

Lecture 3

Empirical Research Methods IN4304

Experimental design (fixed design)

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Previous lecture

A research plan

- Consider: purpose, theory, research question, mode inquiry, sampling method

Research question

- Descriptive/ Difference/ Relationship
- Properties, Unit

Conceptual model

- Causal relationship
- Independent, dependent variable

Type of research

- Explorative
- Descriptive
- Explanatory
- Correlational

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Today

- General information about the module
 - Trustworthiness of findings
 - True experimental designs
 - Quasi-experimental designs

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Learning outcomes of lecture 3

After today's lecture you should :

- Be able to describe a number true experimental designs
- Be able to list a number of threats to internal validity

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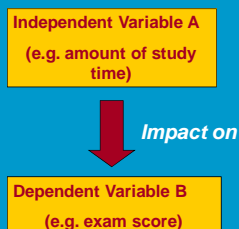


Class question - Causality

What is needed to claim causality?

Causality requires at least three conditions:

1. **significant correlation between the variables**
2. **temporal asymmetry (time precedence) between the variables**
3. **elimination of any common causal variable (extraneous variables)**



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Trustworthiness in Fixed Design Research

- Reliability: "The stability or consistency with which we measure something"
 - Participant error / bias
 - Observer error / bias
- Validity: "accuracy of a result"
 - "Internal validity means there are no errors internal to the design of the research" (Neuman, 1997, p.145)
 - External validity / Generalizability: "the extent to which the findings of the enquiry are more generally applicable" (Robson, 2002)

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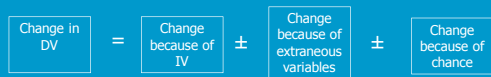
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Class Question

What could threaten internal validity?

Internal validity: "The extent to which a study establishes that a factor or variable has actually caused the effect that is found (and in particular that it has not been caused by other factors)" (Robson, 2002, p. 549)



(Kumar, 2005, p. 86)

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Internal Validity - History

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
6. Maturation
7. Selection
8. Selection by maturation interaction
9. Ambiguity about causal direction
10. Diffusion of treatment
11. Compensatory equalization of treatments
12. Compensatory rivalry

Things that have changed in the participants' environment other than caused by independent variable

(Robson, 2002)

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Internal Validity - Testing

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Changing caused by pre-test

(Robson, 2002)

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Internal Validity - Instrumentation

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
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8. Selection by maturation interaction
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Change caused by difference in measurement instrumentation between pre-test and post-test

(Robson, 2002)

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Internal Validity - Regression

1. History
2. Testing
3. Instrumentation
4. Regression
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9. Ambiguity about causal direction
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Statistical regression: a problem of extreme values or a tendency for random errors to move group results toward the average (Neuman, 1997, p.191).

- a. Select extreme group (more likely to become less extreme)
- b. Extreme score on a test likely to become less extreme in a second test

(Robson, 2002)

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Internal Validity - Mortality

1. History
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Participant dropping out of the experiment (what was the cause?)

(Robson, 2002)

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Internal Validity - Maturation

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
6. Maturation
7. Selection
8. Selection by maturation interaction
9. Ambiguity about causal direction
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12. Compensatory rivalry

Growth, change or development in participants unrelated to independent variable

(Robson, 2002)

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Internal Validity – Selection Bias

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
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7. Selection
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9. Ambiguity about causal direction
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Participants will not form equivalent groups

(Robson, 2002)

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Internal Validity – Selection by maturation interaction

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
6. Maturation
7. Selection
8. Selection by maturation interaction
9. Ambiguity about causal direction
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Initial groups are equal but over time change by maturation which is not caused by independent variable

e.g. groups of boys and girls initial equal physical strength

(Robson, 2002)

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Internal Validity – Ambiguity about causal direction

1. History
2. Testing
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Is the independent variable causing change in dependent variable or the other way around?

(Robson, 2002)

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Internal Validity – Diffusion of treatment

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
6. Maturation
7. Selection
8. Selection by maturation interaction
9. Ambiguity about causal direction
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Groups/conditions are effecting change in other groups/conditions.

For example members of one group are talking with members of another group.

(Robson, 2002)

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Internal Validity – Compensatory equalization of treatment

1. History
2. Testing
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4. Regression
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7. Selection
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Situation where control group needs to be compensated because they did not receive treatment

(Robson, 2002)

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Internal Validity – Compensatory Rivalry

1. History
2. Testing
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7. Selection
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9. Ambiguity about causal direction
10. Diffusion of treatment
11. Compensatory equalization of treatments
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Group members change their behaviour to rival member in another group

For example making some extra effort to show that the new system is better and the old system

(Robson, 2002)

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Threats to external validity

- **Selection:** Findings being specific to the group studies
- **Setting:** Findings being specific to the particular context in which the study took place
- **History:** Specific and unique historical experiences may determine or affect the findings
- **Construct effects:** The particular constructs studied may be specific to the group studied

(Robson, 2002)

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Type of Fixed Design Research

- **True experimental** – Random allocation of participant to groups and the experimenter maintains complete control over all variables, and manipulates IV
- **Quasi-experimental** – Almost true experiment but missing one or more essential features such as random allocation of participant to groups, or full control of IV
- **Single case experimental** – Focus is on individual(s) instead of groups, and individual acts as his/her own control group
- **Non-experimental fixed design** – Lack of active manipulation of situation by experimenter

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Class question

Write down an experimental design to study the effect various image compression algorithms have on perceived image quality

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True experimental

- Two groups design
 - Post-test-only randomized controlled trial (RCT)
 - Post-test-only two treatment comparison
 - Pre-test post-test randomized controlled trial (RCT)
 - Pre-test post-test two treatment comparison
- Three (or more) group simple designs
- Factorial design
- Parametric design
- Matched pairs design
- Repeated measure design
- Mixed design

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Two groups design - Post-test-only randomized controlled trial (RCT)

Pocket Negotiator



Independent Variable (IV)

Dependent Variable (DV)

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Post-test-only randomized controlled trail (RCT)



Potential threats to internal validity can be ruled out: history, selection, instrumentation, and testing.

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Two groups design - Post-test-only two treatment comparison

Pocket Negotiator



Independent Variable (IV)

Dependent Variable (DV)

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Two groups design - Post-test-only two treatment comparison



Potential threats to internal validity can be ruled out: history, selection, instrumentation, and testing.

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Two groups design - Pre-test post-test randomized controlled trail (RCT)

Pocket Negotiator



Independent Variable (IV)

Dependent Variable (DV)

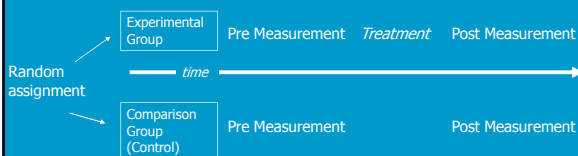
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Pre-test Post-test randomized controlled trail (RCT)



What are advantage and disadvantage of this design ?

Advantage: Can control (statistically) for pre-differences in groups
Disadvantage: testing threat, more work

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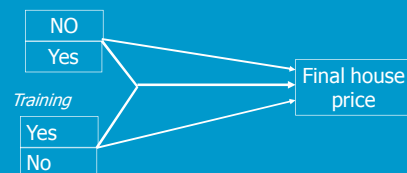


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Factorial Design (2 X 2 design)

More than one IV

Pocket Negotiator (PN)



Independent Variables (IVs)

Dependent Variable (DV)

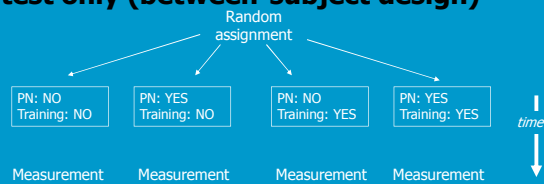
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Factorial Design (2 X 2 design) – post test only (between-subject design)



With multiple variable and with multiple levels this design can become very complex.

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Class Question

- How many groups do you need for experiment to study the effect on house price by
 - 3 User interface design of Pocket Negotiator
 - Give training (Yes/No)
 - 4 Negotiation strategy in PN

$3 \times 2 \times 4 = 24$ groups !!

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Matching pairs design

- Equal Participants are paired
- Equal based on criteria known to effect DV
- Members of the pair are randomly assigned to one group and other member is assign to the other group
- Advantage: More equal groups (less noise caused by extraneous factors)
- Disadvantage:
 - Matching increase with multiple criteria
 - Matching data could require pre-test which has its problems

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Repeated Measure design (Within-subjects design)

Image
compression
algorithm

A participant is exposed to all conditions

algorithm A
algorithm B
algorithm C
algorithm D

Image
quality

Independent Variable (IV)

Dependent Variable (DV)

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Repeated Measure Design – Order effect

- Order effect / Fatigue effect / learning effect
- Counter balancing (two conditions):
 - 50% of the participants have sequence AB
 - 50% of the participants have sequence BA
- Latin square (more conditions)
 - ABCD
 - DABC
 - CDAB
 - BCDA

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Mixed design (combination of between-subjects and within-subjects)

Image compression
algorithm (within)

algorithm A
algorithm B
algorithm C
algorithm D

Image
quality

Training (between)

Yes
No

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Type of Fixed Design Research – Quasi-experimental design

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- **Single case experimental** – Focus is on individual(s) instead of groups, and individual act as his/her own control group
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Quasi-experimental design

- Pre-experimental designs ("should be avoided")
 - Single-group post-test-only
 - Post-test only non-equivalent groups
 - Pre-test post-test single group design
- Pre-test post-test non-equivalent groups
- Interrupted time series design

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Type of Fixed Design Research – Quasi-experimental design

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Non-experimental fixed design

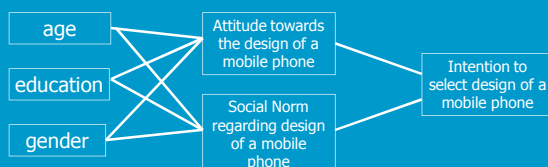
- Relational designs (correlational study)
 - Cross-sectional designs (survey method)
 - Prediction study
- Longitudinal designs

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Cross-sectional study



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Sample size

Three approaches

1. Sample limit is set by practical limits
 2. Determine sample size required max error size
 3. Determine sample size on the effect size that is still of interest
- For more see chapter Brinkman on blackboard

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Summary

Internal validity

1. History
2. Testing
3. Instrumentation
4. Regression
5. Mortality
6. Maturation
7. Selection
8. Selection by maturation interaction
9. Ambiguity about causal direction
10. Diffusion of treatment
11. Compensatory equalization of treatments
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True experimental designs

- Two groups design
- Three (or more) group simple designs
- Factorial design
- Matched pairs design
- Repeated measure design
- Mixed design

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This week in practicum

Week 3 Experimental design*

- Analysis research paper on their experimental design
- Working on project coursework on experimental design

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Next time

Week 4 - Surveys and Questionnaires

- Scales of measurement
- Validity and Reliability
- (Robson ch. 8 and 10, Brinkman on blackboard)

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References

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- Neuman, W.L., (1997). *Social research methods; Qualitative and quantitative approaches*. (3rd ed). Boston, MA: Allyn and Bacon.
- Robson, C., (2002) *Real world research: A resource for social scientists and practitioner-researchers* (2nd ed). Malden: MA, Blackwell.

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