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Personalization of digital health interventions: challenges and current best practices

Laura H.H. Winkens, Felix Naughton, Anouk Middelweerd, Olga Perski
and Monique Simons

Abstract

The 2024 EHPS roundtable on personalized digital health interventions brought together experts and participants for lively discussions and shared insights. Drawing on survey results and these conversations, this article explores the key challenges in advancing personalization, such as limited theoretical guidance, technical and data complexities relating to the dynamic adaptation of intervention delivery, and keeping users engaged over time. Participants emphasized the urgent need for focused research to better understand long-term engagement, use data science more effectively, and strengthen theoretical foundations. They also highlighted that strong interdisciplinary collaboration and ongoing user involvement are crucial to unlocking the true potential of personalized digital health interventions.

Key words: Theory development, User engagement, Stakeholder involvement, Sustained collaboration, Dynamic Adaptation, Machine Learning

Introduction

This paper reflects on the discussions held during the roundtable titled "Personalization of digital health interventions: Sharing and advancing best practices" at the European Health Psychology Society (EHPS) conference 2024 in Estoril, Portugal. Convened by Laura Winkens, the roundtable began with a survey to gain insight into participants' perspectives, followed by three thought-provoking presentations from Prof. Dr. Felix Naughton, Dr. Olga Perski, and Dr. Anouk Middelweerd. Their presentations covered their experiences, challenges, and best practices in the field and are available at `https://osf.io/su6rm`. This was followed by an interactive discussion with the speakers serving as an expert panel.

Through this engagement with the EHPS community, common challenges were identified, and strategies for addressing them were shared. This paper consolidates those insights to foster collaboration and advance the development of personalized digital health interventions.

Summary of the presentations

Personalized digital health interventions are becoming increasingly prominent within health psychology due to their potential to tailor intervention strategies to individual needs, preferences, and contexts. Designing and developing these interventions presents unique opportunities and challenges, from selecting appropriate theoretical foundations to employing rigorous evaluation methodologies.

Dr. Olga Perski highlighted a significant challenge in drawing on current theories (and, by extension, causal frameworks) to inform the personalization used within an intervention. She noted that current theoretical models often lack specificity regarding within-person temporal dynamics of behavior change (Spruijt-Metz et al., 2015). To address this, Dr. Perski proposed two key steps: developing formal, dynamical systems models to represent the evolving nature of individual health behaviors and refining these models through within-person observation and experimentation, leveraging methods such as system identification (Hekler et al., 2018; Perski et al., 2024). This iterative refinement can inform the creation of reinforcement learning algorithms or 'controllers', enabling interventions to adapt in real-time to an individual's changing needs and progression of behavior change (Hekler et al., 2018). This approach aims to bridge the gap between theory and practice by grounding personalized interventions in a dynamic understanding of health behavior change.

Prof. Dr. Felix Naughton addressed the challenge of maintaining user engagement in dynamic digital interventions, which, in order to be personalized, typically require significant user input (e.g., to tailor content) and sustained engagement (e.g., to refine recommendations over time). He emphasized that real-world uptake and effective engagement (Yardley et al., 2016) are crucial for the public health impact of these interventions and to attain the benefits of personalization. To help improve this, we need to identify and target determinants of engagement. Citing a systematic review, Prof. Naughton highlighted 26 factors influencing engagement, categorized into capability, opportunity, and motivation components (Szinay et al., 2020). The example of motivation, including intentions, reinforcement, and emotion, was given and he suggested that gamification, conversational agents, and peer or clinician support could be ways to target key motivational determinants. Other potential targets to promote engagement included memory and attention as capability determinants, and the environment and context as opportunity determinants. He also pointed

out three major engagement challenges: 1) that to provide personalized support some systems require extensive user input and engagement to function effectively (high data demand) but this is seldom achieved, 2) the need for approaches to sustain long-term engagement where this is required, particularly for continued personalization, and 3) reaching low engagers, since individuals who engage the least are often those most in need of support.

Dr. Anouk Middelweerd emphasized the importance of involving a diverse range of stakeholders and maintaining ongoing collaboration throughout the development of personalized digital health interventions. She highlighted several key challenges, including the need for a holistic monitoring approach (e.g., lifestyle behaviors, psychological factors, clinical parameters) using wearables (e.g., Fitbit, Garmin), self-report tools (e.g., food diary, ecological momentary assessment), and sensors (e.g., glucose sensors) to meet individual preferences (Marsch, 2020). However, such comprehensive monitoring is still uncommon, as many personalized eHealth interventions rely on a single type of variable for personalization (Klooster et al., 2024). Engaging patients, healthcare providers, and behavioral scientists from the start was highlighted as being crucial for tailoring interventions effectively and ensuring they address diverse needs. Additionally, handling missing data was also raised as a significant issue for personalization. Collaboration with data scientists was considered essential for developing techniques to manage incomplete data, while also respecting patient privacy and data-sharing preferences. Cost and accessibility are other critical concerns; high costs and integration challenges can impede widespread adoption, particularly among vulnerable populations. Engaging stakeholders such as insurance companies, policymakers, and healthcare organizations early on was indicated to help address these barriers and ensure interventions are affordable and accessible. Dr. Middelweerd ended by lobbying for the involvement of stakeholders from the outset, so interventions can be designed to be both technically feasible and user-friendly, maximizing their effectiveness in real-world settings.

Reflection on survey responses

The results of the survey, while unlikely to be representative of the EHPS community, offer valuable insights into the current state of personalized digital health interventions, particularly regarding the diversity of experiences and challenges faced by the respondents.

Diverse levels of experience

A total of 22 respondents completed the survey of which 12 utilized personalization in their research. The other 10 respondents expressed curiosity about personalized digital health interventions but had no prior experience, indicating increasing interest among the EHPS community. It is promising to see that several early- and mid-career researchers (7 out of 22) are actively planning or conducting work in this area, although this included only one PhD student.

Domains of application and personalization factors

The 12 respondents who utilize personalization indicated a wide range of application areas, including physical activity (n=7), nutrition (n=5), (chronic) disease management (n=4), and mental well-being (n=3), showcasing the versatility of personalized interventions.

When asked about the personalization factors employed, respondents (n=12) highlighted emotions and stress (n=7), personalized goals (n=7), socio-demographics (n=6), current behaviors (n=6), interpersonal factors (n=5), environmental factors (n=4), and time of day or agenda (n=4). These factors are primarily measured through app-based questionnaires at fixed time points (n=8) or random moments (n=4), along with data from wearables (n=6) and app usage patterns (n=3). The frequent reliance on emotions, stress, and personalized goals indicates a focus on tailoring interventions to users' mental and emotional states, while the inclusion of time-sensitive factors, such as agenda and time of day, suggests attempts to deliver support at optimal moments.

Type of data and personalization models

The most common personalization methods include periodically updated data (n=5) and real-time data streams (n=3). The reliance on regularly updated data suggests many interventions have yet to fully utilize real-time data streams and adaptive capabilities, presenting an area for future growth. The limited use of AI and machine learning (n=3) suggests there is still potential for these technologies to be integrated into health interventions.

Challenges identified

The top challenges raised by respondents (n=12) included the lack of sufficient theories (n=6) and difficulty applying behavioral theories (n=5), emphasizing the need for further theoretical development. Other important issues, such as a lack of available data to base decisions on (n=7) and technical complexities (n=10) call for more inter- and trans-disciplinary collaboration. However, engaging stakeholders aside from end-users (e.g. intermediate users such as health professionals) in the design is another challenge mentioned often (n=5). Moreover, concerns about user compliance (n=5 for compliance with intervention components and n=3 for compliance with data collection) underline that even when personalization strategies are developed, the practical application still faces significant engagement hurdles.

Machine learning presents its own challenges, with participants noting difficulties in algorithm development (n=6) and maintaining up-to-date algorithms (n=4). So, despite its promise, many researchers and practitioners are grappling with how best to develop and apply such data science approaches effectively. Likewise, a lack of expertise across multiple domains (n=7) shows that personalized digital health interventions require a broad knowledge base that spans technology, healthcare, data science and behavior change.

Needs for future development

Finally, the expressed need for education (n=7), a network (n=7), and collaborators (n=9) underscore a desire for greater collective efforts in pushing the boundaries of personalization. This is consistent with the growing recognition that advancing this field will

require more extensive collaboration across disciplines and better access to educational resources. Creating structured opportunities for training, networking, and interdisciplinary collaboration could be crucial next steps.

Summary of the discussion

Firstly, the need for long-term engagement required for personalization was debated. The discussion highlighted that personalization could enable dynamic app engagement, where users only need support until they have internalized strategies and are capable of maintaining them without ongoing technological assistance. Adaptive push notifications, for example, could detect when users have transitioned into a maintenance phase and no longer need prompts, tailoring the intervention to their individual progress.

The conversation also delved into the opportunities and challenges of collaborating with commercial partners. One key advantage of such partnerships is access to large datasets and the financial resources to create user-friendly, visually appealing interfaces. However, the potential pitfalls were also noted. Commercially driven interventions may lack a solid theoretical underpinning, and differing motivations between commercial and research partners can complicate the development and implementation of behavior change interventions.

Lastly, the importance of theory development in digital health interventions was emphasized. While there are numerous digital health apps in use, a key point raised was that many apps do not perform as well as expected. To rigorously address what makes an intervention effective, for whom, and why, developing theoretical understanding alongside practical applications is essential. Without a robust theoretical foundation, it is difficult to generalize and upscale findings or improve intervention efficacy in a targeted way.

These discussions underscore the need for a balanced approach that integrates theoretical rigor with practical, user-focused design and highlights both the promise and complexity of personalizing digital health interventions. This approach should also be adaptable to rapidly evolving technologies, ensuring that interventions remain relevant and effective as new advancements emerge.

Conclusion and next steps

The survey results and the discussion reflect both the enthusiasm and the complexity surrounding personalized digital health interventions. While many are eager to explore the possibilities, the barriers are significant—ranging from theoretical gaps to technical and data (science techniques) challenges. To move the field forward, attention should be placed on overcoming these hurdles through better education, interdisciplinary collaboration, developing more robust theories and frameworks, applying data science techniques, enhancing user engagement strategies and exploring effective collaborations with commercial and technical partners. These findings set the stage for the next steps in co-creating solutions that address these barriers while maximizing the potential impact of personalization on health outcomes.

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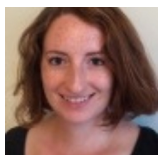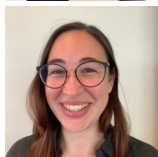
Laura H.H. Winkens works at Consumption and Healthy Lifestyles, Wageningen University & Research, The Netherlands.
ORCID: 0000-0002-9856-6509.
Email: `laura.winkens@wur.nl`
Website: `https://www.linkedin.com/in/laurawinkens/`

Felix Naughton works at the School of Health Sciences, University of East Anglia, United Kingdom.
ORCID: 0000-0001-9790-2796.
Email: `f.naughton@uea.ac.uk`
Website: `https://www.linkedin.com/in/felix-naughton-3461aa173/`

Anouk Middelweerd works at University of Twente, Biomedical Signals and Systems, Enschede, The Netherlands.
ORCID: 0000-0002-1274-968X.
Email: `a.middelweerd@utwente.nl`
Website: `https://www.linkedin.com/in/anouk-middelweerd-b778a226/`

Olga Perski works at University of California, San Diego, United States and Tampere University, Finland.
ORCID: 0000-0003-3285-3174.
Email: `olga.perski@tuni.fi`
Website: `https://www.olgaperski.com`

Monique Simons works at Consumption and Healthy Lifestyles, Wageningen University & Research, The Netherlands.
ORCID: 0000-0002-6475-4616.
Email: `monique.simons@wur.nl`
Website: `https://www.linkedin.com/in/mosimons/`