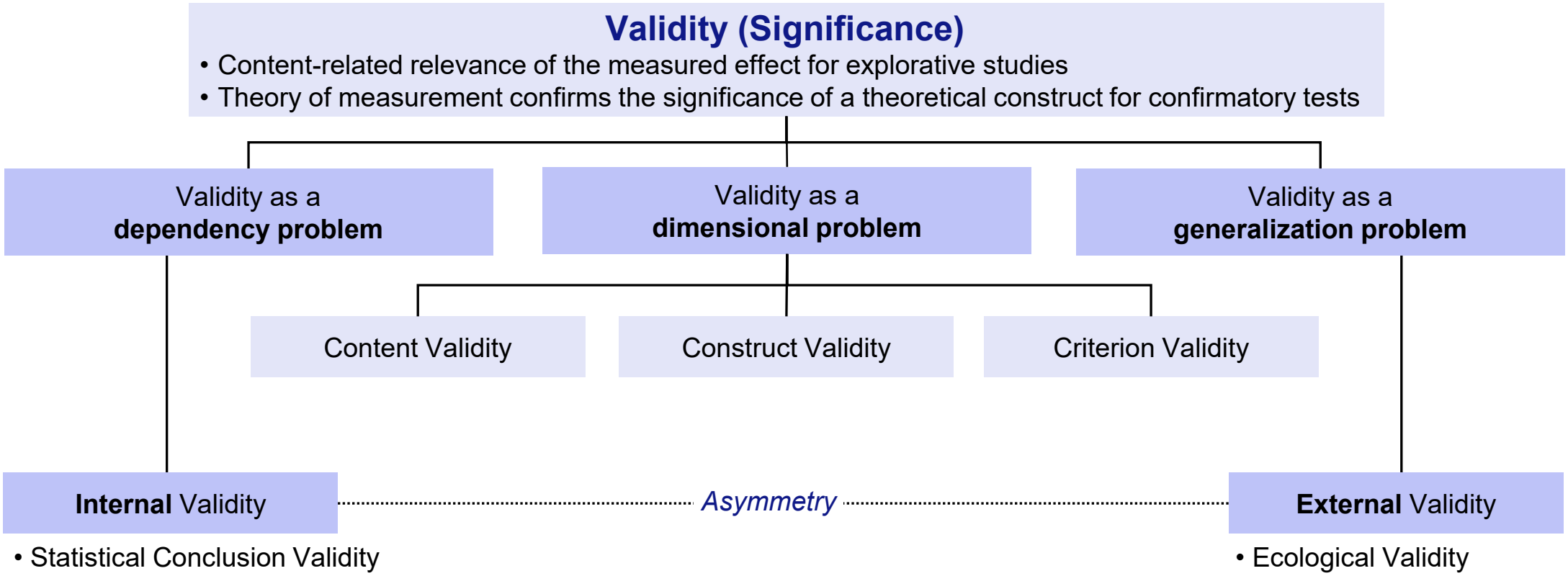
Essence of experiments

- Experiments are test arrangements to **verify causal hypotheses**. Thereby, the effect of variation of one or multiple independent variables on a dependent variable is measured.
- The basic principle is the **specific variation of the independent variables**, while eliminating any other potential influences on the dependent variable.

- **Laboratory experiments**: carried out in a laboratory environment to control for confounding factors, in general provide a high internal validity
- **Field experiments**: carried out in a real life environment, commonly provide a high external validity
- **Projective** (true) **experiments**: participants are randomly assigned to groups
- **Ex-post-facto-experiments**: comparison of two natural groups that differ in regard to the independent variable

Source: Cook/Campbell (1979), Chapter 1.

Validity



Source: Cook/Campbell (1979), Chapter 2.

Internal and external validity

- **Internal validity:** Changes in the dependent variable can unambiguously be assigned to the influence of the independent variable. The results of the analysis can be interpreted distinctly.

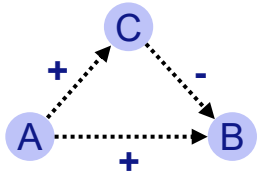
- **External validity:** The results of the sample analysis can be generalized to other persons, situations and points of time.

- **There is a trade-off between internal and external validity:** Adaptations of a setting in favor of internal validity mostly show negative impact on external validity, and vice versa.

Source: Cook/Campbell (1979), Chapter 2.

Internal validity: Confounding factors

Correlation vs. causality



History/Time	Uncontrolled treatment-like influences and events that affect the dependant variable between pretest and posttest.
Maturation	Biological and psychological maturation of the respondents, or other intrapersonal processes.
Measurement effects	Changes in the dependant variable due to confrontation with the measurement instrument.
Instrumentation	Change of the results due to variation of the measuring instrument, i.e. adaptions in the survey, interviewer, or other supplementary tools.
Statistical regression	Mitigation of extreme values between pretest and posttest.
Selection	Differences between the experimental and control group in regards to factors that influence the dependant variable.
Mortality	Treatment caused dropout of respondents.

Source: Cook/Campbell (1979), p. 51 ff.

Internal validity: Additional confounding factors for field experiments

Resentful demoralization	Perceived unfair treatments of the experimental/control group lead to resentment and demoralization based on envy and refusal.
Compensatory rivalry	Participants of the control group try to perform as good as the experimental group, although having a disadvantage.
Compensatory equalization	The experimenter tries to compensate injustices between the experimental and the control group by means of targeted actions.
Treatment diffusion	The control group receives information about treatment of the experimental group and tries to anticipate the reactions.

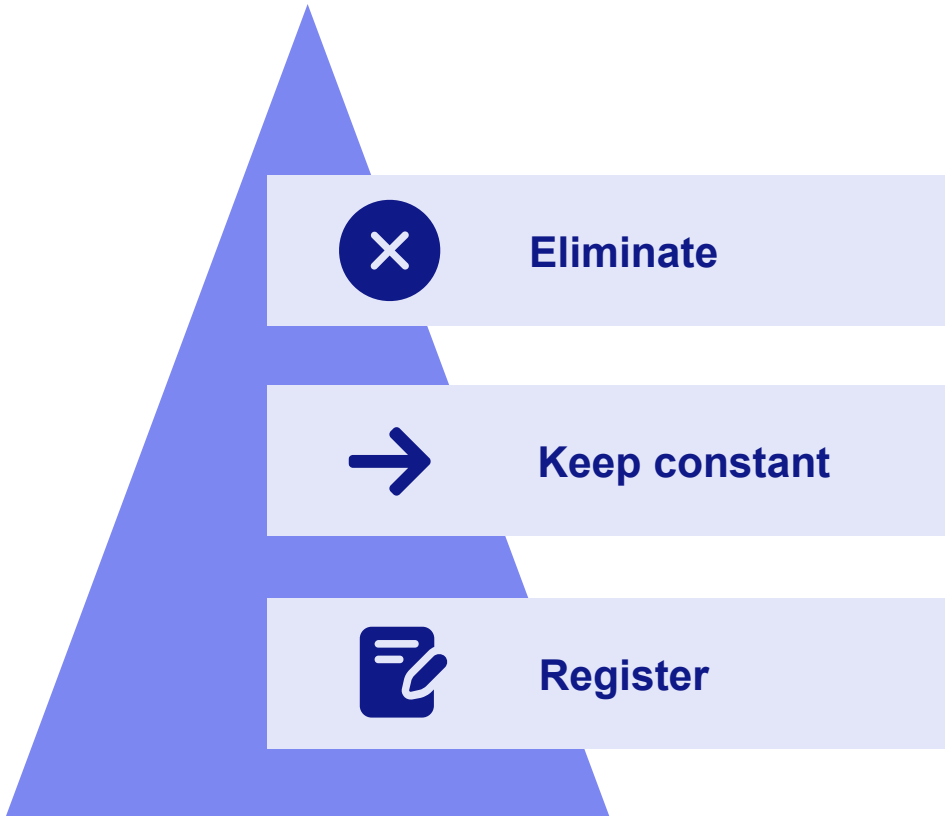
Source: Cook/Campbell (1979), p. 54 ff.

External validity: Confounding factors

Lack of instrumental validity	The measurement instrument does not capture the effect it is supposed to measure.
Sample error	The sample doesn't represent the population for which the results should be valid.
Experimental reactivity	The results are only valid for the experimental setting; problem of generalization.
Pretest effects	Pretests affect the participants and therefore limit the generalization of results.
“Hawthorne effect”	The awareness of being a participant in an experiment affects the behavior.

Source: Cook/Campbell (1979), p. 51 ff.

Techniques to control for design-based confounding factors



If possible, the analysis of all groups should take place without confounding factors.

If the confounding factors cannot be eliminated, they should be held constant in the experimental setting.

If the confounding factors cannot be stabilized during the conductions, the type and intensity of the factors have to be registered as precise as possible.

Source: Cook/Campbell (1979), Chapter 2.

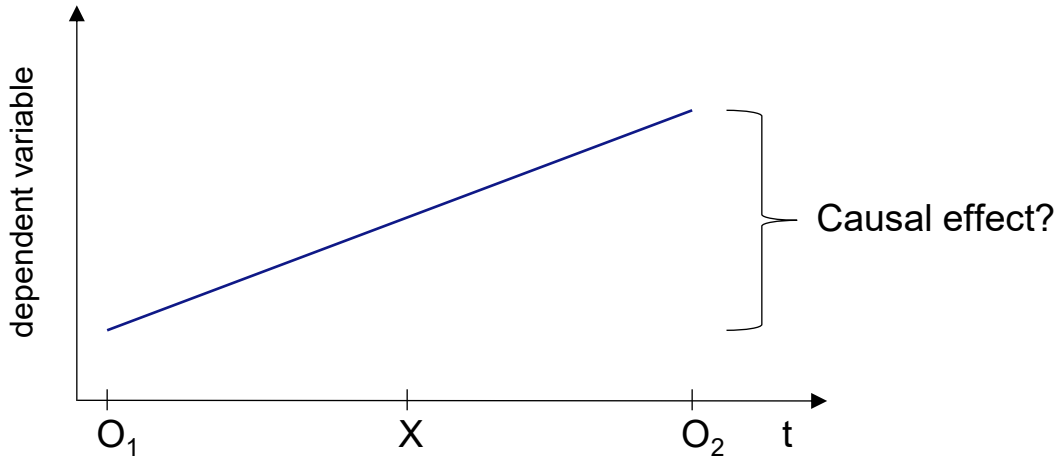
Techniques to control for person confounding factors

Randomization	Most important technique to control: random selection of participants to experimental settings. Experimental analyses always use randomization. Confounding variables are eliminated even if they are unknown before the experiment. The sample groups therefore get comparable in regard to all personal confounding factors.
Keep constant	The analysis is limited to probands, who have similar examined characteristic(s).
Parallelization	Equal distribution of the confounding factors between the groups.
Matching	Pairwise distribution of participants to the groups concerning the confounding factors.
Multifactorial designs	The confounding factors are included as additional independent variables.
Covariance analytical control	Calculated control of the confounding factors.

Source: De Vaus (2001), Chapter 3.

Function of the control group

- Experimental design **without** a control group

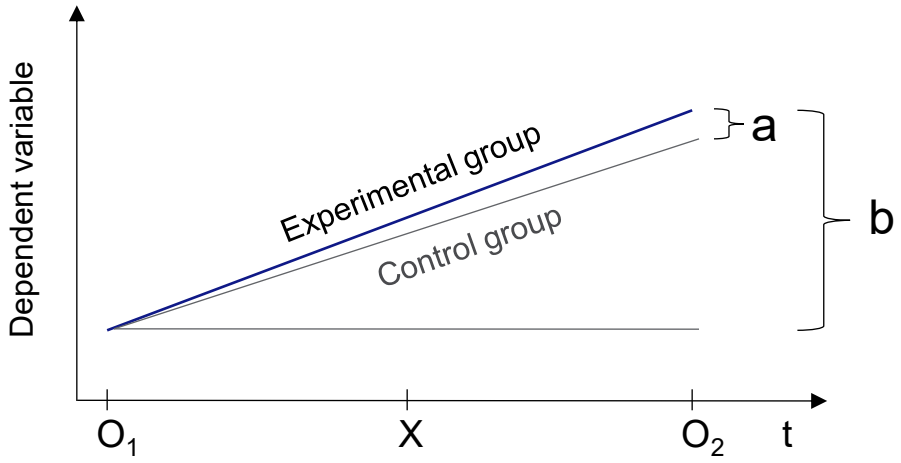


X	Treatment (indep. variable)
O_1	Pretest
O_2	Posttest

- Changes in the dependent variable cannot be attributed to the independent variable.
- The proof of a causal relation is not possible.
- Possible confounding factors cannot be controlled for, internal validity cannot be achieved.

Function of the control group

- Experimental design **with** a control group



X	Treatment (indep. variable)
O_1	Pretest
O_2	Posttest

- **Case a:** The results of the experimental and control group changed nearly equal (no significant difference). The change cannot explained by the treatment, but by other influencing factors.
- **Case b:** The results for experimental and control group differ significantly. The treatment seems to be causal for the change.

Pre-experimental designs

One-group posttest-only design

	t_0	t_1
EG	*X*	*O*

One-group pretest-posttest design

	t_0	t_1	t_2
EG	O_1	*X*	O_2

Two-group posttest-only design

	t_0	t_1
EG	*X*	O_1
CG		O_2

Pre-experimental designs hardly provide valid results of analysis. Changes of the dependent variable cannot be attributed to the independent variable. Pre-experimental designs are therefore inappropriate.

Source: Cook/Campbell (1979), p. 95 ff.

True experimental designs

Randomized **two-group** design with **pretest, treatment** and **posttest**

	t_0	t_1	t_2	t_3
EG	R	O_1	X	O_2
CG	R	O_3		O_4

Advantages:

- → Direct comparison between the experimental and control group is possible.
- → If there are significant differences for the experimental group‘s results, the effect may be traced back to the treatment (X) exclusively.

Limitation:

- → Potential bias of the results due to a sensitization based on the pretest or an interdependency of the treatment and the pretest.

True experimental designs

Randomized **two-group** design with **treatment** and **posttest**

	t_0	t_1	t_2
EG	*R*	*X*	O_1
CG	*R*		O_2

- No pretests
- Due to randomization still a true experimental design.

Advantages:

→ Potential to sensitize participants to the treatment and interdependencies with the treatment are avoided.

True experimental designs

Solomon four-group design:

	t_0	t_1	t_2	t_3
EG_1	*R*	O_1	*X*	O_2
CG_1	*R*	O_3		O_4
EG_2	*R*		*X*	O_5
CG_2	*R*			O_6

Advantages:

- All confounding factors of the internal validity can be controlled.
- Influences of external validity factors are determinable.
- Control of pretest effects is possible.
- Control of the interdependencies between pretest and stimulus is possible.
- Estimation of the „pure“ treatment effect is possible.

Limitation: High effort.

Source: De Vaus (2001), p. 63.

True experimental designs

Reversed-treatment design:

	t_0	t_1	t_2	t_3
EG_{pos}	*R*	O_1	*X+*	O_2
EG_{neg}	*R*	O_3	*X-*	O_4

Advantages:

→ Higher construct validity than control group without a treatment, since the independent variables have to be determined precisely.

→ Hawthorne effects get mitigated.

Limitation:

→ In case both groups show the same kind of development no conclusions can be derived.

→ A negative treatment is not always applicable.

Source: Cook/Campbell (1979), p. 124 f.

True experimental designs

Reversed-treatment design with a **placebo control group** and a **no-treatment control group**

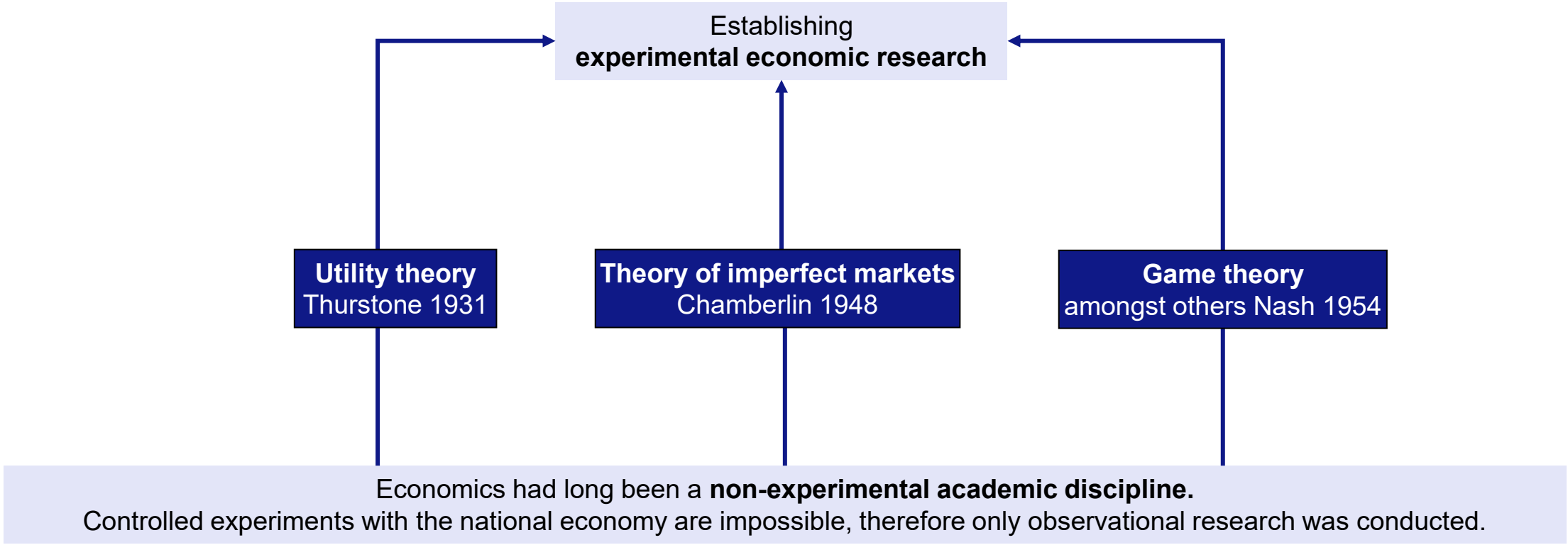
	t_0	t_1	t_2	t_3
EG_{pos}	R	O_1	$X+$	O_2
EG_{neg}	R	O_3	$X-$	O_4
$CG_{Placebo}$	R	O_5	$X_{Placebo}$	O_6
CG	R	O_7		O_8

Advantages:

→ Placebo has only an effect via the Hawthorne effect and allows therefore its measurement.
→ Groups without a treatment serve as „No Cause-Baseline“.

Source: Cook/Campbell (1979), p. 126.

Experiments in economics: Origins



Source: Bardsley et al. (2010), Chapter 1.

Experiments in economics

- Examination of certain aspects of theories.
- **Generating insights about decision-making and economic behavior:**
  - Risk affinity
  - Utility function
  - Allocation of public goods
  - Behavior in principal-agent situations
- Examination of the market mechanisms and processes.

- **Applications**:
  - Individual experiments about individual decision-making processes
  - Ultimatum game (single period negotiation game)
  - Dictator game (only one player contributes to the outcome of the game)
  - Gift exchange game (anonymous exchange of goods/effort etc.)
  - Public goods game

Source: Bardsley et al. (2010), Chapter 1.

Experiments in business and management sciences

- Long period of skepticism about experiments: cause and effect depend on multiple factors that cannot be isolated.
- Although experiments were applied later in this field than in economics, they are now highly significant.

- **Applications**:
  - Examination of group- and organizational behavior
  - Negotiation research
  - Advertising effectiveness research
  - Pricing research
  - Preference analyses, selection behavior
  - (Stock) Market behavior
  - Management training (simulation games)

Source: cf. Cassar/Friedmann (2004), Chapter 3.

Experiments in social sciences

Research objects are people and their actions

→ Every type of social science influences the research object

→ Special situations arise in social science experiments

- **Specific problems:**
  - Interdependencies: Close interlinkage of social factors
  - Selectivity: Only selective observation of the social situation
  - Social dynamics: Social entities change as time passes (changing values, trends)
  - Self-fulfilling/self-destroying prophecies as participants are aware of being part of the experiment
  - Some variables cannot be manipulated due to technical and practical problems or ethical restrictions
  - Behavior is not always consistent: Test subjects may act differently in the same/similar situations

Source: De Vaus (2001), Chapter 5.

Experiments in social sciences

- **Particular advantages:**
  - Researcher have high control over important factors and the setting of the experiment
  - Possibility to create extreme situations
  - Most valid method to establish causal links between social phenomena
  - Documentation and control of the influencing factors allow to replicate the experiment

  → Review of the results

Source: Wickens/Keppel (2004), Chapter 1.

Summary

Basics of experiments:

- Test of existing hypotheses
- High degree of control for confounding factors
- Many differences depending on the area of application; the choice of a suitable design determines the quality of the results

Application of experiments:

- Origin in natural sciences
- Today they are of high importance in various academic disciplines

Benefits of this course:

- Knowledge about the basic functions and setup of experiments
- Awareness of possible pitfalls when designing and conducting experiments as well as knowledge of remedies for these problems