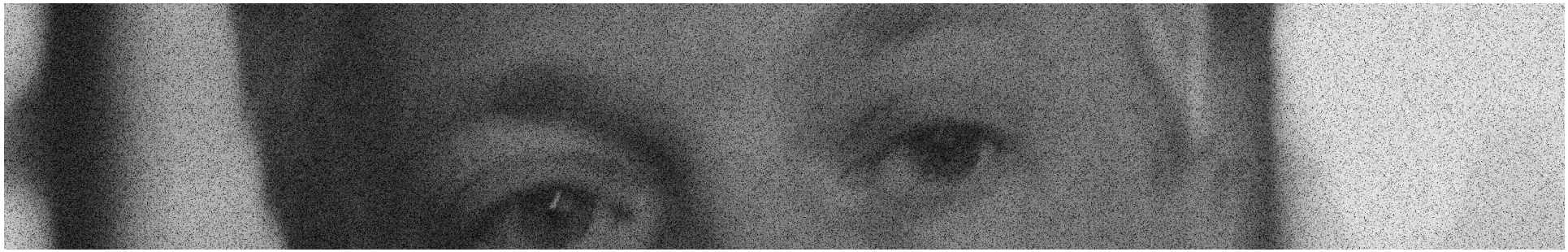
Virtual health agents for behavior change

Research perspectives and directions

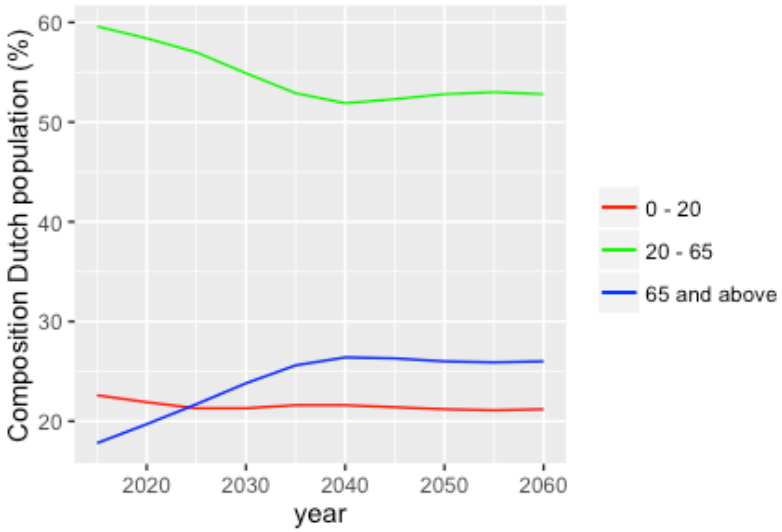


Topics

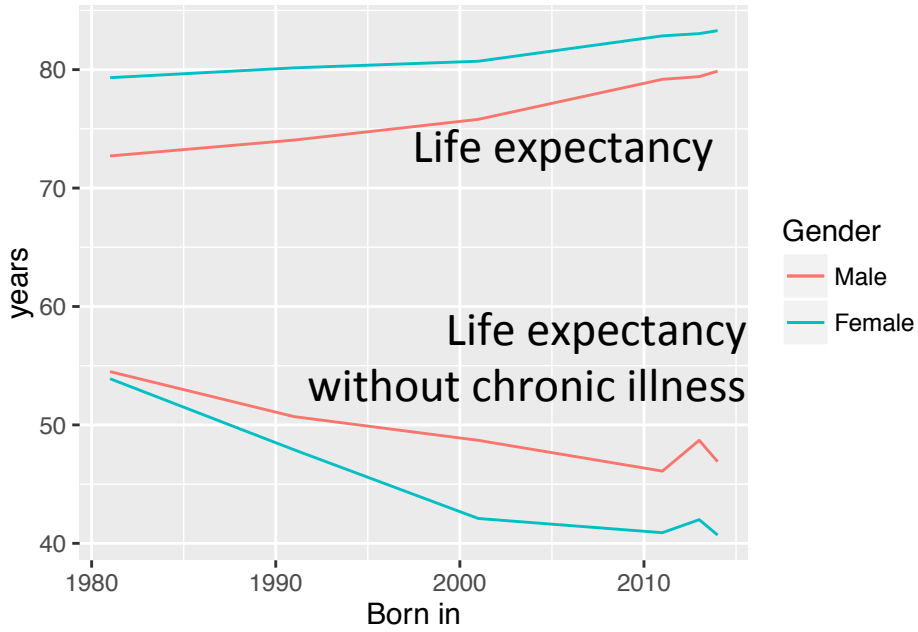
- Trends
- Virtual health agents
- Paradigms
- Type of Support of human competence
- Technological challenges
- “Moral” challenges

trends

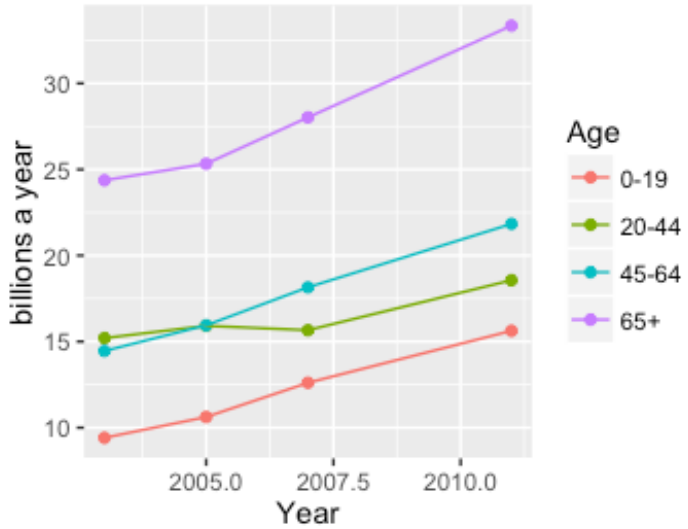
Dutch Demographics



Dutch Life Expectancy



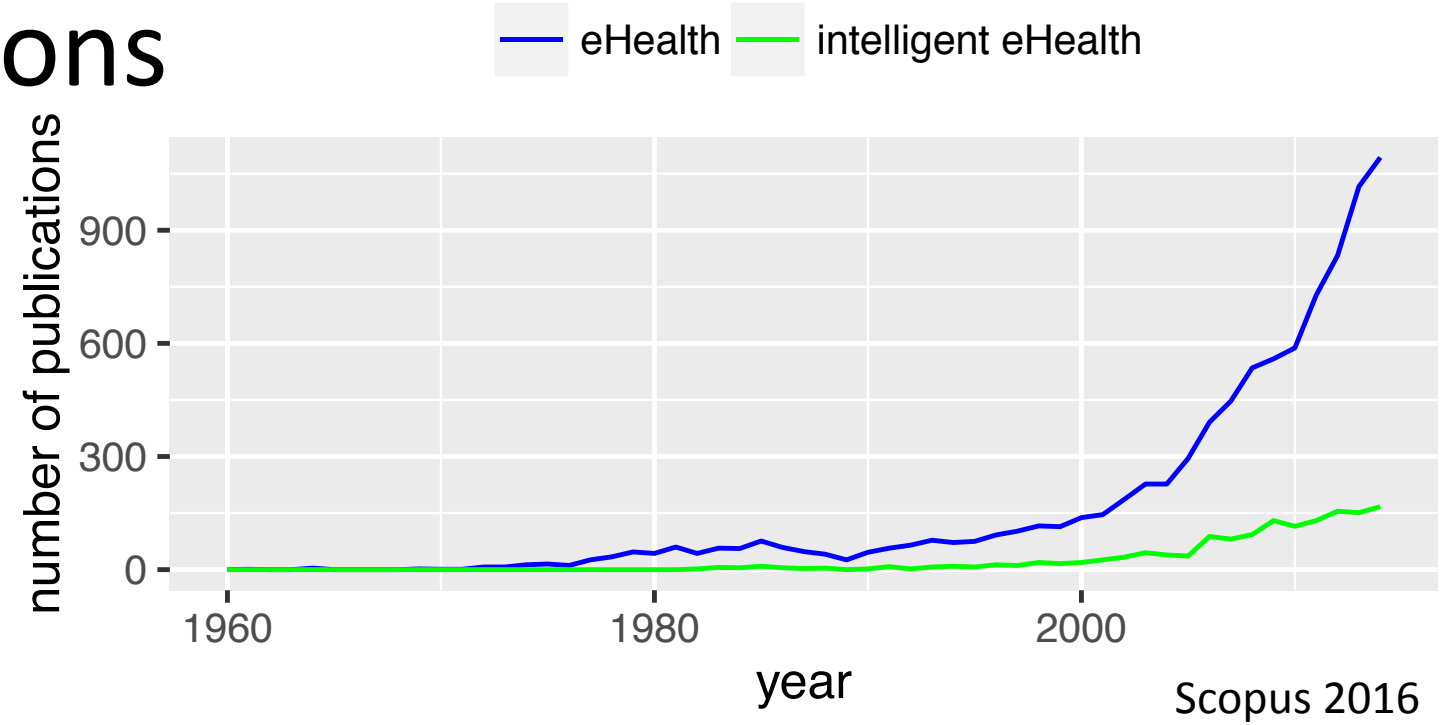
Dutch Health Cost



Trends:

- More people that require health care
- Health care cost is increasing
- Earlier and longer chronic illnesses

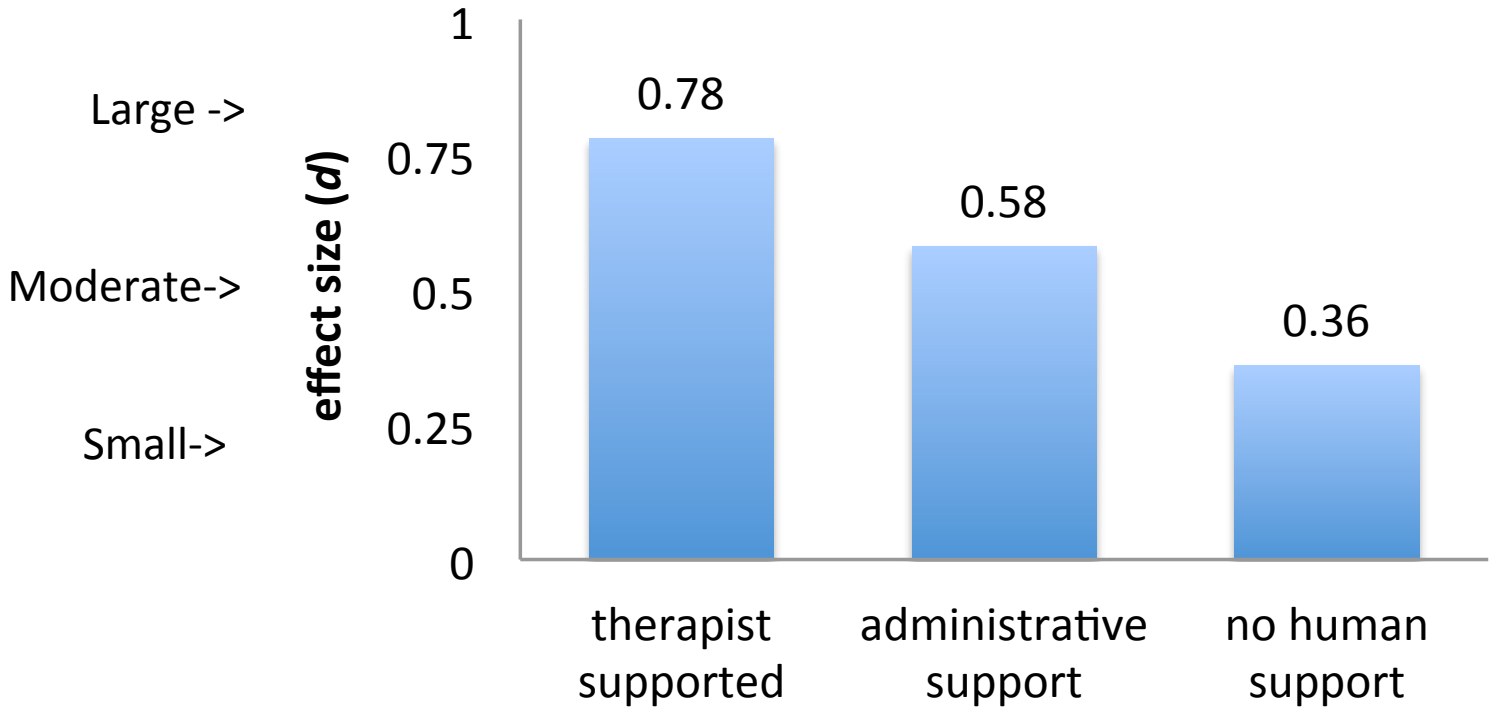
Publications



Top 5 eHealth outlets

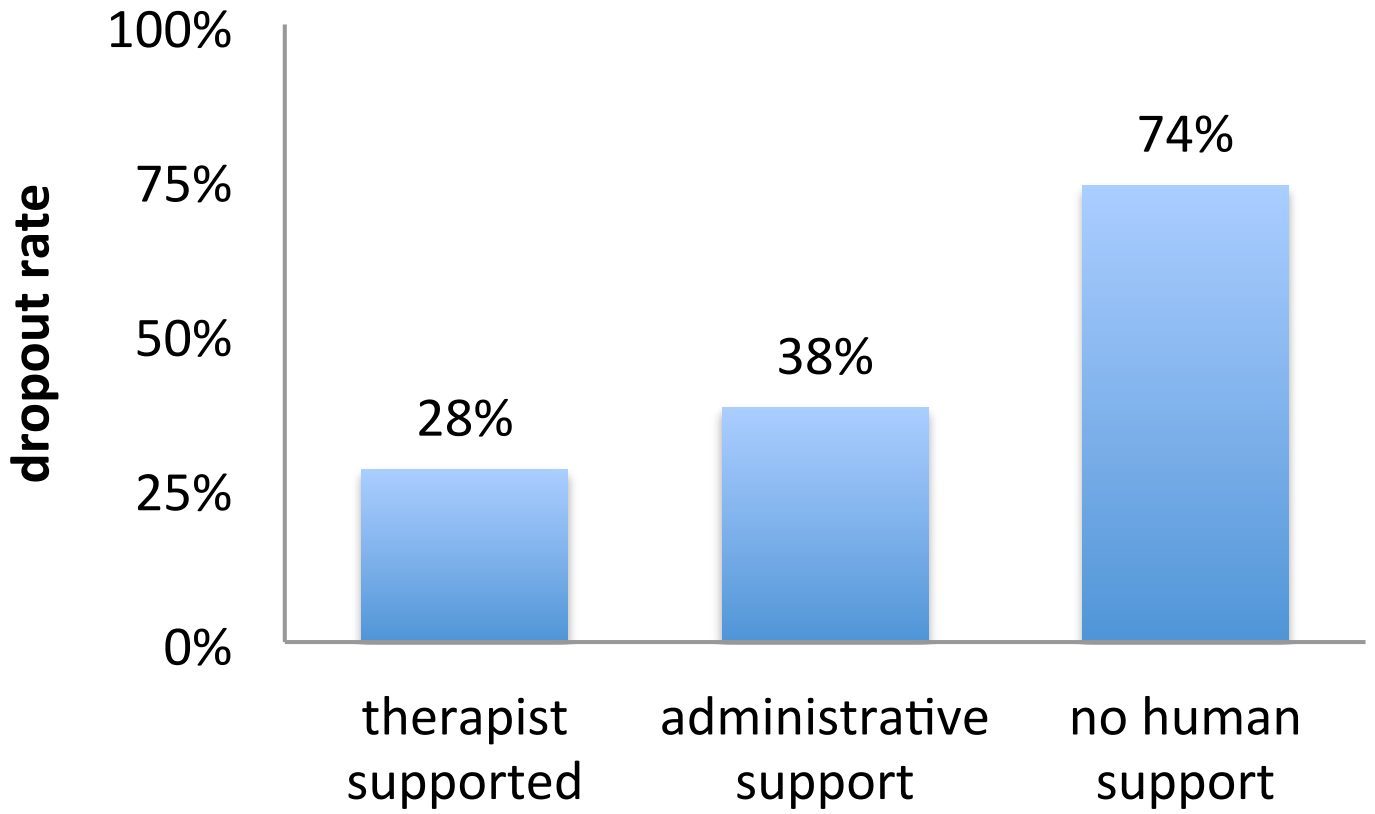
1. Journal of Medical Internet Research (158),
2. Lecture Notes in Computer Science (including subseries Lecture notes **in artificial intelligence** and lecture notes in bioinformatics) (126),
3. Plos One (101),
4. BMC Public Health (89),
5. Patient Education and Counseling (80).

Computer-based psychological treatment for depression



Richards, D., & Richardson, T. (2012). Computer-based psychological treatments for depression: a systematic review and meta-analysis. *Clinical psychology review*, 32(4), 329-342.

Computer-based psychological treatment for depression

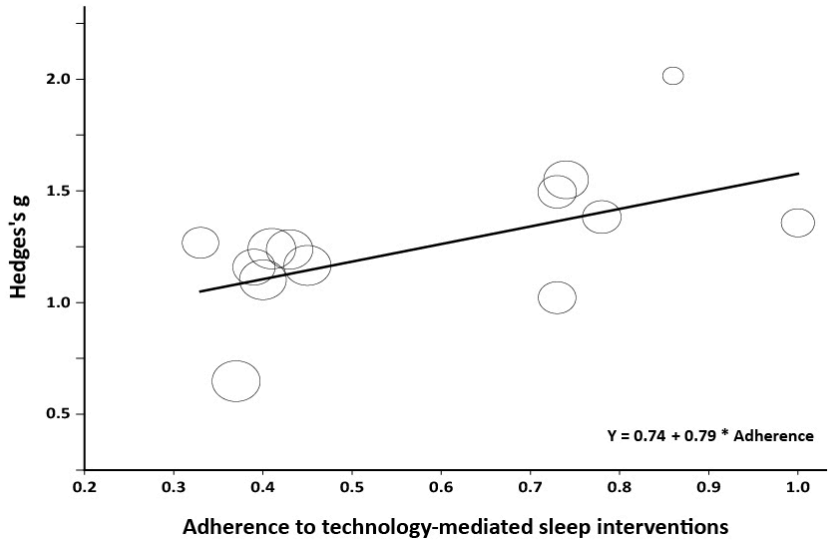


Richards, D., & Richardson, T. (2012). Computer-based psychological treatments for depression: a systematic review and meta-analysis. *Clinical psychology review*, 32(4), 329-342.

Ways to improve therapy

- Improve the effect of the therapy
- Improve the adherence of the therapy

Effect size



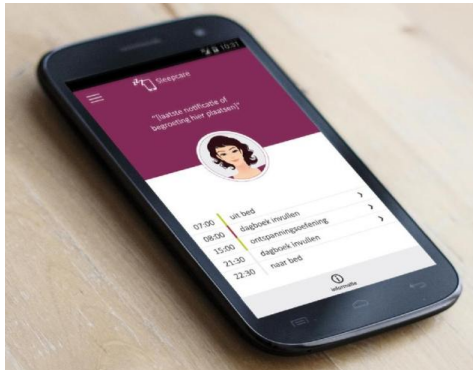
adherence

Horsch, C., Lancee, J., Beun, R. J., Neerincx, M. A., & Brinkman, W. P. (2015). Adherence to Technology-Mediated Insomnia Treatment: A Meta-Analysis, Interviews, and Focus Groups. *Journal of medical Internet research*, 17(9).

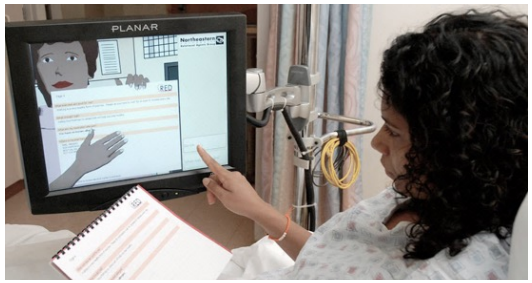
Virtual health agents

Simcoach

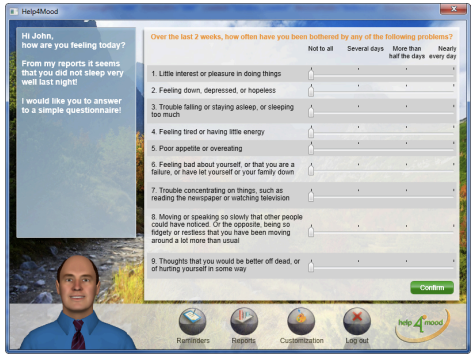
Sleepcare



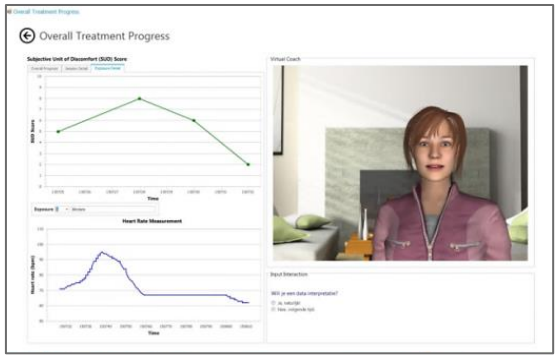
Virtual Nurse



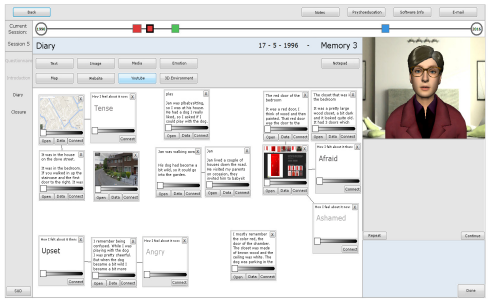
help4mood



Memphis



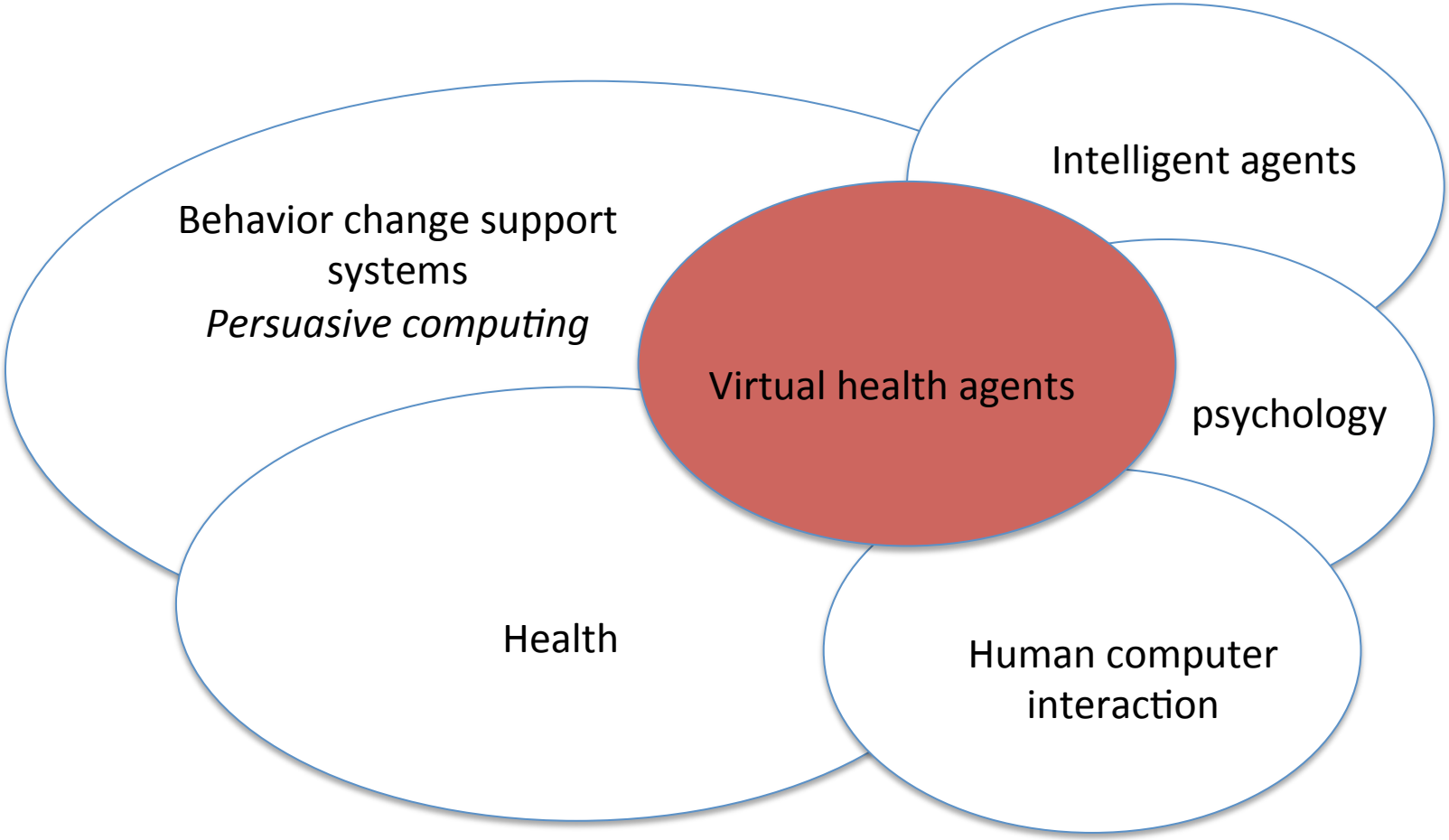
3MR 2.0



Virtual health agents for behavior change

Scaffolding

Positioning



What is a virtual health agent?

"*Persuasive technology:* ***interactive computing systems designed to change people's attitudes and behaviour***" (Fogg, 2003, p. 1)

"*A behavior change support system (BCSS) is a social-technical information system with psychological and behavioral outcomes* ***designed to form, alter or reinforce attitude, behaviours or an act of complying without using coercion or deception***" (Oinas-Kukkonen, 2013, p. 1225).

"In artificial intelligence, an intelligent agent (IA) is an **autonomous** entity which observes through sensors and acts upon an environment using actuators (i.e. it is an agent) and directs its **activity towards achieving goals**" wikipedia

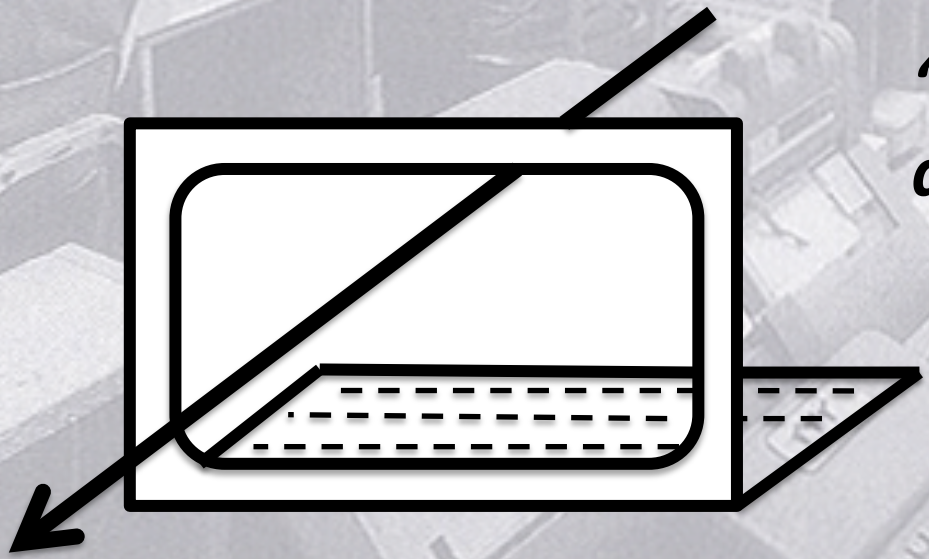
"…intelligent virtual agents. These agents are **interactive characters**, which humans can interact with. They often have **anthropomorphic** elements to evoke responses that humans would exhibit when interacting with other humans " Preface IVA2015 proceedings

Virtual health agents are interactive computer characters which human can interact with. They often have anthropomorphic elements, and they are designed to form, alter or reinforce <u>healthy</u> attitude, behaviors or an act of complying without using coercion or deception.

The Paradigm

System centered view

Data provider



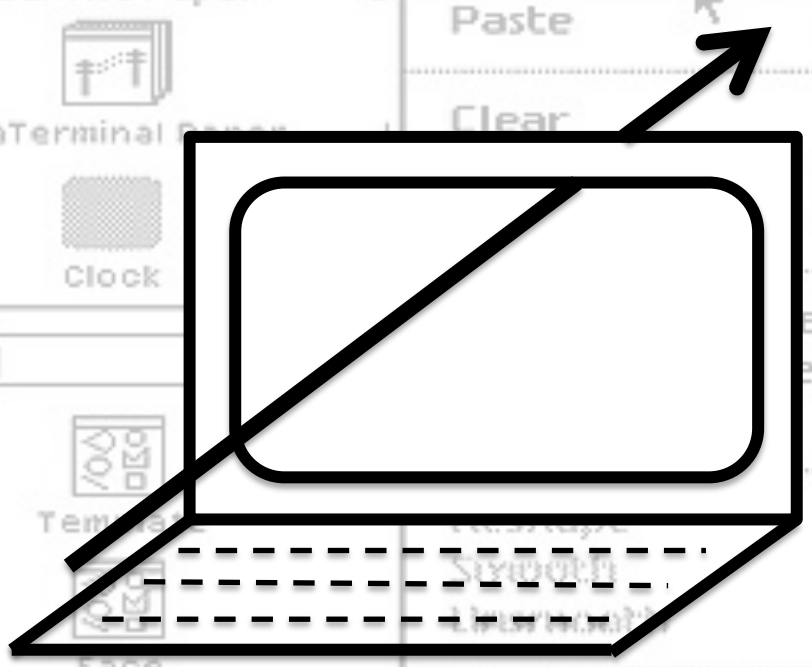
"I can make my computer do X"

Data processor

Optimizing: Computer performance

Input –> Processing -> Output

User centered view



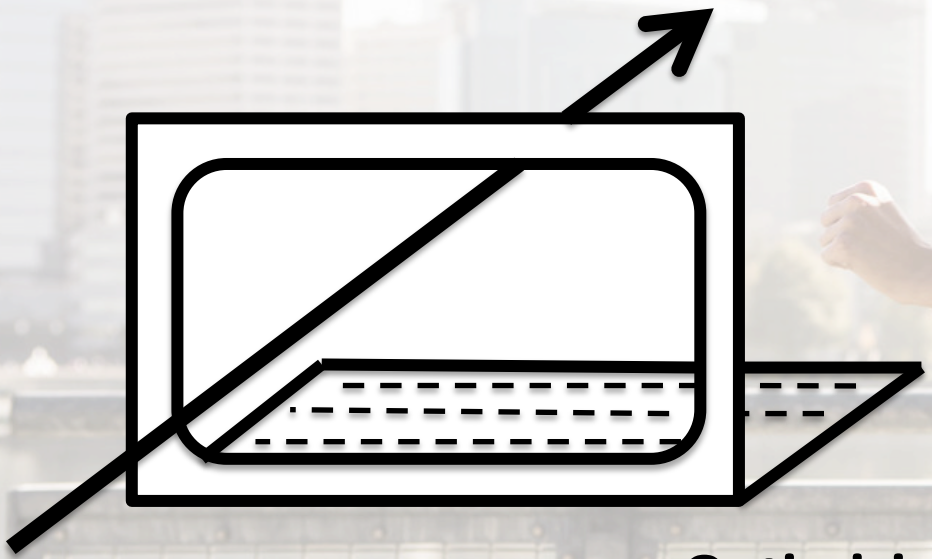
"I can make my computer support the user to do X"

Optimizing: User task performance

Perception –> Cognition-> Action

System

Behavior centered view



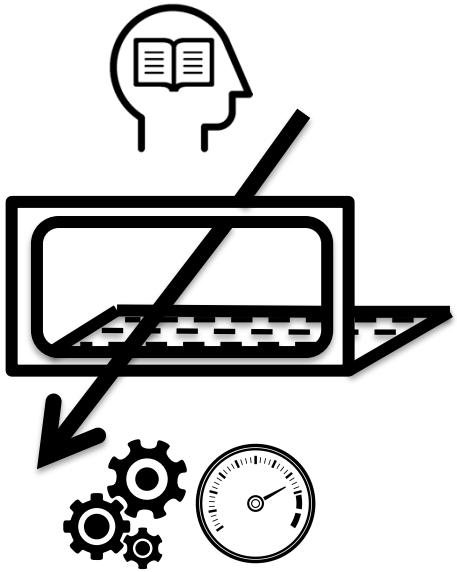
"I can let my computer make a person do X"

Optimizing: Adherence to target behavior

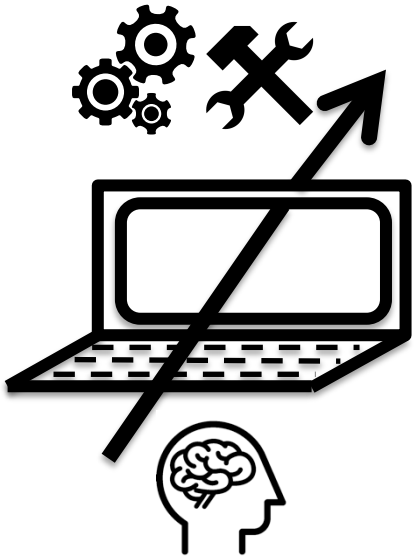
Monitoring –> Artificial Cognition-> Action

Human

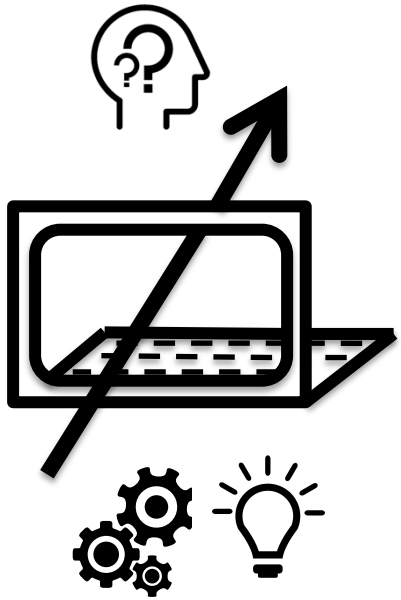
Computer centred



User centred



Behavior centred



Paradigm	Computer centred	User centred	Behavior centred
Computer	Data processing	Tool	Expert
Human	Data provider	User	Client
Optimizing	Computer performance	User task performance	Adherence to target behavior

The Support of human competence

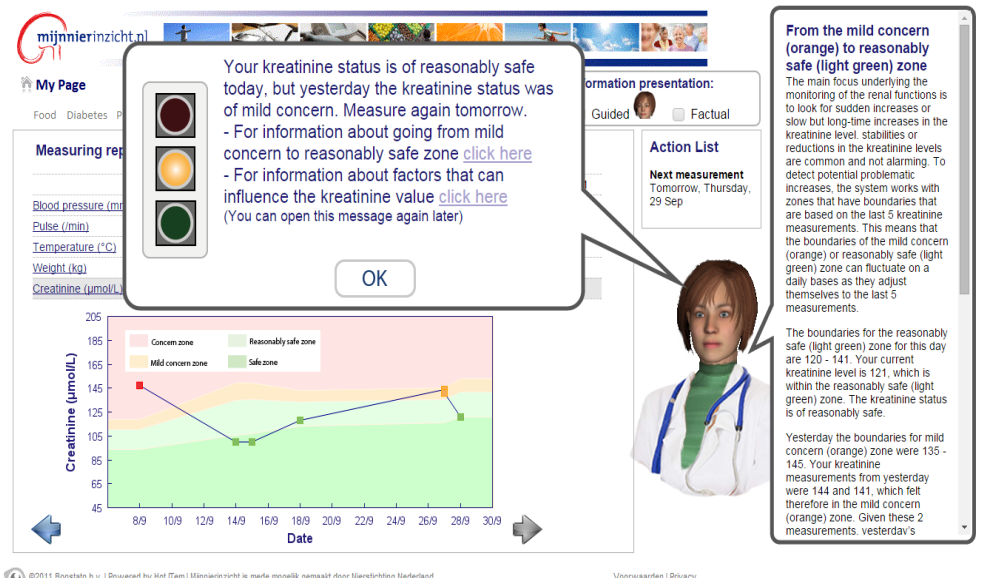
Monitoring

Human Needs

- People need to perceive the current situation as less desirable compared to potential future situation
  - Perceptual Control Theory
  - Transtheoretical model of behavior change
  - Protection Motivation Theory
  - Health Belief Model
- Re-enforce healthy behavior
- Hawthrorne effect (effect of being monitored)

Computer potential

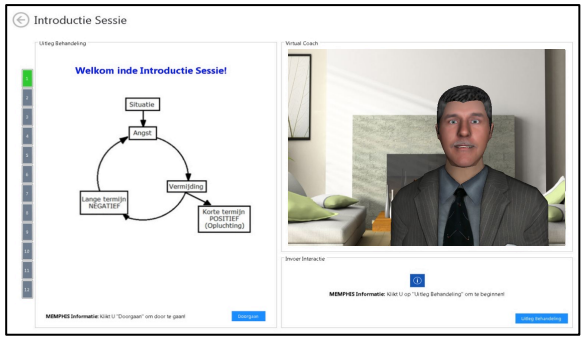
- Computerized motivational interviewing
- Make monitoring easy
  - Sensors
  - Process lower level data into high level data
  - Compare with theory-based models or Data-driven models



Cognition

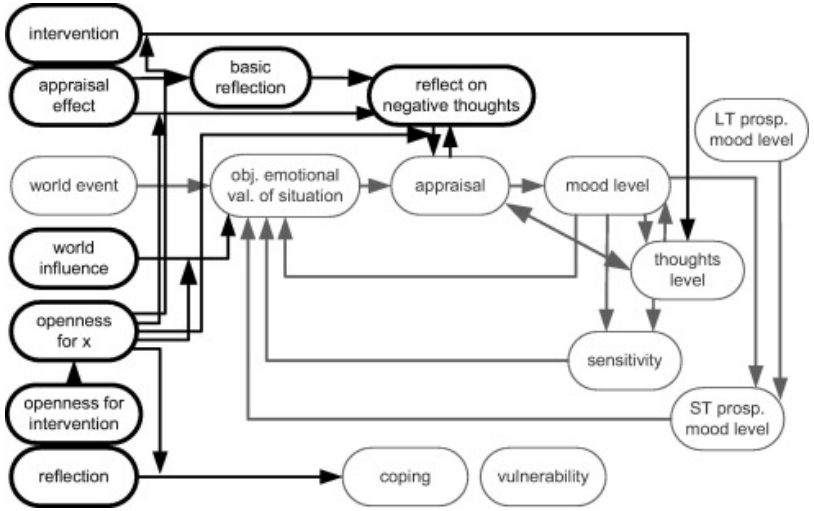
Human Needs

- Understanding (what is happening to me, the illness)
- Decision making
- Intervention formation



Computer potential

- 24/7 Computerized health knowledge education
- Intervention space analysis
- Situation adaptation
- Decision support



Both, F., Hoogendoorn, M., Klein, M. C., & Treur, J. (2015). A generic computational model of mood regulation and its use to model therapeutical interventions. Biologically Inspired Cognitive Architectures, 13, 17-34.

Affect and Attitude

Human needs

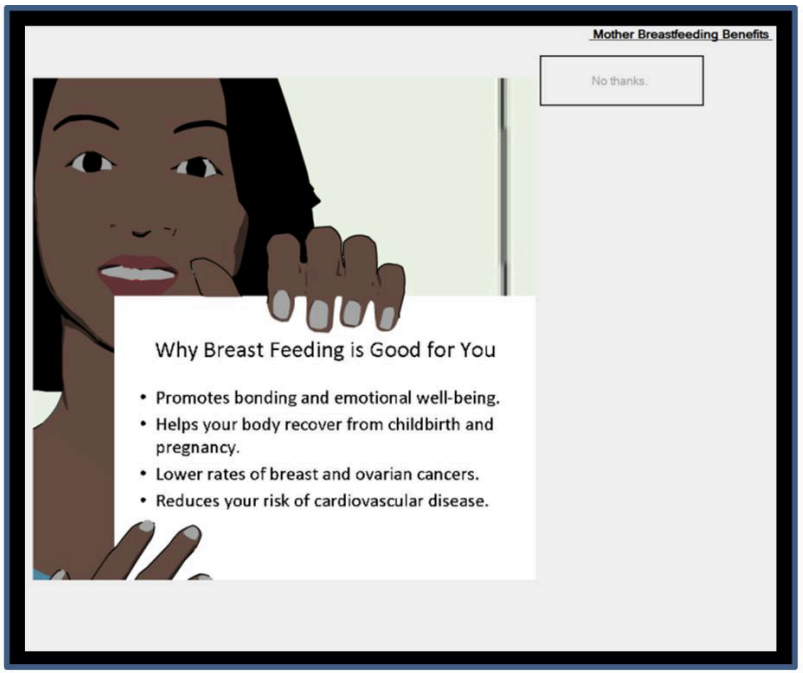
- Motivation to support change process
  - Self-Efficacy (Social Cognitive Theory, Goal Setting Theory)
- Affect and Attitude as the object of change itself
- Attitude alignment
  - Elaboration likelihood model of persuasion
  - Social Judgment Theory

Shi, L., Bickmore, T., & Edwards, R. (2015, August). A Feminist Virtual Agent for Breastfeeding Promotion. In International Conference on Intelligent Virtual Agents (pp. 461-470). Springer International Publishing.

Computer potential

Persuasiveness

- 24/7 Computerized health Education
- Relational agents

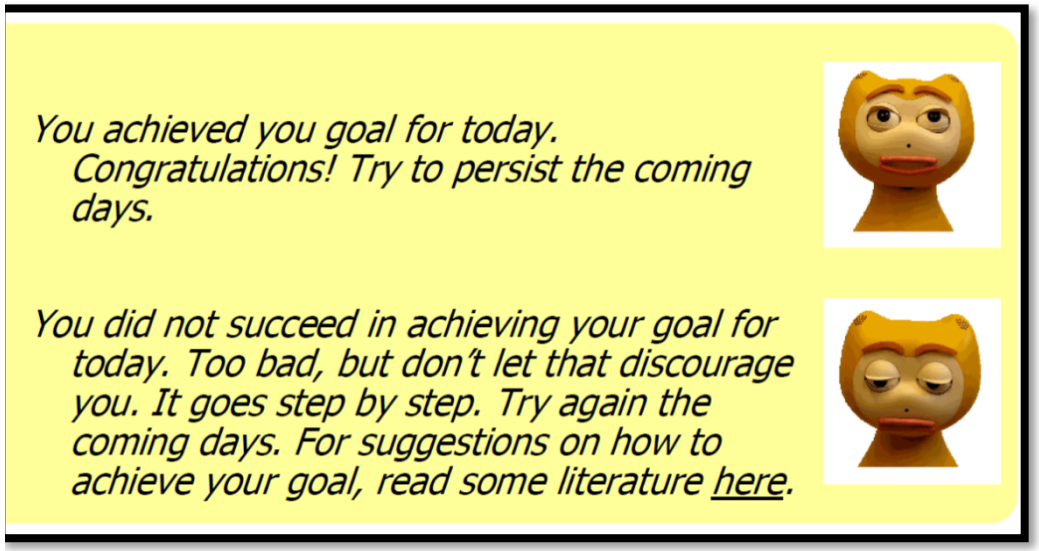


Behavior

Human needs

Execute target behavior

- Planning
- Skills training
- Triggering behavior
- Block unhealthy habits



Computer potential

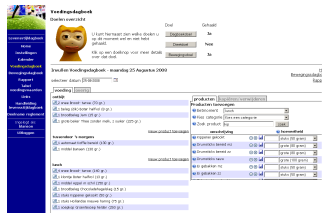
- 24/7 Computerized skills training

Adapting environment

- Automatic reminders
- Control light, temperature, electronic devices (wiffi, TV)
- Block emails
- Organize social support

Persuasiveness

- Reward good behavior
- Automatic scheduling
- Automatic health suggestions (for healthy food, activities)



Blanson Henkemans, O. A., van der Boog, P. J., Lindenberg, J., van der Mast, C. A., Neerincx, M. A., & Zwetsloot-Schonk, B. J. (2009). An online lifestyle diary with a persuasive computer assistant providing feedback on self-management. Technology and Health Care, 17(3), 253-267.

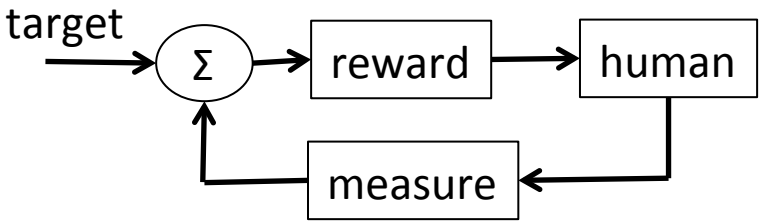
Challenges

Main research challenge on system integration level:

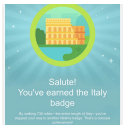
Establish computer models that regulate human behavior

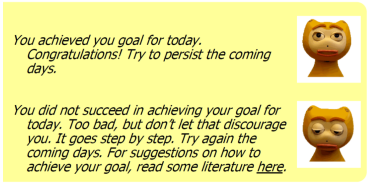
Direct regulation

Positive Feedback Model

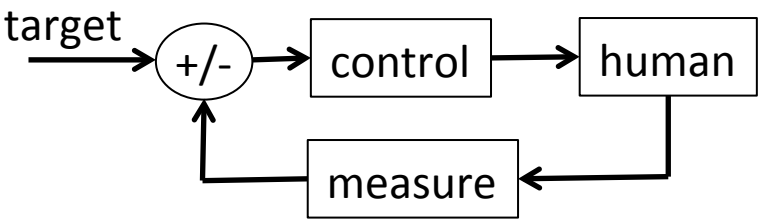


Positive reinforcement

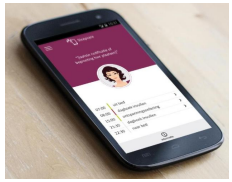




Negative Feedback Model

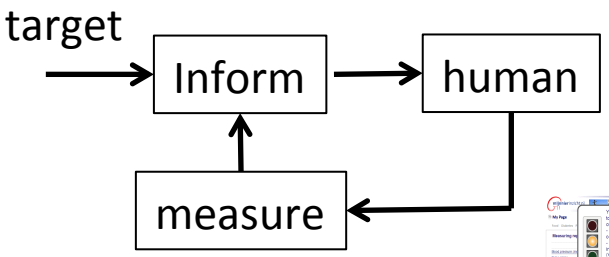


e.g.: sleep restriction



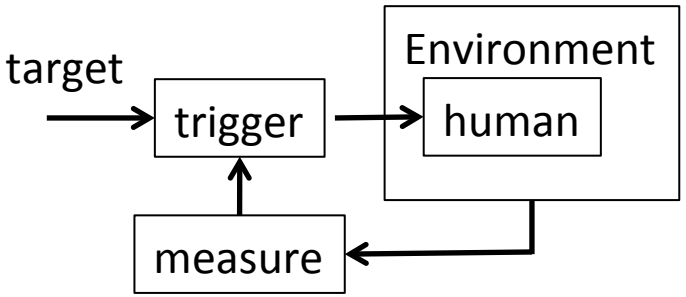
Support human regulation

Monitoring and advising model

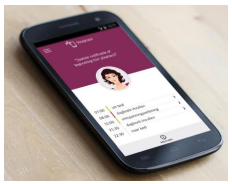


e.g.: stop light

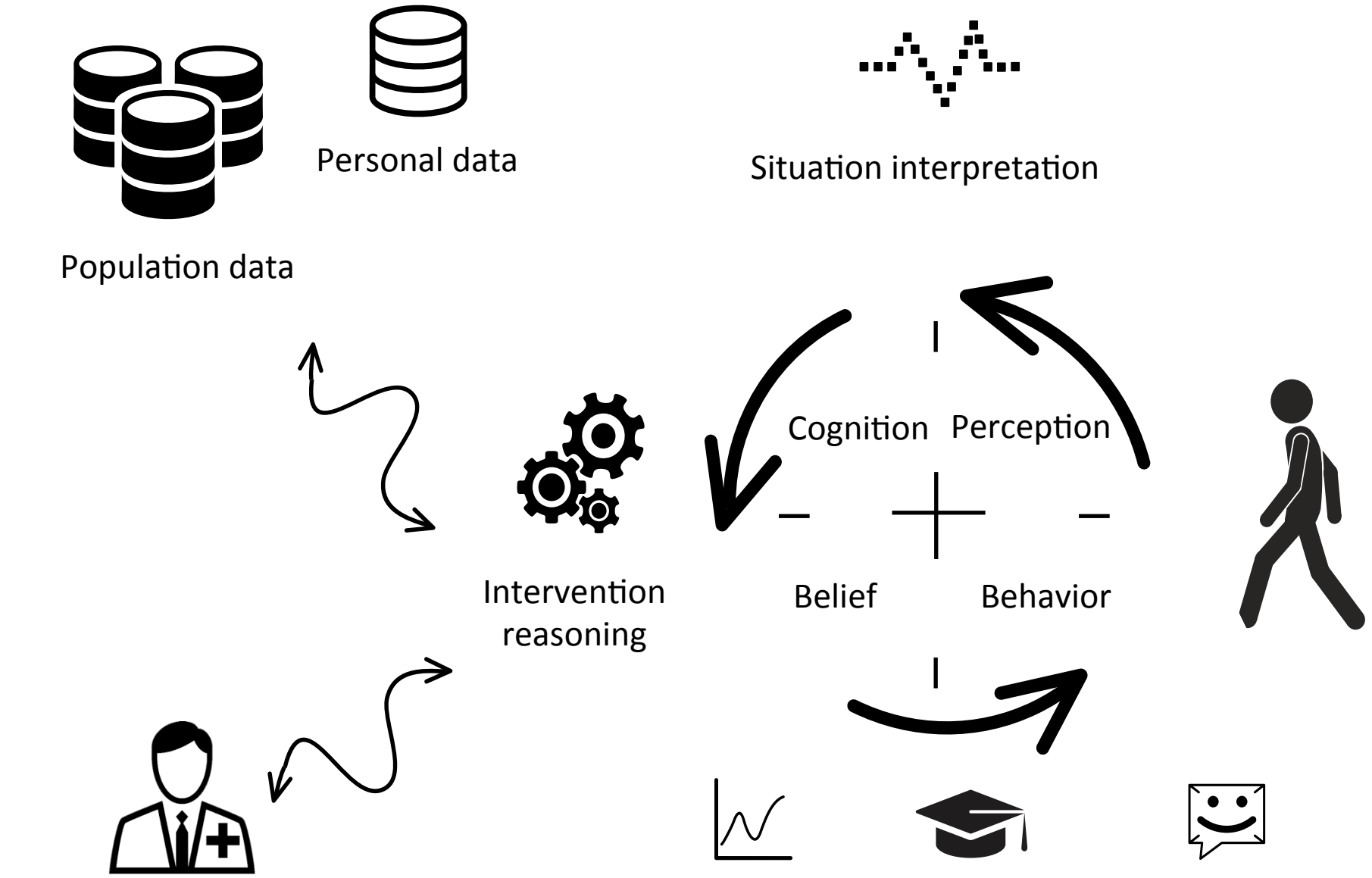
Behavior triggering model



e.g.: reminder based on facebook

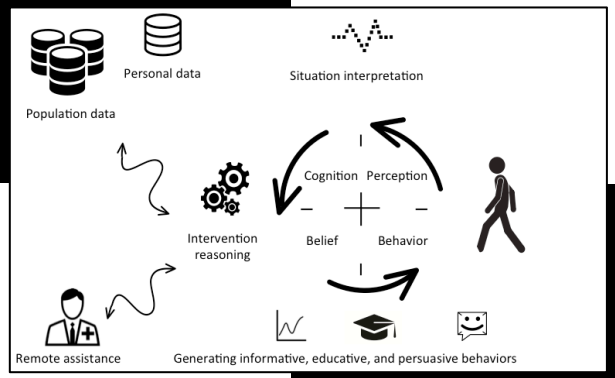


Virtual health agents for behavior change


Personal data
Situation interpretation
Population data
Cognition
Perception
Intervention
reasoning
Belief
Behavior
Remote assistance
Generating informative, educative, and persuasive behaviors

Intervention Reasoning

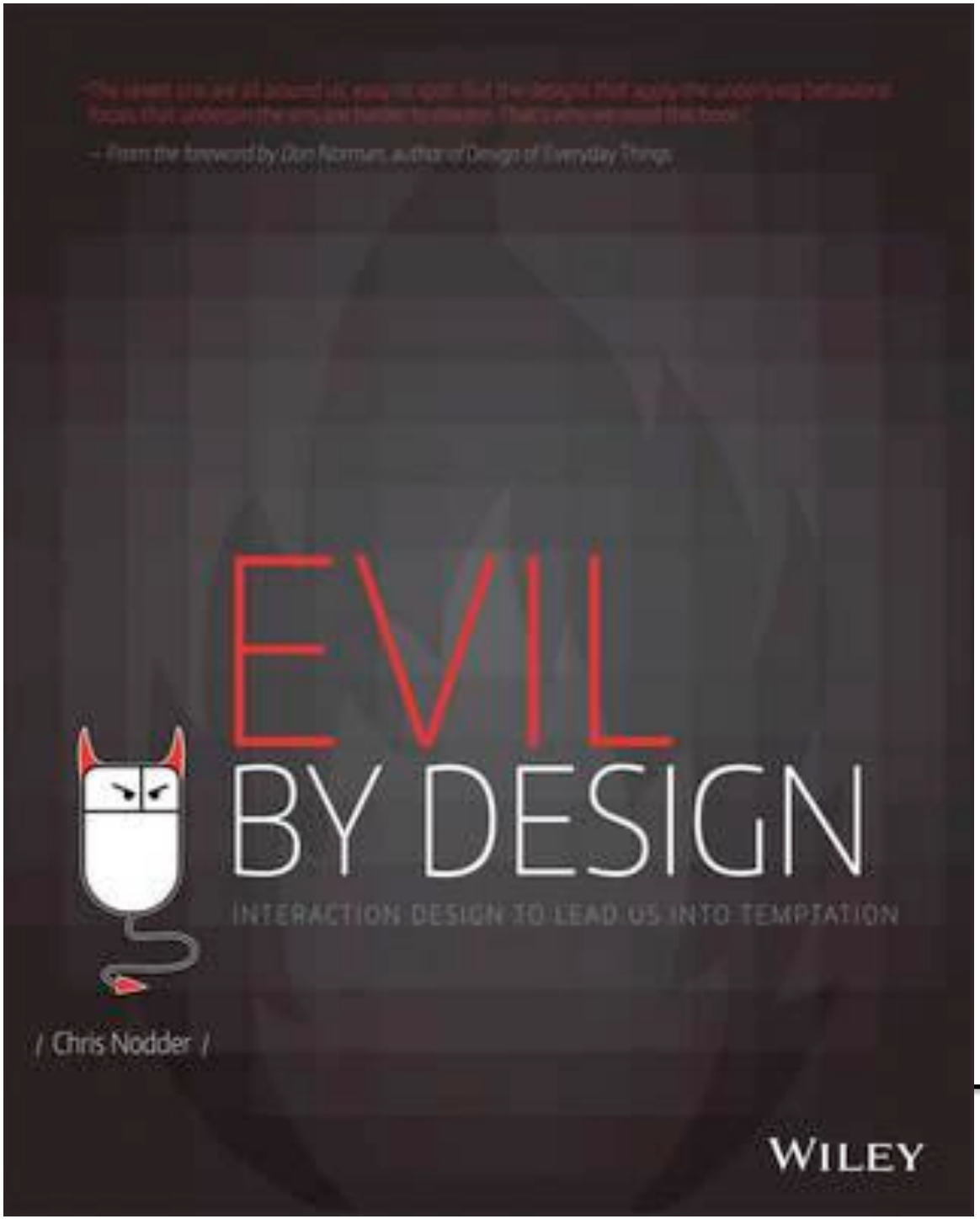
Situated intelligent actor behavior and intention interpretation

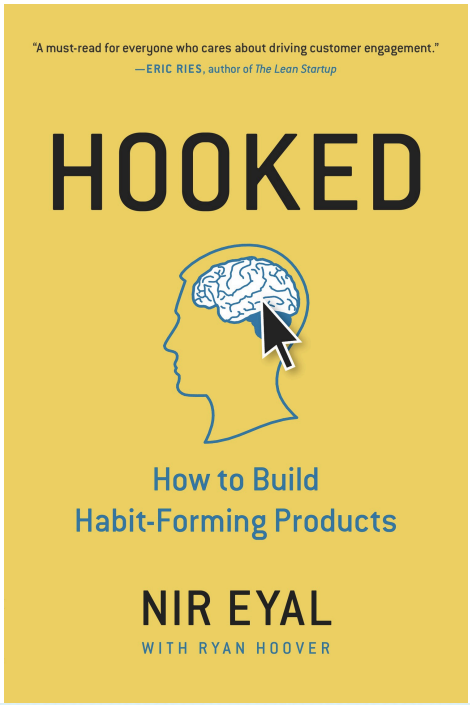


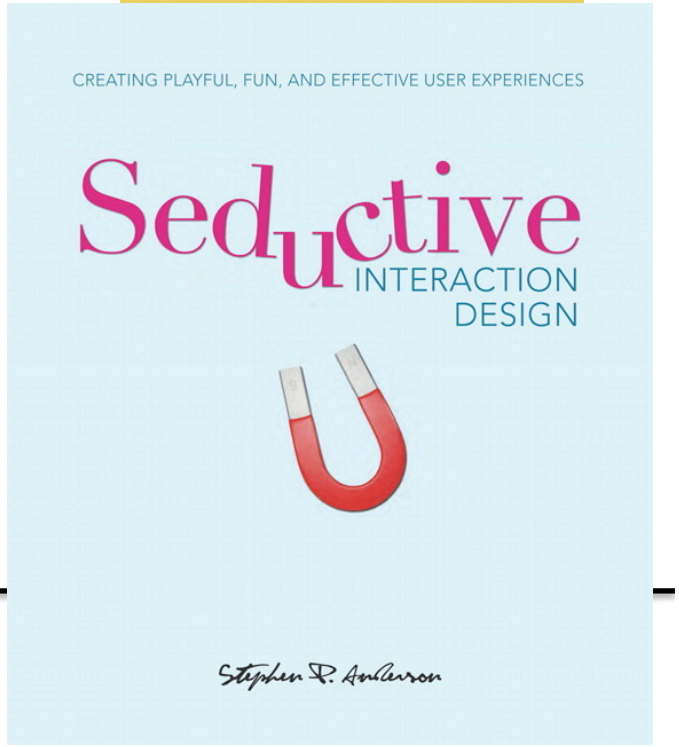
Generating Informative, Educative, and Persuasive Computer Behavior

Engineering Generic Solutions

The Moral Challenges

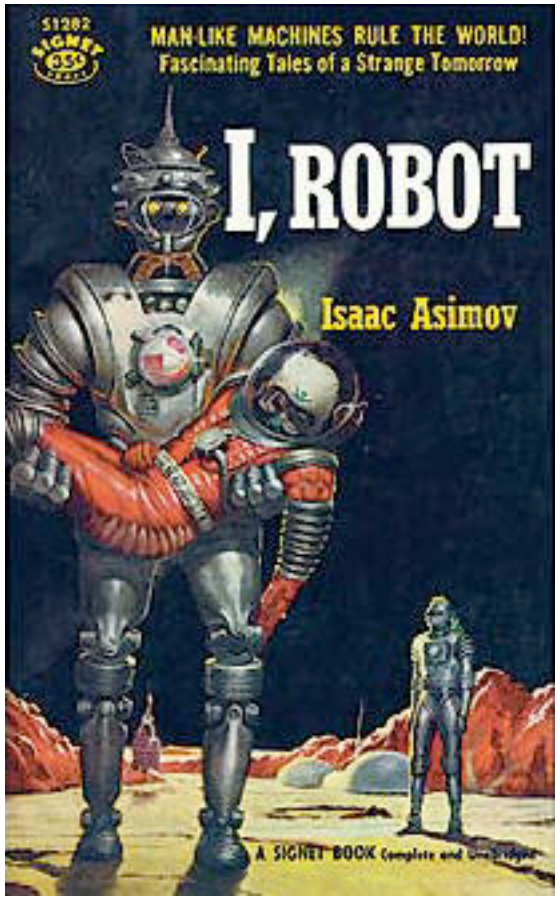

EVIL
BY DESIGN
INTERACTION DESIGN TO LEAD US INTO TEMPTATION
Chris Nodder
WILEY


"A must-read for everyone who cares about driving customer engagement."
—ERIC RIES, author of The Lean Startup
HOOKED
How to Build
Habit-Forming Products
NIR EYAL
WITH RYAN HOOVER


CREATING PLAYFUL, FUN, AND EFFECTIVE USER EXPERIENCES
Seductive
INTERACTION
DESIGN
Stephen P. Anderson

Three laws of Robotics
Asimov's Laws

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.



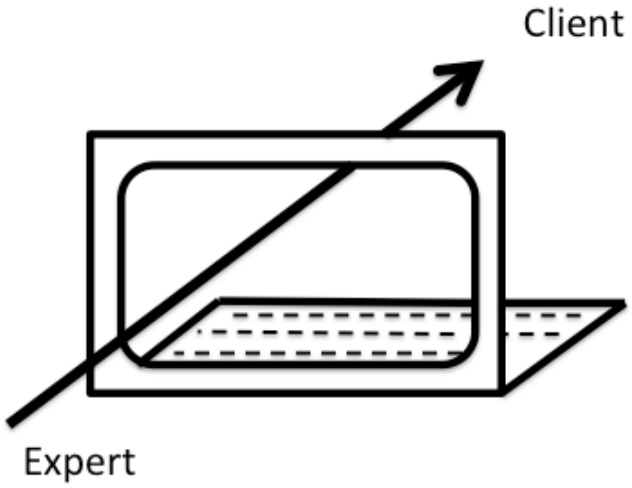
More extended version - EPSRC Principles of Robotics

Informed consent

"*A behavior change support system (BCSS) is a social-technical information system with psychological and behavioral outcomes designed to form, alter or reinforce attitude, behaviours or an act of complying without using coercion or* ***deception***" (Oinas-Kukkonen, 2013, p.1225)

informed consent…
transparency

But…Expert versus Client



Ethics from a caregiver perspective

BioMedical Ethics principles

1. **Respect for autonomy** (respecting decision making capacities of autonomous persons
2. **Non maleficence** (avoiding the causation of harm)
3. **Beneficence** (providing benefits, and balancing benefits against risk and cost)
4. **Justice** (distributing benefits, risks, and cost fairly)

From real to virtual

Beauchamp, T.L., Childress, J.F.: Principles of biomedical ethics. Oxford University Press, USA (2001)

Security

- ISO 27799:2016 Health informatics -- Information security management in health using ISO/IEC 27002

- "…maintain the confidentiality, integrity and availability of personal health information in their care."

To conclude

- Current trends justify research in virtual health agents
- Four human competence to support
  - Awareness (perception)
  - Cognition
  - Affect & Attitude
  - Behavior
- Research challenges
  - Behavior regulation models
  - Situation interpretation
  - Intervention reasoning
  - Generating informative, educative, and persuasive computer behavior
  - Engineering generic solutions
- Ethics: ethical design for behavior change

Virtual health agents for behavior change

Thanks for your attention

ICT is successful when it supports your need for change, and fails when you need to change for its support

TU Delft