Biomarkers in Psychology: An interactive EMG workshop
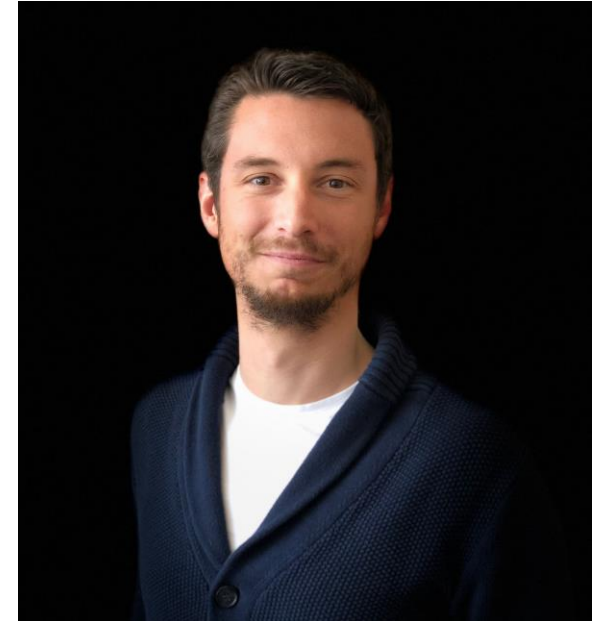
Dr. Sebastian Feger

Dr. Lena Gmelch (geb. Schindler)

03.- 04.03.2023

1. Intro and agenda

- Computer scientist
- Specialized in Human-Computer Interaction
- Postdoc @ LMU Munich
- CERN alumni: Studied sharing and replication in data-intensive science

Dr. Sebastian Feger

1. Intro and agenda

- Psychologist
- Specialized in biomarkers for psychological conditions
- Postdoc @ FAU Erlangen-Nürnberg
- Clinical practitioner at Hochschulambulanz Erlangen-Nürnberg

M. Sc. Psychologie, Dr. rer. nat.

Lena Gmelch
(geb. Schindler)

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nach Vereinbarung

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LEHRSTUHL FÜR KLINISCHE
PSYCHOLOGIE UND PSYCHOTHERAPIE

Friedrich-Alexander-Universität
Erlangen-Nürnberg

Invote.de/Code: 92784

1. Intro and agenda

Biomarkers in Psychology: An interactive EMG workshop

UE-L25.01585

Master

3 ECTS

SP-2023

⤓ Kalender herunterladen

‹ Zurück

Unterricht	Einzeltermine und Räume	Leistungskontrolle	Zuordnung

Details

Fakultät	Philosophische Fakultät
Bereich	Psychologie
Code	UE-L25.01585
Sprachen	Englisch
Art der Unterrichtseinheit	Seminar
Kursus	Master
Semester	SP-2023

Zeitplan und Räume

Vorlesungszeiten	Freitag 10:15 - 19:00, Blockkurs, RM 01, Raum C-01.109 (Frühlingssemester)

1. Intro and agenda

Unterricht	Einzeltermine und Räume	Leistungskontrolle	Zuordnung

Zählt für die folgenden Studienpläne:

Digitale Neurowissenschaft (Spezialisierter Master) 120 [MA]
Version: 2022_1/V_01

sp-MSc in Digitaler Neurowissenschaft, obligatorischen UE (Praktika, Projekte, Seminare) > sp-MSc in Digitaler Neurowissenschaft, obligatorischen UE (ab HS2022)

Psychologie 30 [MA]
Version: SA21_MA_PS_fr_de_bil_v01

Option Kognitive Neurowissenschaften > Social, Cognitive and Affective Neuroscience – SCAN

Psychologie 30 [MA]
Version: SA22_MA_PS_fr_de_bil_v01

Option Kognitive Neurowissenschaften > Social, Cognitive and Affective Neuroscience – SCAN

1. Intro and agenda

Biomarkers gain more and more importance

in psychological research, but also clinical psychological practice.

The aim of the course is to gather an overview over different biomarkers relevant for psychological application, with a focus on EMG technology. In a practical session, the students will develop, implement, and test EMG solutions for different psychological contexts through the creation of digital and/or physical prototypes.

Further, they will gain an understanding about the chances, risks and open questions of biomarker research in psychology.

Finally, the students will learn about the basics of user-centered design with a focus on the evaluation of their prototypes.

1. Intro and agenda

- **Workshop (3 ECTS)**

  - Learning in a cooperative, hands-on way
    - Discussions, critical reflection, group work
    - Questions, feedback, requests

  - Trial-and-error

  - Hopefully fun! ☺

1. Intro and agenda

Aims

- Theoretical knowledge

- Practical skills in implementing biomarkers

- Critical reflection of individual and general chances and benefits

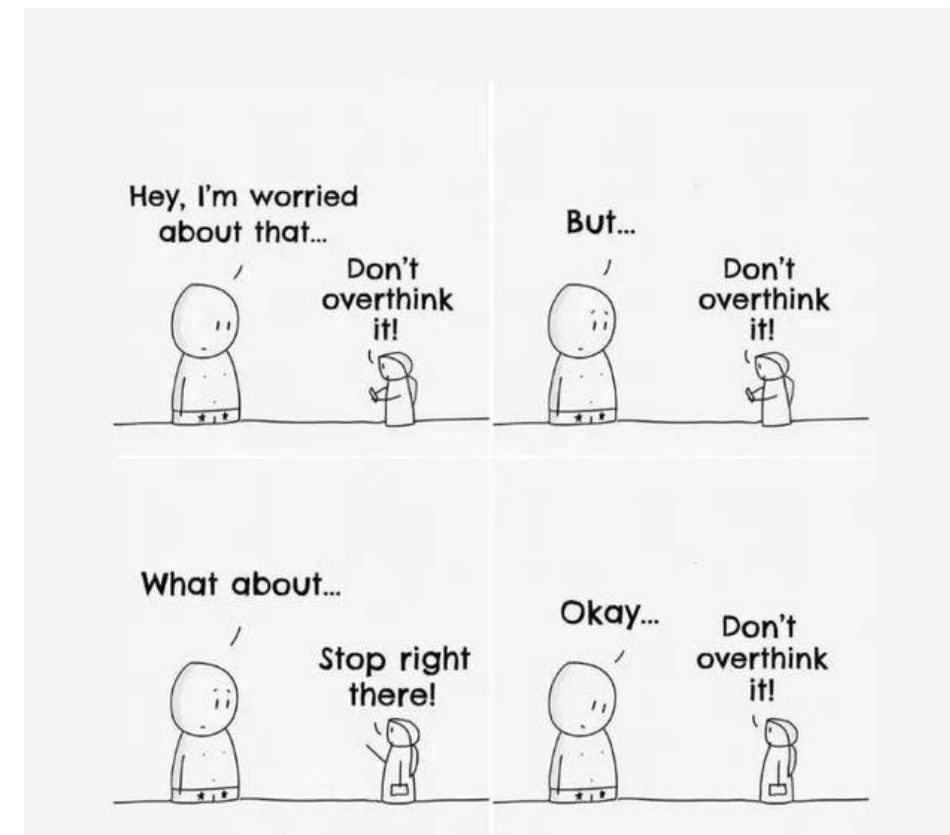# 1. Intro and agenda

Friday

1. 10:15 – 10:45: Intro and agenda
2. 10:45 – 11:45 Biomarkers in Psychology I: What, why, how?
3. 12:00 – 13:00: Getting started with the EMG toolkit
4. 13:00: Lunch Break
5. 14:00 – 15:00: Project ideation
6. 15:00 – 19:00: Practical Session I: Getting started

Saturday

7. 08:15 – 08:55: Biomarkers in Psychology II: Chances, risks, open questions
8. 9:00 – 12:00: Practical Session II: Project Finalization
9. 12:00: Lunch Break
10. 13:00 – 13:45: Practical Session III: Wrapup & Presentation
11. 14:00 – 15:00: User-centered design & Evaluation

1. Intro and agenda

- **Assessment: „Travail écrit"**
  - 10 pages per person, ~ following current APA/DGPs guidelines, to hand in on April 8, PDF, via e-mail
  - Structure
    - Background: (Clinical) rationale/area, motivation, hypotheses/evaluation plan
    - Method: Description of built and tested application, description of evaluation plan
    - Results: Description of results following the evaluation plan
    - Discussion: Integration of results into clinical rationale/area

1. Intro and agenda

- **Remember: Scientific writing follows an hourglass structure**
  - Start out broadly with a brief general intro into the topic
  - Narrow down throughout the introduction by getting more and more specific until you reach your research question
  - Stay narrow throughout methods and results
  - Broaden the scope again in the discussion section when integrating your findings into the literature
  - Finalize your work with a broad statement as outlook (ideally referring back to your introductory statement)

- **Please use any kind of reference management tool (citavi, Zotero, Endnote)**

Questions/comments?

Thank you for your kind attention!

References

Universität Fribourg, Course Information:
https://www.unifr.ch/timetable/de/vorlesungsbeschreibung.html?show=110667

Picture sources

https://klips.phil.fau.de/gmelch

https://www.um.informatik.uni-muenchen.de/personen/mitarbeiter/feger/index.html

https://bladenonline.com/friday-funny-forgotten/

https://makeameme.org/meme/brace-yourself-workshop

https://zerotoonesearch.com/how-to-quickly-fit-in-a-new-team-recommendations-for-newbies/

https://knowyourmeme.com/photos/2156128-wholesome-memes

https://www.ikea.com/us/en/p/eftertaenka-decorative-hourglass-clear-glass-sand-00495483/
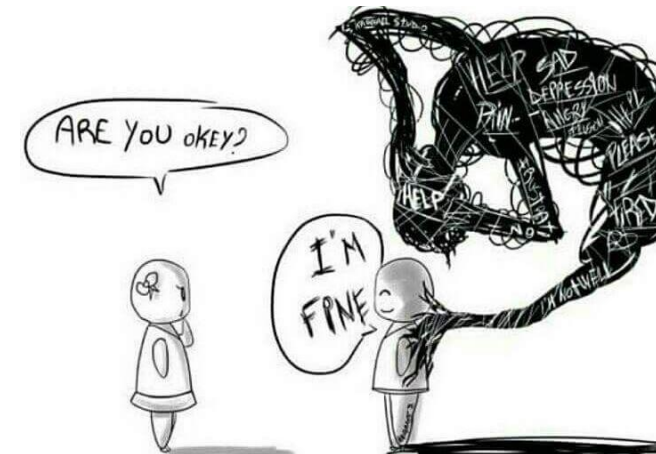
2. Biomarkers in Psychology I: What, when, how?

2.1 Necessity for objective markers in psychology

2.1 Necessity for objective markers in psychology

– **Limitations of self-report in psychology/psychotherapy** (z.B. Groth-Marnat & Wright, 2016; WHO, 2018)

- On participants'/patients' side
    - Memory biases (e.g., context effects)
    - Role effects (e.g., social desirability, simulation/dissimulation...)
    - High burden (in particular, e.g., in trauma, depression...)
    - ...

- On examiners' side
    - High burden/workload (in particular for analyses)
    - ...

2.1 Necessity for objective markers in psychology

- **Limitations of self-report in psychology/psychotherapy** (z.B. Moosbrugger & Kelava, 2012)

  - On the instruments' side

    Main quality criteria of diagnostic tests

    - Validity (test measures what it is intended to measure; but: e.g., major overlaps in symptomatology of posttraumatic stress disorder and depression)

    - Reliability (test measures the same repeatedly: but: most psychological tests show high interindividual variability and are sensitive to repeated assessment)

    - Objectivity (test measures the same, independent of rater, but: Most psychological tests require subjective ratings)

2.1 Necessity for objective markers in psychology

– Cognitive-behavioral therapy (CBT) gold standard for treating majority of psychological conditions (e.g., PTSD, Bryant et al., 2019; Morkved et al., 2014 or depression, Barth et al., 2013; Cuijpers et al., 2014)

– But: Considerable dropout and non-response rates (e.g., PTSD: up to 54% and 50%, z.B. Bradley et al., 2005; Morkved et al., 2014; Najavits, 2015, depression: around 25% und 34%, respectively; z.B. Cuijpers et al., 2014; Hans & Hiller, 2013)

Cognitions

Emotions

Behavior
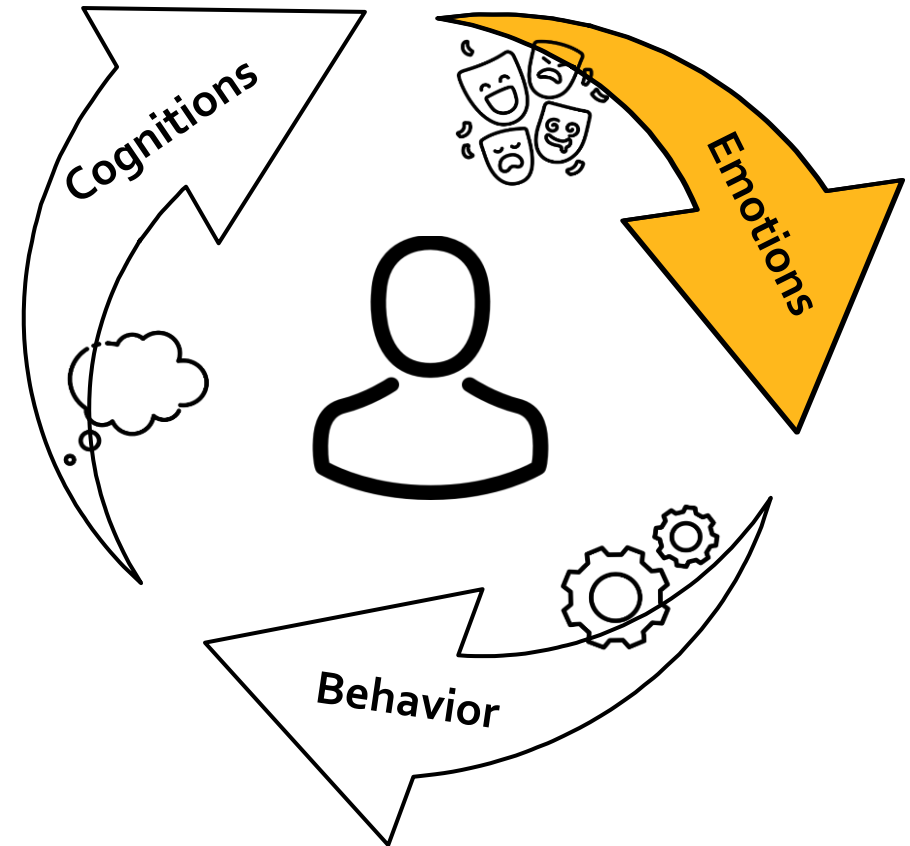
„I understand what we are working on and agree it's useful. But I just can't feel it."

2.1 Necessity for objective markers in psychology

‒ **What might those markers be needed for?**

    ‒ Understanding mechanisms -> basic research

    ‒ Identifying individuals afflicted -> diagnosis

    ‒ Predicting disease courses -> prognosis

    ‒ Preventing/treating disease courses -> intervention
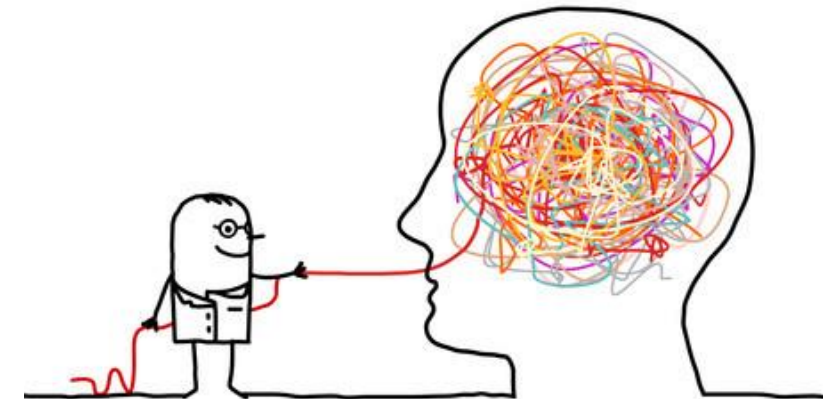
2.1 Necessity for objective markers in psychology

- **What we currently know**
  - Psychiatric conditions (and, by the way, any medical condition, as well as our personality, our life choices…) are generally multicausal
    - Biological vulnerability (e.g., genetic predispositions)
    - Psychological vulnerability (e.g., early experiences
    - Stress/Life events

  - (Some) psychiatric conditions benefit from psychopharmacological treatment
    - Usually: Combination with psychotherapy for best effects

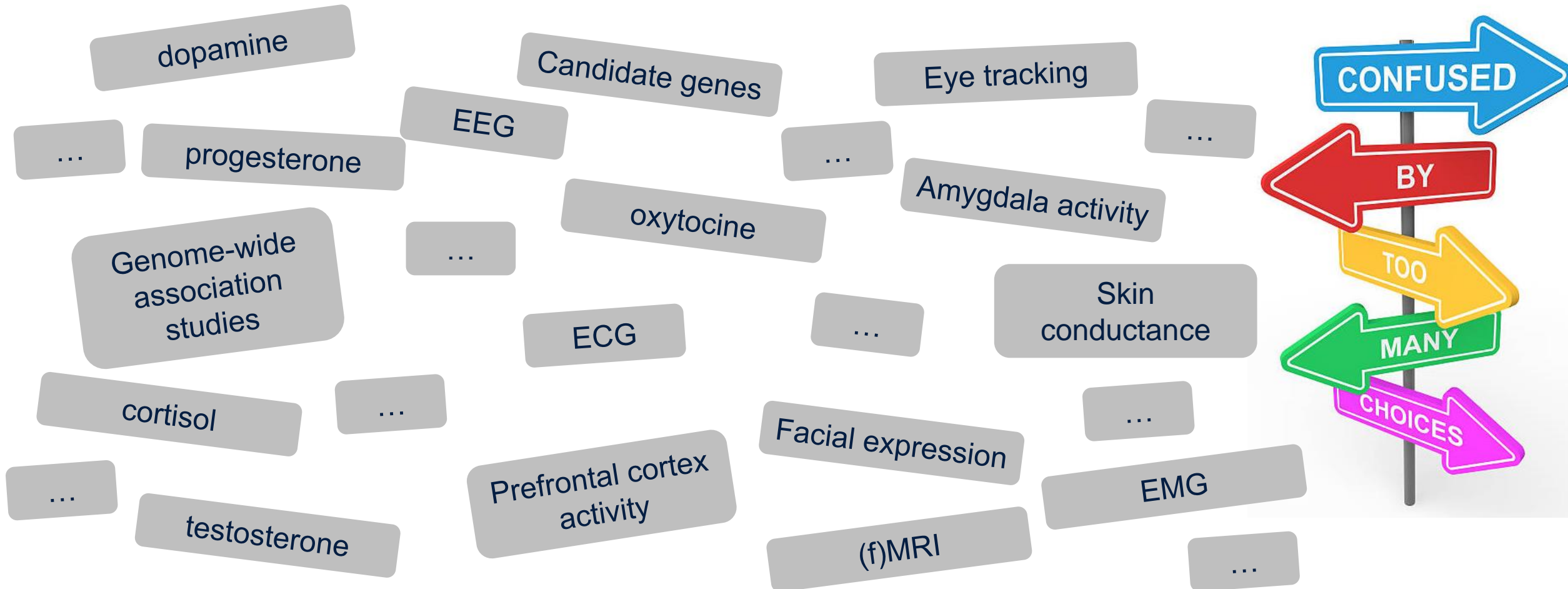- **So: There must be something biological going on in psychology!**

> Wilhelm Wundt
>
> Hence, wherever we meet with vital phenomena that present the two aspects, physical and psychical there naturally arises a question as to the relations in which these aspects stand to each other.
>
> AZ QUOTES

2.2 Potential biomarkers in psychology

2.2 Potential biomarkers in psychology

dopamine

Candidate genes

Eye tracking

EEG

…

…

progesterone

…

Amygdala activity

oxytocine

Genome-wide association studies

…

Skin conductance

ECG

…

cortisol

…

…

Facial expression

…

Prefrontal cortex activity

EMG

…

testosterone

(f)MRI

…

CONFUSED
BY
TOO
MANY
CHOICES

2.2 Potential biomarkers in psychology

- **What requirements would they need to meet?** (e.g., Wilcox et al., 2020)

- Objective
- Reliable
- Valid

+

- Easy-to-administer
- Affordable
- Non-invasive
- Easy-to-analyse/automated?
- Specific for symptoms/whole diseases?
- Non-yucky
- Able to allow long-term/repeated monitoring

2.2 Potential biomarkers in psychology

– **Potential biomarkers: Research Domain Criteria (RDoC)** (Insel et al., 2010)

   – National Institute of Mental Health, U.S.: Structure for research that considers mental health/psychopathology in the context of major neurobehavioral domains

   – Encouragement to integrate behavioral, physiological, and self-report data
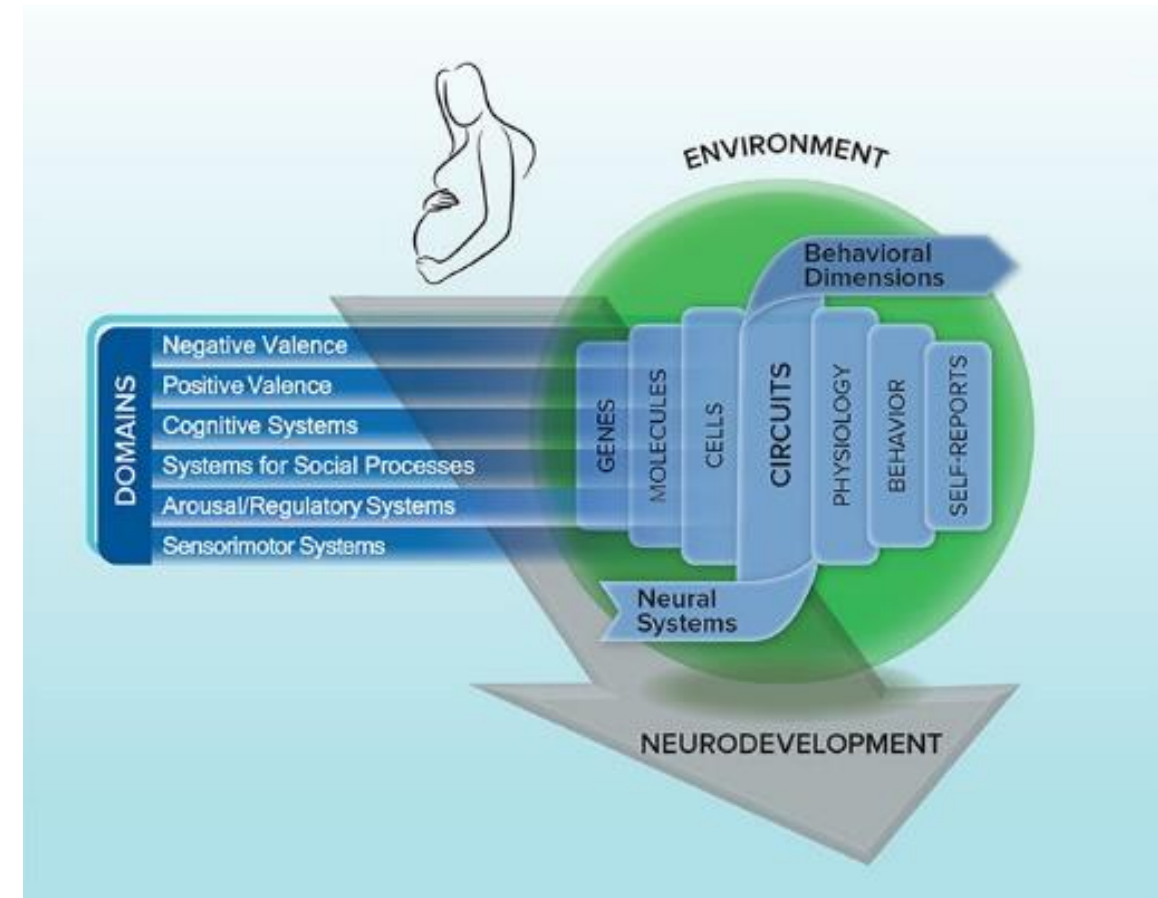
2.2 Potential biomarkers in psychology

– Example for matrix system: Negative Valence System

Negative Valence Systems

Construct/Subconstruct	Genes Notice	Molecules	Cells	Circuits	Physiology	Behavior	Self-Report	Parad
Acute Threat ("Fear")		Elements	Elements	Elements	Elements	Elements	Elements	Element
Potential Threat ("Anxiety")		Elements	Elements	Elements	Elements		Elements	Element
Sustained Threat		Elements	Elements	Elements	Elements	Elements	Elements	
Loss		Elements		Elements	Elements	Elements	Elements	Element
Frustrative Nonreward		Elements		Elements		Elements	Elements	Element

Cells

GABAergic cells · Glia · Neurons · Pyramidal cells

Circuits

autonomic nervous system · BasAmyg · Central Nucleus · d-hippocampus (post) · dmPFC (pl) · dorsal ACC · dPAG · Hypothalamus · ICMs · insular cortex · LatAmyg · latPFC/insula · LC · Medial Amyg · OFC · PAG · Pons · rostral/vent ACC · RPVM · v-hippocampus (ant) · vmPFC (il) · vPAG
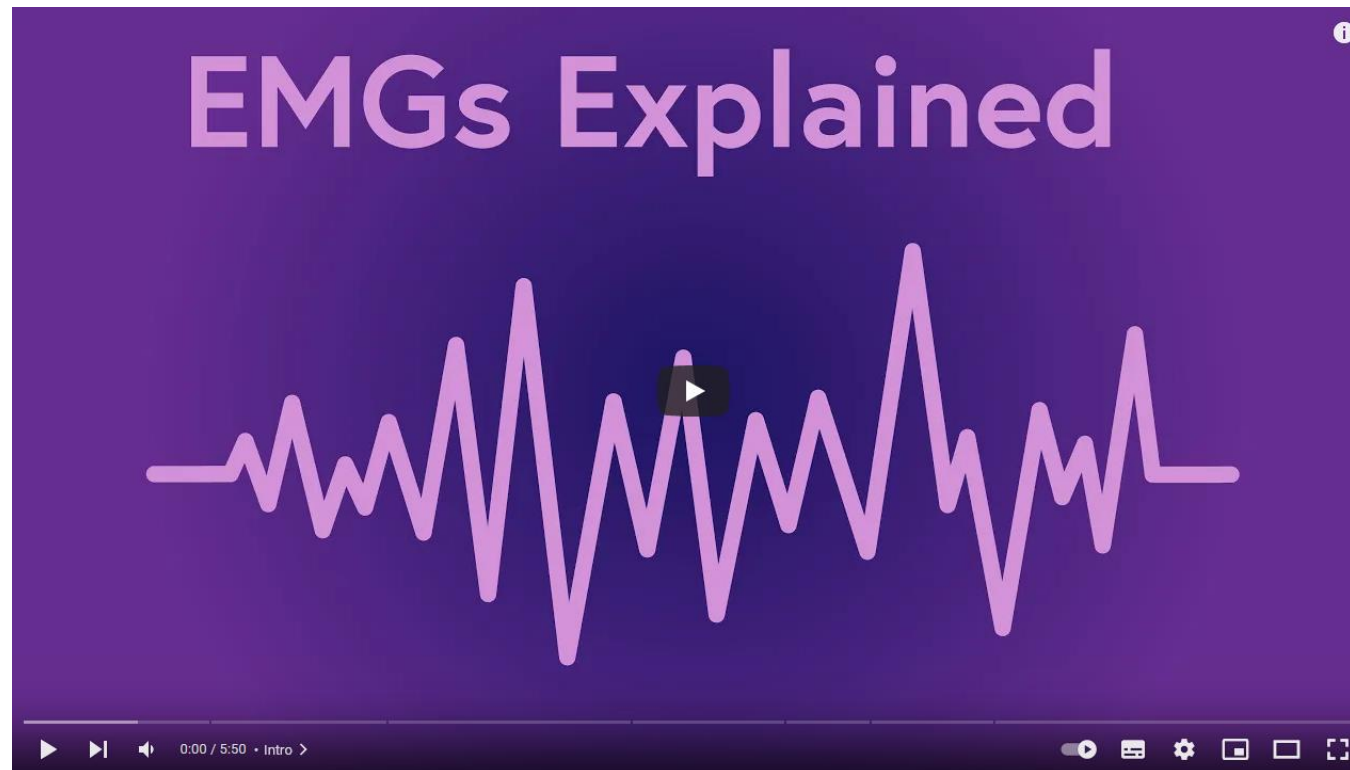
Physiology

BP · Context Startle · EMG · Eye Tracking · Facial EMG · Fear Potentiated Startle · Heart Rate · pupillometry · Respiration · Response accuracy · Skin Conductance

Behavior

Analgesia · approach (early development) · Avoidance · Facial expressions · Freezing · Open field · Response inhibition · Response time · Risk assessment · Social approach
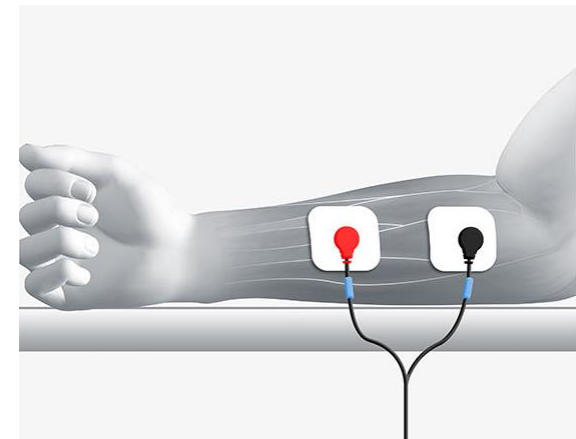
2.3 EMG – Brief overview

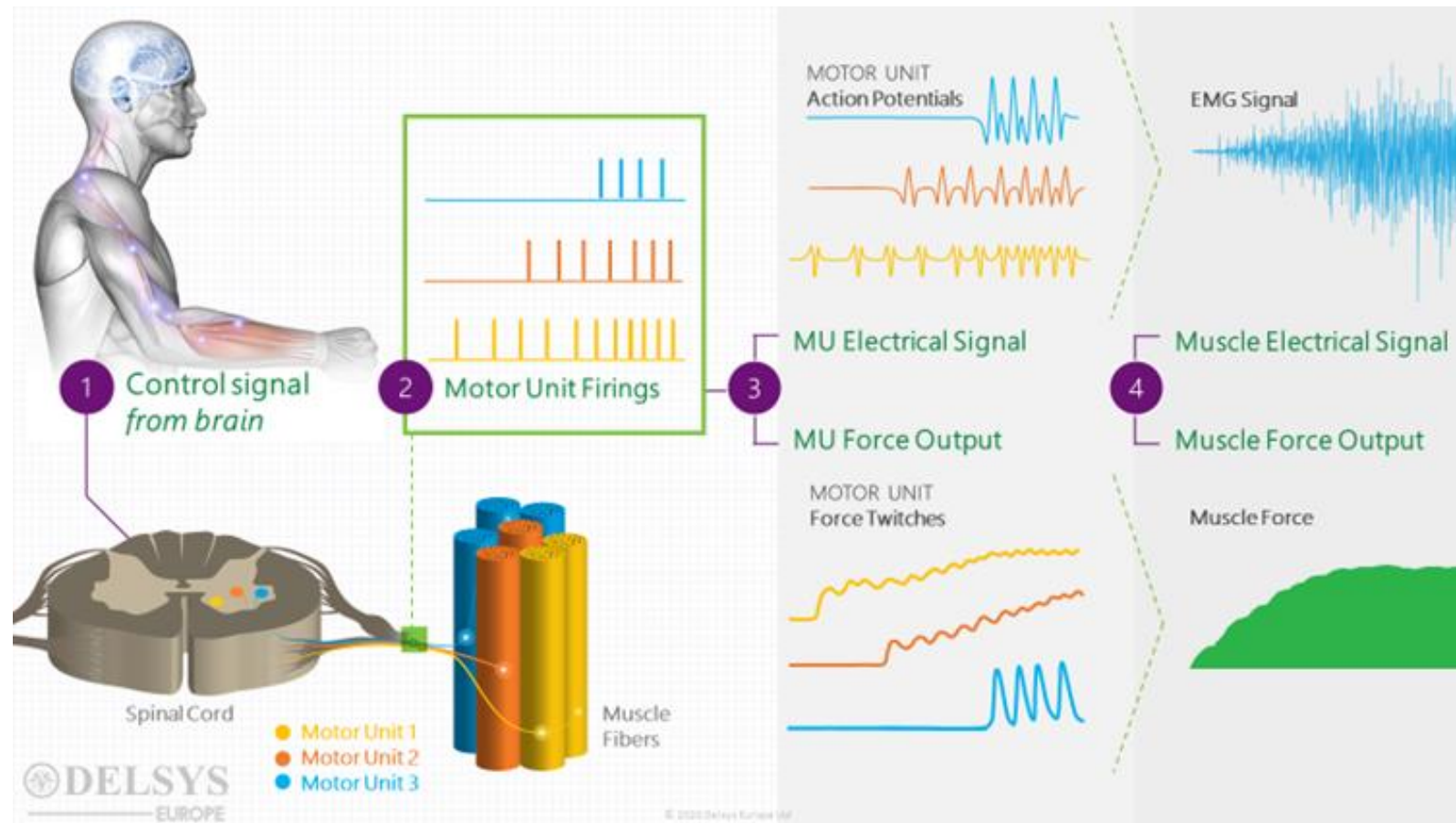https://www.youtube.com/watch?v=HBj-8EagPi8 (00:00 – 02:58

2.3 EMG – Brief overview

- **Central characteristics of EMG**

  - Technique to evaluate and record the electrical activity of muscles
    - Instrument = Electromyograph
    - Record = Electromyogram

  - Needle/intramuscular vs. surface electrodes

www.biomechanist.net

2.3 EMG – Brief overview

www.biomechanist.net

2.3 EMG – Brief overview

– **Typical setup**

  – Two electrodes per sensor, distance ~10mm

  – Skin shaved, cleaned with alcohol, peeled

  – Signal checked („Please now flex your muscle/smile/frown…")

2.3 EMG – Brief overview

- Potential markers from EMG:
  - Timing: When is a muscle activated?
  - Duration: How long is it activated?
  - Force: How strongly does it contract? (Typical amplitude: µV – mV, typical frequency 0 – 500 Hz)

- Analysis
  - Formerly: Visual categorization
  - Increasingly: Machine-learning-based pattern recognition

2.3 EMG – Brief overview

– **Potential applications in psychology** (cf. Schoenberg & David, 2014)

Phenomenon	Relevant (psychological) conditions	Relevant measurement points

2.3 EMG – Brief overview

	depressor 🔵	frontalis 🟣	corrugator 🔴	zygomaticus 🟡
SAD	+	+	+	
FEAR		+		
ANGRY			+	-
HAPPY			-	+

Deschamps et al. (2012)

Questions/comments?

Thank you for your kind attention!

References

- Barth, J., Munder, T., Gerger, H., Nüesch, E., Trelle, S., Znoj, H., Jüni, P., & Cuijpers, P. (2013). Comparative efficacy of seven psychotherapeutic interventions for patients with depression: A network meta-analysis. *PLoS Medicine*, *10*(5), e1001454. https://doi.org/10.1371/journal.pmed.1001454
- https://www.biomechanist.net/electromyography-basics-of-practical-application/
- Bradley, R., Greene, J., Russ, E., Dutra, L., & Westen, D. (2005). A multidimensional meta-analysis of psychotherapy for PTSD. *The American Journal of Psychiatry, 162*(2), 214–227. https://doi.org/10.1176/appi.ajp.162.2.214
- Bryant, R. A. (2019). Post-traumatic stress disorder: a state-of-the-art review of evidence and challenges. *World Psychiatry : Official Journal of the World Psychiatric Association (WPA), 18*(3), 259–269. https://doi.org/10.1002/wps.20656
- Cuijpers, P.; Karyotaki, E.i; Weitz, E.; Andersson, G.; Hollon, S. D.; van Straten, A. (2014): The effects of psychotherapies for major depression in adults on remission, recovery and improvement: a meta-analysis. *Journal of Affective Disorders, 159*, 118–126. DOI: 10.1016/j.jad.2014.02.026.
- Deschamps, P. K. H., Schutte, I., Kenemans, J. L., Matthys, W. C. H. J., & Schutter, D. J. L. G. (2012). Electromyographic responses to emotional facial expressions in 6–7 year olds: A feasibility study. *International Journal of Psychophysiology*, *85*(2), 195-199.
- EMG explained: https://www.youtube.com/watch?v=HBj-8EagPi8
- Groth-Marnat, G., & Wright, A. J. (2016). Handbook of psychological assessment (6th ed.). John Wiley & Sons.
- Hans, E.; Hiller, W. (2013): Effectiveness of and dropout from outpatient cognitive behavioral therapy for adult unipolar depression: a meta-analysis of nonrandomized effectiveness studies. Journal of consulting and clinical psychology ,81 (1), 75–88. DOI: 10.1037/a0031080.
- Insel T., Cuthbert B., Garvey M., Heinssen R., Pine D.S., Quinn K., et al. Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. Aust. J. Pharm. 2010;167:748–751. doi: 10.1176/appi.ajp.2010.09091379

References

- Moosbrugger H. & Kelava A. (2007). *Testtheorie und Fragebogenkonstruktion*. Springer Medizin Verlag Heidelberg. https://doi.org/10.1007/978-3-540-71635-8
- Moosbrugger, H., Kelava, A. (2012). Qualitätsanforderungen an einen psychologischen Test (Testgütekriterien). In: Moosbrugger, H., Kelava, A. (eds) Testtheorie und Fragebogenkonstruktion. Springer-Lehrbuch. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-20072-4_2
- Research Domain Criteria: https://www.nimh.nih.gov/research/research-funded-by-nimh/rdoc/about-rdoc
- Morkved, N., Hartmann, K., Aarsheim, L. M., Holen, D., Milde, A. M., Bomyea, J., & Thorp, S. R. (2014). A comparison of Narrative Exposure Therapy and Prolonged Exposure therapy for PTSD. *Clinical Psychology Review, 34*(6), 453–467. https://doi.org/10.1016/j.cpr.2014.06.005
- Najavits, L. M. (2015). The problem of dropout from "gold standard" PTSD therapies. *F1000prime reports, 7*, 43. https://doi.org/10.12703/P7-43
- Schoenberg, P. L. A., & David, A. S.. (2014). Biofeedback for Psychiatric Disorders: A Systematic Review. *Applied Psychophysiology and Biofeedback, 39*(2), 109–135. https://doi.org/10.1007/s10484-014-9246-9
- Wess, R., Klock, H., Siller, H.-S., & Greefrath, G.. (2021). Test Quality. In International Perspectives on the Teaching and Learning of Mathematical Modelling (pp. 77–84). International Perspectives on the Teaching and Learning of Mathematical Modelling. https://doi.org/10.1007/978-3-030-78071-5_4
- World Health Organization (Ed.). (2018). *International statistical classification of diseases and re-lated health problems (11th Revision)*. Geneva: World Health Organization.

Picture Sources

- https://andertoons.com/psychology/cartoon/1211/and-how-does-your-crippling-depression-make-you-feel

- https://commons.wikimedia.org/wiki/File:RDoC_Framework.jpg

- https://mfimedical.com/products/ambu-neuroline-concentric-emg-needle-electrode

- https://medium.com/@y4shchauhan/playing-game-with-emg-signals-a67917ffa39b

- https://www.biomechanist.net/electromyography-basics-of-practical-application/

3. Getting started with the EMG toolkit

# 3.1 The prototype EMG toolkit: EMBody

- Developed and tested in research by Dr. Jakob Karolus

- Open Source project on GitHub: https://github.com/HCUM/embody

- Full paper: https://dl.acm.org/doi/10.1145/3457142

  - Open Access

  - Best Paper at EICS 2021
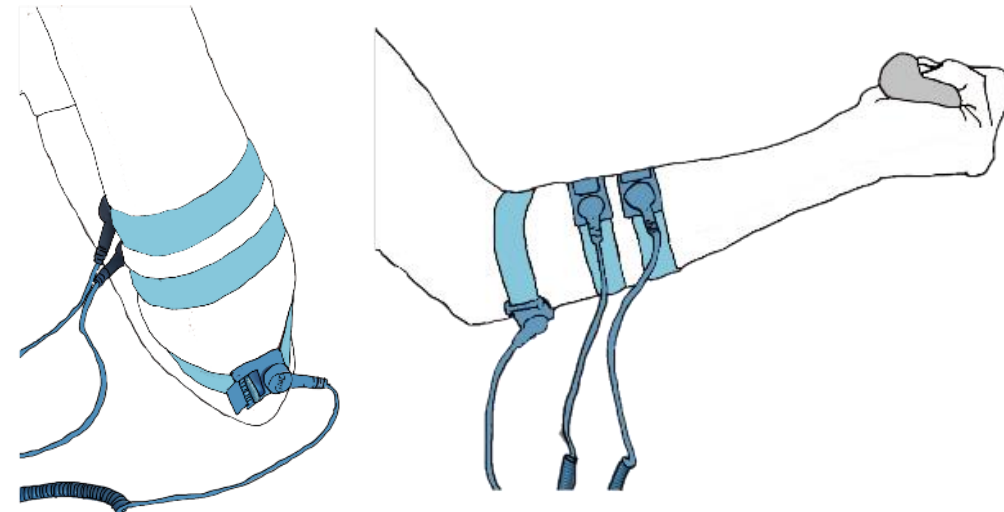
3.1 The prototype EMG toolkit: EMBody

- One toolkit per group
- Each toolkit auto connects to the dedicated WiFi router
- Broadcasts data that can be read by all connected devices
  - Laptop
  - Microcontroller
  - Mobile phone
  - …
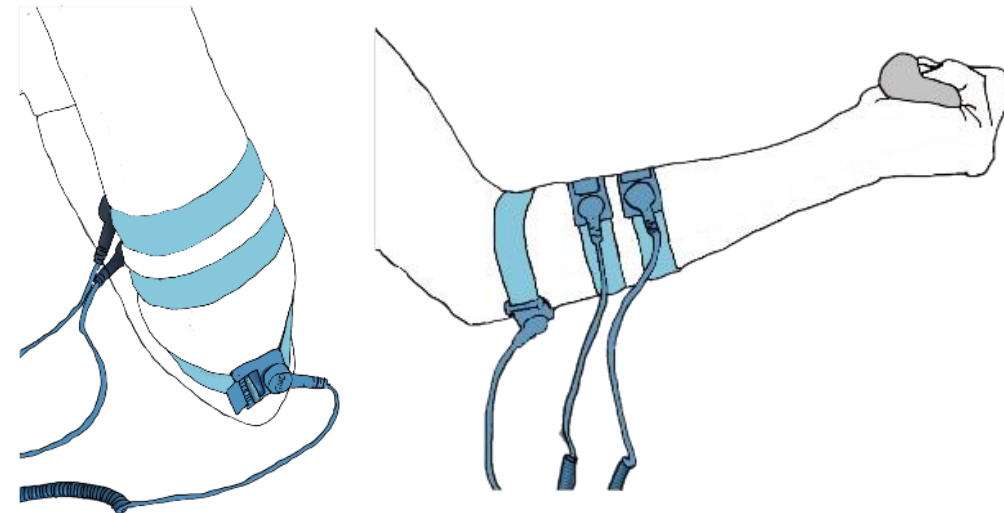
3.2 Use case: Approach-Avoidance Modification Training

- – Simple Java (Processing) application

Demo/Code walkthrough

3.2 Use case: Approach-Avoidance Modification Training

- Your task: Read the raw data shared by the toolkit to support users in physically pushing negative images away through muscle movement

- 45 minutes to work on the project

- 15 minutes for reflection on the data analysis

- GitHub link to the demo application:

- Download Processing: https://processing.org/download

```
55    /*
56
57        Your code goes here.
58
59        1. Analyze the raw data you receive from the EMG toolkit
60        2. Based on your analysis, either
61           (a) do nothing;
62           (b) call pushBack(); or
63           (c) call moveForward();
64
65    */
66
```

3.3 Reflecting on the data analysis

- What strategies did you use?

- How well did it work?

- What were the main challenges that you encountered?

3.3 Reflecting on the data analysis

How does a modern analysis approach look like?

3.3 Reflecting on the data analysis

- Machine learning (ML) helps recognize and match patterns in (complex) data

- Supervised ML is based on annotated data, e.g. Fist_actuated or No_actuation

- EMBody uses a Support Vector Machine (SVM)

https://github.com/HCUM/embody/tree/master/manual
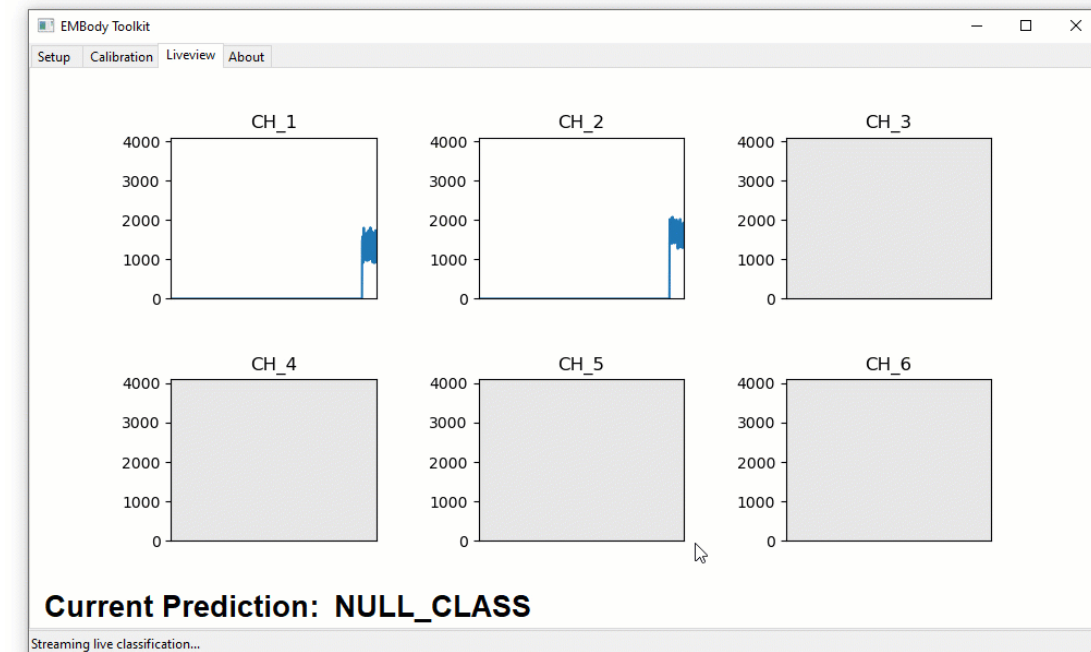
Questions/comments?

Thank you for your kind attention!

4. Project ideation

5. Building the prototype

Three sessions:

- Friday: 15:00 – 19:00
- Saturday:
    - 9:00 - 12:00
    - Wrap-up and presentations: 13:00 – 13:45

6. Biomarkers in Psychology II: Chances, risks, open questions

1. Intro and agenda

Friday

1. 10:15 – 10:45: Intro and agenda
2. 10:45 – 11:45 Biomarkers in Psychology I: What, why, how?
3. 12:00 – 13:00: Getting started with the EMG toolkit
4. 13:00: Lunch Break
5. 14:00 – 15:00: Project ideation
6. 15:00 – 19:00: Practical Session I: Getting started

Saturday

7. 08:15 – 08:55: Biomarkers in Psychology II: Chances, risks, open questions
8. 9:00 – 12:00: Practical Session II: Project Finalization, end of data collection
9. 12:00: Lunch Break
10. 13:15 – 14:00: Practical Session III: Wrapup & Presentation
11. 14:05– 15:00: User-centered design & Evaluation + Course Evaluation + Info on Github Repository

6.1 Risks of Biomarkers - Examples

– **Brief research task in small groups**

    – What is XY?

    – How is XY currently applied?

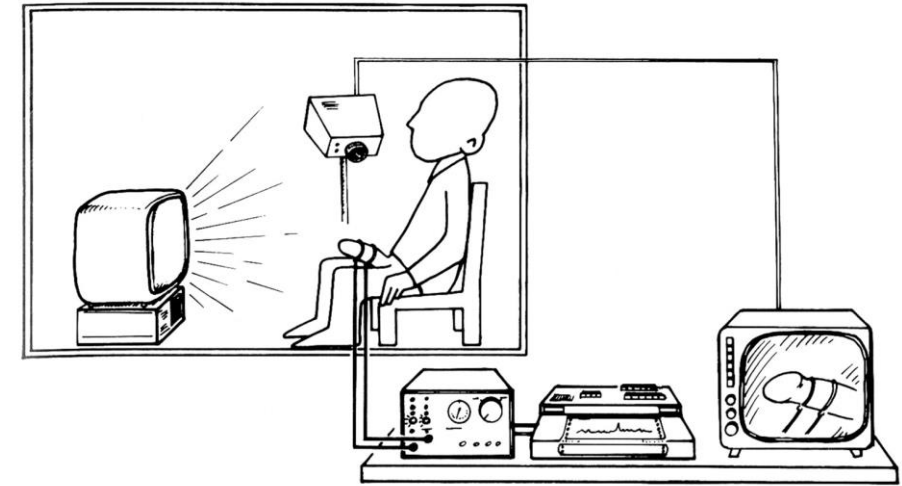   – Is that valid/ethical?
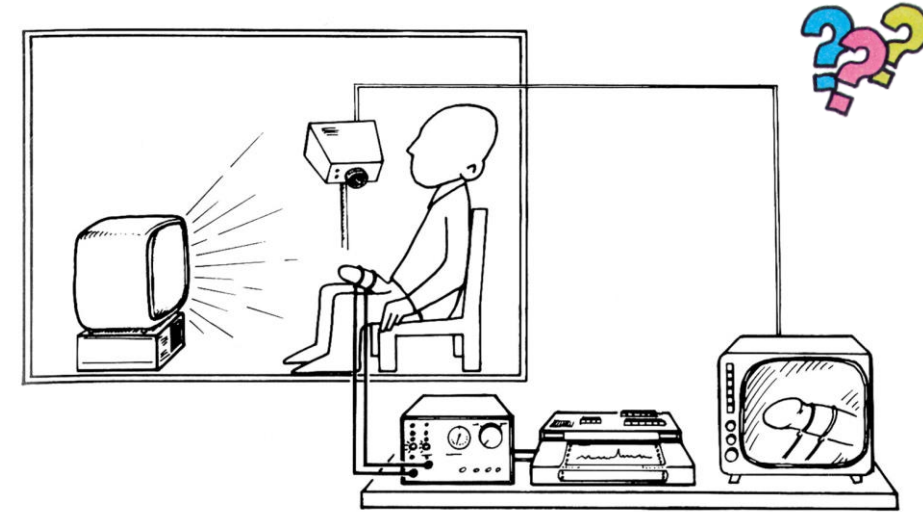
Phallometry

Polygraph/lie detector

6.1 Risks of Biomarkers - Examples

– **Phallometry**

  – Brief description

  – Current application

  – Criticism

6.1 Risks of Biomarkers - Examples

- **Polygraph**
  - Brief description

  - Current application

  - Criticism

6.2. Risks of Biomarkers - Overview

– **Ethical issues**

  – So far: Biomarker measurement burdensome, oftentimes invasive, with little benefit for individual patient

  – Possibility of assessing implicit, unconscious, or embarrassing content

  – Particular dangers of contactless sensing

  – Huge costs (e.g.: professional EMG kit: ~20 000€ + consumables)

  – Professional solutions: Data privacy?

6.2. Risks of Biomarkers - Overview

- **Methodological issues** (z.B. Engel et al., 2022, Schindler-Gmelch et al., in press)

  - Analysis complex, time-consuming

  - So far: Lack of specificity of any biomarker for specific psychological condition

  - Frequently only small associations with self-report
    - Due to measurement errors on both sides?
    - Due to inherently different constructs, and thus, incremental validity of combination?

  - High intra- and interindividual fluctuations

6.3 Specific issues of surface EMG

– **Recording issues characteristic for surface EMG: Noise**

  – Physiological noise (any other physiological electrical signals, e.g. other muscles of motor control, respiration...)

  – Ambient noises (e.g., powerline noise 50-60Hz, cable artifacts)

  – Baseline noise (between electrode and skin -> thorough cleaning/peeling)

  – Movement artifacts (e.g., skin wrinkling and electrodes losing contact, muscle changing position)

  – Intraindividual characteristics (e.g., hairs, skin temperature, BMI...)

> ➢ Techniques available for dealing with noise, but oftentimes not possible to eliminate it completely

6.3 Specific issues of surface EMG

– **What requirements would they need to meet?** (e.g., Wilcox et al., 2020)

???

– Objective

– Reliable

– Valid

+

– Easy-to-administer

– Affordable

– Non-invasive

– Easy-to-analyse/automated?

– Specific for symptoms/whole diseases?

– Non-yucky

– Able to allow long-term/repeated monitoring

6.3 Specific issues of surface EMG

– **Learning from the workshop: Fulfilling those criteria is not easy at all…**

– **…and currently is ~ that difficult for any of the possible biomarkers**
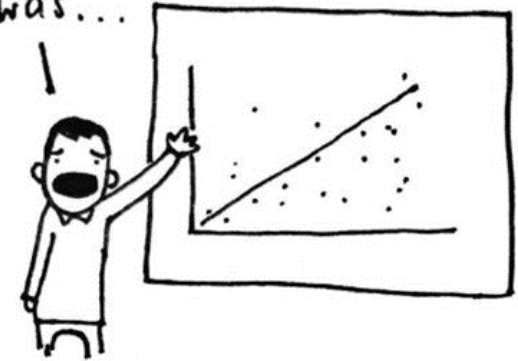
6.4 Future of Biomarkers in Psychology

- **Huge, well-powered, methodologically sound studies needed** (e.g., Wilcox et al., 2020)
    - Identification of objective, reliable, valid, and specific biomarkers
    - Development of shared guidelines (e.g., for EMG analysis and dealing with noise)
    - Particular need for longitudinal studies in order to disentagle causes, effects, and correlates

- **Open science needed** (e.g., Wilcox et al., 2020)
    - Publication of all, not only „fancy" results
    - Sharing of data and methods
   - Funding of replication studies

6.4 Future of Biomarkers in Psychology

- **Wireless, if possible contactless sensing needed**

  - e.g., assessment of heart rate (variability) via RADAR-based technology

  - e.g., assessment of facial muscle activity via sophisticated video data

- **Automated analysis and feedback needed**

  - e.g. fully automated biofeedback systems

  - e.g., integration of automatically-collected and clinician-based data to a holistic diagnostic overview

6.4 Future of Biomarkers in Psychology

- **Close interaction between research and clinical practice needed**

  - Evidence-based practice
    - i.e., clinical practitioners follow and apply current research insights

  - Practice-based evidence
    - i.e., researchers integrate feedback from clinical practitioners
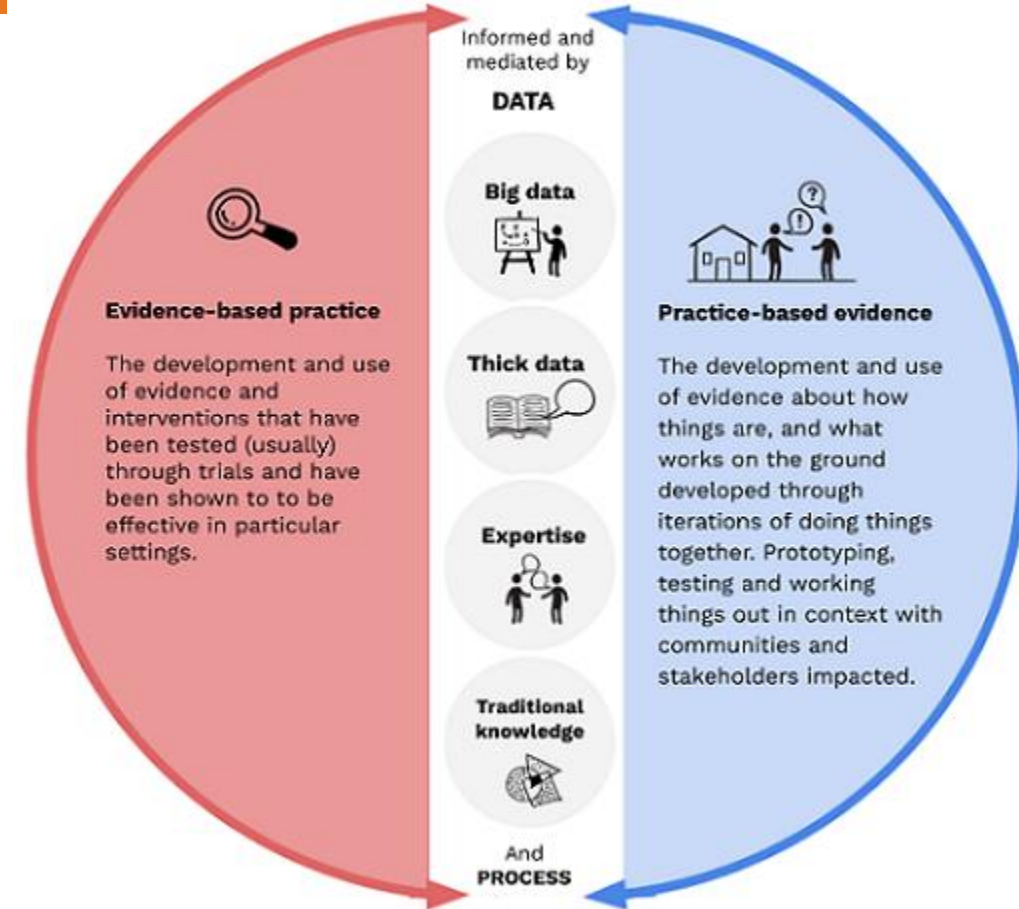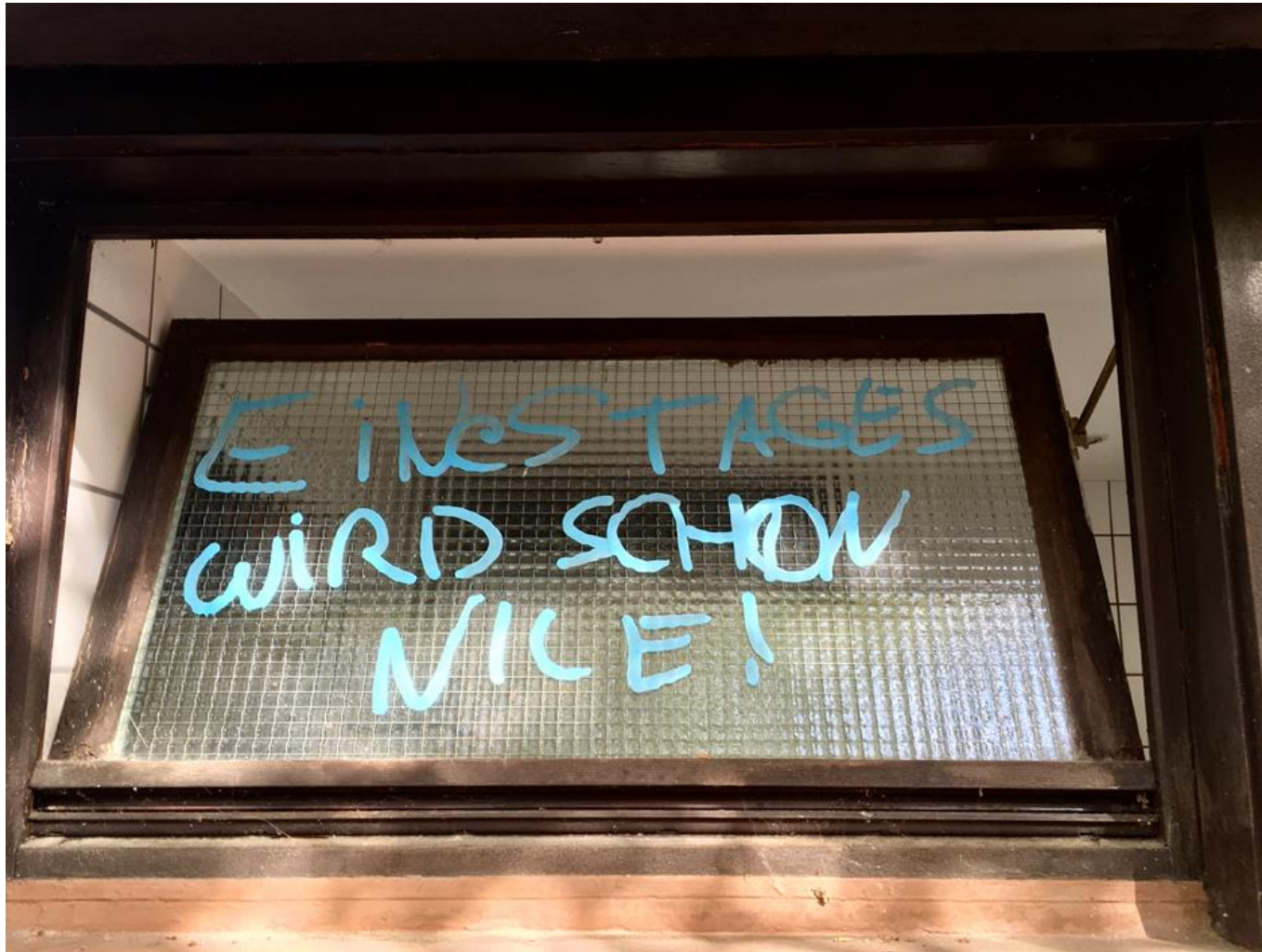
Questions/comments?

Thank you for your kind attention!

References

− DuBois, R. (2020, September 22). From Evidence-Based Practice to Practice-Based Evidence. A paradigm shift in clinical psychology worth paying attention to. Psychology Today, https://www.psychologytoday.com/us/blog/the-digital-doctor/202009/evidence-based-practice-practice-based-evidence

− Engel, S., Klusmann, H., Laufer, S., Kapp, C., Schumacher, S., & Knaevelsrud, C. (2022). Biological markers in clinical psychological research - A systematic framework applied to HPA axis regulation in PTSD. *Comprehensive psychoneuroendocrinology*, *11*, 100148. https://doi.org/10.1016/j.cpnec.2022.100148

− Schindler-Gmelch, L., Capito, K., Steudte-Schmiedgen, S., Kirschbaum, C. & Berking, M. (in press). Hair cortisol research in posttraumatic stress disorder – 10 years of insights and open questions. A systematic review. Current Neuropharmacology

− Wilcox CE, Brett ME, Calhoun VD. Objective markers for psychiatric decision-making: How to move imaging into clinical practice. Neuroimage Clin. 2020;26:102084. doi: 10.1016/j.nicl.2019.102084

Picture references

- https://www.cabinetmagazine.org/issues/34/waidzunas.php
- https://andertoons.com/psychology/cartoon/1211/and-how-does-your-crippling-depression-make-you-feel
- https://commons.wikimedia.org/wiki/File:RDoC_Framework.jpg
- https://mfimedical.com/products/ambu-neuroline-concentric-emg-needle-electrode
- https://medium.com/@y4shchauhan/playing-game-with-emg-signals-a67917ffa39b
- https://www.biomechanist.net/electromyography-basics-of-practical-application/
- https://www.aucklandco-lab.nz/the-lab-blog/evidenceforinnovation

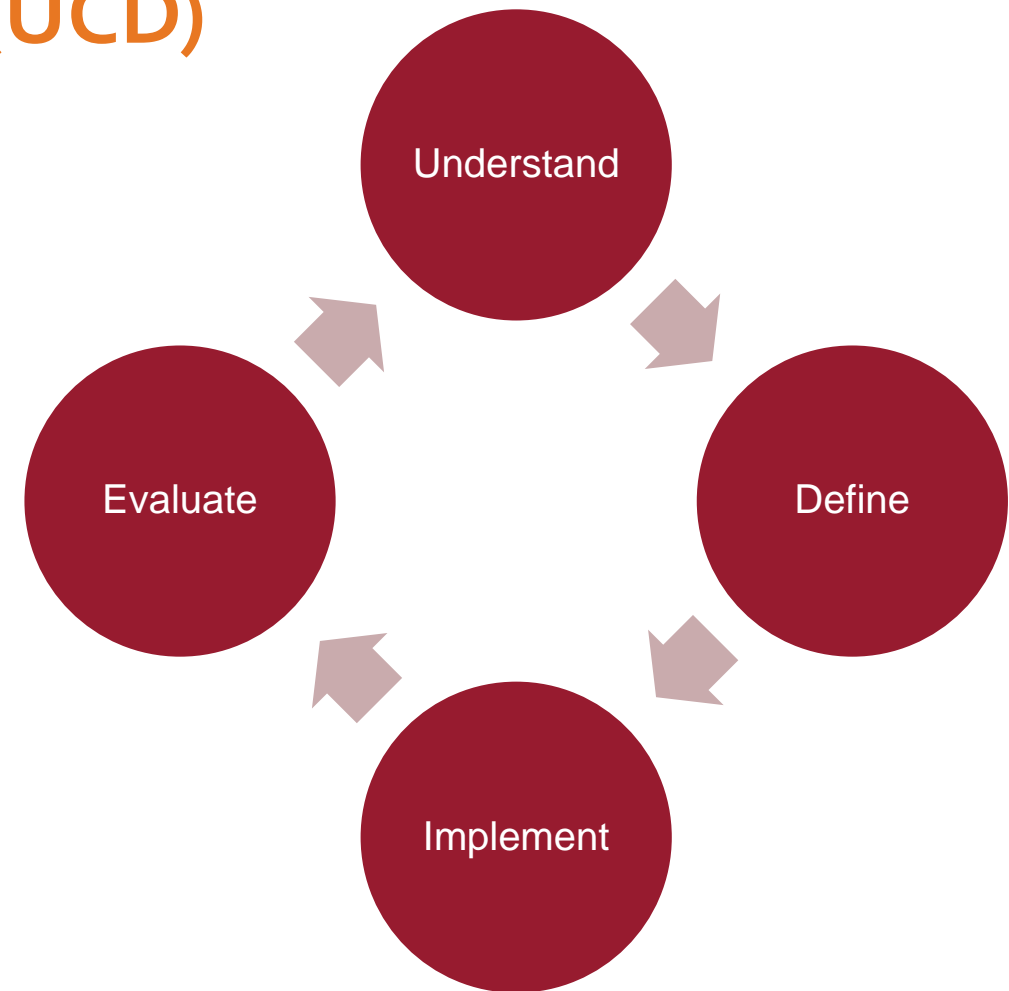# 7. User-centered design & Evaluation

7.1 Basics of user-centered design (UCD)

– **What is UCD?**

– **Why do we use UCD?**

7.1 Basics of user-centered design (UCD)

– Iterative process

– Variations with different names exist that prescribe the same common approach

See also: **ISO 9241-210:2019** (Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems)

7.1 Basics of user-centered design (UCD)

–   Creates a systematic understanding of real user needs

–   Emphasis on requirements analysis allows to create real value for the users

–   Iterative design and evaluation allows for early adaptions

–   Focus on the entire User Experience (**UX**); this goes way beyond system **Usability**

7.2 System Evaluation

What methods exist to evaluate our developments?

7.2 System Evaluation: A few common methods

– Qualitative

  – **Interviews**

  – **Focus groups**

  – **Observational studies**

- Quantitative

  - **Usage analysis**

  - **Survey (Likert scale items)**
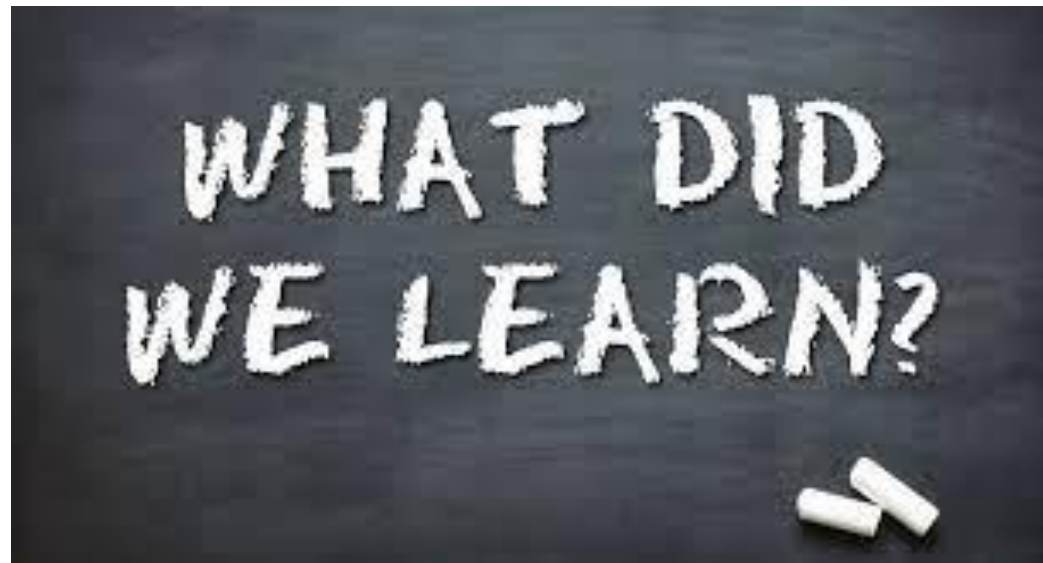
- Mixed-method

  - **Mix of the above**

7.3 Evaluating your prototype

– Discuss suitable evaluation strategies for your prototype

  – **Which ones are suitable?**

  – **Which methods are less suitable?**

- Sketch a first concept for a study design

- 20 minutes for the task

- 2 minutes presentation per group

7.4 Course evaluation and outlook

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Questions/comments?

Thank you for your kind attention!