Centre for Digital Health Interventions

CAS ETH HSG UZH in
Digital Health: Therapeutics

University of Zurich | University of St.Gallen | ETH zürich | OST

Anatomy of Digital Health Technologies

Dr. Rasita Vinay

Postdoctoral Researcher, IBME & IfIS, University of Zurich

Core Director & Lecturer, D-MTEC, ETH Zurich

Sabra Melamed, MBA

Programme Co-Manager

Today’s Agenda

13:00 – 13:15 **Introduction**, Sabra

13:15 – 14:00 **Guest Lecture,** Sam Ewing

14:00 – 15:00 **Relevance of DHTs & States of Vulnerability**, Rasita

15:00 – 15:15 Break

15:15 – 15:45 **Group Work & States of Receptivity**, Rasita

15:45 – 16:00 Break

16:00 – 17:00 **Precision Support & Next Steps**, Rasita & Sabra

Updates & Questions

Quick check-in: Has everyone…

1. **Enrolled** for term FS2025 and Modules 1 and 2 on MyStudies?
2. **Accessed Moodle** course **375-0001-00L Introduction to Digital Health**?
3. **Completed the Quiz ?**“Assess your experience with digital health interventions”
4. **Gotten on Discord?** https://discord.com/invite/rzq6JjWYpu --> First create an account, then follow this link and write Sabra a private message “Hi, I am …”

Photos: First photos are posted on Moodle under Session 1, news post to follow

Individual assignments: Available from today at 17:00, due on **March 13th 23:59**

Sabra’s Office Hours: M, T, Th, F

Zoom recording

Questions?

Support
cas-digital-health@ethz.ch
info@sce.ethz.ch

Course Viewing Locations

HG

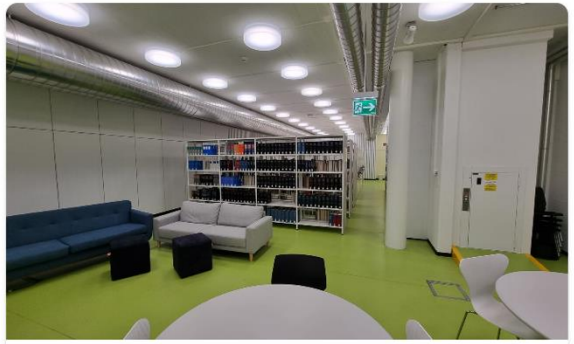
Risalit HG E Nord HG E 20.0029 — 24 Seats

Seminare / Kurse HG E 22 — 48 Seats

Seminare / Kurse HG E 23 — 38 Seats

IFW

Sitznische IFW B 30.0015 — 2 Seats



GESS-Bibliothek IFW B 35.1 — 30 Seats

Seminare / Kurse IFW B 42 — 32 Seats

https://eduapp.ethz.ch/workspaces

Feb 27th?

Upcoming Events

Free, in-person lecture series
Always Wednesdays 17:15-18:30 @ HSG Square

Focus more on health economics & policy, less digital health

Language: German

Upcoming Events

CDHI Digital Health Forum

Keynote by Prof. Dr. Gilbert on The regulation and implementation of LLMs: past, current and future paradigms (and controversies) from around the world … and what happens when these meet JITAI

Thursday, 5 March 2026, 4:15 pm
Zoom Link & in-person at HSG Square Arena (please RSVP for in-person with victoria.bruegger@unisg.ch)

Email invitations for the series

Upcoming Events

CDHI Digital Health Forum

Keynote by Dipl.-Wi.-Inf. Weimann on Embodied Conversational Agents for Collecting Patient-Reported Data: Current Evidence and Future Perspectives on LLM-driven PROMs, March 6, 2026

Friday, 6 March 2026, 10:15 am
Zoom Link & in-person at HSG Square Arena (please RSVP for in-person with victoria.bruegger@unisg.ch)

Upcoming Events

IfIS lunch talk: Dr. Amal Fakha, University of Groningen, NL

Good Ideas, Hard Reality: Implementing Transitional Care Innovations

Exploring why promising innovations in transitional care encounter challenges in practice and how implementation science can make them work; insights and lessons from the TRANS-SENIOR EU research consortium

Our topic

Transitional care remains challenging due to fragmented service delivery, poor information transfer, and misaligned organizational incentives, often resulting in adverse patient outcomes. This lunch talk synthesizes five recent, interrelated studies – a scoping review, an international DELPHI study, qualitative case studies, an implementation mapping exercise, and a study exploring the growing use of AI in transitional care – conducted within the TRANS-SENIOR research network to examine transitional care innovations, implementation challenges, and emerging directions, particularly in long-term care settings.

Learn more about the EU-funded TRANS-SENIOR project – and join our IFIS lunch talk to discuss how to improve innovations in long-term care!

February 18th, 12:00-13:00, on Zoom
https://uzh.zoom.us/j/69734748216?pwd=cxmLvhv466ZnVJdt7mSa6yJdOjEpd4.1

(Past) Event

DHZ Webinar on Multi-Modal Exploration of Medical Data with Agentic AI

January Keynote by Prof. Kurt Stockinger (ZHAW) how agentic AI systems can be used to explore heterogeneous medical datasets — combining structured numerical data, unstructured clinical text, and medical images through natural-language queries.

RECORDING and Slides available here:
https://www.digitalhealthzurich.com/en/node/6800

Schedule and content

Introduction to Digital Health

Module 1, 3 ECTS
primarily individual work

1. The health and economic burden of non-communicable diseases
2. Key characteristics of digital health technologies
3. Business models for digital health technologies

Assessing Digital Health Interventions

Module 2, 4 ECTS
primarily group work

1. Design and assessment frameworks for digital health technologies
2. Market analysis of digital health technologies and presentation of your “superior” technology incl. business model

Designing a Digital Biomarker

Module 3, **4** ECTS
primarily group work

1. Overview and data collection methods for digital biomarkers
2. Design of a wearable-based digital biomarker with a data collection study
3. Presentation of your digital biomarker study

Designing a Just-in-time Adaptive Intervention

Module 4, **4** ECTS
primarily group work

1. Development of a conceptual model
2. Implementation of a smartphone-based and chatbot-delivered intervention
3. Intervention delivery, data collection and analysis
4. Results presentation and suggestions for improvement

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16:00 – 17:00 **Precision Support & Next Steps**, Rasita & Sabra

Sam Ewing Guest Lecture

Will be uploaded separately on Moodle ☺

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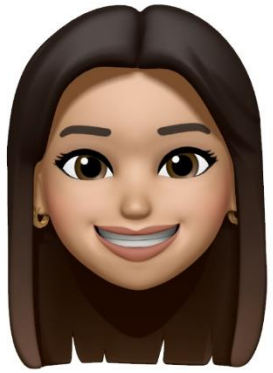


Which health apps or health-related podcasts do you really like?

Join at
slido.com
#cdh

Which health apps or health-related podcasts do you really like?

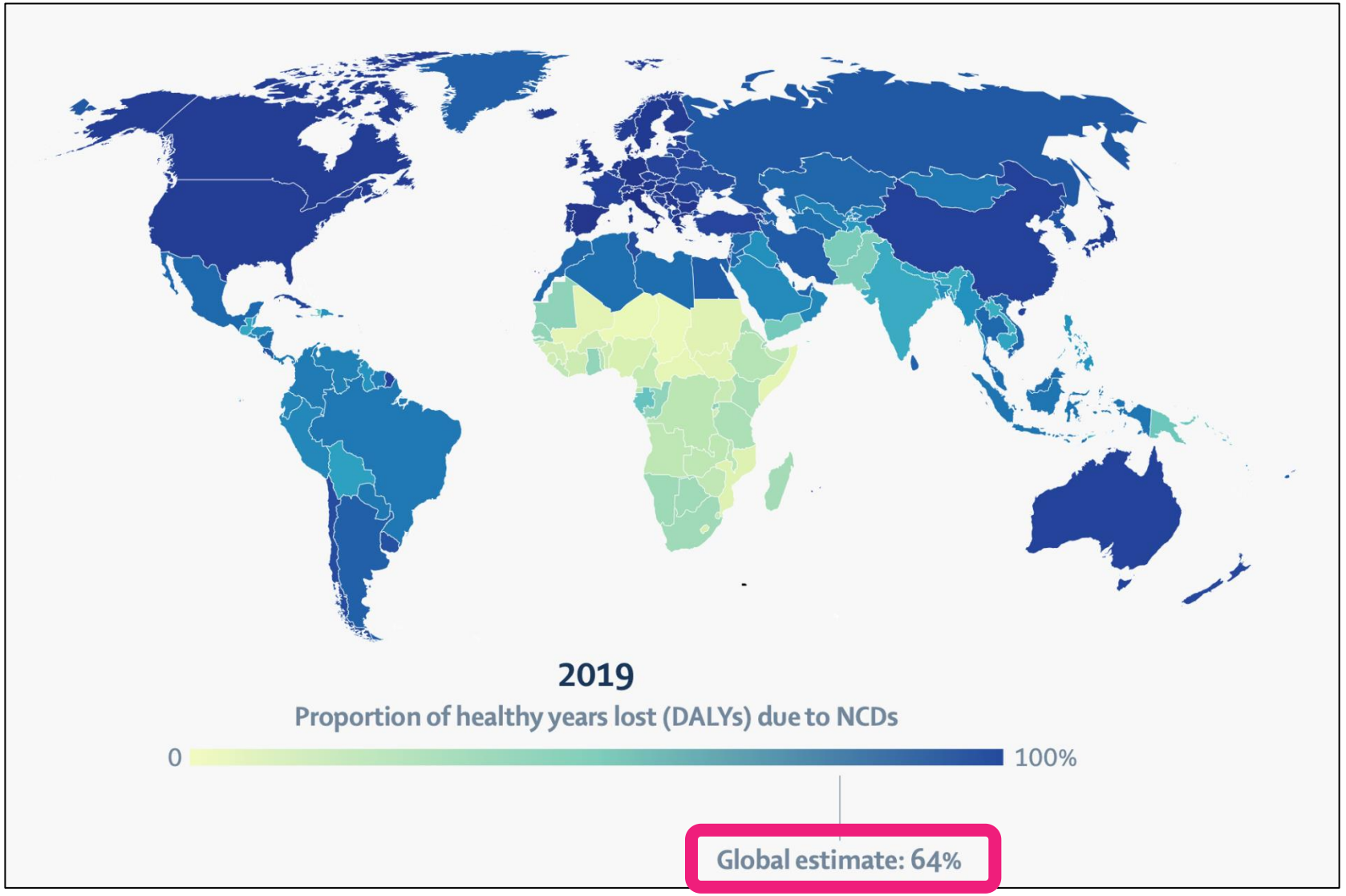
The Health & Economic Burden of Non-communicable Diseases

Health Angels

The Rise of the Darkest Enemy

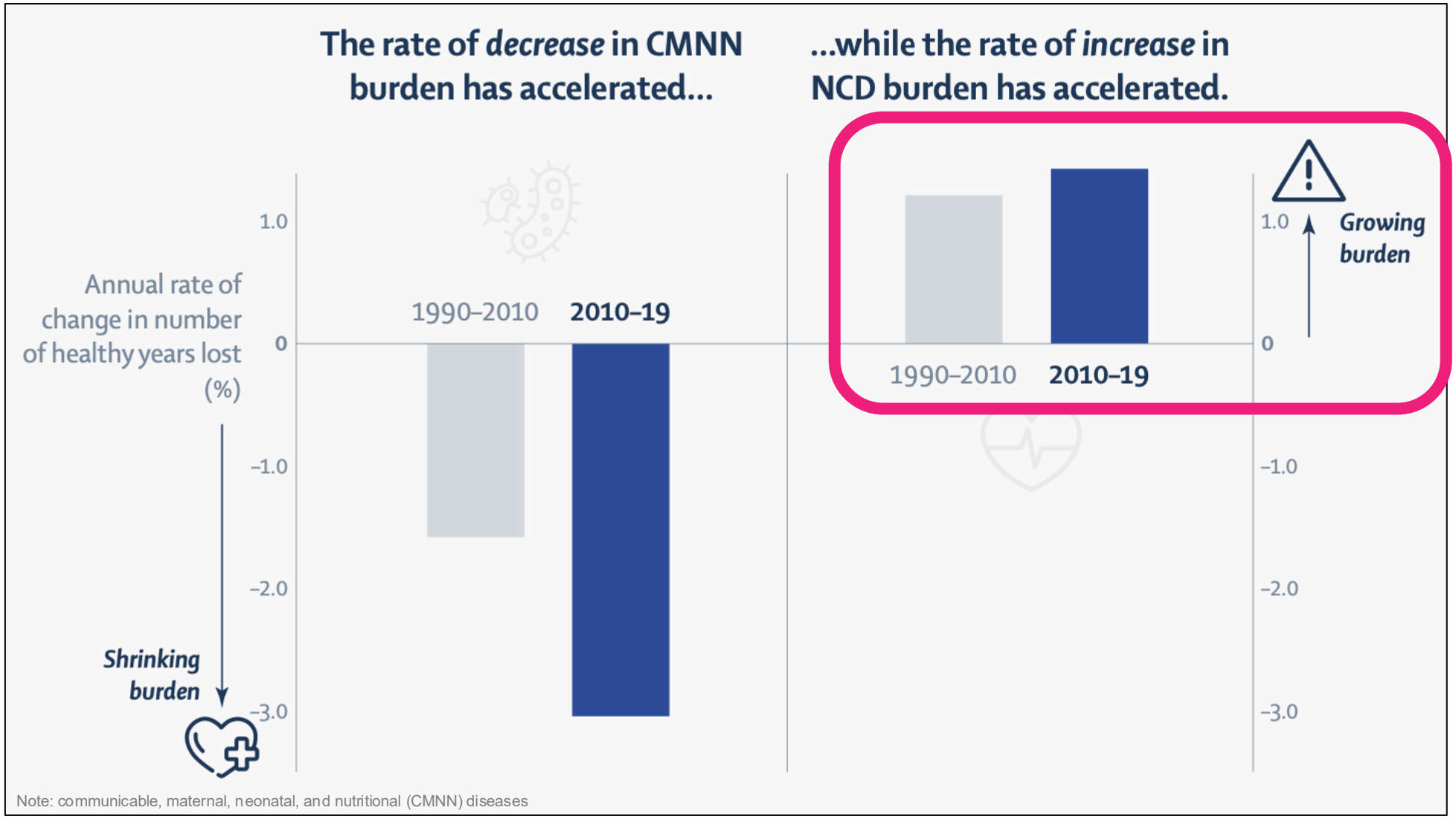
13 Feb 2026

Healthy years lost due to NCDs

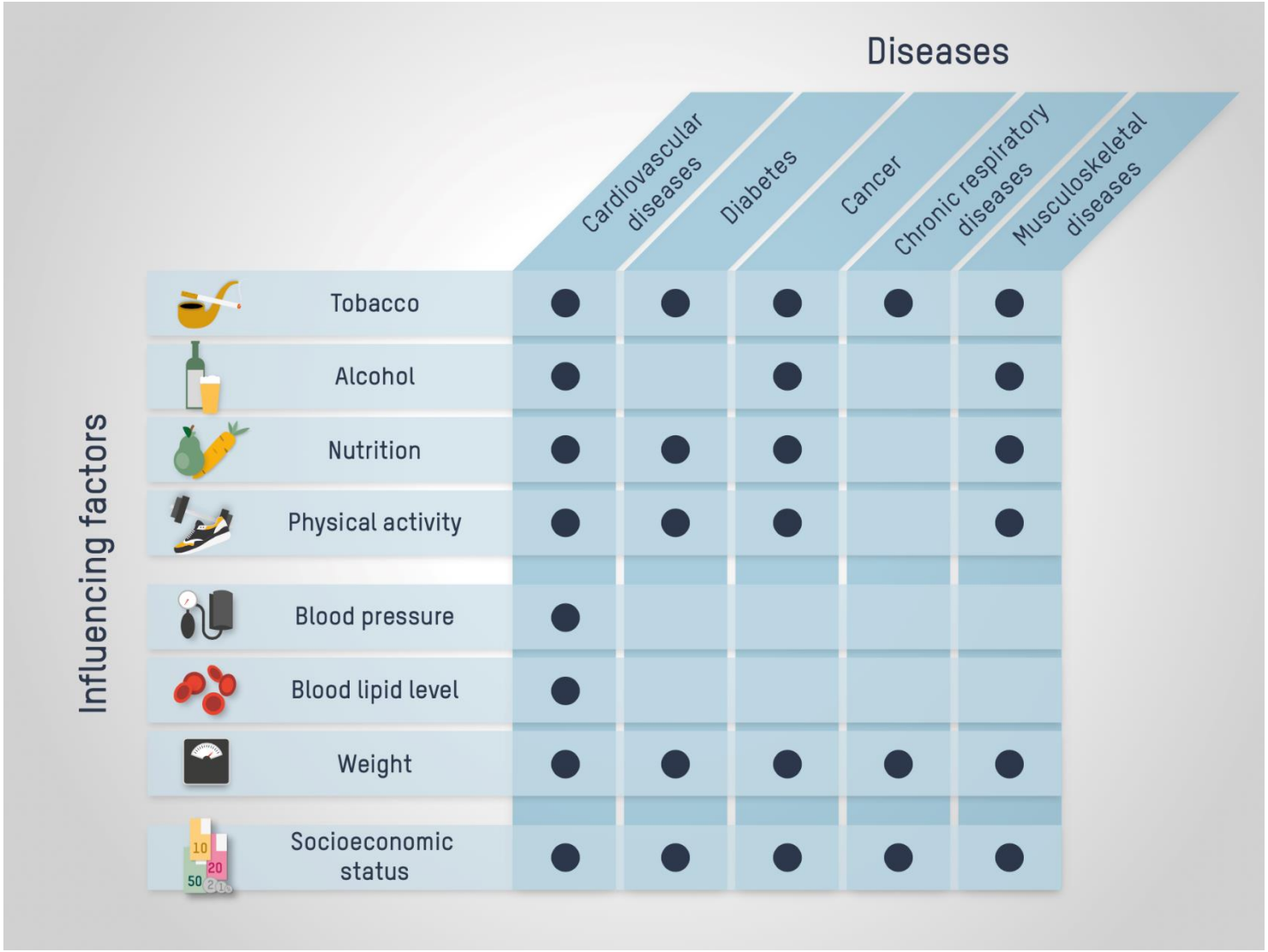


https://www.thelancet.com/infographics-do/gbd-2019

Increasing rate of NCDs



Impact of our lifestyle on health



https://www.bag.admin.ch/dam/bag/en/dokumente/nat-gesundheitsstrategien/ncd-strategie/ncd-strategie_in_kuerze.pdf.download.pdf/ncd-strategie_in_kuerze.pdf

- **Lifestyle factors**, i.e., poor diet, lack of physical activity, smoking and excessive alcohol consumption
- **Physiological factors**, i.e., weight, blood pressure, body lipids and cholesterol.
  = Influenced by our genes and lifestyle
- **Social and economic factors**, i.e., level of education, influences occurrence of NCDs

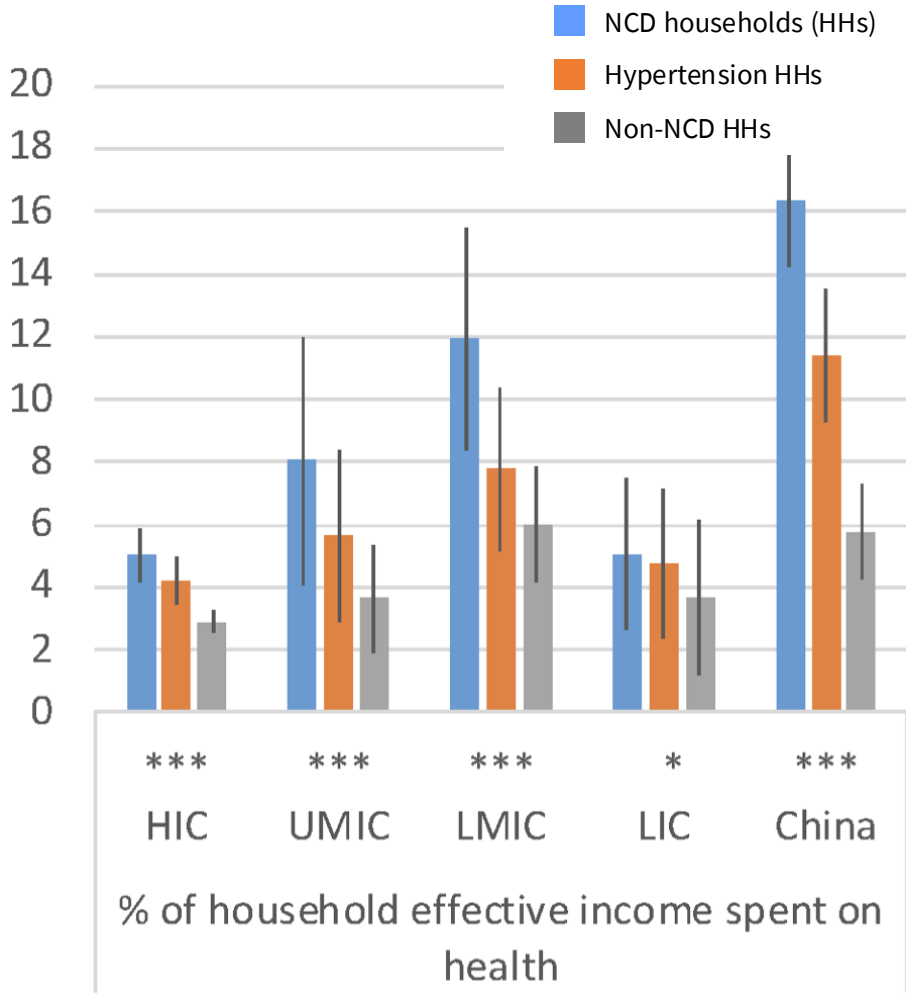
VISION OF THE NATIONAL NCD STRATEGY

More people stay **healthy** or have a **high quality of life** despite chronic illness.

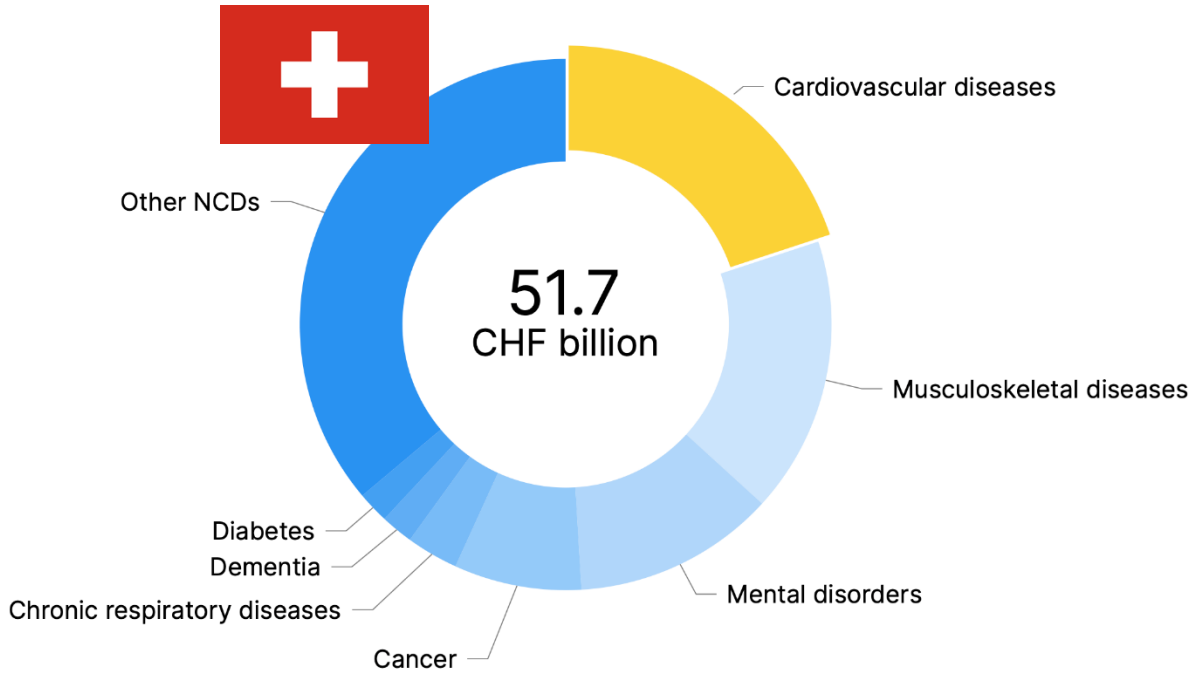
Fewer people suffer from avoidable non-communicable diseases or die prematurely.

Regardless of their socioeconomic status, people are empowered in their efforts to cultivate a healthy lifestyle in a **health-promoting environment.**

Economic burden of healthcare costs



Murphy, A., Palafox, B., Walli-Attaei, M., Powell-Jackson, T., Rangarajan, S., Alhabib, K. F., Avezum, A. J., Calik, K. B. T., Chifamba, J., Choudhury, T., Dagenais, G., Dans, A. L., Gupta, R., Iqbal, R., Kaur, M., Kelishadi, R., Khatib, R., Kruger, I. M., Kutty, V. R., . . . McKee, M. (2020). The household economic burden of non-communicable diseases in 18 countries. *BMJ Glob Health*, *5*(2), e002040. https://doi.org/10.1136/bmjgh-2019-002040



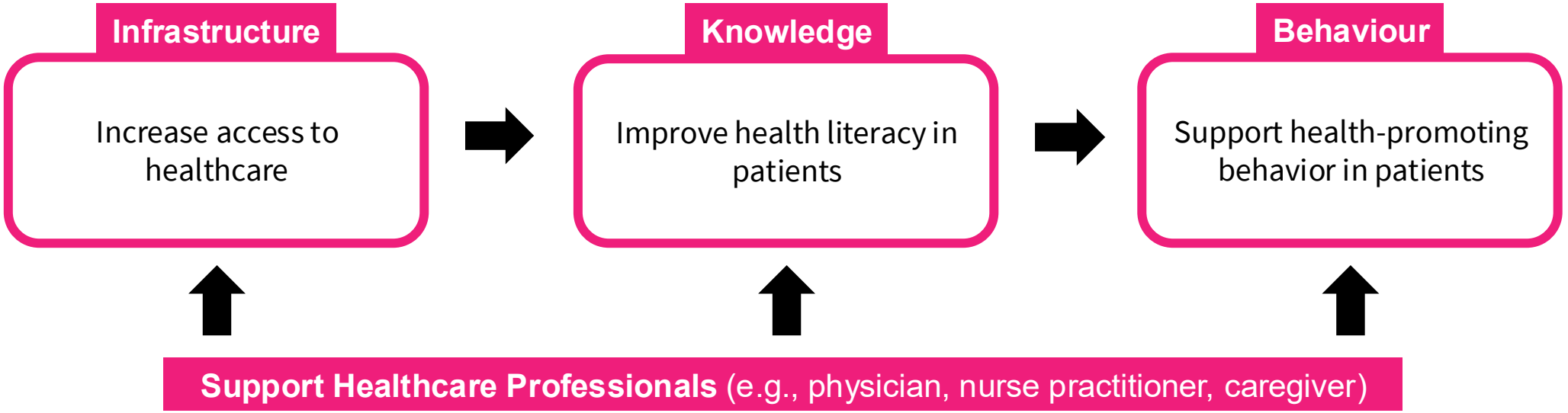
«For Switzerland, the total direct costs of NCDs in 2011 were estimated at just under CHF 52 billion. This means that NCDs accounted for **80% of all direct health care expenditure** (not shown in indicator; see Wieser et al. 2014).»

https://ind.obsan.admin.ch/en/indicator/monam/the-economic-cost-of-non-communicable-diseases-ncds

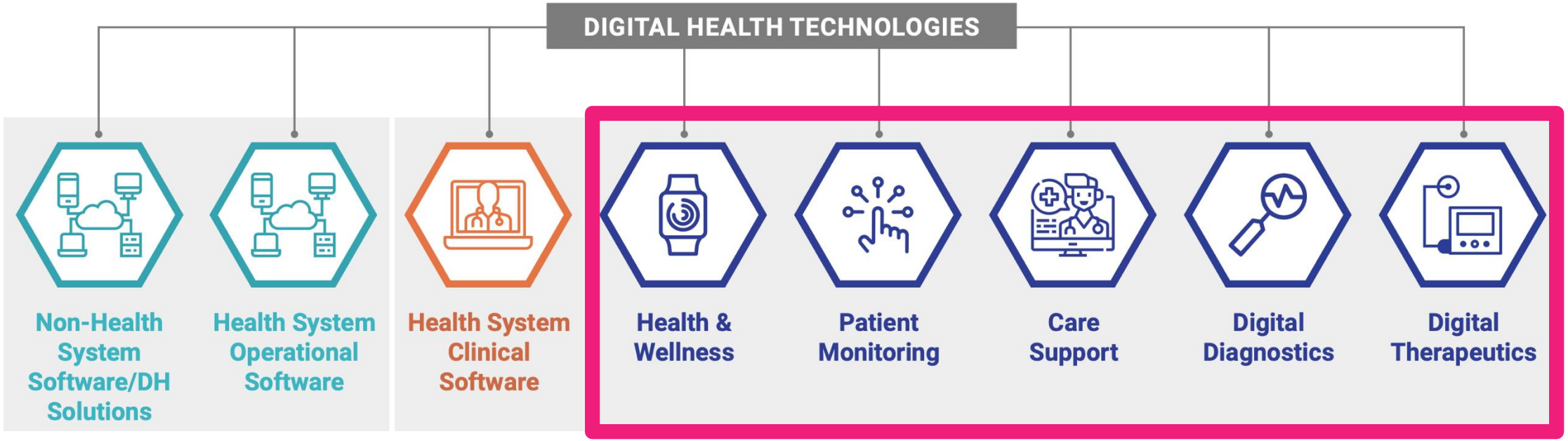
What is the fundamental problem?

The **health** and **economic** **burden** of **noncommunicable diseases** (NCDs).

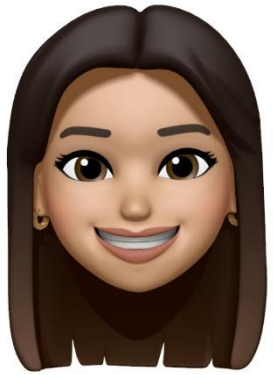
What can we do with technology?



Recap: An overview of digital health technologies



https://dtxalliance.org/wp-content/uploads/2023/06/DTA_FS_DHT-Ecosystem-Categorization.pdf



20 Min Group Work

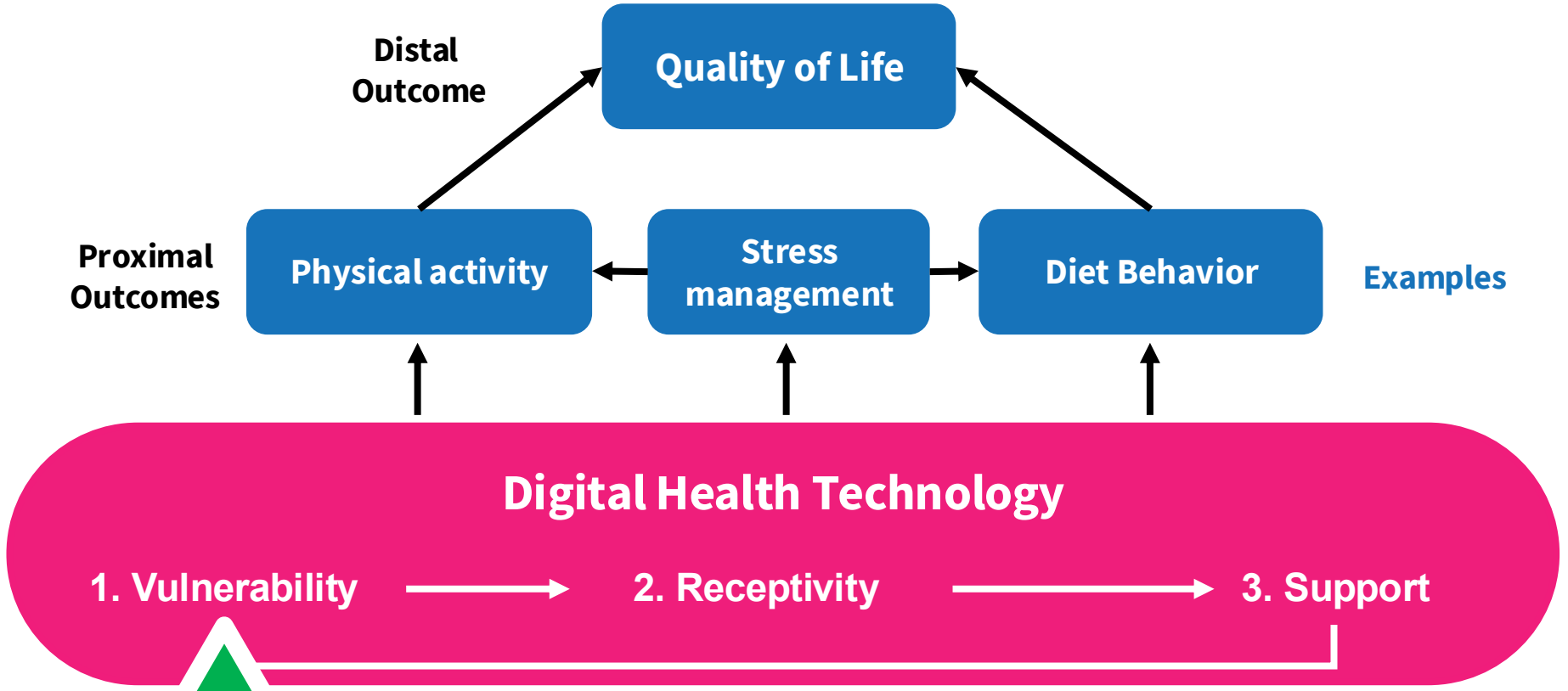
Let’s find out more about NCDs and Digital Health Technologies. 💪

https://miro.com/app/board/uXjVGHUKzjs=/

Password: **casethdh2026**

How would an “ideal” digital health technology look like?

The anatomy of an "ideal" digital health technology



These interventions are alsocalled Just-in-time adaptive inte

Nahum-Shani, I., Smith, S. N., Spring, B. J., Collins, L. M., Wit[illegible]n-Time Adaptive Interventions (JITAIs) in Mobile Health: Key Components and Design Principles for Ongoing Health Behavior Support. Ann Behav Med, 52(6), 446-462. https://doi.org/10.1007/s12160-016-9830-8
Jacobson, N., Kowatsch, T., & Marsch, L. (Eds.). (202[illegible]tion: The State of the Science and Vision for the Future (1st ed.). Elsevier, Academic Press. 10.1016/C2020-0-02801-X
Kowatsch, T., & Fleisch, E. (2021). Digital Health Interventions. In [illegible] (Eds.), *Connected Business: Create Value in a Networked Economy* (pp. 71-95). Springer International Publishing. 10.1007/978-3-030-76897-3_4
Kowatsch, T., Otto, L., Harperink, S., Cotti, A., & Schlieter, H. (2019). A design and evaluation framework for digital health interventions. *it - Information Technology*, *61*(5-6), 253-263. 10.1515/itit-2019-0019
https://dtxalliance.org/understanding-dtx/dtx-evaluation-toolkit/ & https://dtxalliance.org/wp-content/uploads/2023/06/DTA_FS_ISO-Definition.pdf

State of Vulnerability: A definition

A **vulnerable state** is a "person's transient tendency to experience adverse health outcomes or to engage in maladaptive behaviors."

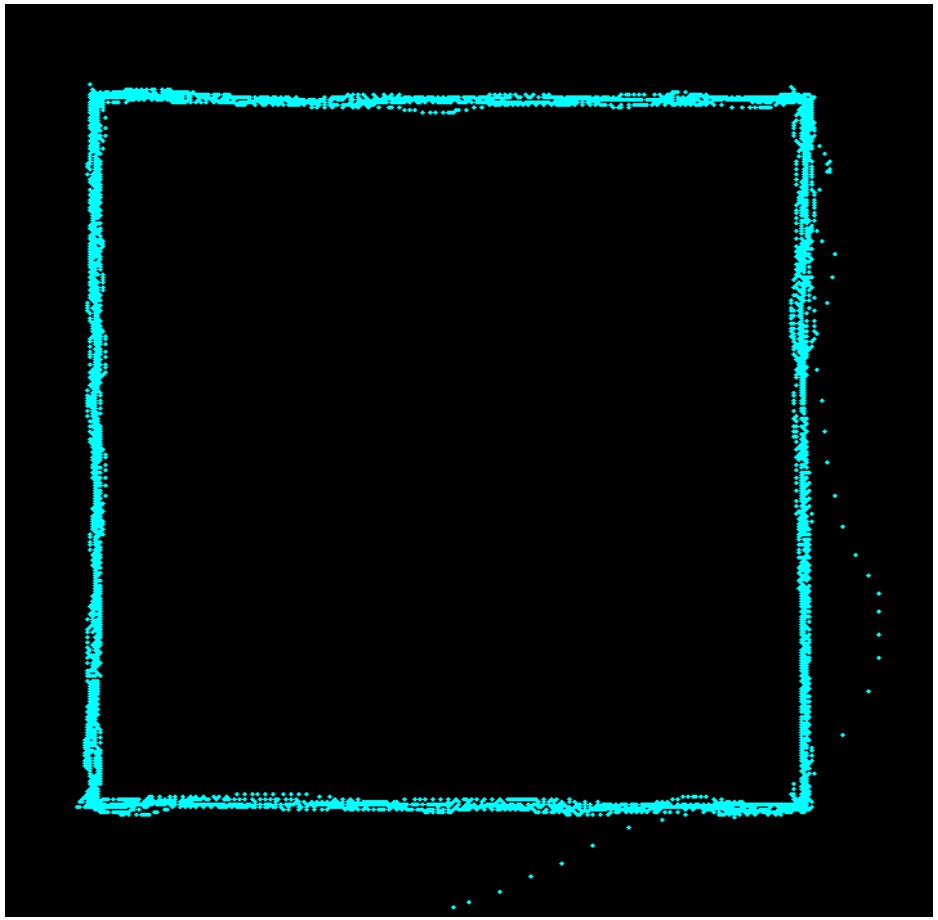
Nahum-Shani et al (2015, p. 1210)

The **goal** of an **"ideal"** **digital health technology** is to **detect** or, if possible, even **to predict** **vulnerable states** at an **early** stage **to prevent** or, at least, **minimize** any negative health outcomes.

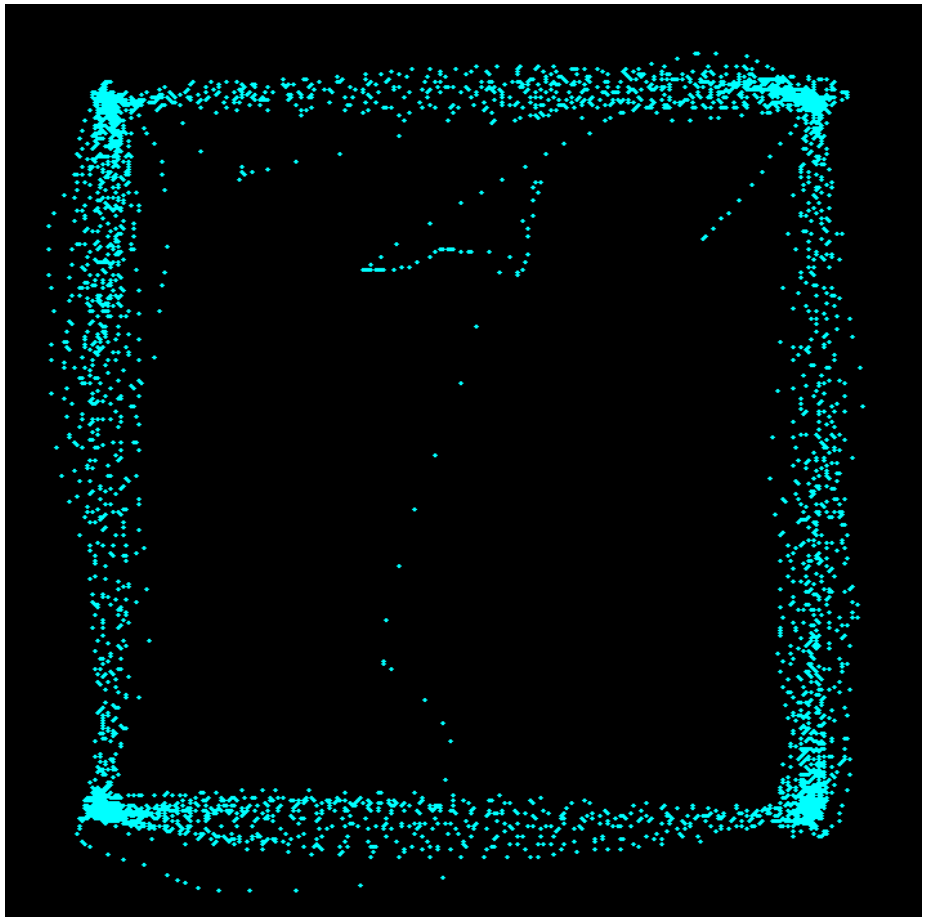
Sensing stress at the workplace with the help of a computer mouse

Banholzer N, Feuerriegel S, Fleisch E, Bauer GF, Kowatsch T (2021) Computer Mouse Movements as an Indicator of Work Stress: Longitudinal Observational Field Study, J Med Internet Res 2021;23(4):e27121, 10.2196/27121
Kowatsch, T., Wahle, F., & Filler, A. (2017). Design and Lab Experiment of a Stress Detection Service based on Mouse Movements. 11th Mediterranean Conference on Information Systems (MCIS), Genoa, Italy.

Visual results of a lab experiment (N=18)



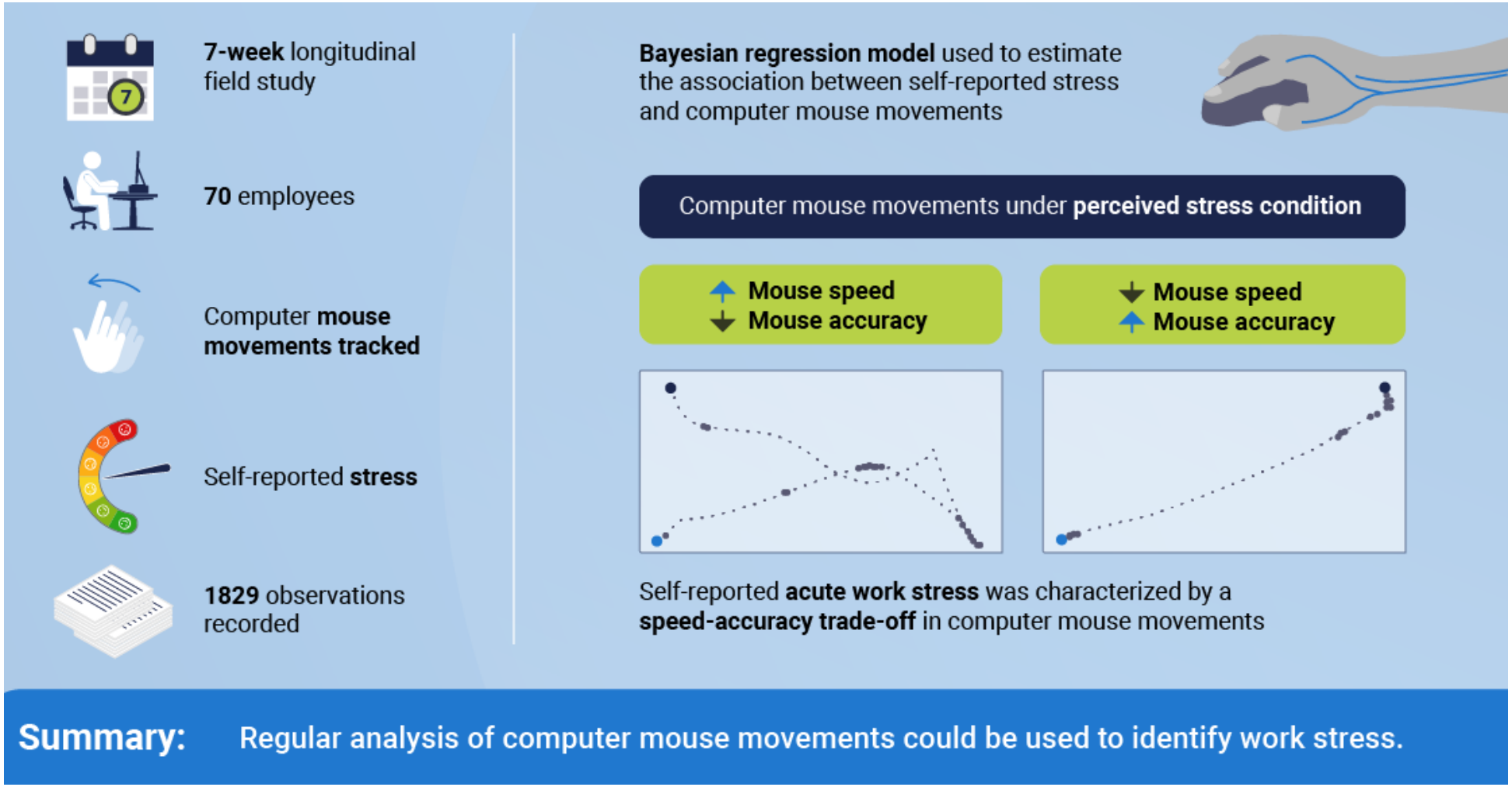
Subject was **relaxed (Square Task 1)**



Subject was **stressed (Square Task 2)**

https://www.c4dhi.org/projects/jsiss/

And in real life?



Banholzer N, Feuerriegel S, Fleisch E, Bauer GF, Kowatsch T (2021) Computer Mouse Movements as an Indicator of Work Stress: Longitudinal Observational Field Study, J Med Internet Res 2021;23(4):e27121, 10.2196/27121

HEADWIND: Using car sensor data to predict hypoglycemia

Source: youtu.be/sgF4ijJ2FGIw

Mercedes text was developed with a type-1 diabetes patient.

Maritsch, M., Föll, S., Lehmann, V., Styger, N., Bérubé, C., Kraus, M., Feuerriegel, S., Kowatsch, T., Züger, T., Fleisch, E., Wortmann, F., Stettler, C. (2024) **Smartwatches for noninvasive hypoglycemia detection during cognitive and psychomotor stress, Diabetes, Obesity and Metabolism**, 10.1111/dom.15402, 26(3), 1133-1136.

Lehmann, V., Züger, T., Maritsch, M., Notter, M., Schallmoser, S., Bérubé, C., Albrecht, C., Kraus, M., Feuerriegel, S., Fleisch, E., Kowatsch, T., Lagger, S., Laimer, M., Wortmann, F., Stettler, C. (2024) **Machine learning to infer a health state using biomedical signals – detection of hypoglycemia in people with diabetes while driving real cars**, New England Journal of Medicine (NEJM) AI, Aloa2300013.10.1056/Aloa2300013 .

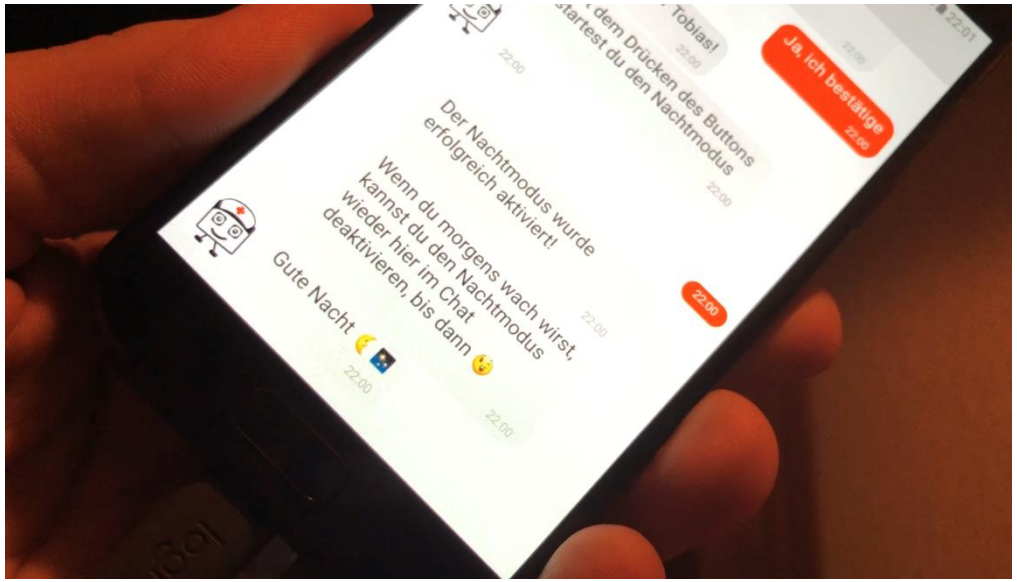
Sinergia

Swiss National Science Foundation

INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HOPITAL UNIVERSITAIRE DE BERNE

https://www.c4dhi.org/projects/headwind-a-vehicle-hypoglycemia-warning-system/

CLARA: Design of a prognostic digital biomarker for asthma control



Kantonsspital St.Gallen | University of Zurich[UZH] | LUNGENLIGA | CSS

https://www.c4dhi.org/projects/css-mobile-asthma-companion/

Study 1: Cough detection with a smartphone is feasible

Automatic Recognition, Segmentation, and Sex Assignment of Nocturnal Asthmatic Coughs and Cough Epochs in Smartphone Audio Recordings: Observational Field Study

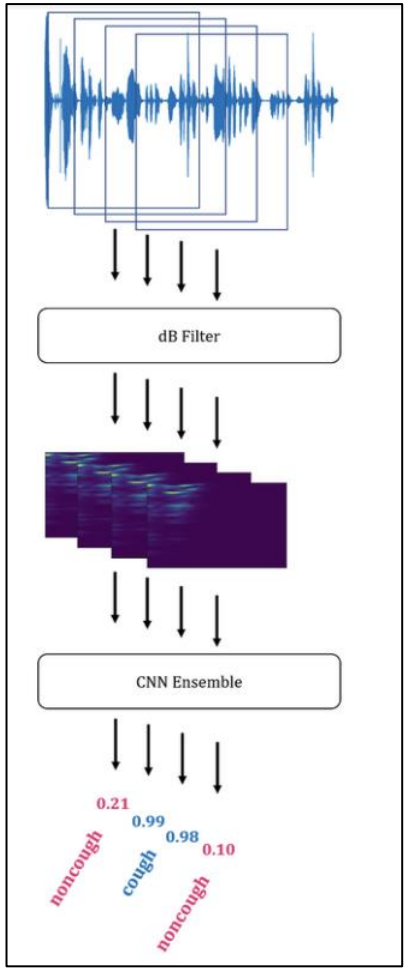
Filipe Barata [1]; Peter Tinschert [2]; Frank Rassouli [3]; Claudia Steurer-Stey [4, 5]; Elgar Fleisch [1, 2]; Milo Alan Puhan [4]; Martin Brutsche [3]; David Kotz [1, 6, 7]; Tobias Kowatsch [1, 2]

Authors | Cited by (21) | Tweetations (4) | Metrics

Abstract

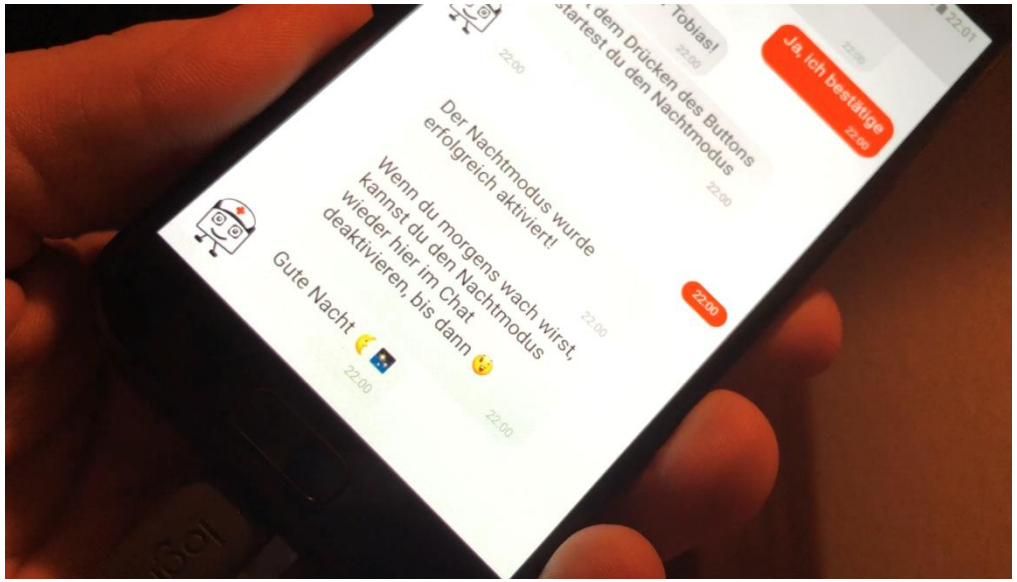
Background:
Asthma is one of the most prevalent chronic respiratory diseases. Despite increased investment in treatment, little progress has been made in the early recognition and treatment of asthma exacerbations over the last decade. Nocturnal cough monitoring may provide an opportunity to identify patients at risk for imminent exacerbations. Recently developed approaches enable smartphone-based cough monitoring. These approaches, however, have not undergone longitudinal overnight testing nor have they been specifically evaluated in the context of asthma. Also, the problem of distinguishing partner coughs from patient coughs when two or more people are sleeping in the same room using contact-free audio recordings remains unsolved.

Objective:
The objective of this study was to evaluate the automatic recognition and segmentation of nocturnal asthmatic coughs and cough epochs in smartphone-based audio recordings that were collected in the field. We also aimed to distinguish partner coughs from patient coughs in contact-free audio recordings by classifying coughs based on sex.



Barata, F., Tinschert, P., Rassouli, F., Steurer-Stey, C., Fleisch, E., Puhan, M. A., Brutsche, M., Kotz, D., & Kowatsch, T. (2020). Automatic Recognition, Segmentation, and Sex Assignment of Nocturnal Asthmatic Coughs and Cough Epochs in Smartphone Audio Recordings: Observational Field Study. *J Med Internet Res*, *22*(7), e18082. 10.2196/18082

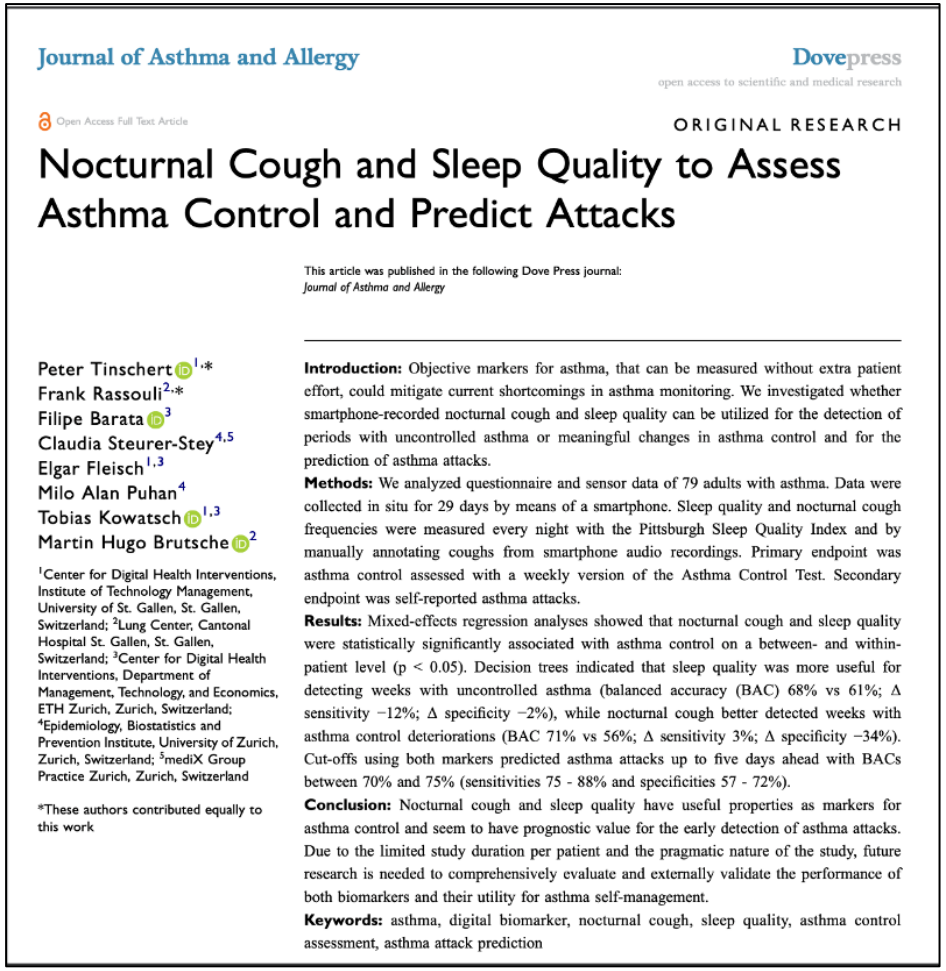
CLARA: Design of a prognostic digital biomarker for asthma control



Kantonsspital St.Gallen | University of Zurich[UZH] | LUNGENLIGA | CSS

https://www.c4dhi.org/projects/css-mobile-asthma-companion/

Study 2: Prediction of asthma attacks?



Journal of Asthma and Allergy — Dovepress
open access to scientific and medical research

Open Access Full Text Article — ORIGINAL RESEARCH

Nocturnal Cough and Sleep Quality to Assess Asthma Control and Predict Attacks

This article was published in the following Dove Press journal:
Journal of Asthma and Allergy

Peter Tinschert[1,*]
Frank Rassouli[2,*]
Filipe Barata[3]
Claudia Steurer-Stey[4,5]
Elgar Fleisch[1,3]
Milo Alan Puhan[4]
Tobias Kowatsch[1,3]
Martin Hugo Brutsche[2]

[1]Center for Digital Health Interventions, Institute of Technology Management, University of St. Gallen, St. Gallen, Switzerland; [2]Lung Center, Cantonal Hospital St. Gallen, St. Gallen, Switzerland; [3]Center for Digital Health Interventions, Department of Management, Technology, and Economics, ETH Zurich, Zurich, Switzerland; [4]Epidemiology, Biostatistics and Prevention Institute, University of Zurich, Zurich, Switzerland; [5]mediX Group Practice Zurich, Zurich, Switzerland

*These authors contributed equally to this work

Introduction: Objective markers for asthma, that can be measured without extra patient effort, could mitigate current shortcomings in asthma monitoring. We investigated whether smartphone-recorded nocturnal cough and sleep quality can be utilized for the detection of periods with uncontrolled asthma or meaningful changes in asthma control and for the prediction of asthma attacks.

Methods: We analyzed questionnaire and sensor data of 79 adults with asthma. Data were collected in situ for 29 days by means of a smartphone. Sleep quality and nocturnal cough frequencies were measured every night with the Pittsburgh Sleep Quality Index and by manually annotating coughs from smartphone audio recordings. Primary endpoint was asthma control assessed with a weekly version of the Asthma Control Test. Secondary endpoint was self-reported asthma attacks.

Results: Mixed-effects regression analyses showed that nocturnal cough and sleep quality were statistically significantly associated with asthma control on a between- and within-patient level ($p < 0.05$). Decision trees indicated that sleep quality was more useful for detecting weeks with uncontrolled asthma (balanced accuracy (BAC) 68% vs 61%; Δ sensitivity −12%; Δ specificity −2%), while nocturnal cough better detected weeks with asthma control deteriorations (BAC 71% vs 56%; Δ sensitivity 3%; Δ specificity −34%). Cut-offs using both markers predicted asthma attacks up to five days ahead with BACs between 70% and 75% (sensitivities 75 - 88% and specificities 57 - 72%).

Conclusion: Nocturnal cough and sleep quality have useful properties as markers for asthma control and seem to have prognostic value for the early detection of asthma attacks. Due to the limited study duration per patient and the pragmatic nature of the study, future research is needed to comprehensively evaluate and externally validate the performance of both biomarkers and their utility for asthma self-management.

Keywords: asthma, digital biomarker, nocturnal cough, sleep quality, asthma control assessment, asthma attack prediction

Resmonics
www.resmonics.ai

Tinschert, P., Rassouli, F., Barata, F., Steurer-Stey, C., Fleisch, E., Puhan, M., Kowatsch, T., Brutsche, M., **Nocturnal cough and sleep quality to assess asthma control and predict attacks**, Journal of Asthma and Allergy 13, 669-678 10.2147/JAA.In.
Rassouli, F., Tinschert, P., Barata, F., Steurer-Stey, C., Fleisch, E., Puhan, M., Baty, F., Kowatsch, T., Brutsche, M., **Characteristics of Asthma-related Nocturnal Cough: A Potential New Digital Biomarker**, Journal of Asthma and Allergy 13, 649—657 10.2147/JAA.S278119.

Further examples of sensing vulnerable states

1. Sensing **cardiac arrhythmias** with **wearables** such as smartwatches and/or dedicated mobile devices such as sensor patches

2. Sensing **hypoglycemia** events with **mobile continuous blood glucose meters**

3. Sensing **stress** with **mobile skin conductance recording** devices

4. Sensing **states of vulnerability** through therapy adherence measures, e.g., with the help of **ingestible sensors** and **wearable sensor patches** that track whether a drug has been taken or not.

https://www.apple.com/watch/

https://www.freestylelibre.co.uk/libre/

Take Home Message: States of Vulnerability

1. A **vulnerable state** is a person's tendency to experience **adverse health outcomes** or to engage in **maladaptive behaviors**.

2. The overall goal of **sensing** is to **detect** or even **predict vulnerable states** at an **early stage** to prevent or, at least, minimize any negative health outcomes.

3. Sensing **states of vulnerability** is **highly specific** concerning the **target behavior or disease**.
   There is (not yet) a one-sensor-fits-all approach to sense states of vulnerability.

4. Sensing **states of vulnerability** with high accuracy often requires **dedicated (medical) devices** and **software**.

5. Sensors from **general-purpose devices** like smartphones are **not made for medical purposes but** may be "**good enough**" to get a **rough picture** of a vulnerable state.

6. A **multi-modal sensing approach**, i.e., using several data sources to sense a state of vulnerability, may lead to **higher** detection **accuracies** but also **higher implementation** and **maintenance costs**.

7. As a **researcher** and **digital health innovator**, try to think "**outside the box**": where are sensors around us, and how could we re-use them for something **relevant in healthcare**?

References and further reading

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Today’s Agenda

13:00 – 13:15 **Introduction**, Sabra

13:15 – 14:00 **Guest Lecture,** Sam Ewing

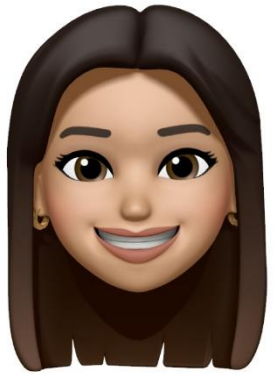
14:00 – 15:00 **Relevance of DHTs & States of Vulnerability**, Rasita

15:00 – 15:15 Break

15:15 – 15:45 **Group Work & States of Receptivity**, Rasita

15:45 – 16:00 Break

16:00 – 17:00 **Precision Support & Next Steps**, Rasita & Sabra



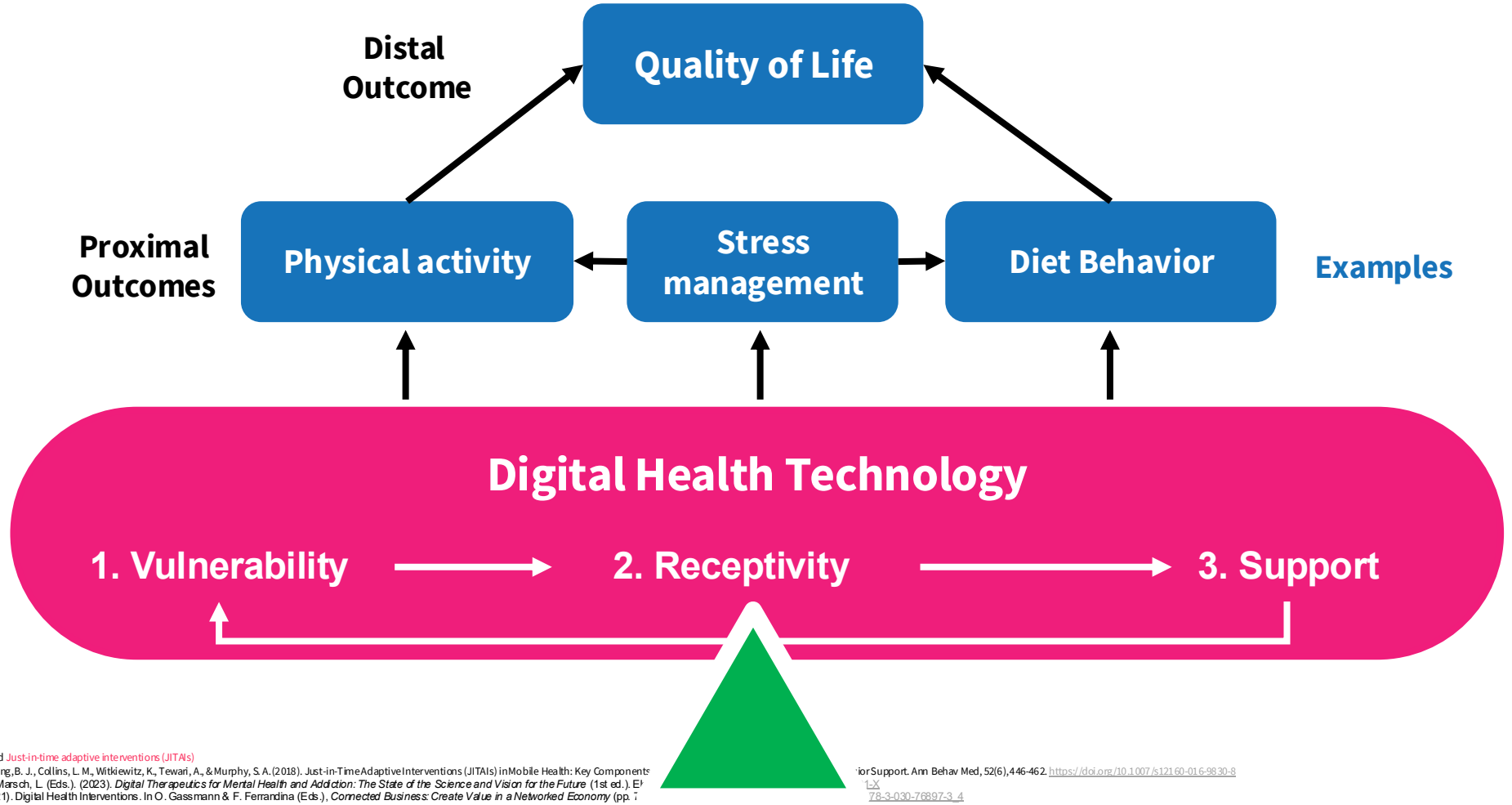
10 Min Group Work

What about your Digital Health Technology and States of Vulnerability? 💪

https://miro.com/app/board/uXjVGHUKzjs=/

Password: **casethdh2026**

The anatomy of an "ideal" digital health technology



These interventions are alsocalled Just-in-time adaptive interventions (JITAIs)

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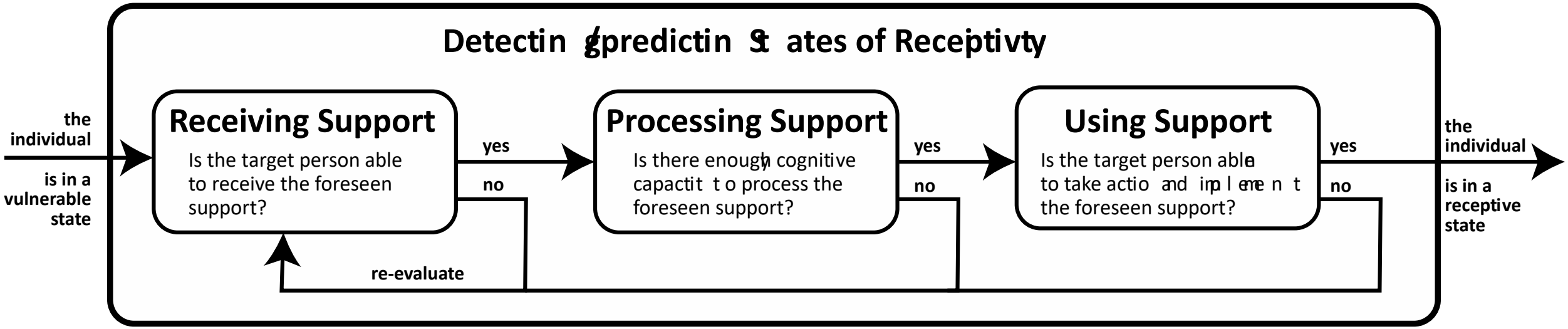
State of Receptivity: A definition

States of receptivity are "conditions in which the person can receive, process and use the support provided."

Nahum-Shani et al (2015, p. 1210)

Given **vulnerable** individuals, the overall **goal** of an **"ideal" digital health technology** is to **detect** or, if possible, even **to predict receptive states to provide support** at **opportune moments.**

States of Receptivity: A Conceptual Model



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The dark side of notifications

Information Systems Research
Vol. 27, No. 4, December 2016, pp. 880–896
ISSN 1047-7047 (print) | ISSN 1526-5536 (online)

https://doi.org/10.1287/isre.2016.0644

More Harm Than Good? How Messages That Interrupt Can Make Us Vulnerable

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dave@daveeargle.com

System-generated alerts are ubiquitous in personal computing and, with the proliferation of mobile devices, daily activity. While these interruptions provide timely information, research shows they come at a high cost in terms of increased stress and decreased productivity. This is due to dual-task interference (DTI), a cognitive limitation in which even simple tasks cannot be simultaneously performed without significant performance loss.

Jenkins, J. L., Anderson, B. B., & Vance, A. (2016). More Harm Than Good? How Messages That Interrupt Can Make Us Vulnerable. Information Systems Research, 27(4), 880-896. 10.1287/isre.2016.0644

The impact of **technostress** and the **attention economy** on **productivity** and **well-being** (esp. in times of COVID-19)

10.1016/j.puhe.2020.09.013
10.1080/13607863.2020.1861213
10.25300/MISQ/2020/14818
10.3389/fpsyg.2018.02569
10.14616/sands-2017-1-358361
10.1037/mgr0000107
10.1017/beq.2020.32
10.3389/fpsyt.2021.642634

https://www.c4dhi.org/news/guest-lecture-by-m-sobolev-on-digital-nudges-and-screen-time-22-april-2021/

But **how would we know** when individuals are **receptive**?

Approach 1: Think about yourself. 🤔
When are you receptive?

Join at
slido.com
#cdh

When are you receptive?

But **how would we know** when individuals are **receptive**?

Approach 2:
We assess related work.

Due: March 13th

See the individual assignment of Session 2 👍

Keller, R., von Wangenheim, F., Mair, J., Kowatsch, T. (2023) **Receptivity to Mobile Health Interventions**, In N. Jacobson, T. Kowatsch, & L. A. Marsch (eds.), Digital Therapeutics for Mental Health and Addiction: The State of the Science and Vision for the Future (1st ed.), Elsevier, Academic Press: Cambridge, MA, USA, 65-77, 10.1016/B978-0-323-90045-4.00006-X.

But **how would we know** when individuals are **receptive**?

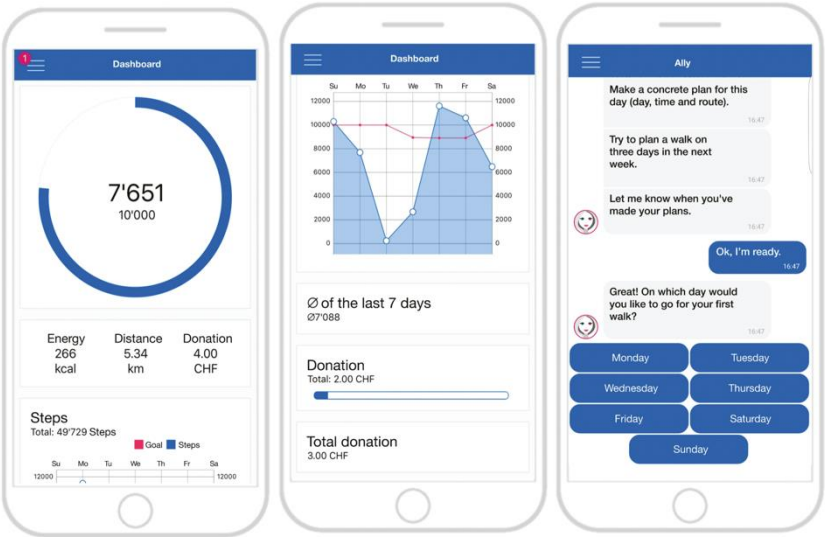
Approach 3:
We conduct a study and find out.

Introducing Ally

The Assistant to Lift Your Level of Activity

DARTMOUTH · UNIVERSITY OF MICHIGAN · University of Zurich[UZH] · CSS

https://www.c4dhi.org/projects/ally-a-digital-assistant-to-lift-your-level-of-activity/



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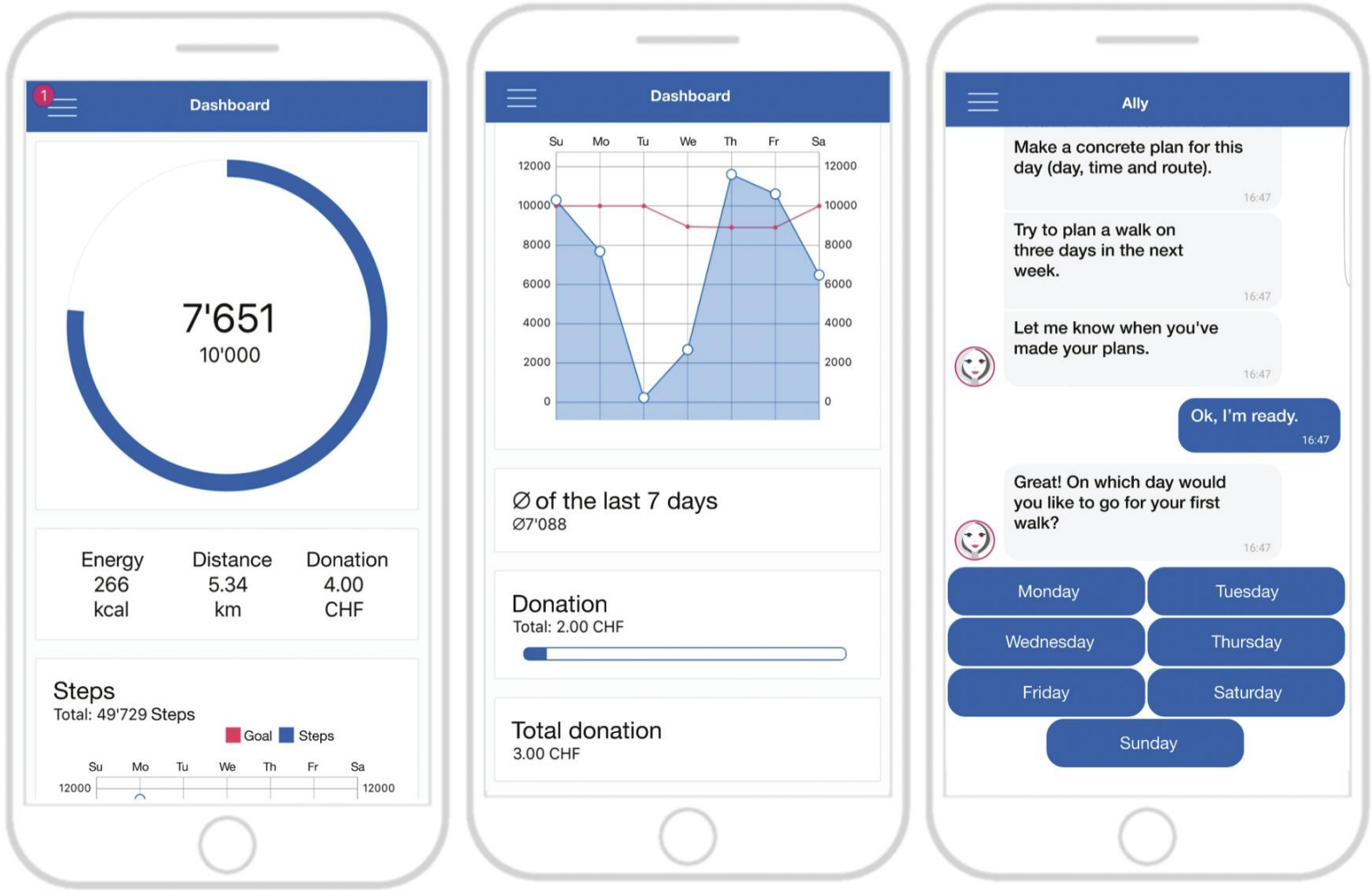
Collecting state of receptivity data



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Results from the Ally study

Summary

N=141 | N=48 | Over 6 wks

3 notifications/interventions per day

Participants were more receptive if …

10am-6pm (vs before 10 am or after 6pm)

android iOS weekdays only

Smartphone was unplugged (vs charging)

android

android Android (vs iOS devices)

Personalized prediction models?

Mishra, V., Künzler, F., Kramer, J.-N., Fleisch, E., Kowatsch, T., & Kotz, D. (2023). Detecting Receptivity for mHealth Interventions. *GetMobile: Mobile Comp. and Comm.*, *27*(2), 23–28. 10.1145/3614214.3614221

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Digital Health Technologies with Personalized Prediction Models

The Health Burden of Non-communicable Diseases

Health Angels

The Rise of the Darkest Enemy

13 Feb 2026

Take Home Message: States of Receptivity

1. A **state of receptivity** refers to a **situation** in which individuals are able to **receive, process, and use support**.

2. Given **vulnerable individuals**, the overall goal of sensing is to **detect** or, if possible, even **predict receptive states** to provide **support at opportune moments**.

3. A significant amount of **notifications are sent** at the **wrong time** with the result that they are **probably not read (or even worse, lead to negative side effects)**. This may be an important problem when it comes to "serious" health-related notifications that "**must**" be **received**.

4. Sending out messages at the **wrong time** may increase **stress** in individuals, lead to the **deinstallation of underlying digital therapeutics**, or may even contribute to **smartphone addiction**.

5. To better understand the link between **sensing** and **states of receptivity**, you would probably need to conduct a **dedicated study** with a particular **target (patient) population**.

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15:45 – 16:00 Break

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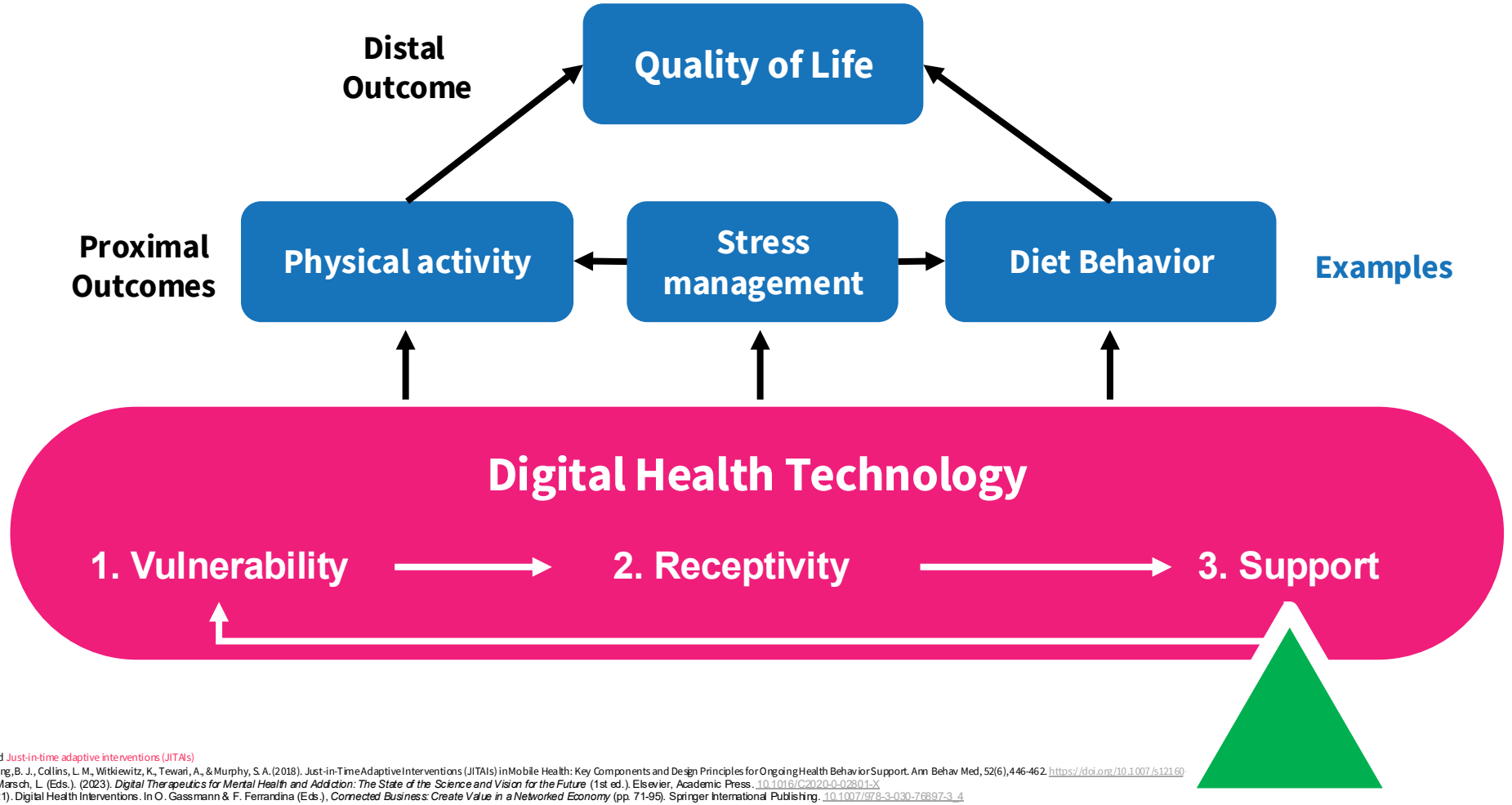
The anatomy of an "ideal" digital health technology



These interventions are alsocalled Just-in-time adaptive interventions (JITAIs)

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What are you doing to stay healthy?

Join at
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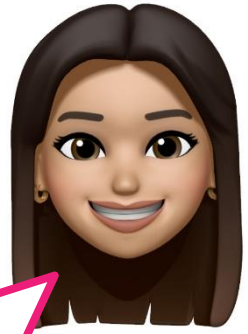
#cdh

What are you doing to stay healthy?



Love & Relationships

having a romantic partner, family member, good friend, social health

Support: A definition

Support is defined as any **intervention that addresses the vulnerable state** of an individual. For example, support can be a **motivational interview** delivered by health professionals in counseling sessions. **Drugs** represent another class of support, as do **software-based interventions**.

We focus on **support** primarily delivered into individuals' everyday lives with the help of **technology**. To this end, we introduce the notion of a **digital coach** that provides **support**.

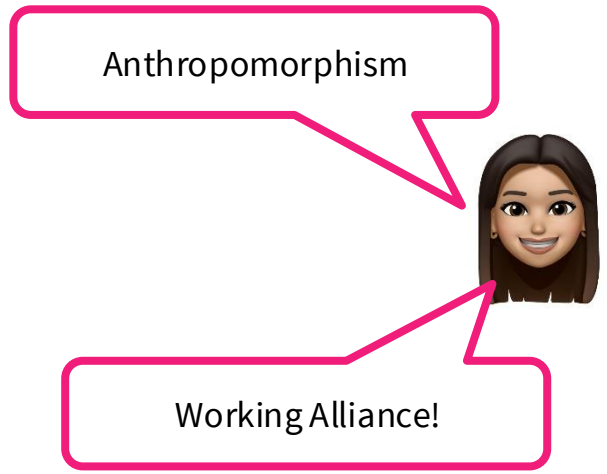
Computers are social actors

Human Factors in Computing Systems CHI '94 • "Celebrating Interdependence"

Computers are Social Actors

Clifford Nass, Jonathan Steuer, and Ellen R. Tauber

- 5 lab experiments, overall 180 participants
- Main finding: **Human-computer relationships** are **social**.



What can we do with this finding for our purposes?

Well, we know that the **doctor-patient relationship** is also **social** and robustly linked to **treatment success.**

(Di Blasi 2001; Flückiger et al. 2018; Del Re et al. 2021)

Computers are social actors

Voice assistants and chatbots are all around us

American Heart Association | American Stroke Association
life is why™

+

amazon alexa

Alexa, what are the warning signs of a stroke?

https://www.amazon.com/dp/B06WP3HFCK

"These first aid skills are for informational and educational purposes only"

Hey Siri
Apple.com

Hi, how can I help?
Google.com

Copilot
Microsoft.com

ChatGPT
OpenAI.com

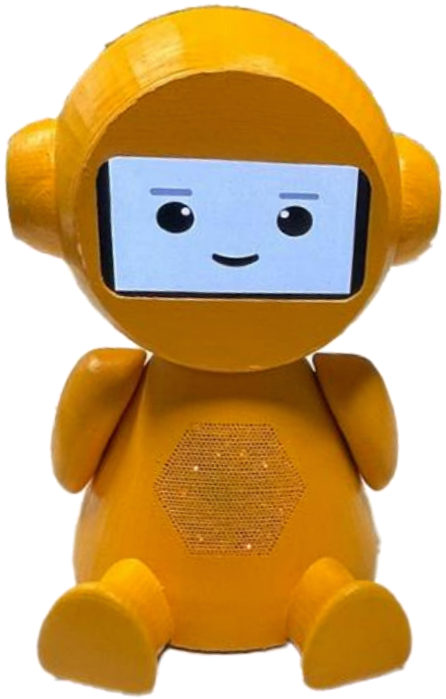
Smartphones, The Web, TVs, Cars, etc.

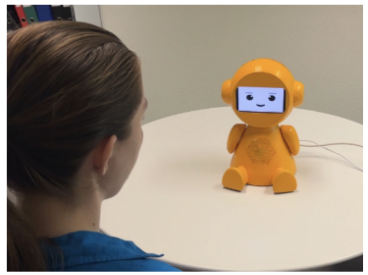
buoy
buoyhealth.com

lark
www.lark.com

SENSELY
sensely.com

Digital coach example: GRACE





https://doi.org/10.2196/76489

A Hybrid Rule- and Large Language Model–Based Embodied Voice Assistant (GRACE) for Cognitive Stimulation in Older Adults: Usability Study Assessing Technical Feasibility, Technology Acceptance, and Working Alliance

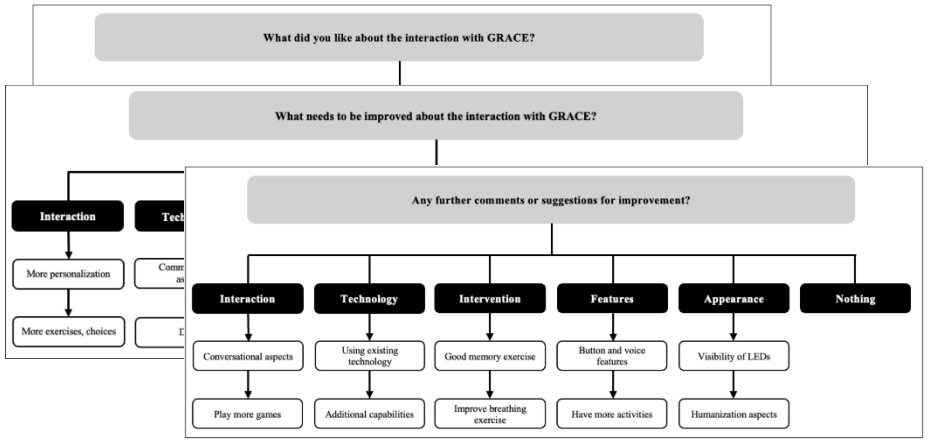
Rasita Vinay[1, 2]; Ekaterina Uetova[3]; Nora Camilla Tommila[2]; Nikola Biller-Andorno[1]; Tobias Kowatsch[2, 4, 5]

Quantitative Assessment

	Item	Mean (SD)	V^b
PEU	I thought the response from GRACE was easy to understand.	6.19 (0.81)	231.0[c]
PU1	I found it useful to work on the intervention with GRACE.	5.76 (1.14)	205.5[c]
PU2	I found GRACE motivated me to perform the exercises.	5.48 (1.21)	178.5[c]
PEN	I had fun using GRACE.	5.95 (0.86)	231.0[c]
PC	I was able to control the interaction with GRACE.	5.19 (1.69)	174.0[d]
ITI	I would continue interacting with GRACE.	5.14 (1.53)	105.0[d]
PSA1	I felt that GRACE and I respected each other.	5.81 (1.25)	204.0[c]
PSA2	I felt that GRACE appreciated me.	5.57 (1.21)	198.0[c]
PSA3	I felt that GRACE cared about me even when I did things it did not approve of.	5.33 (1.06)	120.0[c]
PSA4	I felt that GRACE and I are working toward mutually agreed upon goals.	5.67 (1.15)	222.0[c]
PSA5	I felt that GRACE and I agree on what is important for me to work on.	5.10 (1.73)	121.0[c]
PSA6	I believe the way GRACE and I are working with my problem is correct.	5.48 (1.03)	136.0[c]
PSA	Overall	5.49 (1.06)	222.0[c]

[a]The 7-point Likert scales were used from 1=strongly disagree to 7=strongly agree, and a 6-point scale for PSA items.
[b]V is the test statistic of the Wilcoxon signed rank with test value 4.
[c]P<.001.
[d]P=.009.
[e]P=.01.

Qualitative Assessment



Quantitative Assessment

Technology Acceptance

Perceived Ease of Use (PEU)

Perceived Usefulness (PU)

Perceived Enjoyment (PEN)

Perceived Control (PC)

Intention to Continue Interacting (ITI)

Technology Acceptance Model:
http://dx.doi.org/10.1287/mnsc.35.8.982
http://dx.doi.org/10.2307/249008
http://dx.doi.org/10.1287/isre.11.4.342.11872

Working Alliance

Perceived Session Alliance (PSA)

6-item Session Alliance Inventory:
http://dx.doi.org/10.1037/0022-0167.36.2.223

	Item	Mean (SD)	V [b]
PEU	I thought the response from GRACE was easy to understand.	6.19 (0.81)	231.0[c]
PU1	I found it useful to work on the intervention with GRACE.	5.76 (1.14)	205.5[c]
PU2	I found GRACE motivated me to perform the exercises.	5.48 (1.21)	178.5[c]
PEN	I had fun using GRACE.	5.95 (0.86)	231.0[c]
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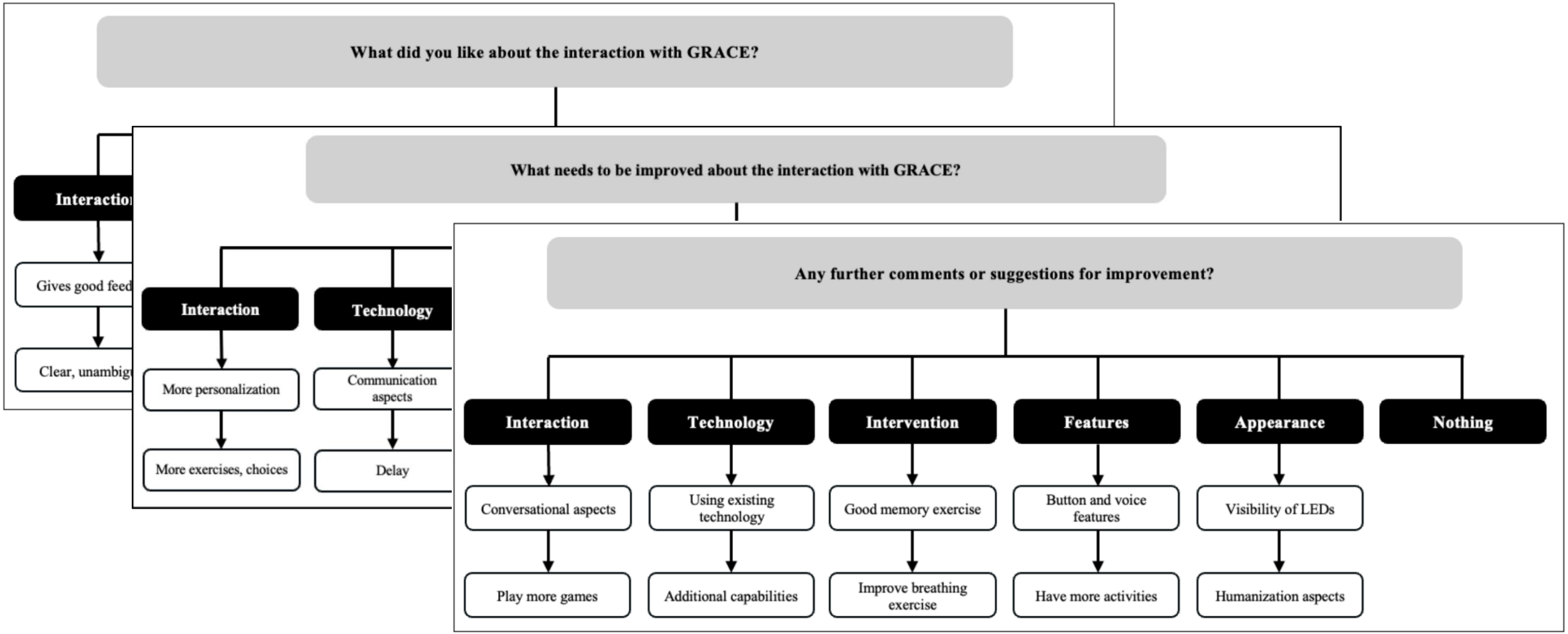
PSA5	I felt that GRACE and I agree on what is important for me to work on.	5.10 (1.73)	121.0[e]
PSA6	I believe the way GRACE and I are working with my problem is correct.	5.48 (1.03)	136.0[c]
PSA	Overall	5.49 (1.06)	222.0[c]

[a]The 7-point Likert scales were used from 1=strongly disagree to 7=strongly agree, and a 6-point scale for PSA items.
[b]V is the test statistic of the Wilcoxon signed rank with test value 4.
[c]$P<.001$.
[d]$P=.009$.
[e]$P=.01$.

Qualitative Assessment



Digital coach example: Woebot

Woebot® Health

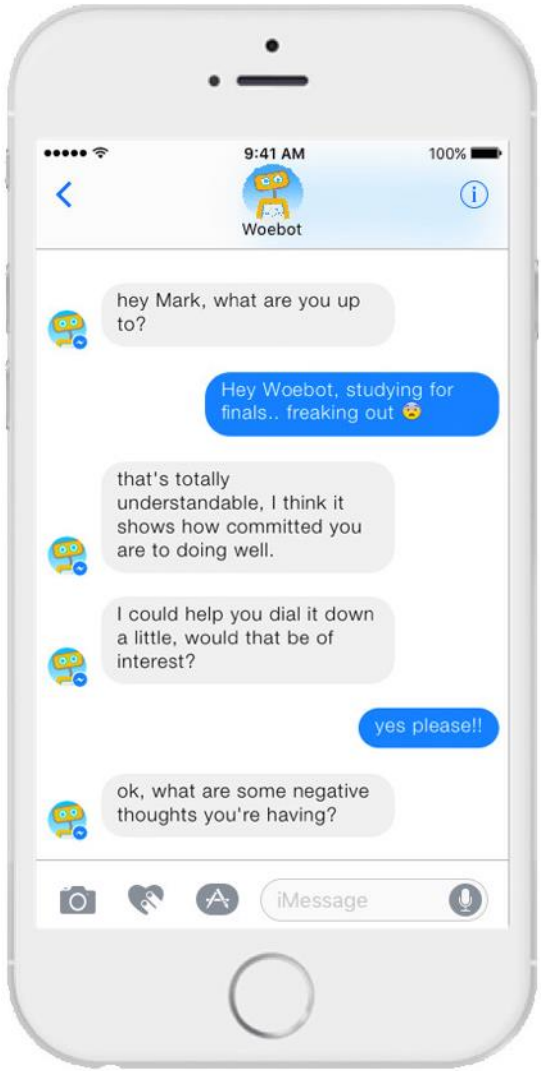
4.7M
messages exchanged with Woebot every week

75%
of users report feeling better after using a tool for the first time

98.9%
accuracy rate in detecting crisis language

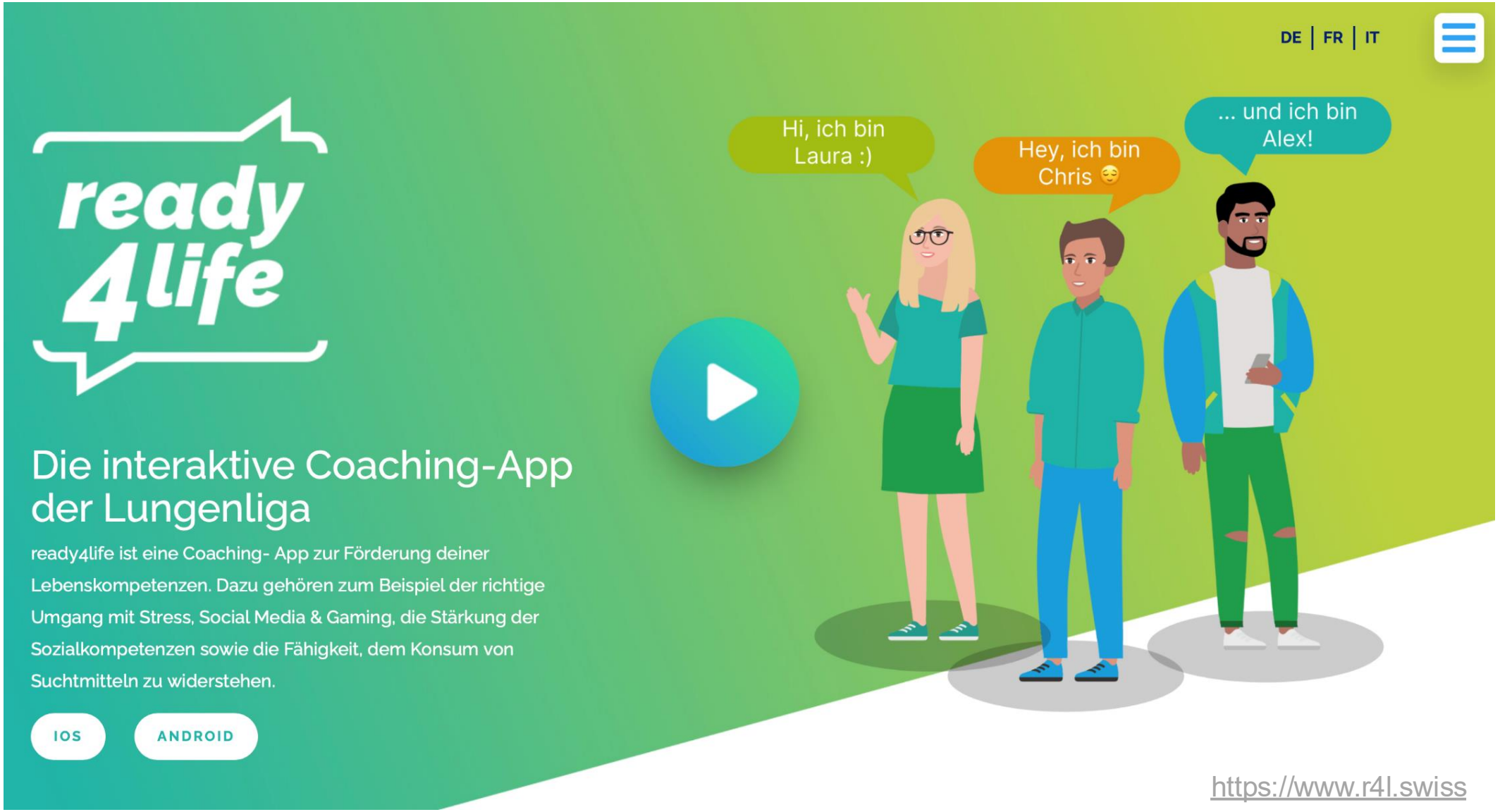
Groundbreaking digital therapeutics for a global crisis

https://woebothealth.com



Fitzpatrick et al. 2017: The "analysis […] revealed **a significant group difference on depression** such that those in the Woebot group significantly reduced their symptoms […] while those in the information control group did not."
https://mental.jmir.org/2017/2/e19/

Digital coach example: Laura, Chris, and Alex



https://www.r4l.swiss

Digital coach example: Anna and Lukas

MySwissFoodPyramid 4+

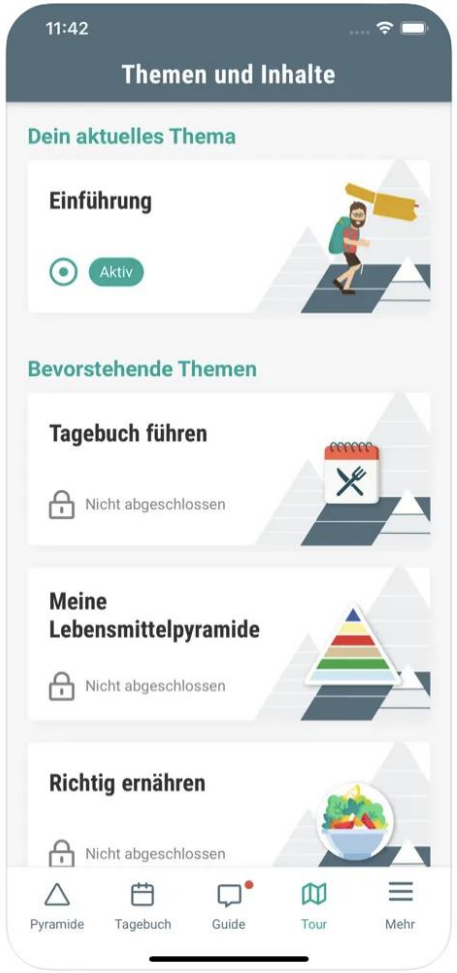
Bundesamt fuer Lebensmittelsicherheit und Veterinaerwesen BLV

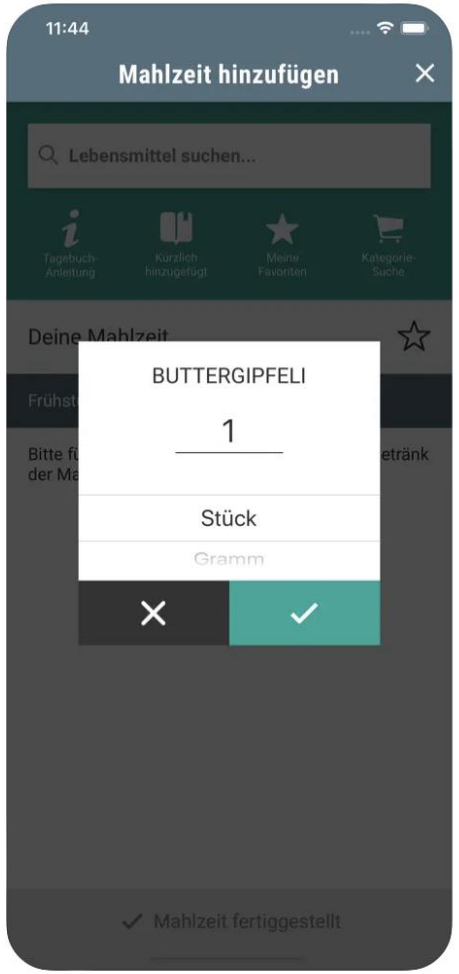
Nr. 164 in Bildung

★★★★★ 4.8 • 269 Bewertungen

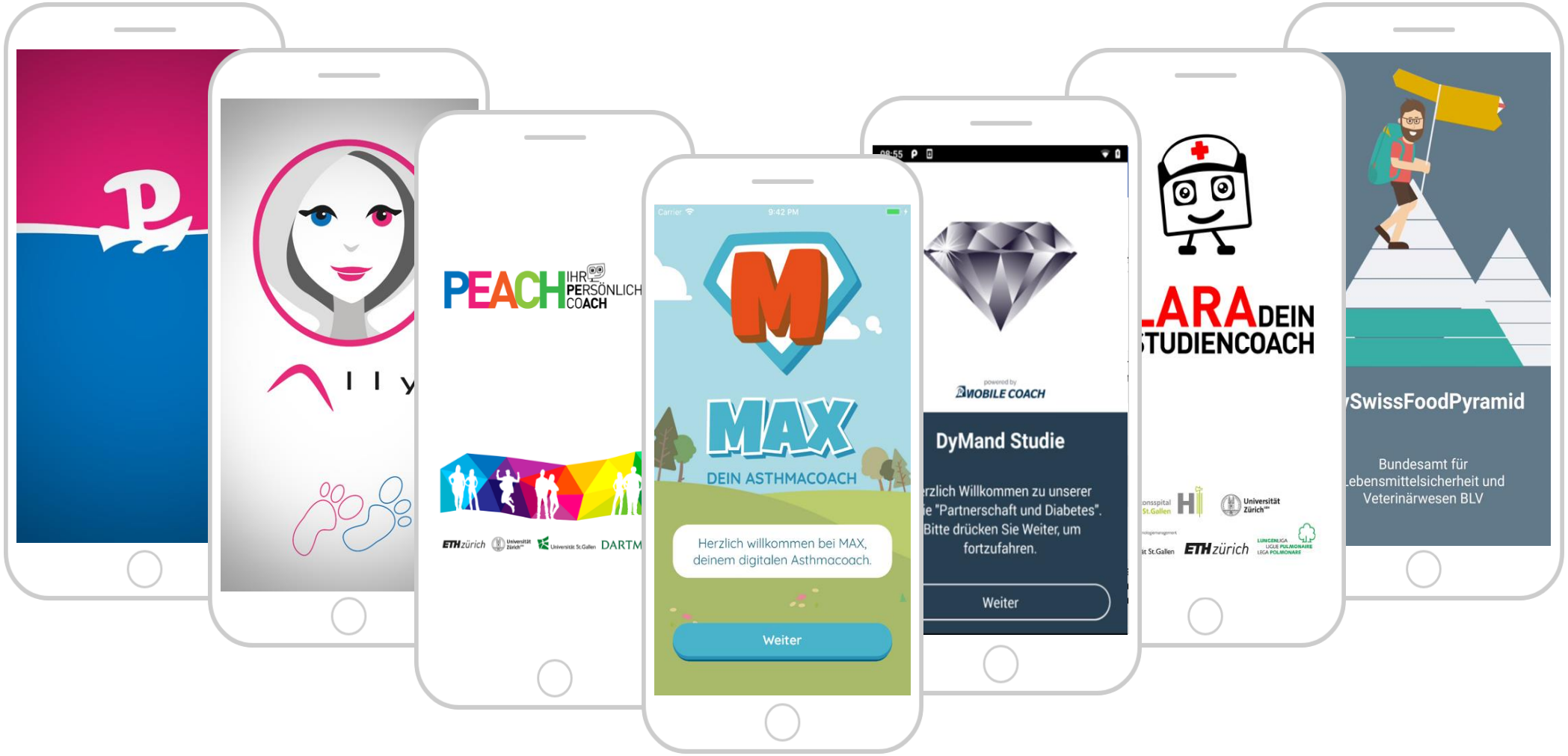
Gratis

https://www.blv.admin.ch/blv/de/home/lebensmittel-und-ernaehrung/ernaehrung/empfehlungen-informationen/schweizer-lebensmittelpyramide.html





A selection of the CDHI digital coaches

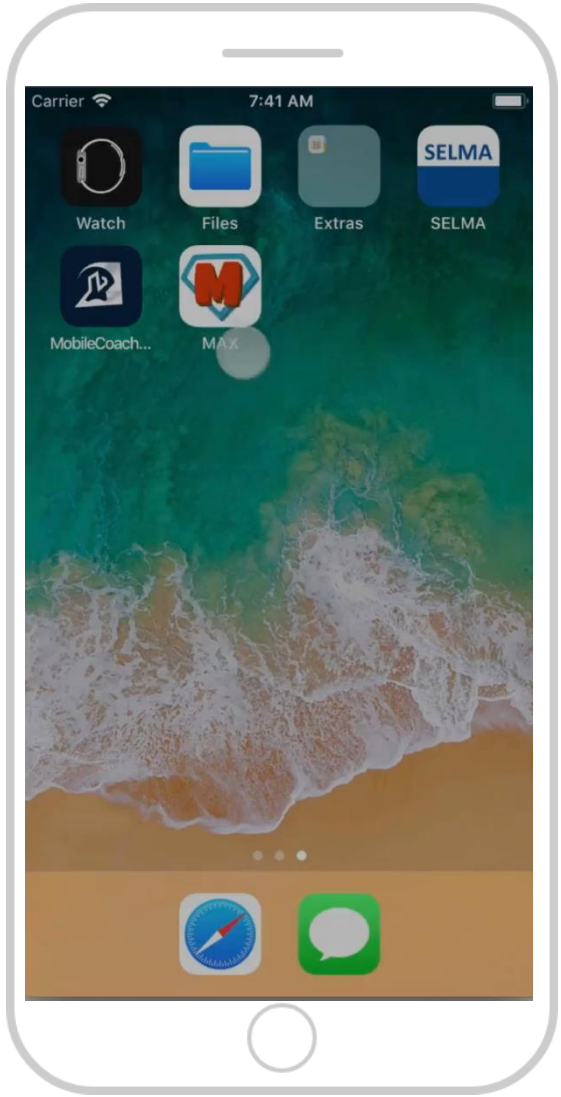


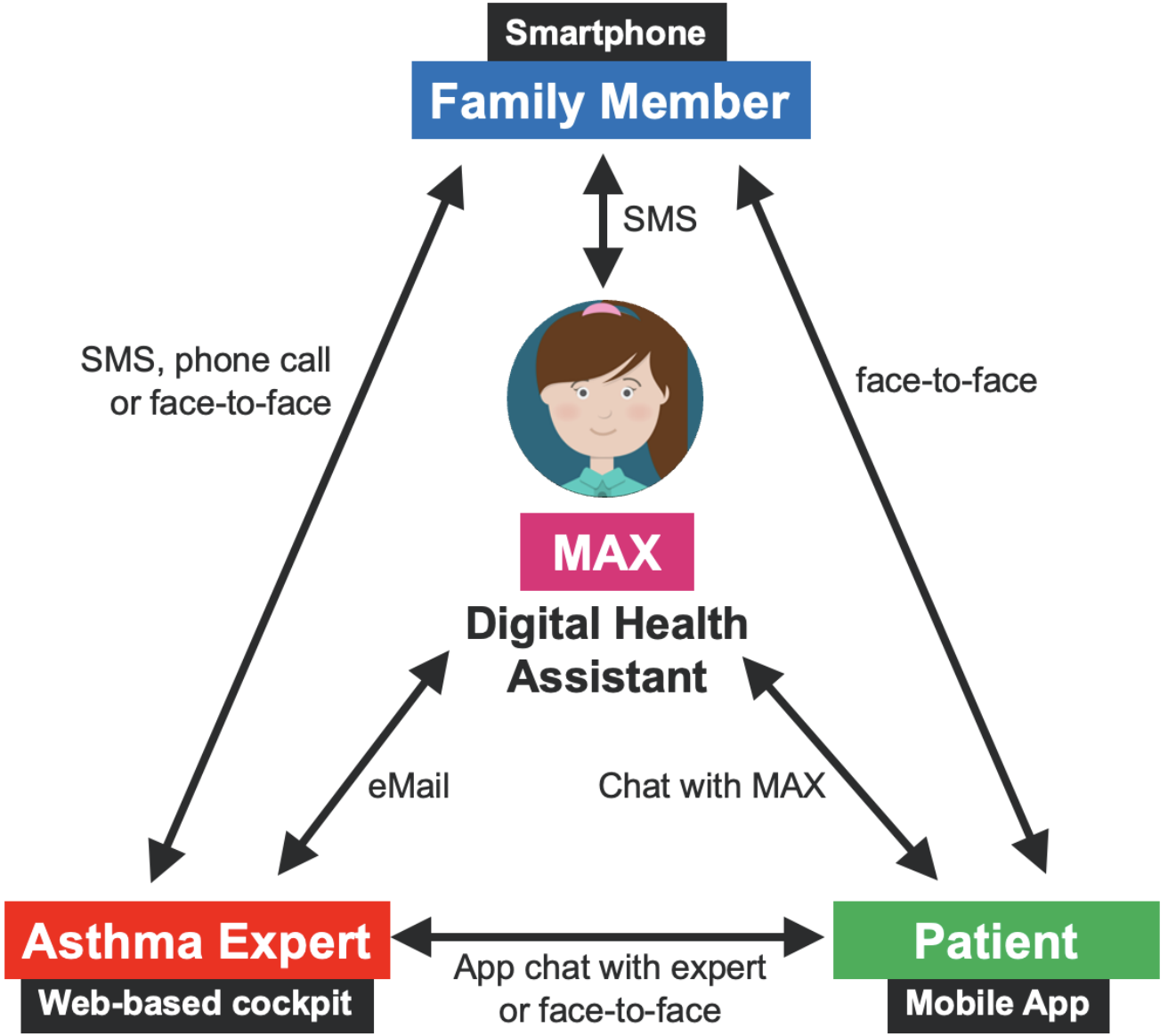
https://www.c4dhi.org/projects/

MAX, a health literacy intervention for children with asthma

www.c4dhi.org/projects/health-literacy-children-asthma/

Interactions with MAX





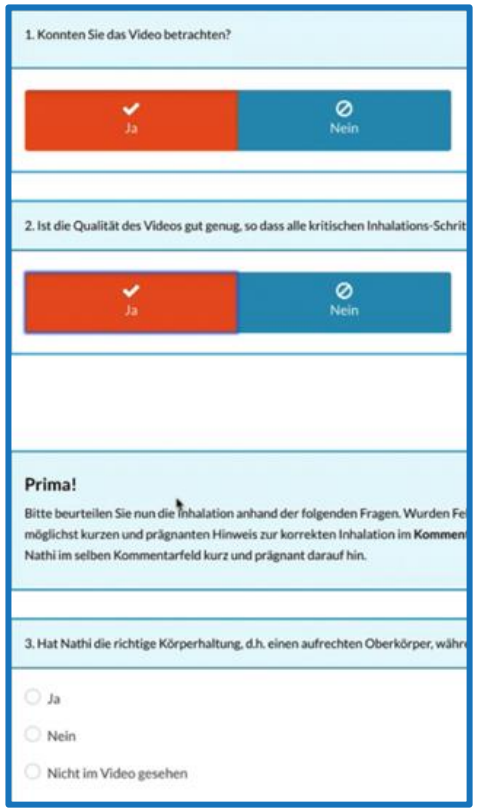
Kowatsch, T., Schachner, T., Harperink, S., Barata, F., Dittler, U., Xiao, G., Stanger, C., Oswald, H., Fleisch, E., von Wangenheim, F., Möller, A. (2021) **Conversational Agents as Mediating Social Actors in Chronic Disease Management Involving Health Care Professionals, Patients, and Family Members: Multisite Single-Arm Feasibility Study**, Journal of Medical Internet Research (JMIR) 23(2):e25060 10.2196/25060

Inhalation assessment of Norah, age 12*

*Informed consent was received from the patient and parent to use video, name, and age for presentation purposes

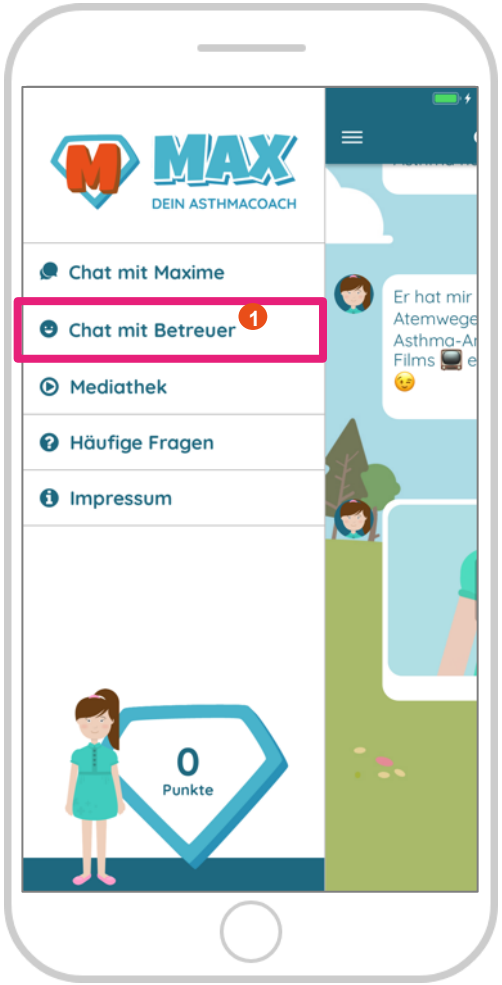
1. Video recording by family member

2. Expert rating



+ Automated feedback generation based on inhalation guidelines

3. Feedback to Norah



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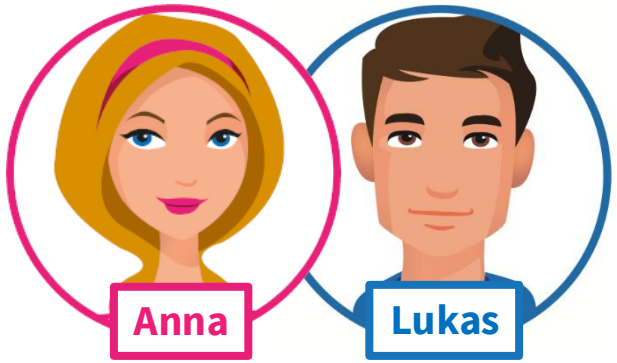
PathMate 2

A Multi-component behavioral intervention for adolescents with obesity

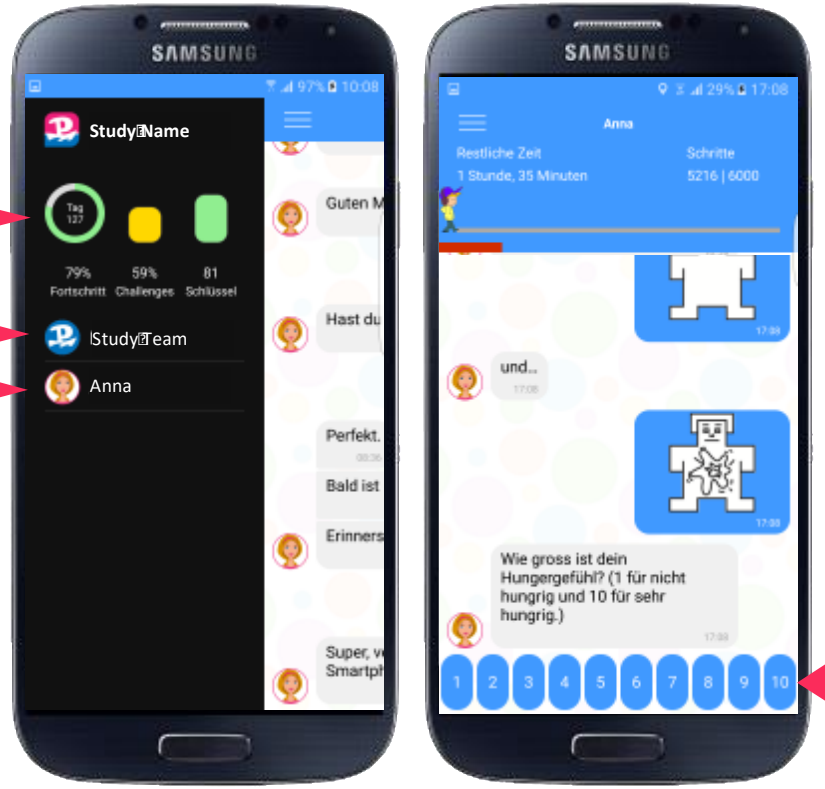


Schweizerischer Nationalfonds | OSTSCHWEIZER KINDERSPITAL | UNIVERSITÉ DE GENÈVE

Stasinaki, A., Büchter, D., Shih, I., Heldt, K., Güsewell, S., Brogle, B., Farpour-Lambert, N., Kowatsch, T., l'Allemand, D. (2021) **Effects of a novel mobile health intervention compared to a multi-component behaviour changing program on body mass index, physical capacities and stress parameters in adolescents with obesity: a randomized controlled trial**, BMC Pediatrics 21 (308), 10.1186/s12887-021-02781-2.
https://www.c4dhi.org/projects/snf-pathmate2-childhood-obesity/

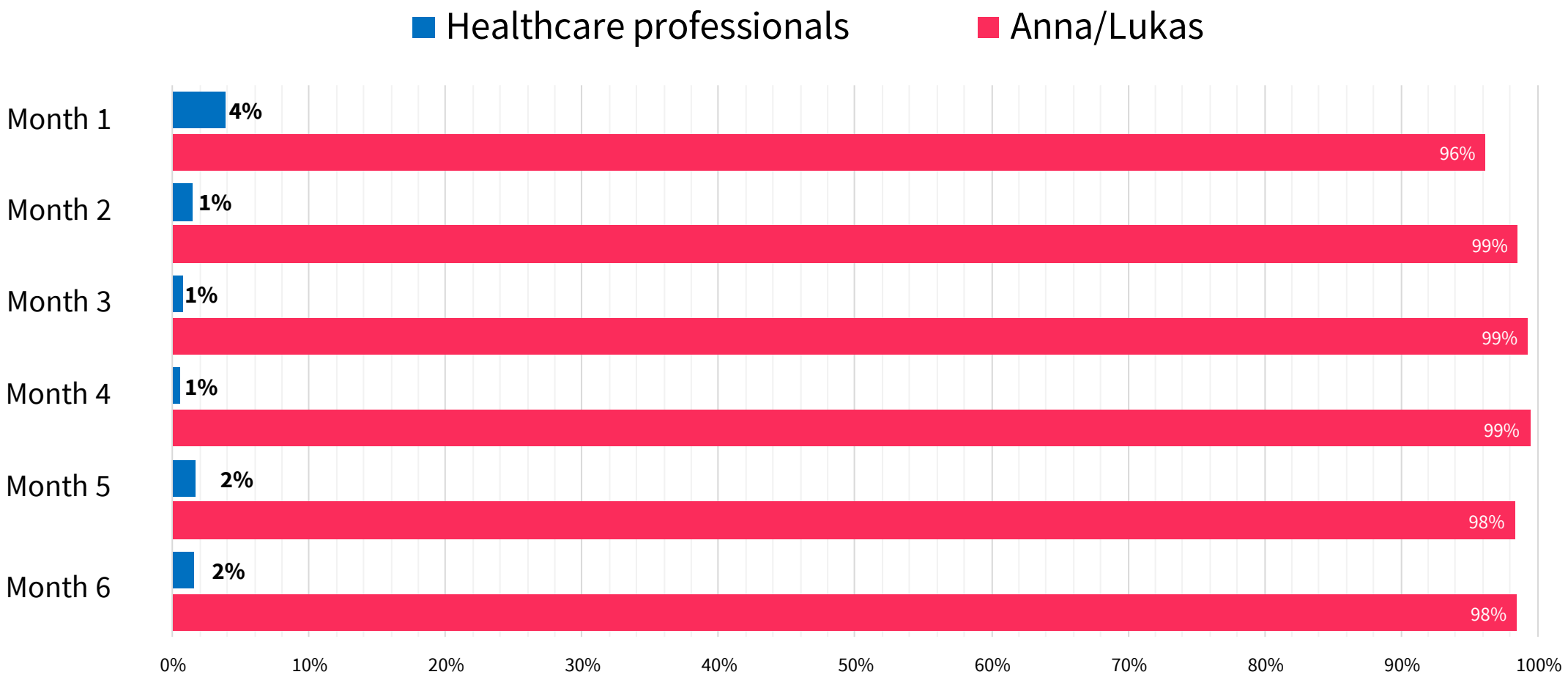
Dashboard View

Health Professional & THCB (Anna) chat channels



Pre-defined answer options (e.g. Likert or pictorial scales, photos), **text or sensor input**

Interactions per chat channel

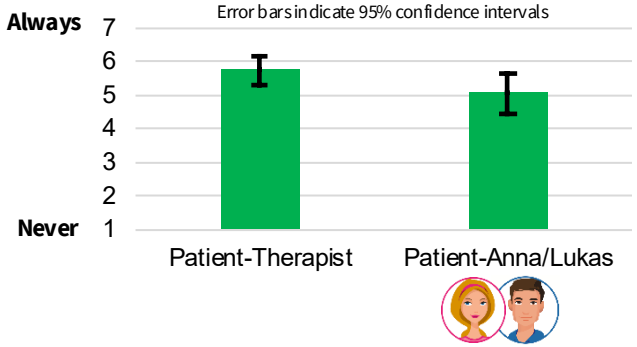


Interactions in % with 13 young patients with obesity (Total: 18.064 interactions)

Daily goal achievement rate: 58%*

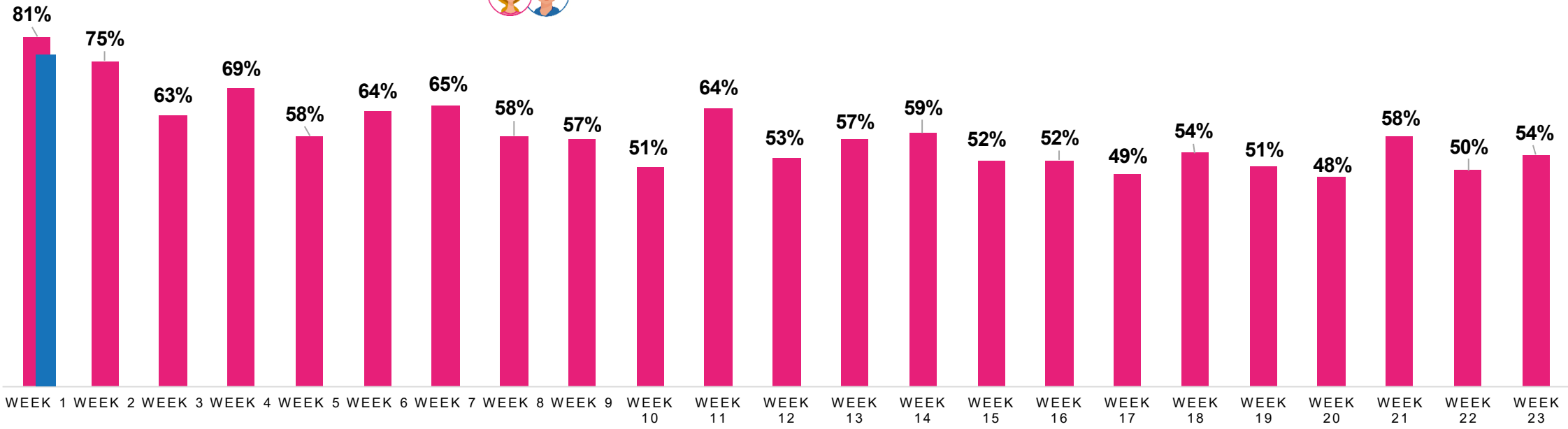
*in 18 obese patients, aged 12-17 years

Working Alliance after 6-months



Outcomes at 12-month follow-up

- Muscle mass increased significantly
- Fat mass decreased significantly
- Physical capacities improved significantly
- BMI-SDS decreased non-significantly



Our first study in 2012-2014 without digital coach Anna.

Digital coach example: ALEX

Delivering scalable treatment for chronic back pain patients

Applied Health Care

magic leap

CSS

University of Zurich[UZH]

ETH JUNIORS SMART SOLUTIONS

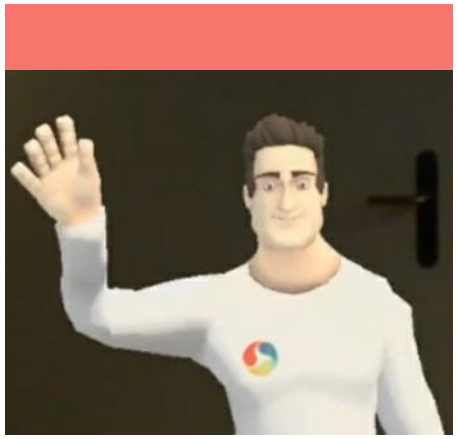
https://www.c4dhi.org/projects/digital-physiotherapy-coaching-with-alex/

Kowatsch, T., Lohse, K.M., Erb, V., Schittenhelm, L., Galliker, H., Lehner, R., Huang, E.M. (2021) **Hybrid Ubiquitous Coaching With a Novel Combination of Mobile and Holographic Conversational Agents Targeting Adherence to Home Exercises: 4 Design and Evaluation Studies**, Journal of Medical Internet Research, 23(2):e23612, 10.2196/23612


ALEX
Der digitale Physiocoach
Stand upright and press the trigger to start.

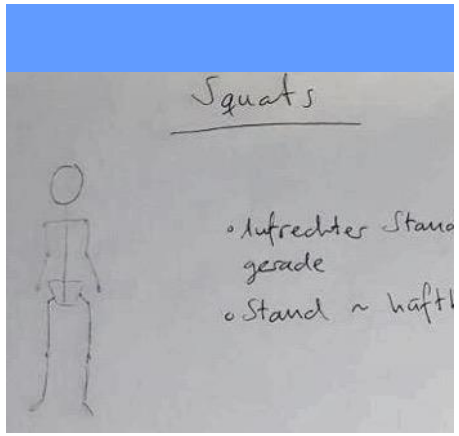
Results from a lab experiment (N=15) & 4-week intervention in the field (N=1)

3 modes of instructions



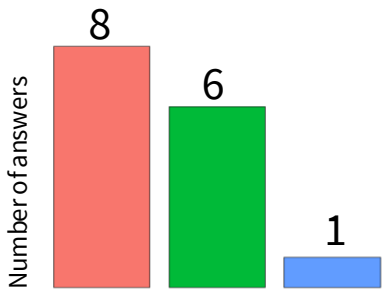
ALEX (Augmented Reality)

Video



Paper

1. What is your preferred mode of instruction?



2. Session Alliance Inventory

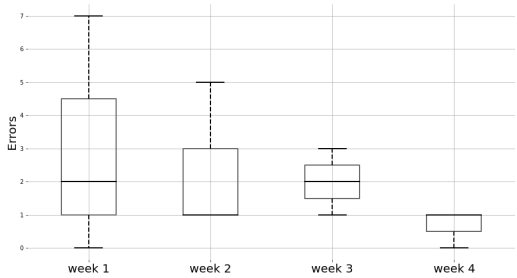
Error bar indicates 95% confidence interval

3. Four-week intervention study (N=1)

Goal: 3 sessions per week for 4 weeks

Adherence: 92% (11 of 12 sessions)

Feedback: Intention to continue working with Alex



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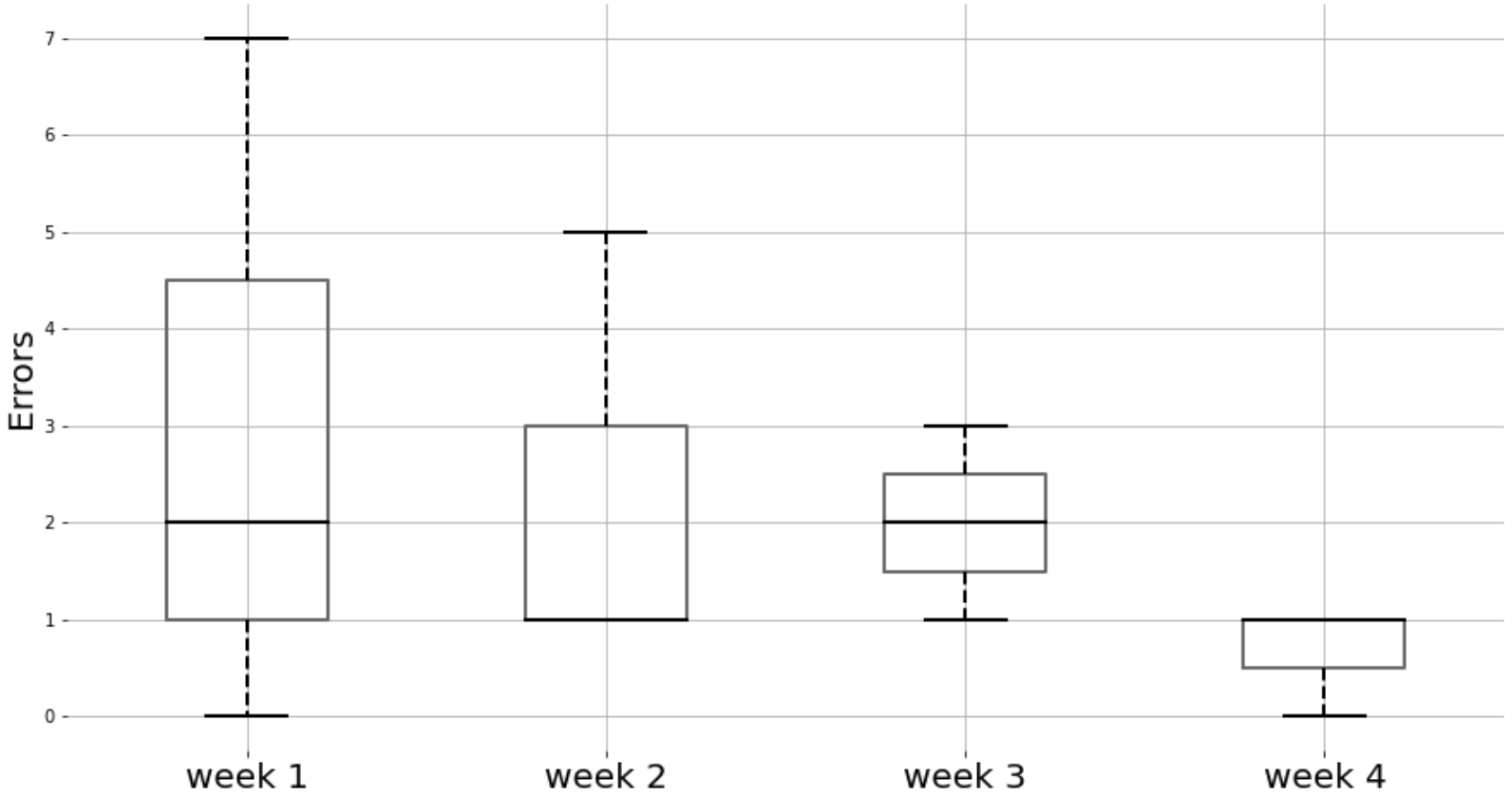
Results from a lab experiment (N=15) & 4-week intervention in the field (N=1)

Box plot of the exercise execution errors during the 4 weeks. The number of errors was aggregated for each week.



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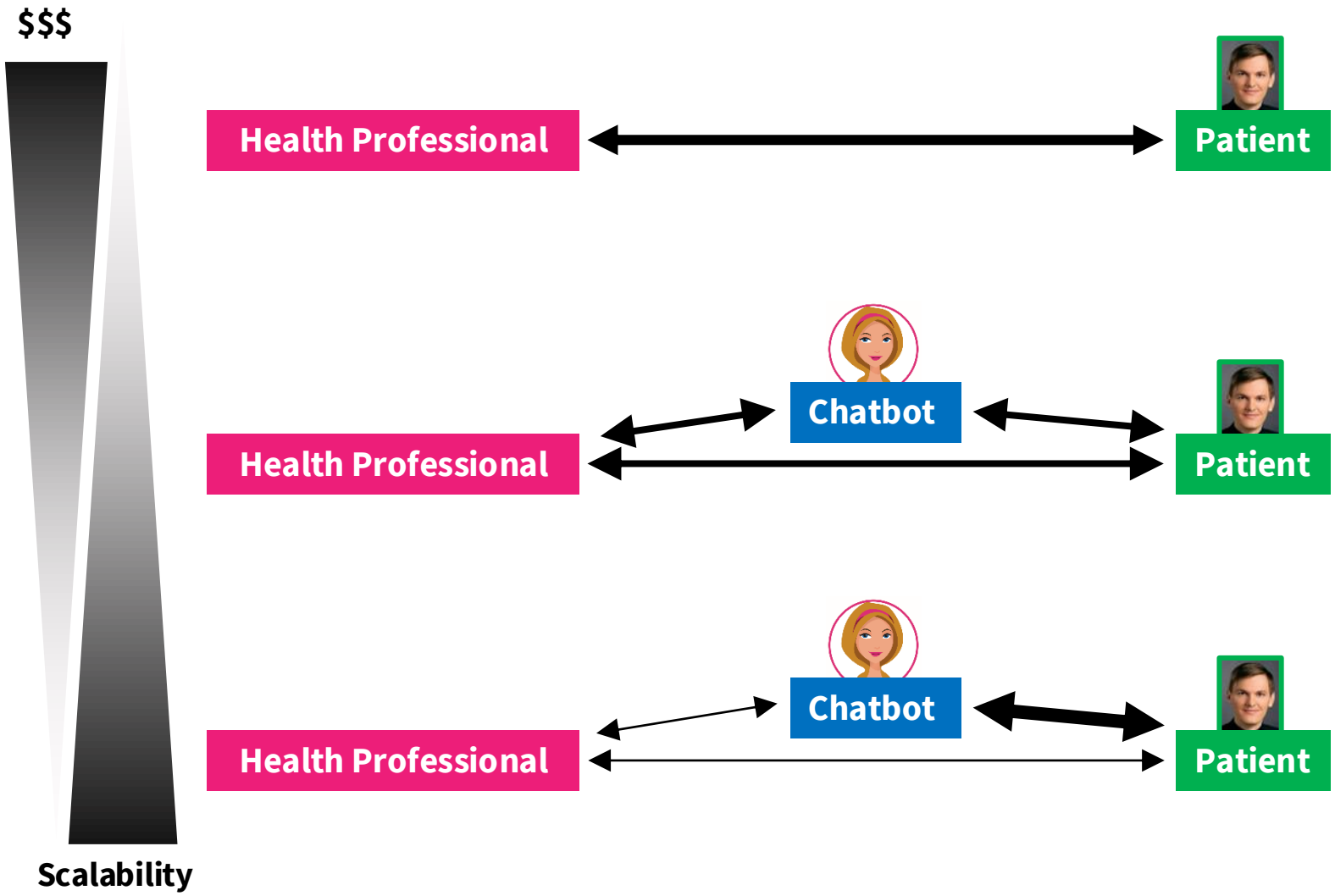
Coaching strategies



15 Min Group Work

Which support can be automated quite well? What not?

https://miro.com/app/board/uXjVGHUKzjs=/

Password: **casethdh2026**

https://digitopoly.org/2017/09/22/kahneman-on-ai-versus-humans/

Take Home Message: Support

1. A **digital coach** can provide **health literacy** and **behavioral support.**

2. Individuals can build up a **working alliance** with **digital coaches**, i.e., (a) **attachment bond**, (b) **shared understanding** about **treatment goals**, and (c) specific **treatment tasks**.

3. Meta-analyses have shown that **working alliance** is robustly linked to **treatment success**.

4. Design **blended interventions** in which **digital coaches** take over the role of a **social actor** and **mediate the relationship** between health professionals, patients, and other stakeholders (e.g., family members).

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Kowatsch, T., Volland, D., Shih, I., Rüegger, D., Künzler, F., Barata, F., Filler, A., Büchter, D., Brogle, B., Heldt, K., Gindrat, P., Farpour-Lambert, N. and l'Allemand, D. "Design and Evaluation of a Mobile Chat App for the Open Source Behavioral Health Intervention Platform MobileCoach," in: Designing the Digital Transformation. DESRIST 2017. Lecture Notes in Computer Science, vol 10243, M. A., v.B. J. and H. A. (eds.), Springer, Berlin; Germany, 2017, pp. 485-489.

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13 Feb 2026

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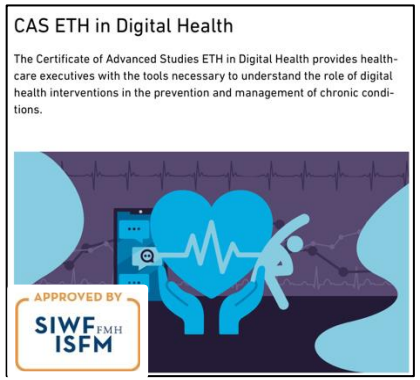

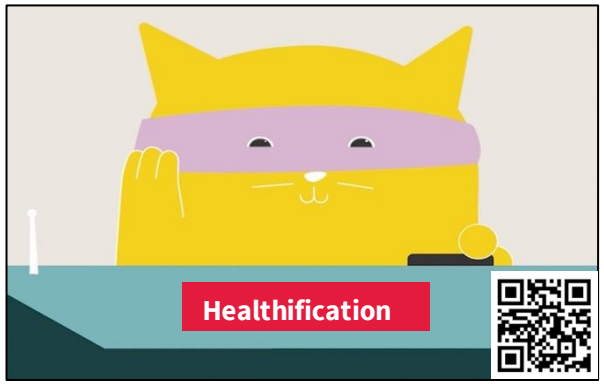

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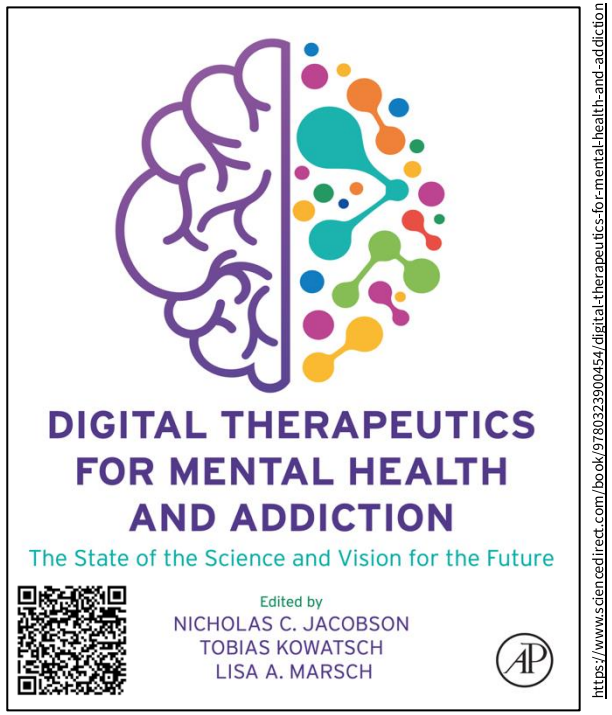

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BE PRECIOUS

Next Steps

1. Please work through the remaining mandatory material of **Session 2 (Moodle)**. Due 13th March

    - Multiple Choice Tests (Vulnerability & Reception, Economic Burden, Benefits & Limitations of AI Chatbots) & Written Assignment: Vulnerability & Receptivity

2. For those of you who are really into Digital Health, you may also go through the material of the **enthusiasts' section of Session 2** 💪.

3. Be excited and wait for the material that will unlock in two weeks for **Session 3: Business Models for DHIs** (27th Feb 13:00-17:00). 👍