From The Art of Reflection to The Art of Noticing: A Shifting View of Self-Tracking Technologies' Role in Supporting Sustainable Food Practices

Janghee Cho

janghee.cho@colorado.edu
Department of Information Science,
University of Colorado Boulder
Boulder, Colorado, USA

Laura Devendorf

Laura.devendorf@colorado.edu
ATLAS Institute & Department of
Information Science, University of
Colorado Boulder
Boulder, Colorado, USA

Stephen Volda

svoida@colorado.edu
Department of Information Science,
University of Colorado Boulder
Boulder, Colorado, USA

ABSTRACT

This paper explores the possibility of using self-tracking technologies to promote sustainable food habits. To explore socio-cultural aspects in food practices and to understand the potential role of self-tracking tools in participants' everyday lives, we designed and deployed a probe kit with seven participants. We found that (1) participants had differing, and at times conflicting, conceptions of what made their diet sustainable; (2) they viewed self-tracking tools as an unobtrusive means to help them achieve a goal—but didn't report that those goals were ever met; and (3) they expressed strong associations between particular eating behaviors and rituals and/or holidays. Reflecting on the results and the concept of design (in)action, we suggest an alternative way of designing self-tracking tools for self-reflection (i.e., *the art of noticing*) that might help people draw attention to the impact of their food practices on the environment. We conclude by recommending a shift in focus from traditional and "always-on" self-tracking solutions to everyday practices, holidays, or rituals in which a technological tool could bring more attention to a particular facet of food sustainability.

CCS CONCEPTS

• **Human-centered computing** → *Human computer interaction (HCI)*.

KEYWORDS

reflection; sustainability; cultural probes; self-tracking; noticing; food; inaction; human-food interaction

ACM Reference Format:

Janghee Cho, Laura Devendorf, and Stephen Volda. 2021. From The Art of Reflection to The Art of Noticing: A Shifting View of Self-Tracking Technologies' Role in Supporting Sustainable Food Practices. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '21 Extended Abstracts)*, May 8–13, 2021, Yokohama, Japan. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3411763.3451838>

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CHI '21 Extended Abstracts, May 8–13, 2021, Yokohama, Japan

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ACM ISBN 978-1-4503-8095-9/21/05...\$15.00
<https://doi.org/10.1145/3411763.3451838>

1 INTRODUCTION

Many people consider climate change to be a distant threat in both space and time [41, 52]. Although more people are now recognizing the crisis of climate change based on media accounts, this issue is also easily forgotten due to cognitive limitations, as well [41]. People often underestimate the environmental impact of everyday food practices; however, they are actually highly associated with the emission of carbon dioxide¹. How then can we encourage people to consider climate change as a current issue of significant importance and to take action now?

Environmental sustainability has been a popular topic in human-computer interaction (HCI) research for more than a decade. Many efforts have been made to induce pro-environmental behaviors by designing, developing, and deploying technology (e.g., [18, 23]). However, these studies generally focus on reducing individual resource consumption and define success according to whether users change their behavior in ways predetermined by system designers [30]. Brynjarsdóttir et al. [7] warned that these narrow approaches can fail to capture a complex set of socio-cultural particularities (e.g., socioeconomic or cultural background) that implicitly foster or hinder pro-environmental behaviors. An intrinsic motivation based on personal knowledge and experience is an important factor for promoting pro-environmental behaviors, but external factors also largely influence them [13]. For instance, Ganglbauer et al. [26] found that the busyness of working lives has a decisive effect on sustainable behaviors. By shifting the primary focus from individual action to everyday practices, researchers have examined how technology might be used to promote environmentally sustainable lifestyles (e.g., [24, 34, 47]). Building upon these contributions, our work explores *if and how self-tracking technologies might serve as a tool to support self-reflection on the sustainability implications of people's diet*. Typically, self-tracking technologies have been designed to capture longitudinal data and support reflection to promote new perspectives and behavior change [9, 35, 40]. These technical supports for fostering reflection might provide an opportunity for people to revisit and make sense of their food practices.

We believe that reflection can play an essential role in addressing this problem. Reflection includes those intellectual and affective activities in which individuals make sense of their experiences in

¹Food waste and a meat-centric diet are the third and fourth largest factors of the emission of carbon dioxide: <https://www.drawdown.org/solutions-summary-by-rank>, retrieved February 2020

order to transform their understanding of their behaviors and to encourage them to contemplate wider implications of their behavior [2, 6, 21]. Reflection allows people to engage in alternative ways of knowing to gain awareness by critically assessing the presuppositions on which beliefs, values, and behaviors have been built [38, 46]. Supporting reflection is viewed as an alternative way to overcome a dominant approach (i.e., persuasion) in designing behavior change interventions [3, 7]. This is because reflection is viewed as a descriptive and appraisive notion rather than prescriptive or designative one [38, 45]. Subjective meaning-making—how people make sense of themselves and social situations—can lead to long-term positive behavior changes by reinforcing more adaptive meanings and support better trajectories [50]. Rapp et al. argued that reflection allows people to make sense of their lived experiences, leading to consideration of more holistic perspectives and inducing individual behavior change [42]. Therefore, our study aims to contribute to an understanding of when and how self-tracking technologies might be meaningfully situated in everyday lives to stimulate reflection on food practices (i.e., reflective informatics [2]), rather than to develop a particular technological intervention intended to persuade people to change their behaviors in a prescriptive manner (i.e., persuasive technology [22]).

Here, given our focus on food practices and particularly on “food consumption” [11], our work explores the potential interaction among self-tracking, reflection, and food-oriented sustainable decision making. Although the potential of reflection to stimulate sustainable behavior has often been discussed as an alternative to persuasive approaches [7, 32, 51], to the best of our knowledge little research has focused on the reflective practices associated with food-related behaviors [25, 48]. Bertran et al. [1] identified that the majority of published research in the Human-Food Interaction (HFI) field focus on development of new functionality in the digital technology, giving technologies the authority to shape human’s food experiences, which might arguably lead to an increasing distancing between people and the impact of their food consumption. Our work seeks to understand the potential role of self-tracking tools in reflecting on food practices with more emphasis on individual experiences of food practices. To do this, we employed probes, inspired by the cultural probes approach [27], to explore socio-cultural particularities in food-related behavior, grounded in participants’ mundane experiences.

The contributions of this paper are twofold. First, we provide empirical findings demonstrating a notable gap between participants’ mental models of self-tracking technologies and their food-oriented sustainable decision-making practices. Second, by applying the concept of design (in)actions, we discuss an alternative way of scaffolding *self-reflection* (i.e., the art of noticing [49]) that might help people appreciate their everyday experiences to notice differently the impact of their food practices on the environment.

2 BACKGROUND

Self-tracking tools, also known as *personal informatics* (PI), refers to a class of systems that help people collect data about and reflect on patterns of individual behavior to gain self-knowledge and induce positive behavior changes [35]. Since a large variety of personal data can be gathered by ubiquitous and wearable technologies,

self-tracking tools have become a popular way to track physical behaviors, mental states, or food consumption in the course of individuals’ everyday lives. These tools epitomize the value of progress: they are mainly designed to capture longitudinal data and support reflection in generating insights for self-improvement and facilitating behavior change, grounded in a goal-oriented perspective. While a goal-oriented perspective has often been the dominant approach to designing self-tracking tools [35], Rooksby et al. presented a new perspective for understanding the use of self-tracking tools, foregrounding peoples’ lived experiences and their values [43]. Rather than techno-centric views that focus on how self-tracking tools can be more effective and efficient in helping people to achieve their goals, Rooksby et al. [43] emphasized the importance of a humanistic point of view on technology design in order to incorporate people’s diverse goals and idiosyncratic technology use in their lives.

In the body of self-tracking research, reflection plays a central role in generating insights about self-improvement and behavior change [20, 35]. With an increased interest in designing technologies for everyday contexts, many researchers in the field of HCI have examined how technology can be designed to support people’s reflection on experience and sense-making by conducting empirical studies or presenting conceptual frameworks of reflection (e.g., [2, 8, 21]). The main technical components of self-tracking tools (i.e., data collection and visual representation) have been expected to support self-reflection by augmenting people’s cognitive ability. For instance, aligned with a measurable and quantifiable goal informed by peoples’ overarching lifestyle objectives and values, self-tracking tools keep providing (typically visual) information that helps people revisit and review their past experiences. (See [2, 21] for more techniques to support reflection.)

The current discourse on reflection in self-tracking research often views reflection as a problem-solving process to cultivate *instrumental knowledge* [29]. Since the education literature is heavily influential as a basis for the theoretical frameworks of reflection employed in HCI [4], self-tracking tools are often designed to support reflection that aims to identify a problem and generate insights for a solution. This is because many approaches to reflection in the education literature assume that reflection is the thinking process associated with making good decisions by generating instrumental knowledge [10, 17, 38]. For instance, Dewey’s notion of reflection [17]—one of the most seminal work in educational research and practices—focuses on rational problem solving by applying the scientific method through deductive reasoning [37]. However, different humans’ interests determine the mode of reflecting on their experiences and discovering knowledge [37]. So in this study, we aim to explore how people might want to make use of self-tracking tools to reflect on their everyday food practices.

3 METHODS

Cultural probes are collections of evocative tasks meant to elicit inspirational responses from people—not comprehensive information about them, but provocative clues about their lives and thoughts [27]. The cultural probes approach takes on a reflective mode of inquiry for generating knowledge about what a potential future might be in a critical manner. Inspired by the cultural

Table 1: Activities in the workbook

<i>Activity</i>	<i>Prompts</i>
Activity 1	Tell me what you ate today. What is the most and least sustainable food you ate?
Activity 2	Tell me which foods you associated with different times of year. Do you have any seasonal eating habits?
Activity 3	Think about a recent purchase of any food or cooking ingredient. Was the item you purchased packaged in any materials (e.g., a plastic bag, a plastic bottle, or to-go box)? Tell me how the food was packaged and how many of these packages you've used in this week. How do you feel about using them? Did you have any left-over food? What was it? Have you thrown it away or composted it?
Activity 4 (current PI users)	(1) Take a picture of your self-tracking/wearable tool. (2) Take a walk for about 10 minutes (to anywhere). Along the way, take a picture of an object that you feel represents your relationship with the self-tracking/wearable. (3) Take a picture of your surroundings at a moment when you notice your self-tracking/wearable tool on you during the day.
Activity 4 (PI non-users)	If you were to use a self-tracking/wearable tool, what habits or behaviors would you be most interested in tracking? Are there reasons why you do not currently use a self-tracking/wearable tool?
Activity 5	To wrap up these activities, I'd like you to envision a new technological tool (or tools) that might help you to track and manage your food choices and habits. Using the clay, make a model of your new technology and place it somewhere in your home where it might be used. Note that your artifact does not need to be realistic. You can make or invent anything that might be plausible in the near future.

probes approach, in this study, we designed and distributed probe kits in a week-long field deployment. These probes enabled us to explore what people's everyday experiences with food look like and to co-speculate possible self-tracking technologies that might support food-related self-reflection and induce environmental-friendly behaviors. While food-tracking tools for personal health are already widely used (e.g., journals), technological tools, especially self-tracking tools, that support sustainable food practices are rarely developed and used. We felt that probes would be particularly useful in stimulating early conversations to help us understand individuals' personal definitions of and practices associated with sustainable eating.

3.1 Developing Our Cultural Probe Kits

Our cultural probe kit includes a booklet-format workbook with a set of five activities (Table 1), as well as diverse materials (i.e., color pens emoji stickers, memo papers, and clay) with which participants express and represent their thoughts and feelings while completing the activities. Our workbook was designed to invite participants to reflect on their food practices (Activities 1–3) and their relationships (if any) with existing self-tracking tools (Activity 4). Using open-ended prompts, activities were developed to elicit inspirational responses and to capture the complexity of everyday food understandings and practices. In the last activity (Activity 5), participants were asked to envision a new technology that would best merge sustainable food practices and self-tracking by reflecting on their earlier responses. To help them easily form and situate their novel technology sketches, we provided participants with modeling clay and asked them to photograph their creation *in situ*. Through these activities, we were interested in exploring socio-cultural particularities in food practices and learning how technologies can be situated in everyday lives to generate insights about how reflective

practices can be stimulated, thereby leading to pro-environmental behaviors.

Participants were asked to complete one activity a day, reflecting on their practice(s) over a period of time. We made two versions of the workbook, based on whether participants were currently using any kind of self-tracking tool. All activities and materials are the same between the two groups, except for activity 4. For people who have no experience in self-tracking tools, we asked why they did not use self-tracking tools and what habits or behaviors they would like to track if they were to use those tools.

3.2 Participants & Procedure

We recruited participants ($n = 7$) by posting flyers on campus, in local coffee shops, to online message boards, and also recruited from our personal networks. After participants returned a signed consent form², they were provided with an overview of how to participate in a probe study and given their kits. Participants then worked on the workbook activities at their homes for one week. After participants completed all probe activities, they were invited to a post-interview session. In this semi-structured interview, participants were asked to reflect on their probe responses. The interview lasted 30–50 minutes, and all participants were compensated with a \$20 gift card.

We transcribed the audio from the interviews and analyzed these transcripts alongside probe artifacts that were generated by participants. Our analysis is an iterative, inductive, qualitative coding approach employing open and axial coding [14]. In the first round of coding, we conducted open coding without analytical categories to elicit concepts that emerged from the data. These concepts were developed through axial coding to identify relations among data as emerging categories.

²Our study design was reviewed and approved by our university IRB.

Table 2: Demographic summary of participants (* indicates participants who self-identified as current users of self-tracking tools)

	Age	Gender	Profession
P1	27	Female	Freelance translator
P2*	28	Male	PhD student
P3	28	Male	PhD student
P4*	31	Female	PhD student
P5	21	Female	College student
P6*	25	Non-binary	Hospice care (Nurse)
P7*	64	Female	(Retired) computer professional

4 PRELIMINARY FINDINGS

In this Late-Breaking Work, we report our preliminary findings in terms of participants' lived experiences of food practices and the new technological tools they envisioned, as captured in the preceding workbook activities.

4.1 The Multifaceted Aspect of Sustainability in Food Practices

Our findings showed that participants have various notions about sustainable food; while some participants identified individual perspectives in food (e.g., nutritional value, financially sustainable life), others mentioned ecological perspectives (e.g., food packaging, food's carbon footprint). For instance, P1 thought that an apple is the most sustainable food because "an apple does not require packaging" and is "minimally processed." On the contrary, given the fact that an apple provides less usable energy, it was considered to be the least sustainable food by P2. Background knowledge and multiple forms of understanding also influenced participants' conceptual notion of sustainable food: while P7 thought canned beans are the most sustainable food because their container is recyclable, for P1 canned bean are still an unsustainable food compared with dried beans. P1 based this decision on knowledge about the zero-waste movement and believed that the ability to recycling packaging is not enough. Our findings highlight that people have their own folk theories [28] in terms of the idea of sustainable food that develop and evolve through everyday experiences.

4.2 The Resonance of a Mode of Life, Holiday, and Ritual in Food Practices

We found that the probe activities in the workbook made participants aware of their behaviors and helped them to reflect on their unconscious habits (e.g., 'When I buy groceries, this activity makes me wonder and it makes me worried about the energy' (P4), 'I was more conscious of like that food that I ate had a log of packaging on it.' (P5)). P4 even reported feeling guilty when she realized that she threw away so many leftovers and packaging. The feeling of guilt sometimes induces pro-environmental behaviors. For instance, P3 has tried to make sure things are recycled as much as possible to avoid feeling guilty: 'I feel very guilty if I don't try my best to make sure things are recycled.... I feel like guilty because I'm purposely not

being environmental' (P3). However, the feeling of guilt or consciousness in their food practices does not necessarily mean that participants' food practices become more environmentally sustainable. Participants reported being unable to pursue pro-environmental behaviors due to other aspects in their lives (e.g., lifestyle or economic reasons). For instance, even though P5 knew how bad it is to eat convenient food, both for her health and for the environment, she couldn't make more environmental-friendly choices due to her busy life: 'time is of the essence and so it's like, okay, I can cut corners by having food already prepared. So I'm hoping that once I graduate I'll have more time to cook' (P5). As previously mentioned [12, 24, 26], a busy lifestyle and financial constraints hinder pro-environmental behaviors. Socio-cultural aspects of seasonality and ritual practice in holiday foods also numbed participants to sustainable issues: 'I think Christmas is kind of a sacred...nothing can be wrong with Christmas' (P5). Our findings showed that participants frequently adopt a subjective point of view about their food practices, especially when recounting their lived experiences (e.g., childhood memories, holiday rituals). While our participants acknowledge the importance of pro-environmental behaviors for sustainability, their food practices are often heavily influenced by their socioeconomic or cultural backgrounds.

4.3 Prototype: Envisioning a New Technological Tool

Participants brought up interesting ideas for plausible tracking technologies in the last activity (Figure 1). However, we observed a mismatch between participants' imagined technology concepts and the complexity of their everyday lives. The two most common themes across prototypes are convenience (i.e., automatic tracking) and information seeking. For instance, P4 made a prototype that can automatically detect information about how much energy has been consumed to produce a particular food, from farm to table, and how much energy is wasted if she throws out leftovers or packaging. P5 made a "food scale" (their name) that can measure basic nutrients and detect any harmful chemicals contained in food when users put a spoonful of the food on the scale. P5 believed that 'it would be eye-opening to know about chemicals that are in [the food]' (p5). The prototype designed by P6 also automatically scans the nutrients, minerals, and calorie information of food.

Participants focused on convenience and novelty in their prototypes to help reflect on food consumption. Although potentially useful directions for future exploration, these prototypes were designed with an isolated perspective, with a heavy bias towards technologies that embodied values of efficiency and automation. At first, we had attempted to explore how self-tracking tools can be situated in participants' everyday space by asking them to propose a new technological tool based on their reflections throughout the week (Activity 5). The results, however, showed us how limiting self-tracking was in relation to the broader scope of their lives. The conceptual constraints in the proposed designs (i.e., the focus on the "technological new" [16]) of the prototype, might hinder the incorporation of participants' everyday practices in the designs, which is highly interwoven with individuals' food-related behaviors. For instance, P1 speculated a novel technology for food practice: '...people will keep upgrading existing furniture to smart

versions or using new apps on existing hardware. I could imagine an Alexa-like smart assistant for the kitchen.... In the distant future, I think bio-machines to track users' physical state may exist' (P1). However, those prototypes did not resonate well with her stated goals to promote environmental-friendly decisions in her life, and, in fact, she was even not interested in using the technologies that she proposed leveraging in the near future. The main bottleneck for environmentally sustainable behavior for P1 is not the awareness of the severity of the environmental issues, but her lifestyles and economic standing: *'It's not that I don't totally care, but I think the convenience and trying to maintain my lifestyle or how much I can spend is important.'* (P1).

Figure 1: Prototypes made as part of Activity 5 by P4 (left), an imagined plastic waste energy usage calculator; P5 (middle), a food scale and contaminant sensor; and P6 (right), a food ingredient and nutrient sensor.

5 DISCUSSION

Reflection is considered as a vital element in cultivating diverse forms of knowledge for making our life more meaningful. In the process of reflection, an individual's leading role in making sense of their experiences should be emphasized in order to support the expected outcomes of reflection, such as generation of knowledge or changes in perspectives or behaviors [6]. Fleck and Fitzpatrick also acknowledged that transformative and critical reflection can occur depending on how people assess information and critique their own mental models [21]. However, current self-tracking technologies are mainly designed to automate reflection on users' experiences, providing *ready-made* insights rather than scaffolding the process of *self-reflection*. Focusing on generating only instrumental knowledge through advanced data-driven techniques might be useful for helping people to understand the impact of their food practice on the environment. However, it does not mean that doing so will cause people to adopt more sustainable behaviors in ordinary moments of their life by actively seeing and analyzing data [15]. Reflection is a powerful means for making sense of experiences to broaden people's perspectives. However, finding the appropriate role of technology in scaffolding the meaningful reflection is not easy.

Previous research, including HFI field, urge that designers should consider whether adopting technological solutions that attempt to resolve our individuals or social issues are inappropriate or potentially harmful [5, 19, 31]. Our findings revealed that solutionism [39],

the idea that technological interventions can unilaterally solve individual or social issues, is also limited in its ability to promote self-reflection and pro-environmental behaviors. Rapp et al. found that technologies actually play a minor role in behavior change [42]. Furthermore, Rooksby et al. also mentioned that "people were not changing their behavior because of a technology, but were using technology because they wanted to change" [43, p. 1163]. Our findings showed that self-tracking tools have become an unobtrusive part of participants' everyday lives. Rather than making a striking impact on their lives, these technologies provide tacit support and indirect encouragement for reflection, at best. P6 said that *'[The self-tracking app] wasn't really something I was thinking of, and I almost forgot about it...but it has a job to do.... So it's not something I actively think about or do, but sometimes I go back and check to count the steps for that day'* (P6).

In response to Solutionism, Sandelin and Homewood [44] propose the concept of design (in)actions as design contributions that provoke discussion about how future technology might be. Given our findings, focusing on self-tracking as a solution to sustainable issues may be fundamentally inappropriate, and *not* designing self-tracking tools specific to food sustainability can be an alternative approach, not only for fostering discussions of sustainability, but also for informing the design of self-tracking tools for supporting reflection, more broadly [31]. One of our participants (P3) refused to design a new technology for food practices in activity 5; instead, he invented a self-tracking tool to track "personal emotion," because he thought that food-related self-tracking tools are developed to promote disordered eating practices. We do not argue that a data-driven approach to tracking personal data is impractical for making people become aware of their behavior. However, simple awareness of behaviors (e.g., the lower levels of reflection [21]) is not enough—and, arguably, not appropriate—for helping people to appreciate their everyday food practices and critically assess the justification(s) for the beliefs represented by these practices.

Perhaps rather than designing self-tracking tools for supporting reflection to pursue instrumental knowledge, cultivating the art of noticing [49] to scaffold critical inquiry may better foster pro-environmental behaviors by helping people make sense of their everyday food experiences. A practice of noticing differently can function as a means to help people make sense of their situations far away from their presuppositions [49]. Jenkins et al. introduced the concept of *careful devices* as technological interventions that integrate "broader contexts and personal idiosyncrasies" to support reflection on personal experiences [33]. Extending the idea of careful devices, we envision possible self-tracking tools that acknowledge the complexity of individuals' everyday lives but also help people critically inquire about their circumstances. For instance, rather than calculating the impact of their food practices on the environment with the intent of making people feel guilty, self-tracking tools might first communicate that eating sustainability is difficult and often requires a sufficient amount of privilege. Then, people can be asked why they feel bad about their behaviors to more deeply engage with their experiences, reflexively and recursively. Rather than promote a feeling of progress (i.e., the "self-improvement" focus of many PI systems), helping people to acknowledge their vulnerability to ask 'why' questions may

result in more durable ‘self’-insights that induce pro-environmental behaviors.

Through our probes study, we explored a possible intersection between promoting sustainable food habits and self-tracking technology. Our findings suggest future research questions that shift from “tracking” to “noticing”: that is, when and how do people notice elements in their food practices differently and engage in alternative ways of knowing [36, 49]? How can technologies be situated in everyday lives as one of the elements to interconnect with other elements, thereby scaffolding a practice of *noticing* that enables people to critically engage with their food practices for environmentally sustainable decisions? By focusing more on cultural aspects of food practice (e.g., ritual celebrations), we also aim to explore how technology can be designed to reflect the totality of our everyday lives.

ACKNOWLEDGMENTS

We would like to thank our participants for sharing their experiences. We also thank Too Much Information lab members, Shiva Darian, and Fujiko Robledo Yamamoto for their input throughout this project. A special thank you to our reviewers for their constructive feedback. The University of Colorado Boulder’s Institute of Cognitive Science provided a student research award to support this work.

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