Promoting Healthy Eating by Design: Opportunities for Meaningful Persuasive Technologies

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ABSTRACT

While eating behavior has a considerable impact on people's health and well-being, it is well known that changing food practices is an incredibly difficult endeavor. People often lack motivation to modify their diet, and a variety of barriers prevent them from adopting a healthy lifestyle. In this paper, we recount the preliminary findings of the PHaSE project by exploring how people conceptualize food and their eating behaviors. Through a series of co-design workshops, we discovered that people ascribe a variety of meanings to food, spanning from health concerns to emotional relief. These meanings play a crucial role in the process of change. Based on the study findings, we suggest that designers should address the meanings associated with food, rather than placing exclusive emphasis on the behavior to be changed. Additionally, they should promote sense-making and reflection on food practices.

Keywords: Persuasive technologies, Behavior change, Food tracking

INTRODUCTION

Eating behaviors have considerable impact on health and well-being. Good nutrition may prevent people from developing chronic diseases, ameliorate mental health, and increase the overall quality of life (Chen et al., 2020). Despite its undeniable benefits, making people embrace a proper diet, or change an unhealthy one, is an incredibly difficult endeavor, because people often lack motivation to modify their own habits (Munt et al., 2017).

In this context, digital technologies may provide support. Persuasive technologies are devices and software applications designed to modify users' behavior (Fogg, 2009), which are now becoming increasingly popular. For example, weight loss apps offer personal digital coaches, calories tracking, and exercise plans to support people in changing their eating habits (Guluzade & Sas, 2024). Nevertheless, despite their popularity and the increasing academic research on persuasive technology, there is a rising wave of concern within the Human-Computer Interaction (HCI) community about these systems' capabilities to produce long-lasting behavior changes (Caraban et al., 2019). Users may stop using persuasive apps prematurely, undermining their potential benefits, due to lack of engagement (Jakob et al., 2022; Jakob et al., 2024): research has shown that fewer than 10% of users keep using these applications after the first seven days of usage (Baumel et al., 2019).

A significant issue in these tools is that they often have a "narrow" perspective on behavior, viewing it as an objective phenomenon that can be modified "from the outside", whereby eating is largely influenced by the individual's personal and subjective experience (Rapp and Tirassa, 2017). This experience is primarily meaning-laden and driven "from the inside", where the individual's perceptions, values and motivations play a fundamental role (Rapp et al., 2019; Rapp and Boldi, 2023).

In this paper, we report on the preliminary findings of the project Promoting Healthy and Sustainable Eating through Interactive and Explainable AI Methods (PHaSE), which is aimed at supporting sustainable and healthy food practices. Within the project, we conducted three co-design workshops for identifying design opportunities to create applications that shift the focus from the "external modification of the behavior" to its lived and subjective experience.

More in detail, we recruited 13 participants (age min 28 – age max 78; females = 7): some of them already attempted to change their diet, whereas others were simply interested in what they eat. We asked participants to discuss the reasons why they were able (or unable) to change their diet and reflect on the meanings they commonly ascribed to food. Participants reported their lived experience of behavior change, describing their own struggles in modifying their diets and the potential of technology to influence their own eating behaviors: they stressed the need to change the meanings and the emotions that people habitually associate to food, to produce long-lasting behavior change. The main contribution of this paper is to highlight a series of meanings that people commonly attach to food and eating habits, which may ground the design of novel technologies addressed to change people's eating habits.

BACKGROUND

By and large, current behavior change designs rely on two main approaches. The first highlights the role of reflection and rational processing as the means to produce behavior change (e.g., Ploderer et al., 2012). The second focuses on the automatic, mindless effects that technology may elicit through behavioral cues and nudging mechanisms (e.g., Caraban et al., 2019).

The "reflective" approach is supported by the increasing availability of behavioral data (like the daily caloric intakes) provided by self-tracking devices (e.g., Rapp and Cena, 2016; Rapp, 2018; Boldi et al., 2024). It generally assumes that individuals lack self-awareness of their own behavior and that gaining more "self-knowledge" can lead to behavioral change (Rapp and Tirassa 2017). Applications leveraging behavioral data may encourage users to reflect on their behavior (Reitberger et al., 2014; Bomfin et al., 2020; Choi et al., 2024; Rapp & Tirabeni, 2020) but rarely promote sense-making or allow users to modify the meanings that they usually associate with food and their eating habits.

By contrast, the "mindless" approach draws from behaviorism and behavioral economics. This approach either uses "environmental cues" to reinforce certain behaviors or introduces subtle changes in how choices and

information are presented, guiding users toward desired behavior (Caraban et al., 2019). Technologies based on this approach also exploit people's heuristics (i.e., mental shortcuts) and biases (i.e., systematic deviations from rational judgment) to promote behavioral change (e.g., DiCosola III and Neff, 2022). The mindless perspective puts emphasis exclusively on the target behavior, overlooking the wider life context in which it occurs, as well as the subjective meanings that people may associate with their eating habits.

Whether adopting a reflective or mindless approach, technology places significant emphasis on the behavior, while the lived and subjective experience of change is often overlooked. However, this subjective experience is crucial for producing long-lasting changes, as highlighted by literature that explored how people reflect on their attempts to modify their behavior (Rapp, 2017; Rutjes et al., 2019; Rapp and Boldi, 2023).

METHOD

Within the PHaSE project, we conducted three online workshops to explore how people reflect on their food practices and their attempts to modify their eating habits. Each workshop lasted approximately 2 hours and was divided into four distinct phases. In the first phase we introduced the PHaSE project, its objectives, and the workshop goals. In the second phase, we engaged participants in an exercise focused on mapping the meanings of food. This activity was aimed at unveiling the values, meanings, and emotions that participants associate with food. An example of the stimuli provided during this phase are the following questions: "*Can you list three words that best represent what food means to you?*" "*Can you share a personal anecdote related to one of these words?*". Participants wrote their responses or verbalized them in a shared space. In the third phase, the participants co-designed a series of persuasive conversational strategies, meant as features that a conversational agent should have to be effective in promoting behavior change. Finally, in the fourth phase participants were invited to provide feedback on the workshop experience.

In this paper, we will focus on the recounting of the findings coming from the second phase of the workshop, when the participants mapped the meanings they usually ascribed to food and reported on their lived experience of their behavior change attempts.

The workshops involved a total of 13 participants (age min 28 – age max 78; females = 7). This sample size aligns with typical practices in qualitative research (Marshall, 1996) and similar HCI studies with comparable objectives (Zhao et al., 2024), since qualitative research focuses on gaining deep insights from a small group rather than aiming for generalization (Marshall, 1996).

We followed a purposeful sampling technique, a gold standard in qualitative research (Marshall, 1996), which involves actively selecting the most relevant participants to address the research questions: researchers determine the variables that could affect a participant's contribution based on their expertise in the research area and prior literature. This approach is commonly applied in qualitative HCI studies (e.g., Boldi et al., 2024).

We primarily distinguished the workshop participants based on their willingness to change their eating behaviors and their level of interest in food-related topics. This is supported by prior research indicating that these factors may influence expectations about behavior change technologies (Rapp and Boldi, 2023). Furthermore, we adhered to the principle of theoretical saturation (Bowen, 2008), which suggests that further data collection and analysis are not needed once sufficient information has been gathered to meet the study's goals.

To capture a wide range of perspectives, life experiences, and dietary behaviors, we prioritized inclusivity across various dimensions. We thus ensured age diversity, with participants ranging from young adults (28 years) to seniors (78 years), and balanced gender representation. Moreover, occupational diversity was considered by including professionals, retirees, and homemakers. Additionally, we included participants with varying educational backgrounds, from elementary school to advanced university degrees.

All workshops were recorded to document both verbal discussions and visual interactions with shared materials (such as digital brainstorming boards). These recordings were transcribed verbatim. We then employed thematic analysis (Braun and Clarke, 2006) to analyze the transcriptions and the materials produced by the participants during the workshops. Thematic analysis is a common method in qualitative research and HCI due to its flexibility and independence from a specific epistemology. The analysis first involved to become familiar with the data by reading the transcriptions and notes multiple times. Then, we defined initial coding, where the data were divided into meaningful segments (e.g., participant quotes) and codes were assigned to each segment. Subsequently, we grouped the codes into broader categories or themes and eventually we refined the themes through an iterative review to ensure they were distinct, coherent, and aligned with the study aims. The study was approved by the ethical board of the University of Turin.

FINDINGS

Participants highlighted the role of food in health, social relationships, daily routines, and cultural traditions. Not only did they describe the various meanings they ascribed to food, but also how these meanings influenced their motivation to make dietary changes, and the barriers they encountered in doing so.

Firstly, food was widely recognized by the participants as a crucial element for both physical and mental well-being, being often linked to energy levels and vitality. For some of them, setting health challenges was a significant motivator for dietary changes. P02 (Workshop 1) explained, "*If you are overweight, your back pain increases, your foot pain worsens... maybe you feel tired, always sleepy, and get migraines. Then you start to think: 'Wait a minute, maybe my weight is too high, and this leads me to pathologies.' For me, it becomes a health issue. I pay attention to what I put on my plate because of this... it's about energy and feeling good*." The decision to change

food behaviors, therefore, was often driven by the need to prioritize health and well-being.

In addition to health concerns, participants often connected food with daily productivity, mental focus, and emotional balance. P07 (Workshop 2) reported that dietary choices impacted the ability to stay focused and energized throughout the day: "*You realize that pasta weighs you down in the evening, you sleep worse, and then maybe you even avoid eating heavier things... these tricks mature over time and become habits.*" Likewise, P09 (Workshop 3) reflected on how menopause acted as a wake-up call, explaining, "*I realized that if I didn't adjust my diet, I'd keep gaining weight, which was affecting how I felt both physically and emotionally.*" Such moments of realization often served as turning points, encouraging participants to take concrete steps toward healthier practices and redefine their relationship with food.

Secondly, food often implied deep emotional significance for participants, serving as a coping mechanism in response to stress. For instance, P11 (Workshop 3) reported that she turns to food when feeling overwhelmed, thus gaining immediate comfort but often reinforcing unhealthy eating patterns. Conversely, P09 (Workshop 3) described how anxiety can lead to loss of appetite: "*When I'm anxious, I completely lose my appetite.*" These contrasting experiences highlight the complex interplay between emotions and eating behaviors, where food can become both a source of solace and a manifestation of emotional struggles. The connection between emotions and food often prevented participants from making healthier dietary changes, as using or avoiding food to manage stress made it difficult to break free from established habits.

Thirdly, food was often seen as a key element for strengthening relationships, with participants emphasizing how shared meals may foster social bonds. P10 (Workshop 3) highlighted the importance of eating together, discussing how communal eating can transform an everyday activity into a meaningful interaction. In this sense, eating practices may also be shaped by the desire to care for others. For instance, P12 (Workshop 3) made dietary adjustments while caring for her husband, highlighting how the health and well-being of loved ones can serve as a powerful motivator to change. Likewise, external encouragement coming from others, such as friends, family members, and colleagues, can support dietary changes. P02 (Workshop 2) described how the support of a partner who shared the same commitment to healthy eating made it easier to stay on track: "*Having someone next to you who is a motivator can help a lot. I speak from personal experience: the motivator is not me, but my partner. She pushes me to keep up with these things, otherwise I wouldn't make it.*" P11 (Workshop 3) also explained: "*Now, after my daughter gave birth, we decided together to focus on taking better care of ourselves through our eating habits, not to satisfy others' judgments but for our own well-being. It feels good.*"

Fourthly, cultural traditions surrounding food shaped participants' eating practices, influencing not just how meals were prepared, but the expectations tied to them. For example, P1 (Workshop 1) stressed that family culture influenced their food choices: "*I come from a family culture where we always*

had a complete meal with a first course, second course, side dishes, and dessert on Sundays. The meal was always full." Similarly, P2 (Workshop 1) noted that "*I come from a culture where the abundance of bread, pasta, and sweets was normal. I've never had a 'health-conscious' culture or an informed approach to food.*" Cultural traditions, particularly those related to food quantity, types of meals, and family routines, become tacit norms and are deeply embedded in shared experiences and relational dynamics. These traditions can make it challenging for individuals to adopt healthier eating habits, as modifying dietary behaviors risks disrupting important social connections and taken-for-granted rules. While a shared commitment to health, as reported before, can serve as a powerful motivator for change, the social significance of food can also act as a barrier, as altering eating practices may conflict with established collective norms and routines.

Lastly, several participants considered food as part of a daily routine, an obligatory "task" of their day. P05 highlighted that food, despite being essential, could feel burdensome: "*During the week, food feels like something I have to manage between tasks.*" Similarly, P06 (Workshop 2) explained how work pressures affected his relationship with food, making it something to be squeezed into an already packed schedule: "*I don't have time or energy to focus on the pleasure or health benefits of food.*" As a result, food became a compulsory part of the day, rather than an act of enjoyment or self-care. In this sense, time constraints emerged as a significant barrier to healthy eating, especially for participants juggling work and personal responsibilities, pushing towards more convenient but less healthy options.

LIMITATIONS

The purposeful sampling we conducted, by selecting participants who had already attempted to change their diet or who were simply interested in what they eat, may have limited the generalizability of the study findings. Although we aimed to include participants with varying levels of willingness to change their eating behavior, individuals who are indifferent to diet were not included, potentially leading to overly optimistic results. Future research could explore the needs and predispositions of these populations regarding persuasive technologies for healthy eating.

CONCLUSION

Workshop participants highlighted that food and changing eating habits are not important per se. Rather, they are associated with a variety of meanings, which pertain to health and well-being, emotional life, important relationships, cultural traditions, and daily routines. In this sense, while technology puts emphasis almost exclusively on behavioral information (Rutjes et al., 2019; Rapp and Boldi, 2023), participants highlight that often there is a deeper meaning underlying a certain behavior change goal, and it is this meaning that technology should address to produce an enduring change in behavior. Changing such meanings associated with the target behavior, as well as making the person aware that its modification is important by

promoting reflection and sense-making, appears thus essential for achieving long-lasting changes. However, current technologies often are not able to support sense-making and lack features that encourage user-driven reflection, thus frustrating insight generation based on lived experiences.

Designing technologies that address the meaningful and lived experience of change is certainly a difficult endeavor. A promising avenue that is in line with this goal lies in the field of conversational agents (Rapp et al., 2021). Here, previous research has designed agents that emulate active listening (Lim et al., 2019) and encourage empathetic responses (Lisetti et al., 2013), while recent advancements in Large Language Models (LLMs) could lead to developing technology able to deliver interventions that really encourage sense-making around the person's relevant meanings attached to food. This would also promote the user's agency, making them feel like the driver of change, rather than the subject of a predefined program who follows a prescriptive approach (Rapp, 2019). In this sense, the PHaSE project, grounded on the findings recounted in this paper, aims to design an LLM-based chatbot able to suggest healthy and sustainable recipes, as well as to modify the person's relevant meanings associated with food and eating habits.

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