How to Design an Experiment

Presented by Annabelle Bergum & Norman Peitek

Disclaimer

Only for this seminar

Broad overview

look up

If you want to know more…

Empirical Software Engineering Research

Prof. Dr. Sven Apel, Dr. Norman Peitek

Advanced Lecture— Winter Semester 2022

Empirical Software Engineering Research

Empirical software engineering research plays an important role to improve software engineering by studying its processes, tools, and humans with empirical methods. In this lecture, we provide an overview of typical quantitative and qualitative research methods. We discuss in-depth on how to properly conduct empirical studies and interpret collected data. Specific topics will include:

- Importance of empirical methods in SE
- Controlled experiments
- Experiment designs and threats to validity
- Data measurement and descriptive statistics
- Data analysis and inference statistics
- Experiment conduct
- Qualitative studies (e.g., surveys, case studies, interviews)
- Secondary studies (e.g., systematic literature reviews)
- Further topics (e.g., replication, open science, ethics, report writing)

In addition to the lectures, we plan for several guest lectures on current topics in empirical software engineering research.

Our Sample Experiment

Research Question (1)

- RQ_0: Which color of a gummy bear is best?

Research Question (2)

- RQ$_1$: Which color of a gummy bear tastes best?

How do we measure what tastes best?

How to measure?

Likert scale

This gummy bear was yummy.

○	○	○	○	○
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

I would like to eat a second one.

○	○	○	○	○
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

How to measure?

Interview
- "Which one do you like best?"

Behavior:
- *if given a choice, which one do they pick first?*
- *If given a choice, which one do they pick last?*
- *If given a choice, which one do they not eat?*
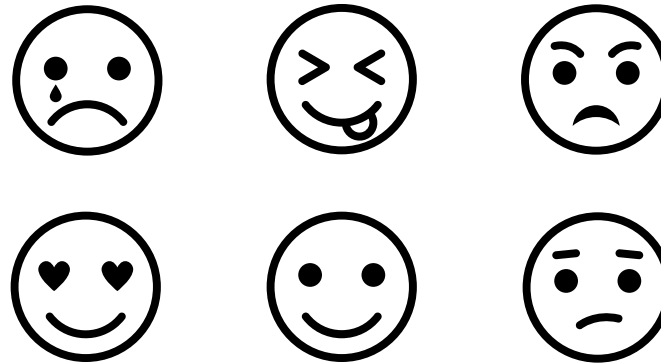
Objective Measurement:
- *Physiological reaction, …*

→ Combination ("triangulation") of measurements for most robust data

How to design the experiment?
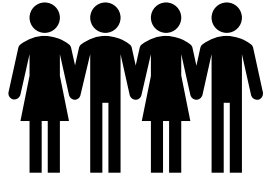
Independent variable

Dependent variable

Behavior, interview response, …

Research Question (3)

- RQ_1: Which color of a gummy bear tastes best?

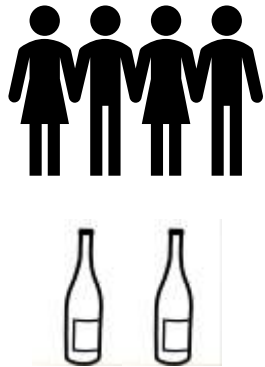- RQ_2: Is there a different taste of gummy bears in children and adults?

How to design the experiment?

Within-subject design

How to design the experiment?
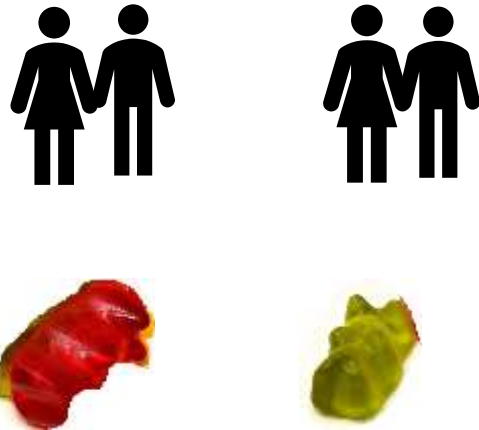
Within-subject design

How to design the experiment?

Between-subject design

Between-subject design
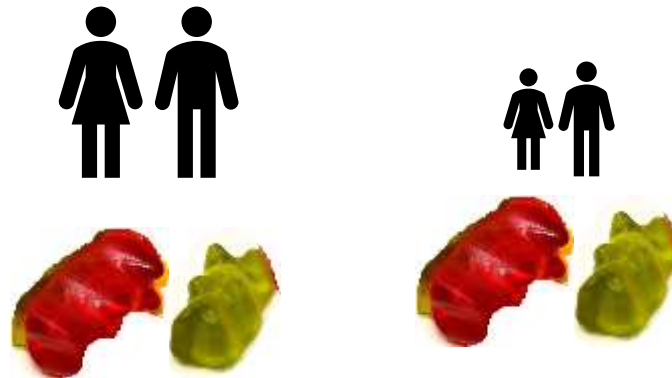
Experiment design needs to fit the research question!

Groups of between-subject designs need to be carefully selected!

Research Question (4)

- RQ_1: Which color of a gummy bear tastes best?
- RQ_2: Is there a different taste of gummy bears in children and adults?
- RQ_3: Do they taste the same when eating them by hand, on a spoon, or with chopsticks?
- RQ_4: Do people consuming them regularly have a different taste than people consuming them only once in a while?
- ….

Use this knowledge to design a good experiment
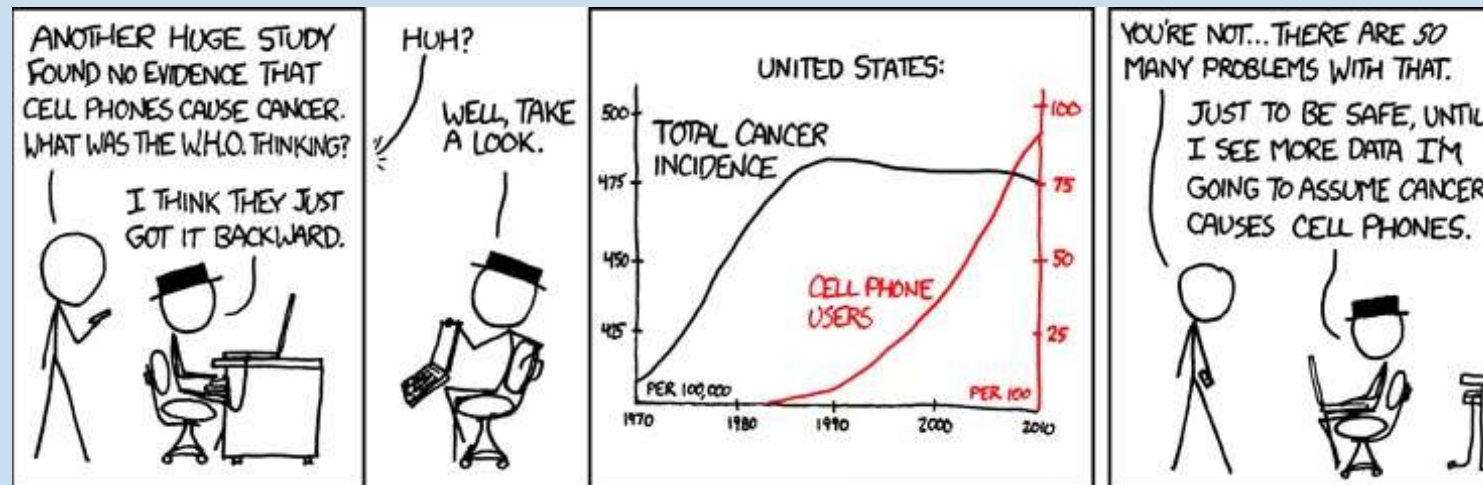
References

- Lecture on Empirical Software Engineering by me ☺
- Lecture on Empirical Software Engineering by Prof. Dr. Janet Siegmund
- Workshop for Empirical Methods by Prof. Dr. Pospeschill (GradUS)
- Janet Siegmund, Norbert Siegmund, and Sven Apel. 2015. Views on Internal and External Validity in Empirical Software Engineering. In Proc. Int'l Conf. Software Engineering (ICSE), Vol. 1. IEEE, 9–19.

Sources (Pictures)

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