

# Using AI Methods for Health Behavior Change

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## Abstract

Artificial intelligence (AI) has been applied to health behavior change research for over a decade. Current research programs include machine learning for delivering just-in-time adaptive interventions, computational modeling of behavior change processes, and the use of social AI for communication and persuasion. With new advances in AI, we propose an international workshop to bring together experts from all related disciplines to discuss and explore the potentials of AI for behavior change research. We discuss in this proposal the aims, planned activities, expected outcomes, and a promotion strategy for the workshop.

## Keywords

Behavior Change, Artificial Intelligence, Health Psychology, Digital Intervention, Persuasive Technology

## 1. Introduction

Digital technologies have been applied to health behavior change for over two decades. At the inaugural conference for persuasive technology in 2006, IJsselstein and colleagues already anticipated the use of digital systems to persuade and support users for better health and well-being [1]. Over the years, digital interventions systems have been used to change people's behaviors in a variety of health domains (e.g., diet, physical activity, smoking, etc.), employing a wide range of behavior change techniques [2]. Compared to traditional interventions, digital interventions are much easier to scale up, and the ubiquitous use of digital devices opens opportunities for understanding and influencing users [1, 3]. Despite these promises, the full potentials of digital interventions are yet to be realized, a status marked by a lack of long-term effectiveness in real-life contexts [4] and a scarcity of commercial success [5]. After all, digital or otherwise, health behavior change is a challenging problem, constrained by the theoretical understanding of behavior change and the availability of high-quality behavioral data [6].

The last two decades have also witnessed remarkable progress in artificial intelligence (AI) research, especially in the application domains of computer vision, natural language processing, and competitive game play. Not only are machine learning algorithms running behind everyday mobile applications for tailored user experience, they have also been the driving force for scientific discoveries, such as in solving protein folding [7]. Can AI methods also help to accelerate health behavior change research? We believe that the answer is a "yes", but the task will not be easy. A lot of the breakthroughs in AI deal with tasks that humans can do very well themselves (e.g., recognizing objects, speaking English, or playing chess), but changing one's own or someone else's health behavior is hard.

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Despite the unique challenge, pioneering research in applying AI methods for health behavior change has been active for more than a decade. One innovative research program is in the name of just-in-time adaptive interventions, or JITAI. The idea of JITAI is to engineer intelligent digital systems that can deliver the right type of intervention to a specific user at the right time and in the right context [8, 9, 10]. Of course, such adaptive interventions are not a given, but require the system to rely on its incessant access to the user and their context in order to predict their receptibility to certain interventions. Technically, such intelligent algorithms are developed using experimentation and statistical modeling (i.e., micro-randomized trial) [11] or more recently through reinforcement learning with user feedback (i.e., user compliance as reward) [12].

A second flourishing research direction is using AI to understand health behavior change through the means of building user models [13]. One decade ago, van Wissen explored the use of agent-based modeling for behavior change in her PhD thesis [14]. One example is the Computerized Behavior Intervention (COMBI) model that provides a knowledge base for digital systems to automatically reason about users' bottlenecks for behavior change. In the context of JITAI, researchers also advocated the importance and potential of modeling human behavior change as complex dynamic processes [15], e.g., as a reinforcement learning process [16]. Finally, the first author proposed a psychological computing approach to digital lifestyle interventions in his PhD work [6]. For instance, a cognitive model of how people form health-related habits was built, which allows digital intervention systems to track users' progress in behavior change [17].

The last approach concerns the use of social AI, such as social robots or chatbots, for delivering interventions [18, 19]. One drawback of using digital systems for intervention and especially persuasion is the lack of social influences and communication capacities. The use of social robots or chatbots addresses this issue by bringing a stronger sense of social presence and agency [20]. In addition, researchers have started to ask the question whether interventions through social control would be more effective if long-term emotional bonds can be formed between artificial agents and users [21].

We believe that a lot more research can be done at the intersection of AI and health behavior change. For one thing, the three lines of research discussed above remain somewhat isolated and more integration can lead to fruitful outcomes. For example, social robots or chatbots can employ cutting-age machine learning methods to produce true social intelligence and cognitive models of human behavior may be used for training intervention agent using reinforcement learning [22, 23]. For another thing, with the explosion of new AI methods, bringing experts from all relevant disciplines together to examine these methods can lead to new research opportunities. Our proposed workshop is intended to serve these two purposes.

## 2. Planned Activities and Expected Outcome

We will organize a half-day workshop that combines research presentations and an interactive session. Below is a tentative schedule for the workshop.

**Introduction (10 min):** The organizing team will give a presentation about the context, aims and agenda of the workshop.

**Long presentations (105 min):** Three invited speakers will give keynote-style presentations that summarize significant research progress in a topic area, each for 30 minutes with 5 minutes for Q&A.

**Short research talks (60 min):** After a short coffee break, six workshop participants present recent research works in 10-min presentations.

**Interactive session (60 min):** Depending on the expertise and interests of the workshop participants, the organizers will prepare a few themes for discussion. This session will be followed by informal interactions with drinks.

We expect the workshop to achieve the following outcomes: (1) Increased awareness and publicity for the use of AI methods in health behavior change research at the regional and international level; (2) A collection of cutting-edge research ideas and programs that can benefit from discussion with experts in the fields; (3) A identification of boundary conditions for applying AI methods in health behavior change (e.g., what target groups and/or health behaviors are more susceptible to AI-driven interventions, what magnitude of change can be achieved?); 4) New collaborations among the workshop participants, with the potential to write a review and perspective paper on the topic of AI for health behavior change.

### 3. Organisers

The workshop will be co-organized by a multidisciplinary team of researchers from several institutes, with expertise in psychology, AI, and human-technology interaction.

**Chao Zhang** is an Assistant Professor in the Human-Technology Interaction group at Eindhoven University of Technology (TU/e). His PhD thesis completed in 2019 at TU/e was on the topic of developing intelligent systems for health behavior change. His current research focuses on computational modeling of health-related decision-making and habit formation, and on human-centered AI in general.

**Shihan Wang** is an Assistant Professor in the Intelligent Systems group at Utrecht University. She has strong expertise in a variety of AI-related methods, including reinforcement learning, data mining, and social network analysis. She applies these methods to the application domain of health and mobility.

**Baptist Liefoghe** is an Assistant Professor in the Department of Psychology at Utrecht University. Trained as a cognitive and experimental psychologist, he started to apply fundamental psychological knowledge to real-world behavior change problems in recent years. He is also a co-coordinator of the “AI for Behavior Change” special interest group at Utrecht University’s Human-Centered AI focus area.

**Hanne Spelt** is a research scientist at Philips Research. She obtained her PhD at TU/e in 2020 on the topic of the psychophysiology of persuasion. At Philips Research, she continues to work on projects relating to digital applications in the domain of personal health, e.g., patient preparation for MRI scanning for adults and children.

**Jiaxin Xu** is a PhD student in the Human-Technology Interaction group at TU/e. His PhD project focuses on designing health persuasive human-robot interaction (HRI). Specifically, he intends to develop effective HRI design patterns that improve social robots’ persuasion for changing people’s health behaviors and improve the establishment of socioemotional human-robot relationships.

**Wijnand A. IJsselstein** is a Full Professor in the Human-Technology Interaction group at TU/e. His current research focus is on conceptualizing and measuring human experiences in relation to digital environments in the service of human learning, health, and wellbeing. He also has a keen interest in the relation between data science, AI and psychology, and works on technological innovations that make possible novel forms of human behavior tracking, combining methodological rigor with ecological validity.

## 4. Promotion Strategy

Once our workshop proposal is accepted, we will set up a webpage with detailed information about the workshop and announce a call for participation. Potential workshop participants will be asked to submit an extended abstract about their recent work (published or unpublished) on one of the following topics: (1) AI methods for empowering digital intervention systems (e.g., tailor and adapt intervention) (2) AI as a means to understand health behavior change processes (e.g., through cognitive modeling); (3) Interventions through social robots or chatbots; (4) Psychological and ethical aspects of using AI for promoting behavior change. The webpage and the call will be distributed through the personal networks of the organizers, social media, relevant mailing lists, and institutional channels (e.g., the Eindhoven AI Systems Institute, Utrecht University's Human-Centered AI focus area).

We will send out invitations to a few high-profile researchers who have done significant works on applying AI methods to health behavior change. Once the three invited speakers are confirmed, their names will be added to the webpage and other promotion materials to attract more participants and attendees.

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