**Seminar 2: Experimental design**

**Experiment, observational studies, and models**

UNDERSTAND:

Experiment: is an observation process characterized by:

* Control of background variables through manipulation
* Intervention on target variable through manipulation
* Observation of difference produced by intervention

Observational studies:

* No manipulation
* No intervention on target variable
* No control of background variables

Natural Experiments:

* No manipulation
* No intervention on target variable
* BUT control of background variable (not achieved through manipulation)

(e.g. water in London upstream/downstream, everything else was the same to only one thing that can cause the sickness)

Field Experiments:

* Same as natural except: intervention on target variable (unsure!)

Models:

* Representations
* Idealizations
* Purpose dependent
* Things to manipulate

Why use models?

* Scaled model, save money
* Rats moral, and legal
* Target often complex, simplified model easier use

Transparency model: easier to understand and easier to work with.

Positive analogy: similarities between model and real object

Negative analogy: differences –“-

Neutral analogy: things we can’t investigate in the target but in the model, e.g. organisms reaction to a drug.

Model vs. Experiments: Similarities:

* In a model, we set variables & parapemter – cf. (compare) experimental control
* We manipulate a model – cf. experimental manipulation
* We observe results of model manipulation – cf. experimentation observation

Differences:

* Internal validity less of a problem for models than for experiments
* (main source of error for models) Justifying neutral analogies is a problem for all models but only for some experiments

Model as mirrors:

* Can hardly even be reached
* High precision, similarity (but high enough to avoid external validity issues)
* Lack of simplicity, transparency, tractability

Model as isolations (of particular features):

* System must be dividable this way
* Difficult to validate isolated models

EXEMPLIFY:

DISCUSS:

**Intervention and observation of difference (Mill’s method of difference)**

UNDERSTAND:

Mill’s method of difference:

1. We ask: what causes phenomenon E?
2. We conjecture: C causes E (hypothesis)
3. We produce two situations S1 and S2, in which neither C nor E occur and in which all causally relevant factors are the same. (successful control)
4. We activate C in S1 but not in S2, (successful intervention)
5. We observe that E occurs in S1 but not in S2. (observation of differences)
6. In S1, something causes E (from 5)
7. In S2, nothing causes E (from 3)
8. The only differences between S1 and S2 are C and E (from 3 and 4)

CONCLUDE: C causes E

EXEMPLIFY:

DISCUSS:

**Internal validity and external validity**

UNDERSTAND:

Internal validity: Possible errors in experimentation:

* Control of background variable
* Intervention only on target variable
* Correct observation

Only if such terrors are absent (not there) can an experimental observation justify accepting or rejecting a hypothesis.

In that case: conclusion from experimental observation are “internally valid”.

External validity: the extent to which the results of a study can be generalized to and across other situations, people, stimuli and times

EXEMPLIFY:

DISCUSS:

**Experimental artifacts**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**The interpretation problem and the influence problem**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**Experimental control**

UNDERSTAND:

Experimental control: consists in

* Accurately identifying the features that are relevant for an experimental result
* Being able to influence these features in such a way that alternative explanations of the experimental result can be ruled out

Strategies:

1. Divide experimental subjects/objects into treatment and control group, perform experimental intervention on treatment group and not on control group.
2. Holding things constant
3. Eliminate disturbing factors
   1. Special case: Blinding: Information which may influence the participants of the experiment is withheld until after the experiment is complete.
   2. Single blinding: subjects do not know what treatment they are getting
   3. Double blinding: Experiments do not know which treatment are administered to what subject
4. Separating factors

EXEMPLIFY:

DISCUSS:

**Constancy, elimination, and effect separation**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**Randomization**

UNDERSTAND:

Randomization: is not random sampling from population

Randomization is not a guarantee for control of known or unknown background factors

Is an important feature of many experimental processes.

Randomized Controlled Trial (RCT)

EXEMPLIFY:

DISCUSS:

**Control and treatment group**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**Single and double blinding**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**Accuracy and precision (measurement qualities)**

UNDERSTAND:

EXEMPLIFY:

DISCUSS:

**Measurement error (random and systematic error)**

UNDERSTAND:

EXEMPLIFY:

DISCUSS: