female**, **76 male** participants rated **attractiveness** of opposite-sex faces
- Faces were manipulated with **photorealistic scarring**
- **Scarring** may increase person‘s attractiveness!

ELSEVIER

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Facial scarring enhances men’s attractiveness for short-term relationships

Robert P. Burriss [a,*], Hannah M. Rowland [a], Anthony C. Little [b]

# Generalizability of experiments?



M. Hickson, A.L. D'Souza, N. Muthu, T.R. Rogers, S. Want, C. Rajkumar, C.J. Bulpitt.: Use of probiotic Lactobacillus preparation to prevent diarrhoea associated with antibiotics: randomised double blind placebo controlled trial. BMJ. 2007 Jul 14;335(7610):80. Epub 2007 Jun 29.

# Why we do experiments?

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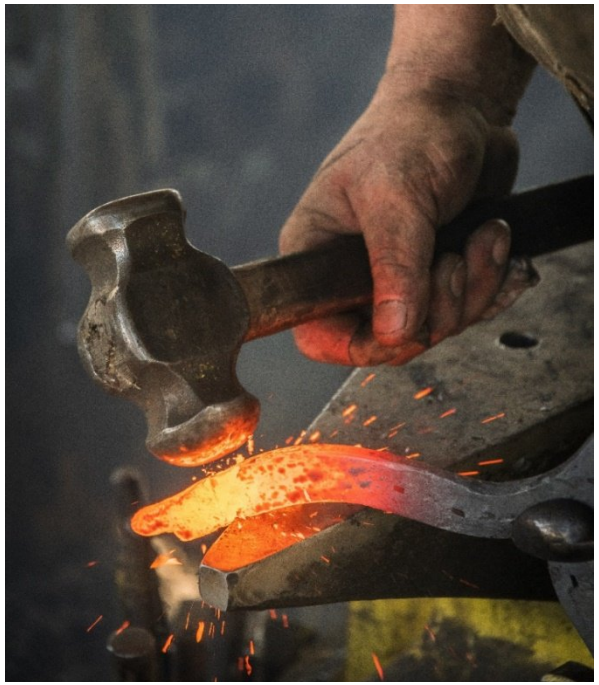
Scientists want to understand **cause** and **effect**

When metal
is heated
it expands



https://genagorlin.substack.com/p/time-to-build-the-builders?s=r

# Why we do experiments?

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## To make **predictions**

Photo by Rich Niewiroski Jr.: http://projectrich.com/gallery/ (CC BY 2.5)

The metal in the bridge needs space to expand in hot weather

## To test **hypotheses**

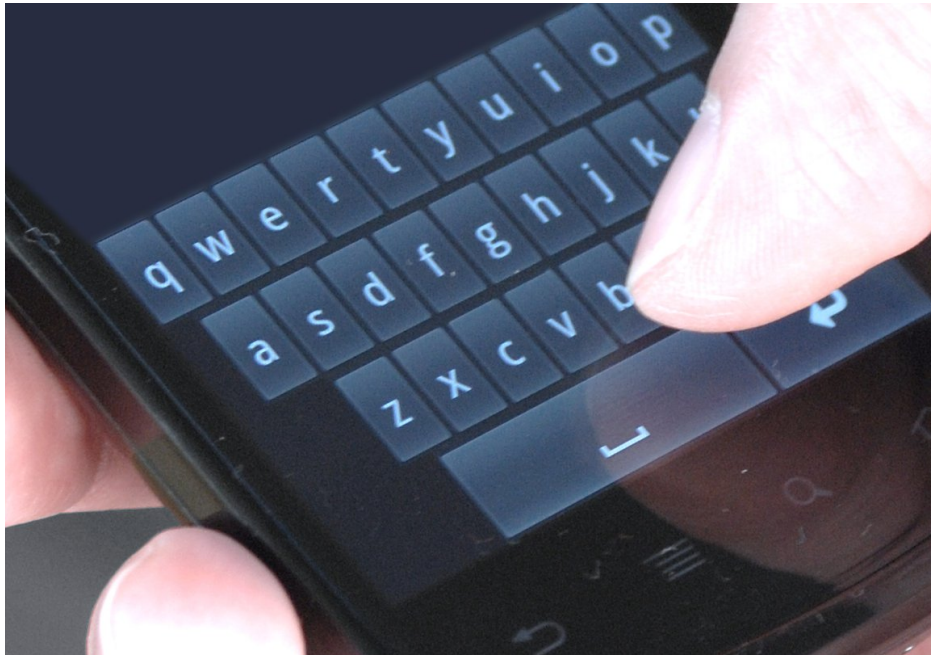


Photo by N. Henze

My Keyboard is faster than yours

# Observational Studies

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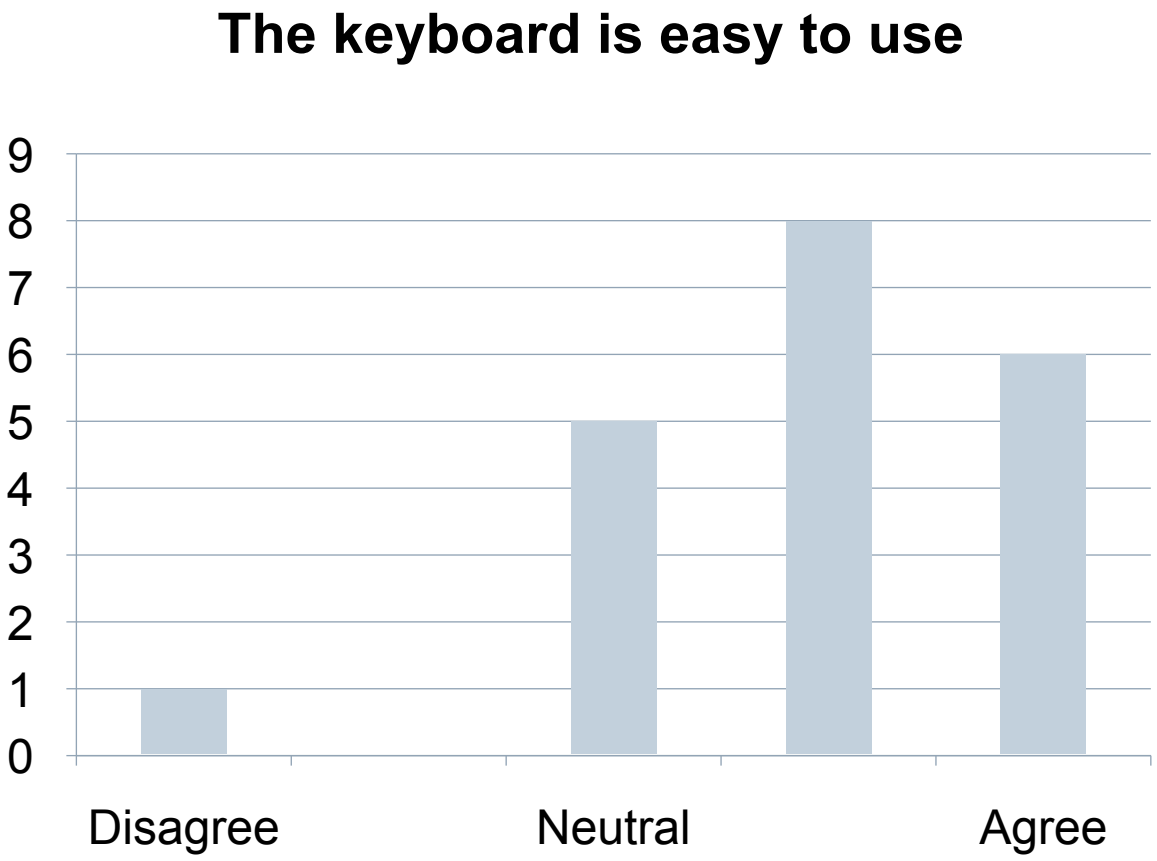
Observe users using the user interface and collect data

Why will this not be sufficient?

# Example: Keyboard usability



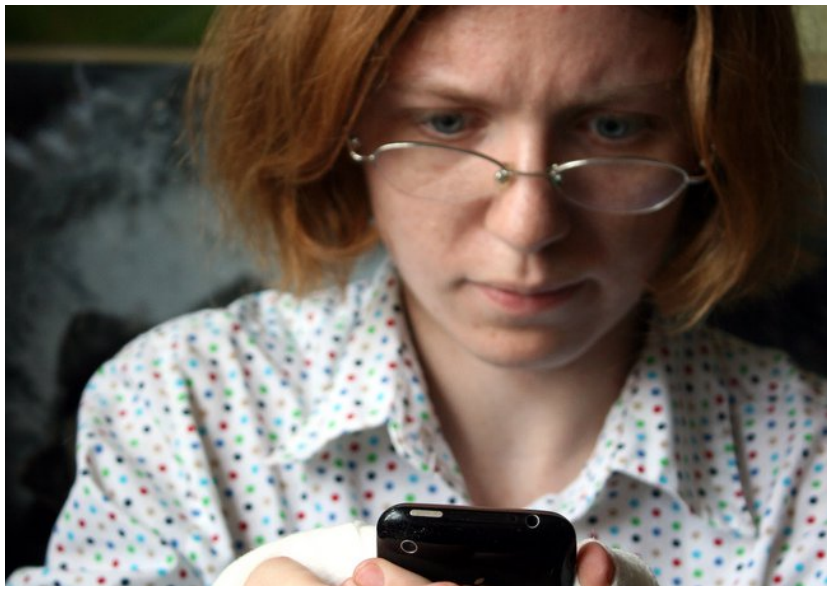



Photo by quinn.anya: http://www.flickr.com/photos/quinnanya/4661638173 (CC BY-SA 2.0)

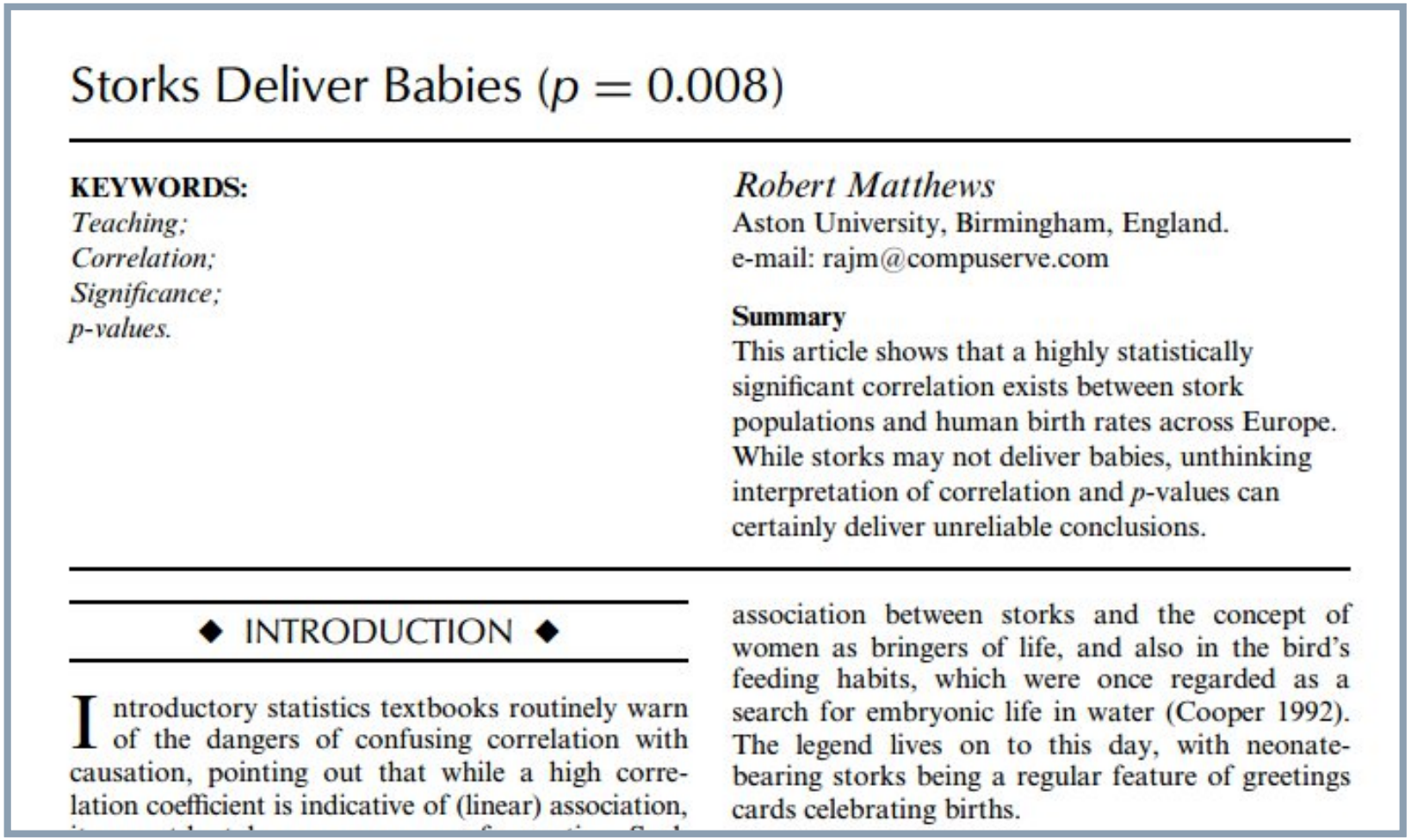
## Isolating the cause

Participants rated the keyboard easy to use, because:

- They actually find the keyboard easy to use?
- They want to support you in your research?
- They were overwhelmed by the system's novelty?
- The German football team won the world cup yesterday?
- …

More observation will not help to find the answer!

# Caution versus Correlation



## Storks Deliver Babies ($p = 0.008$)

**KEYWORDS:**
*Teaching;*
*Correlation;*
*Significance;*
*p-values.*

*Robert Matthews*
Aston University, Birmingham, England.
e-mail: rajm@compuserve.com

**Summary**
This article shows that a highly statistically significant correlation exists between stork populations and human birth rates across Europe. While storks may not deliver babies, unthinking interpretation of correlation and *p*-values can certainly deliver unreliable conclusions.

### ◆ INTRODUCTION ◆

Introductory statistics textbooks routinely warn of the dangers of confusing correlation with causation, pointing out that while a high correlation coefficient is indicative of (linear) association,

association between storks and the concept of women as bringers of life, and also in the bird's feeding habits, which were once regarded as a search for embryonic life in water (Cooper 1992). The legend lives on to this day, with neonate-bearing storks being a regular feature of greetings cards celebrating births.

Matthews, Robert. "Storks deliver babies (p= 0.008)." *Teaching Statistics* 22.2 (2000): 36-38.
http://www.brixtonhealth.com/storksBabies.pdf

# Caution versus Correlation

If I want more babies,
can I move to an area with many storks?

No! Storks do not **cause** babies

Other causes?

http://perfecthealthdiet.com/2012/04/theory-of-the-stork-new-evidence/

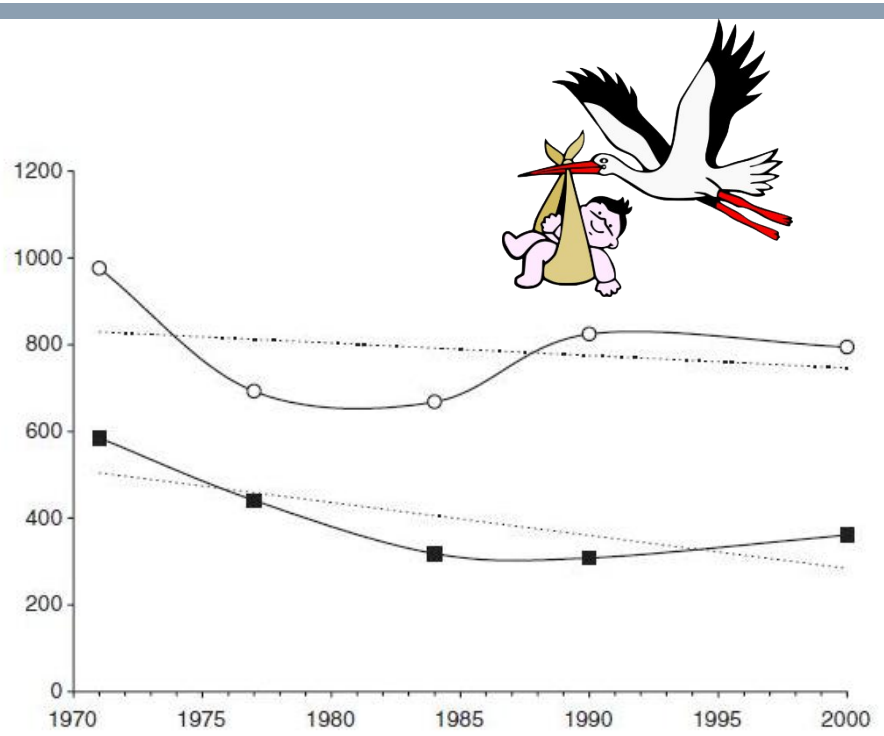



Figure 1. Storks and the birth rate in Lower Saxony, Germany (1971–2000). Open circles show yearly birthrates in hundreds in Lower Saxony. Full squares show numbers pairs of storks in Lower Saxony. Dotted lines represent linear regression trend ($y = mx + b$).

# Caution versus Correlation



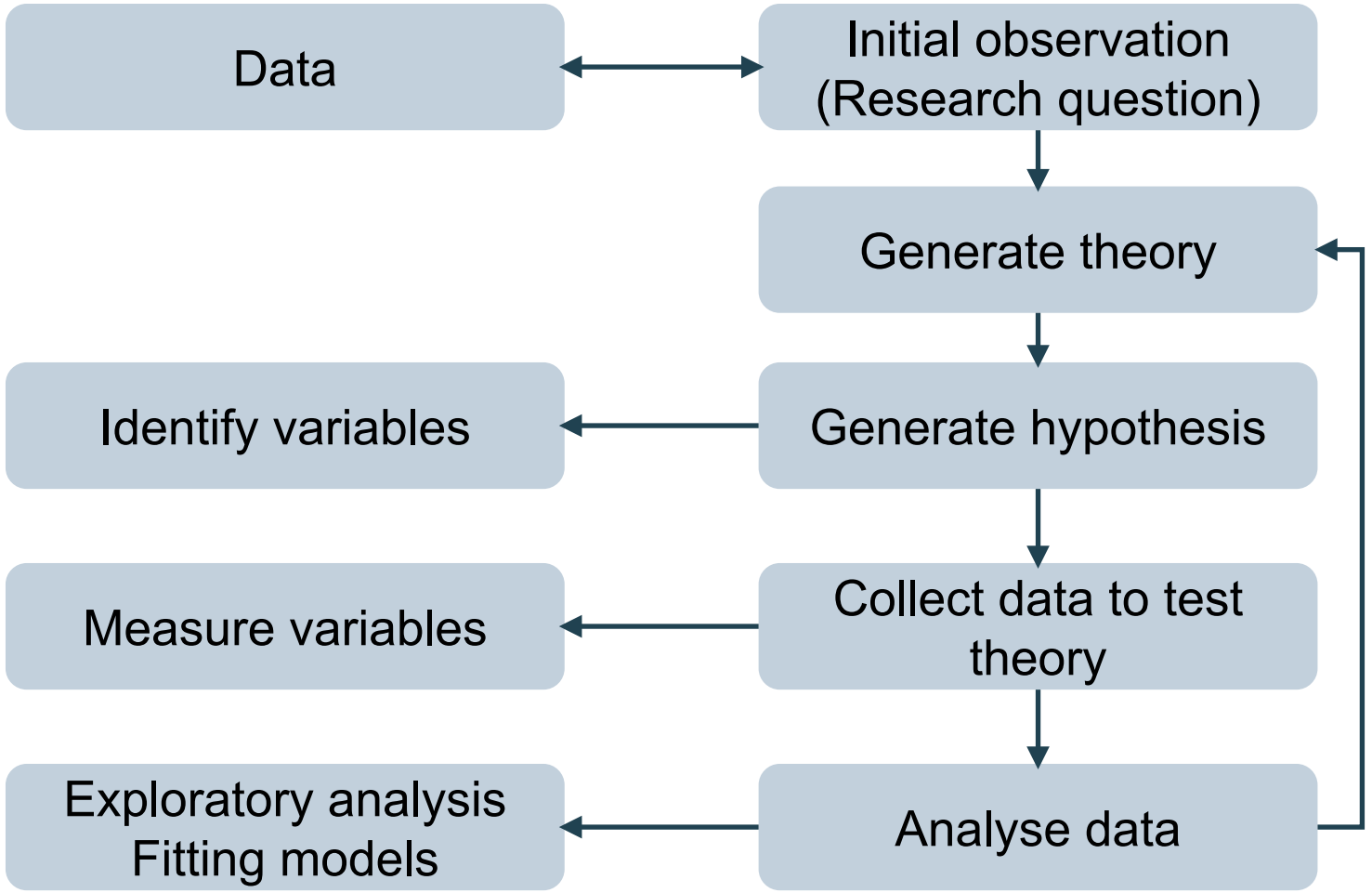
## Birthrate and number of storks correlate

Explanation 1: Children cause storks
For example, the crying of babies attract storks

Explanation 2: Storks cause children
For example, the myth is true and storks bring babies

Explanation 3: A third unknown aspect causes both
For example, the village environment is more friendly to storks and families that desire children.
Called *Tertium Quid*

# Research Process



# Experiments

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Goal: Detection of **causal influences**

Set up a **direct comparison** between **treatments**

Minimize **bias** and **errors**

Main characteristic of experiments and difference to observational studies:

We control the assignment of conditions!

We can isolate **cause** and **effect**

Knowing cause and effect

# Thank you for your attention