

# Experimental methods

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Linguistic Methods Course

# Experiment

- Method for empirical investigation of question or hypothesis
- 2 types
  - a) Lab experiment
  - b) Naturalistic experiment

Question -> Hypothesis (researchable) ->

Operationalize the hypothesis (H0, H1)

- Independent variables (conditions)
- Dependent variables (what you measure)

Predication from the hypotheses  
(testing implication)

# Control

Isolate variables

Operationalize

Experiment group

Control group: sample, matching

Paired = Dependent groups

Unpaired = Independent groups

Single subject studies, baseline A - B - A

- Validity

- Reliability

Help hypotheses:

- Replicability

- Statistical method - significance

# Example 1

Simple memory experiments

Recall - Recognition

Nonsense words

Primacy and recency effects

Godden & Baddeley's divers

# Example 2

An advanced memory experiment  
(Anderson & Pichert 1978)

House description

2 conditions - buyer  
- burglar  
+ change roles

# Lab experiments

## On-line (real time measurements)

- Lexical Decision
- ScriptLog

## Off-line

- Reconstruction experiments
- Pre and post test

# Example 3

The McGurk effect

# Models for word recognition

Visual

Serial search models (active) - Forster

Direct recognition models (passive) - Morton,

ANN (Artificial Neural Network), IAM  
(Interactive Activation Model)

Hybrid, verification models

Auditive

TRACE (cf IAM)

Associative and semantic priming

Automatic and conscious (postlexical) priming

# Naturalistic experiments

- Typological comparisons - different languages
- Neurolinguistics - different types of disorders

# Research questions

- Descriptive questions
- Types of research
  - Quantitative
  - Qualitative
- How frequency changes in relation to something else
  - Questions of difference
    - Between groups
    - Witin group

# True experimental research

3 main factors:

1. Random assignment of subjects to groups
2. Active manipulation
3. Experimental group - control group

# Quasi experimental research

- Subjects are assigned to groups according to conditions
- Constructed control group matched for important factors
- Causal correlations

# Non-experimental research

- No attempt at randomization or manipulation of variables.
- Only correlation possible.

# Scientific method as research plan

1. Observation of problem gives question
2. The problem is formulated as a testable hypothesis
3. Use of suitable methods to test the hypothesis
4. Reporting and interpretation of results
5. Discussion and evaluation of results

# Selection of subjects

- Internal validity  
The results are caused by the independent variable. (Not if other difference between the groups can affect results.)
- External validity  
The results can be generalized to the population. Representativity.
- Number  
Too few - correlations are not discovered by statistics (but many do not necessarily give better external validity)

# Procedures

- Describe carefully - replicability
  - 1) Ways of administering the independent variable
  - 2) Ways of registering the dependent variable
  - 3) Instructions
  - 4) Test environment

# Statistical analysis

## 1. Descriptive statistics

Summarize, organize results

Mean, Median, Variability

## 2. Association between two or more sets of data

Correlation tests

## 3. Sampling - inferential statistics

Selection generalization with inductive reasoning

Sample fact -> "true fact"

Degree of confidence - tolerance for sampling error

Risk tolerance 0.1, 0,5

Probability, e g 95% -> Prediction

# Problem and causal relations

- Correlation - alt. Third variable?
- Problem of direction
- Alternative, rivaling hypothesis
  
- Difference in dependent variable which has or has not been preceded by independent variable

# Variance:

Quantitative evaluation - how much the numbers differ.

3 types:

Population & sample variance

= expected magnitude of variance dependent on random factors

Systematic variance

= between group variance: systematic difference depending on the assignment or active manipulation of the independent variable

Error variance

= the variance that remains when all known sources of systematic variance have been eliminated

Test of significance: systematic var/error var

More error variance - less likely group difference

Sources:

Sampling error

Measurement error

Fluctuations in test conditions

Variance - between groups  
- within groups

# Deductive and inductive reasoning

Deductive

Syllogism

Theory  $\rightarrow$  specific case "a priori generalization"

Inductive reasoning

Inferences from empirical experiments

Theory strengthened or weakened by data about hypotheses

Existing knowledge

Predictive knowledge

GAP

Earlier

Probability

estimated

Inductive

inference

(statistics)

Confidence

interval testing

# Validity

= make correct, well founded arguments based on deductive reasoning

= inductively infer the relative truth in an observation based on its operational definition and empirical measurement

Content validity = face validity = representativity in sampling and procedure

= to what degree a certain measurement measures what was intended

Predictive validity can exist without content validity.

Criterion related validity

# Internal validity

= How much causal inferences are justified, based on observed changes in dependent variable, as response to systematic variations in independent variable

3 conditions:           covariation  
                                  time sequence relation  
                                  other possible causes can be  
                                  eliminated

Threats: History, Maturation, Testing, Instrumentation, Statistical regression, Experimental mortality, Selection bias (subject awareness/Hawthorne effect; compensation, imitation)

Better: untreated control group, randomized assignment

# External validity

= generalizability of results from the sampling of cases of one specific study to populations, environments, treatment variables or measurement variables

The relation Lab - World

Conflict internal - external validity

Threats:

Measurement limitations

Treatment limitations

Sample restrictions -representativity

Task, Conditions, Time, Participants

Imporgant: Relication, selection of subjects

# Statistical conclusion validity

= Relative truth that statistical conclusions are based on

Type 1 error: reject  $H_0$  that is true

Type 2 error: keep  $H_0$  that is false

Zero hypothesis = no difference

Construct validity

= How much the results agree with results from other investigations of the same phenomenon

Accumulated evidence from different researcher

- operational definition / Meta analysis

# Reliable conclusions

Reliability:

Stability

Accuracy most important

True score - what would be the result of repeated measurements (ideal) 1.0

Reliability

= how much deviations from true score reflect random errors in measurement

Reliability coefficient 0-1

# Judge / Rater reliability

1. Intra rater reliability

Degree of consistency within one rater

2. Inter rater reliability

Degree of agreement between two or more raters

Cohens Kappa (1977)

# Lexical Decision Experiment

Lexical access vs. Word recognition

Lexical decision design

	Words	Nonwords
Word group 1		
Word group 2		
Word group 3		

# About ScriptLog

- Editor which records (logs) all keyboard activity and all mouse movements
- Can be used with elicitation material (pictures, text etc)
- Output: produced text, linear text, log files, pause lists, editing data, basic statistics
- Can be downloaded / bought

# Output from ScriptLog

- Bin file (.bin)
- Text files:
  - Final text (.txt)
  - Linear text (.lin)
  - Log file (.log)
  - Editing distance data (.edd)
  - Pause time data (.ptd)
  - Basic statistics (.sta)

# Effects

- Frequency effect
- Word/nonword effect
- Context effects
- Degradation effect

## PART 6. EXPERIMENTAL METHODS Allwood

### Chapter 6 (Choose two of the three assignments below.)

1. Take a journal that publishes experimental studies (for example Journal of Applied Psycholinguistics, Language and Mental Processes, Brain and Language, Journal of Child Language etc.) and read carefully a paper using an experimental method. Summarize the design. What could be criticized in the design or performance of the study.
2. Design an experimental study of how something affects language behavior or how linguistic factors affect for example memory, cognition, willingness to act etc. Describe your design from the original research question to the formulation of the testing implication!
3. Take a non-experimental linguistic study (which you have seen in a journal, book chapter etc.) and try to find hypotheses from it that can be tried experimentally. Maybe you have to reformulate the basic research questions to make it possible to investigate with an experiment. Describe what you would do.