Center for Digital Health Interventions

University of St.Gallen ETH zürich

Computers are Social Actors: Digital Coaches for Patients and Health Professionals

Prof. Dr. Tobias Kowatsch

Assistant Professor for Digital Health, University of St.Gallen

Scientific Director CDHI, ETH Zurich & University of St.Gallen

St.Gallen | Nov 14 | 2019

FNSNF Swiss National Science Foundation

Health Promotion Switzerland

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

CSS Insurance

Computers are social actors
What does that mean?

Center for Digital Health Interventions

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)

Di Blasi, Z., Harkness, E., Ernst, E., Georgiou, A. and Kleijnen, J. (2001) 'Influence of context effects on health outcomes: a systematic review', ***Lancet***, Vol. 10, No. 357, pp.757-762. (25 RCTs)

Flückiger, C., Del Re, A. C., Wampold, B. E., & Horvath, A. O. (2018). The alliance in adult psychotherapy: A meta-analytic synthesis. ***Psychotherapy***, *55*(4), 316-340. (295 studies, Internet-based similar link, i.2. 0.27 as face-to-face consultations)

Computers are social actors

Voice assistants and chatbots are all around us

Center for Digital Health Interventions

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

Hey Cortana
Microsoft.com

Smartphones, The Web, TVs, Cars, etc.

buoy
buoyhealth.com

lark
web.lark.com

SENSELY
sense.ly

babylon
babylonhealth.com

Miner, A.S., Milstein, A., Schueller, S., Hegde, R., Mangurian, C. and Linos, E. (2016) 'Smartphone-Based Conversational Agents and Responses to Questions About Mental Health, Interpersonal Violence, and Physical Health', ***Journal of the American Medical Association (JAMA) Internal Medicine***., Vol. 176, No. 5, pp.619-625.

Computers are social actors
The “healing” car

Center for Digital Health Interventions

Mercedes-Benz

Ford BMW TOYOTA SEAT

FNSNF Sinergia
Swiss National Science Foundation

INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HOPITAL UNIVERSITAIRE DE BERNE

Source: youtu.be/sgF4ij2FGIw

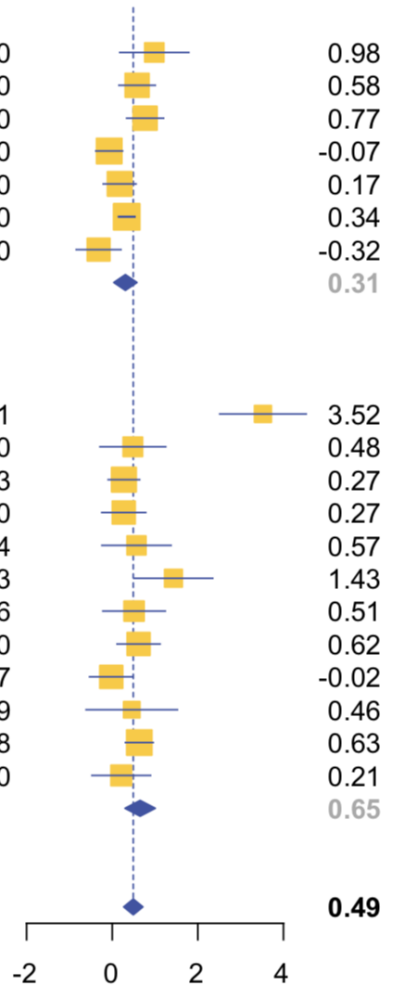
Mercedes text was developed with a type-1 diabetes patient.

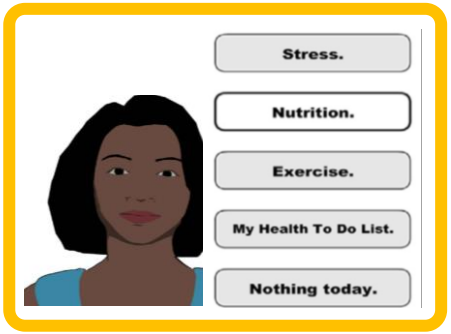
Haben Sie schon einmal einem digitalen Assistenten eine Frage zu Ihrer Gesundheit gestellt?

A Meta-Analysis of 19 RCTs with Digital Coaches

Center for Digital Health Interventions

Study	Experimental Total	Experimental Mean	Experimental SD	Control Total	Control Mean	Control SD	SMD
PEI = Wellness							
Ly et al., 2017	13	-12.38	5.00	14	-17.14	4.40	0.98
Bickmore et al., 2016	43	3.70	1.60	46	2.70	1.80	0.58
Bickmore et al., 2016	43	4.80	1.70	46	3.40	1.90	0.77
Bickmore et al., 2013	79	4418.00	2298.00	79	4603.00	2847.00	-0.07
Bickmore et al., 2013	53	4204.00	2806.00	52	3741.00	2487.00	0.17
Friederichs et al., 2014	162	4.60	1.60	192	4.00	1.90	0.34
Gardiner et al., 2017	28	-20.00	3.10	29	-19.00	3.10	-0.32
							0.31
PEI = Clinical							
Andrade et al., 2015	22	90.90	3.22	19	79.52	3.11	3.52
Burton et al., 2016	13	-13.90	8.10	14	-17.60	6.80	0.48
Craig et al., 2018	57	-22.18	11.12	58	-25.18	10.73	0.27
Gordon et al., 2017	28	-11.00	29.70	31	-26.00	70.30	0.27
Hopkins et al., 2011	11	6.57	2.28	14	5.18	2.44	0.57
Hopkins et al., 2011	13	9.54	2.34	11	6.08	2.33	1.43
Im et al., 2016	15	0.88	0.31	15	0.73	0.26	0.51
Park et al., 2011	33	88.00	6.00	31	82.90	10.00	0.62
Ruiz et al., 2014	30	24.93	6.24	30	25.06	4.97	-0.02
Leff et al., 2013	7	-29.25	4.86	7	-31.75	5.39	0.46
Shamekhi et al., 2017	75	1.10	1.60	79	0.09	1.58	0.63
Utami et al., 2017	17	-27.80	8.90	16	-29.70	8.70	0.21
							0.65
							0.49





Significant positive effect of **0.49**, p. < 01, 95% CI [.27, .72] of using **Digital Coaches** vs. non-Digital Coaches.

These findings are consistent with findings from another review of Scholten et al. (2017)

Scholten, M.R., Kelders, S.M. and van Gemert-Pijnen, J.E.W.C. (2017). 'A Scoped Review of the Potential for Supportive Virtual Coaches as Adjuncts to Self-guided Web-Based Interventions *PERSUASIVE 2017*, Berlin, Germany: Springer, 43-54.

T. Ma, H. Sharifi & D. Chattopadhyay (2019) Virtual Humans in Health-Related Interventions: A Meta-Analysis, **CHI'19 Extended Abstracts, May 4-9, 2019, Glasgow, Scotland UK.**, Glasgow, Scotland UK

A Selection of Our Digital Coaches

Overview of adherence and (medical) outcomes

Center for Digital Health Interventions

#	Coach	Population	Duration	N	Adherence	Outcome
1	Anna & Lukas	Obese children	24 weeks	26	**56%** daily goal achievement	Muscle mass and physical capacities increased sig., fat mass decreased sig.
2	Ally	Adults (public health)	6 weeks	274	**54%** daily goal achievement	Physical activity increased (pre/post), data collected to increase adherence
3	Clara	Adult asthmatics	4 weeks	93	**97%** adherence to data collection protocol	Data for an asthma early-warning system (e.g., ca. 23K cough samples, self-reports)
4	Max	Children with asthma	3 weeks / 14 lessons	49	**80%** intervention completion rate	Asthma knowledge increased sig. (pre/post) and inhalation mistakes were reduced
5	Alex	Chronic back pain patients	4 weeks	1	**92%** exercise completion rate	Preference of Alex to video- and paper-based instructions / improved exercise performance
6	Selma	Individuals with chronic pain	8 weeks	59	**52%** adherence to conversations	Pain intensity was reduced sig. and well-being increased sig. (no delta to control group)
7	PEACH 1	Primarily students	2 weeks	185	**59.5%** completed intervention	Initial evidence for intentional change of self-discipline and openness
8	PEACH 2	Primarily students	10 weeks	1523	**32.8%** completed intervention	Approx. effect size of ca. 0.5 in personality change, final analyses ongoing
9	CAMP	Cardiac rehabilitation patients	4 weeks	114	**56%** adherence to data collection protocol	Observational study (final analyses ongoing)

Center for
Digital Health Interventions

University of St.Gallen ETH zürich

WORLD MEDIA FESTIVALS 2018 GOLD AWARD WINNER
WORLD MEDIA FESTIVALS 2019 GOLD AWARD WINNER
WORLD MEDIA FESTIVALS 2019 GRAND AWARD WINNER

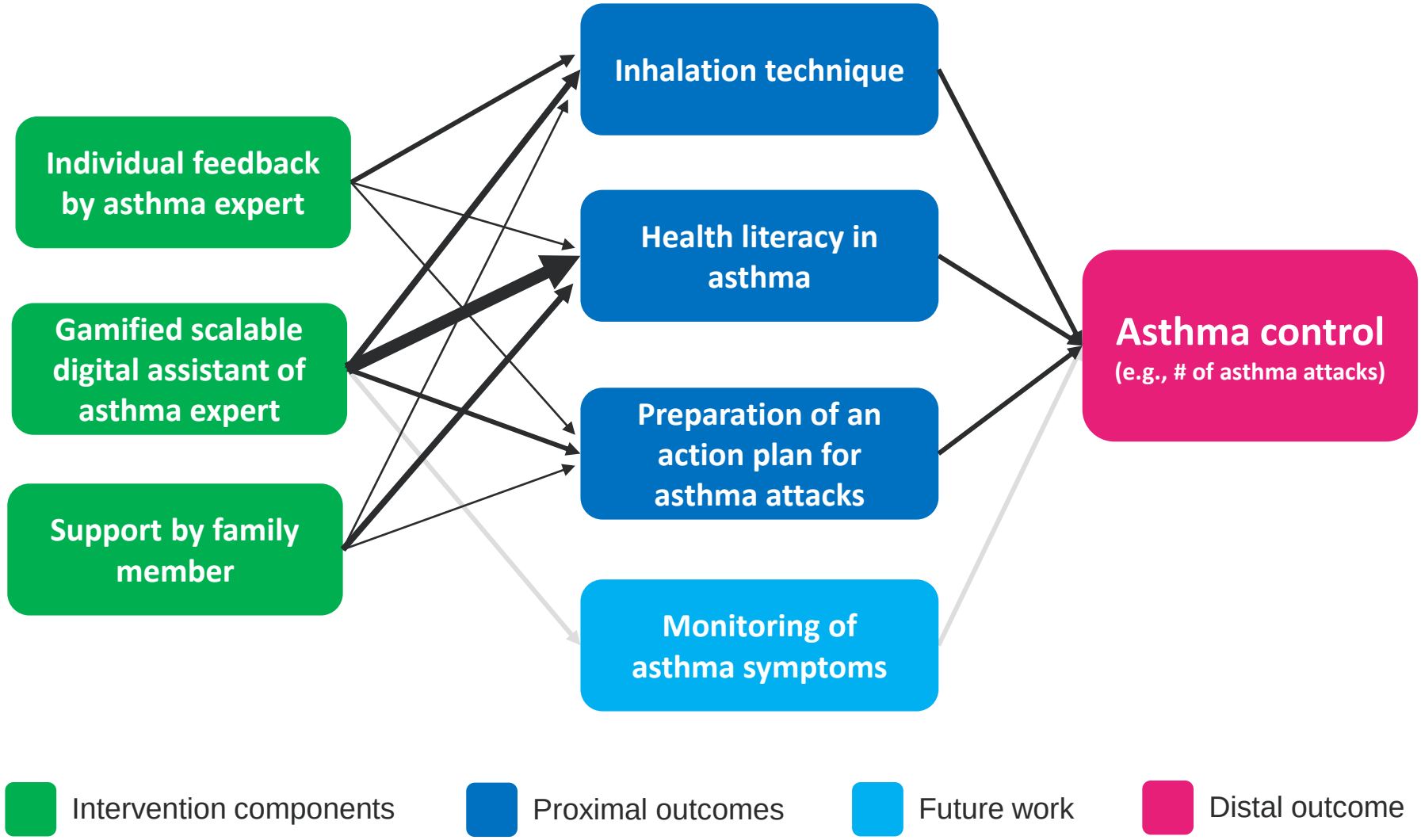
Health literacy intervention for children with asthma

UNIVERSITÄTS-KINDERSPITAL ZÜRICH · KSW KANTONSSPITAL WINTERTHUR · INSELSPITAL UNIVERSITÄTSSPITAL BERN HOPITAL UNIVERSITAIRE DE BERNE · Spitalzentrum Centre hospitalier Biel-Bienne · Spital Thurgau MÜNSTERLINGEN · LUNGENLIGA · HOCHSCHULE FURTWANGEN UNIVERSITY · ROCKS flipping · pathmate · CSS Insurance

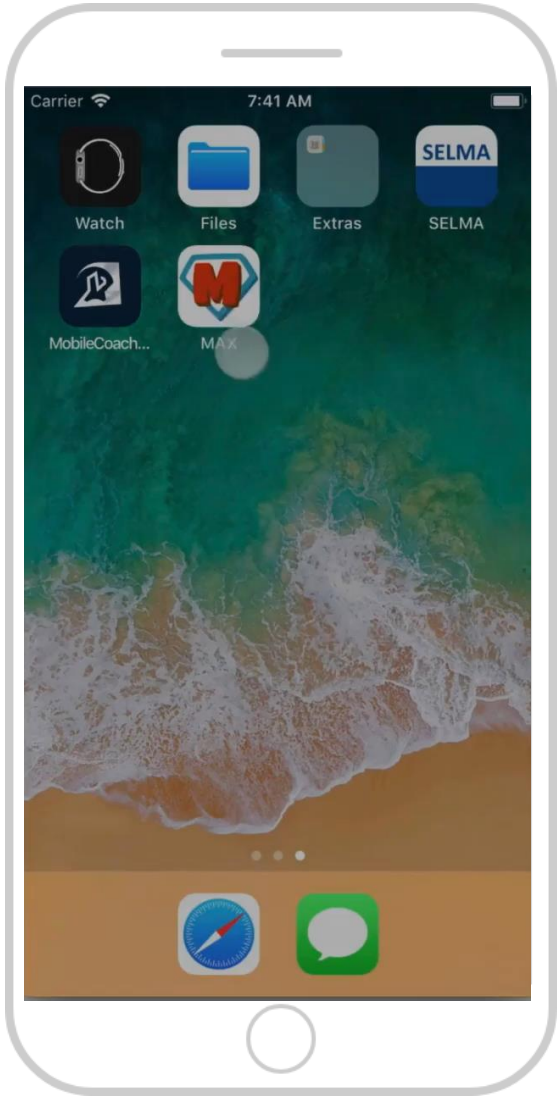
www.c4dhi.org/projects/health-literacy-children-asthma/

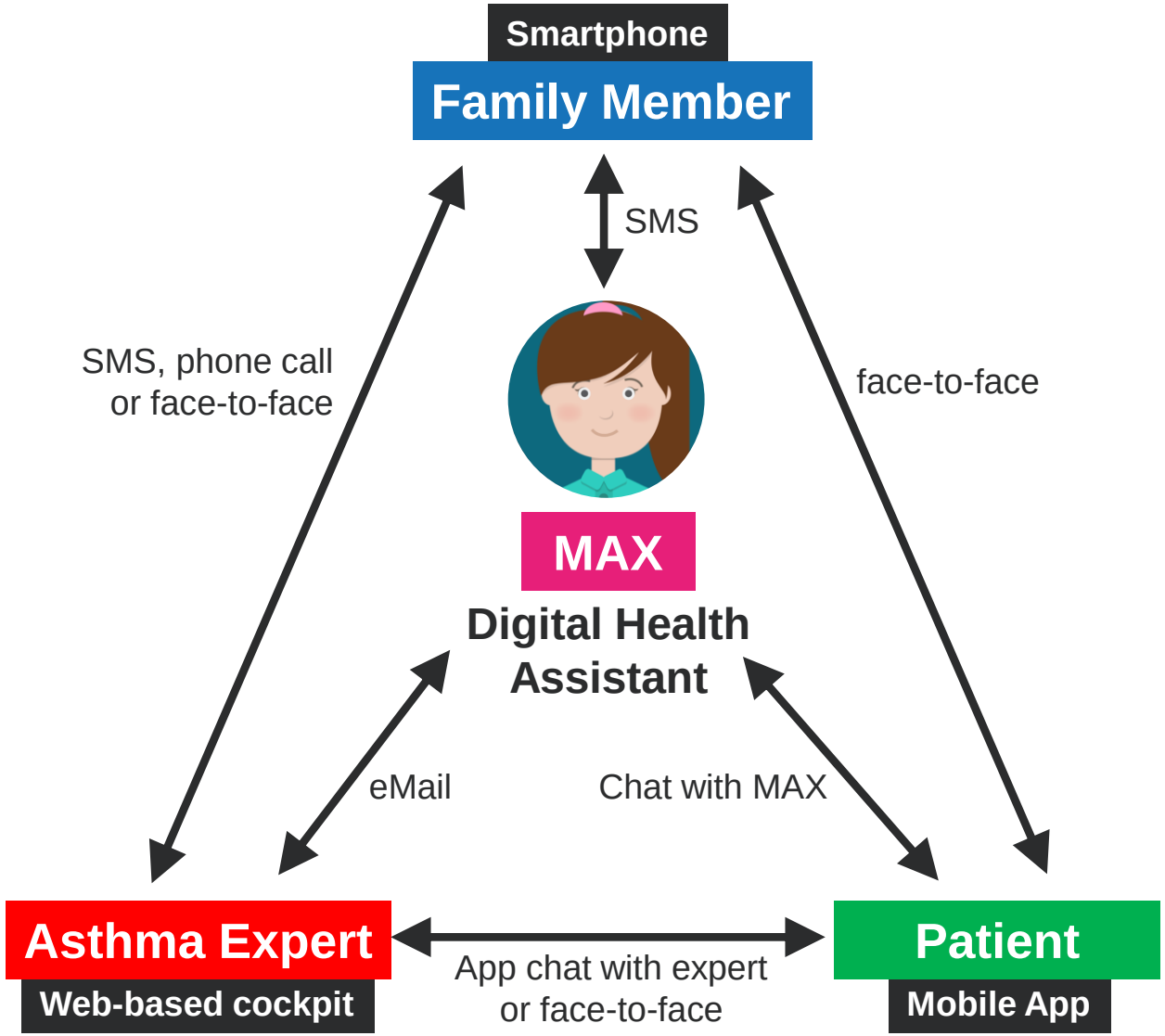
Conceptual Model of MAX

Center for Digital Health Interventions



Interaction with MAX





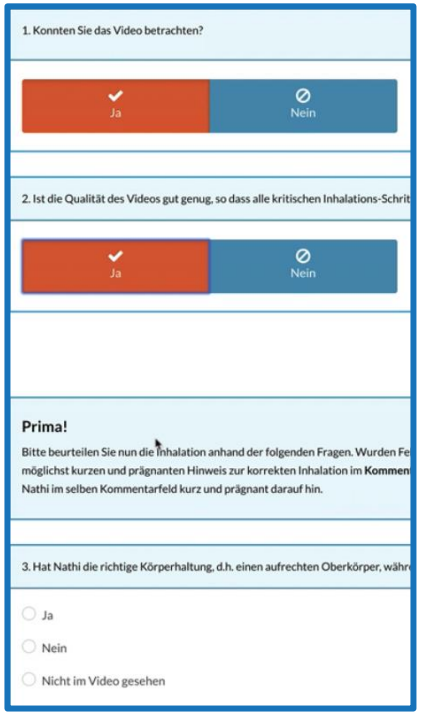
Inhalation Assessment of Norah, 12

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

Center for Digital Health Interventions

1. Video recording by family member

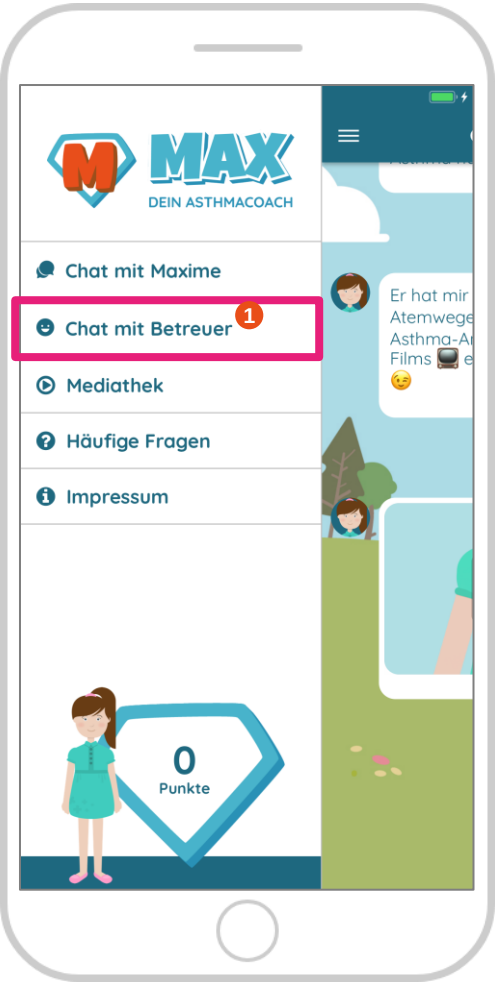
2. Expert rating



\+

Automated feedback generation based on inhalation guidelines

3. Feedback to Norah



Main results of the pilot study

Center for Digital Health Interventions

1. Overall, **99 children** with asthma **have been approached** by asthma experts from **6 study centers**, within 4 months in 2019; **49 (49.5%)** subjects **started to interact** with MAX.

2. The average **adherence rate** of the **49 subjects** was **80.4%**.

3. The result of a **pre-post test** shows that **asthma knowledge** was **improved significantly** with a **large effect size** (d=0.9).

4. On average, **1 inhalation mistake** was identified in each **video clip**; **3 serious inhalation mistakes** could be directly **addressed and eliminated** by the experts' feedback in this trial.

Center for Digital Health Interventions

University of St.Gallen ETH zürich

Design of a prognostic digital biomarker for asthma control

Kantonsspital St.Gallen

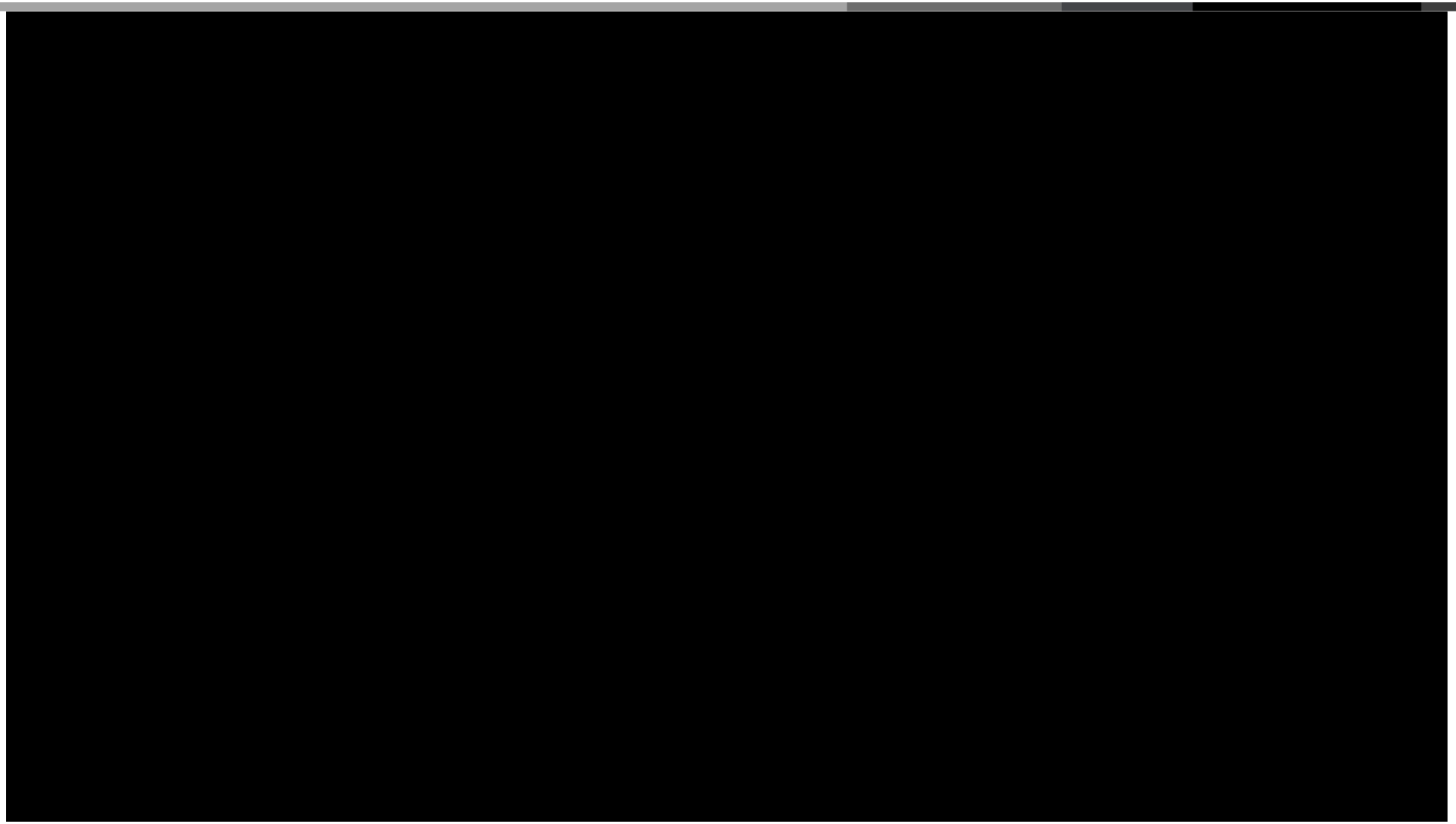
University of Zurich[UZH]

LUNGENLIGA

CSS Insurance

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

Overview of the asthma study with Clara



https://vimeo.com/258412196

Clara assessment by 88 adults with asthma

Center for Digital Health Interventions

CLARA DEIN STUDIENCOACH

#	Item	Scale	Mean	SD
1	**How satisfied were you with Clara?**	1 = Not at all 7 = Very satisfied	**5,95**	1,23
3	**How much would you like to continue working with Clara?** *(n = 87)*	1 = Not at all 7 = Very much	**4,87**	1,72
4	**How likely is it that you will follow Clara's advice?**	1 = Not at all likely 7 = Very likely	**5,59**	1,56

Preliminary results of the study

Center for Digital Health Interventions

Response rate to daily self-reported asthma control tests of 93 participants:

97.3% (2487 / 2557)

Paper	N subjects	N coughs
Vizel et al. 2010	12	n/a
McGuiness et al. 2012	10	n/a
Casaseca-de-La-Higuera et al. 2015	9	n/a
Monge-Alvarez et al. 2018	13	n/a
Swarnkar et al. 2013	3	342
Amoh et al. 2016	14	627
Birring et al. 2008	15	1.836
Barry et al. 2006	15	2.000
Amrulloh et al. 2015	24	2.090
Drugman et al. 2011	22	2.304
Liu et al. 2014	20	2.549
Larson et al. 2011	17	2.558
Coyle et al. 2005	8	3.645
Klco et al. 2018	18	5.200
Kadambi et al 2018	9	5.670
Our Clara study	**> 77**	**23.488**

Center for
Digital Health Interventions
CSS Health Lab | Health IS Lab

University of St.Gallen ETH zürich

Increasing adherence to home exercises in chronic back pain patients

Applied Health Care

University of Zurich[UZH]

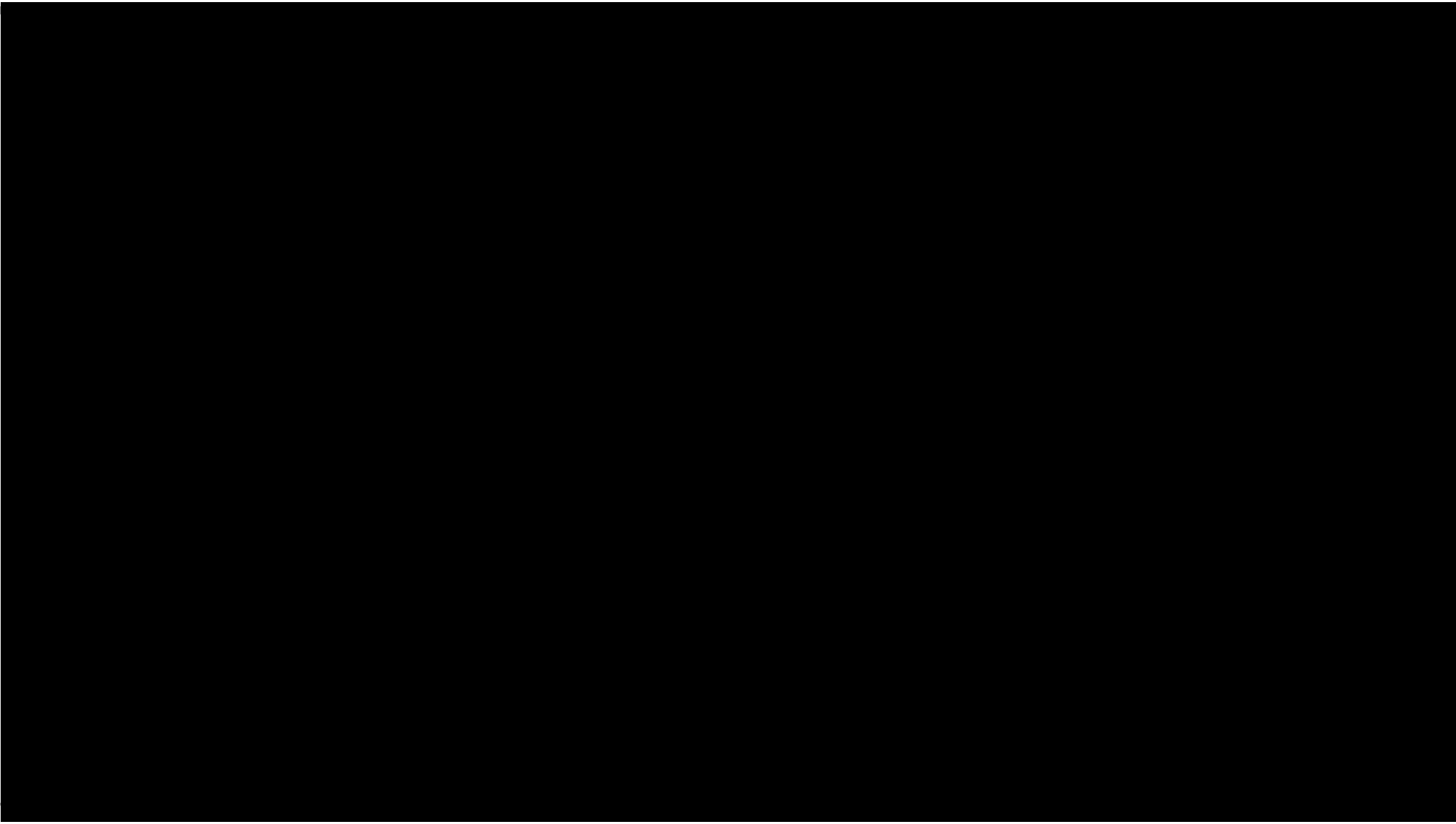
ETH JUNIORS SMART SOLUTIONS

magic leap

CSS Insurance

Max – An augmented reality coach
SRF Puls, December 10, 2018 (extract)

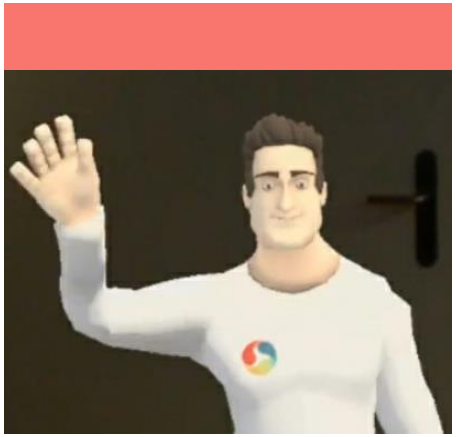
Center for Digital Health Interventions



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

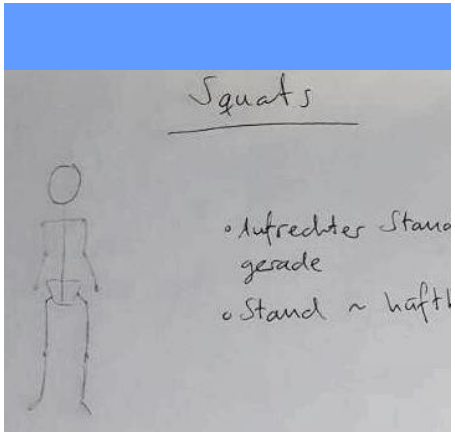
Center for Digital Health Interventions

3 modes of instructions



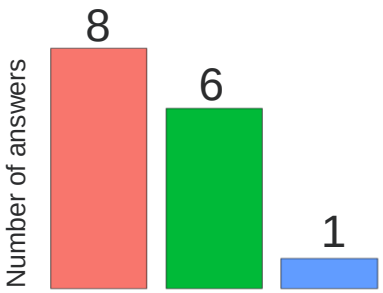
Alex (Augmented Reality)

Video

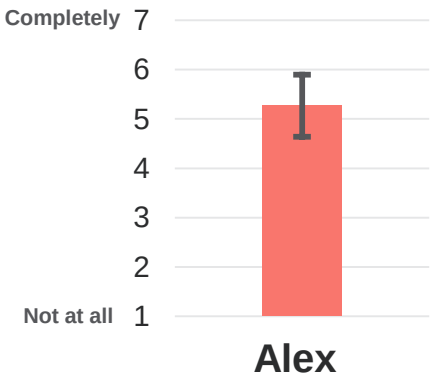


Paper

1. What is your preferred mode of instruction?



2. Session Alliance Inventory



Error bar indicates 95% confidence interval

4-week intervention study (N=1)

Goal: 3 sessions per week for 4 weeks

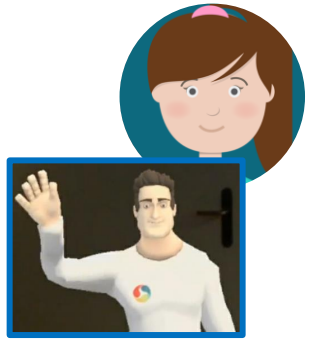
Adherence: 92% (11 of 12 sessions)

Feedback: Intention to continue with Alex

Potentials of Digital Coaches

Center for Digital Health Interventions

1. **Delivery of interventions**
   Frame **digital health interventions** as **digital coaches** of **physicians and other caregivers** that "**live**" **in the pockets of patients** and have the potential to **improve the doctor-patient relationship**, **intervention adherence** and **health outcomes**.



2. **Medical research**
   Use **digital coaches** for **ecological momentary assessments**
   (a) to better understand the **development of diseases** and
   (b) to develop diagnostic or prognostic **digital biomarkers**.

Können Sie sich vorstellen, in Zukunft mit digitalen Gesundheits-Assistenten zu chatten?


Ladina
Nr. 5145

Liebe Frau Mordelet 13.3.'19

Herzlichen Dank
Für die cole App
von Max.

Liebe  Grüsse

Ladina

Härzleche Dank!

[illegible] [illegible]

Center for Digital Health Interventions

Prof. Dr. Tobias Kowatsch

Assistant Professor for Digital Health, University of St.Gallen
Scientific Director, Center for Digital Health Interventions at the University of St.Gallen & ETH Zürich
https://www.c4dhi.org | https://www.mobile-coach.eu | tobias.Kowatsch@unisg.ch

Advisory Board
Prof. Dr. Elgar Fleisch
Lisa Marsch, PhD
Prof. Dr. Urte Scholz
Prof. Dr. Florian von Wangenheim

Center Leadership
Prof. Dr. Tobias Kowatsch
Matthias Heuberger, M.A.

Research Team
Alina Asisof, M.Sc.
Filipe Barata, M.Sc.
Caterina Bérubé, M.Sc.
George Boateng, M.Sc.
Christoph Gross, M.Sc.
Jan-Niklas Kramer, M.Sc.
Yanick Lukic, M.Sc.
Florian Künzler, M.Sc.
Marcia Nißen, M.Sc.
Joseph Ollier, M.Sc.
Dominik Rüegger, M.Sc.
Prabhakaran Santhanam, M.Sc.
Iris Shih, M.Sc.
Peter Tinschert, M.Sc.