

Prescriptive Persuasion and Open-Ended Social Awareness: Expanding the Design Space of Mobile Health

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ABSTRACT

Most mobile technology systems designed to encourage healthy decisions focus on prescriptive persuasion, telling the user either implicitly or explicitly what to do, as the primary means of improving health. However, other technically and socially viable options exist. Drawing on both relevant social theory and previous CSCW research, this paper suggests that *open-ended social awareness*, making users aware of both others' and their own decisions, may also serve as an effective central design principle for mobile health. To explore this approach, this paper presents analysis of qualitative data from two studies of such a system. Results suggest that open-endedness allowed users flexibility and freedom in defining what counts as health, and that the social aspects compounded both the positive and the occasionally negative impacts of this openness. The paper concludes with implications for the design and evaluation of research on mobile health technology, as well as suggestions for how future work can further explore the design space of mobile health beyond prescriptive persuasion.

Author Keywords

Mobile health, awareness, persuasion, user experience, reflective HCI.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors; Design.

INTRODUCTION

"Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." - WHO definition of "health" [42]

Issues of health, healthiness, and well-being have garnered significant attention from researchers in HCI, CSCW,

Ubicomp, and related fields [2,6,7,18,31,33]. However, the best approach to designing technology that facilitates healthy living remains a somewhat open question. Thus far, most research in this space has focused on prescriptive persuasion and behavior change, encouraging users to be more physically active [7], to make healthier food choices [30], to get more restful and consistent sleep [40], to cultivate more stable emotional and social health [14], or to change some other health behavior. Indeed, a recent workshop [10] focused on using "persuasion, influence, nudge, and coercion" to effect general behavior change. This focus on prescriptive persuasion, we argue, unnecessarily constrains both the design space of technologies for health and the use of those technologies. Such designs often do little to account for differentiated users' needs or to encourage reflection on what being healthy means. This paper attempts to open up, and facilitate a conversation about, the design space of mobile health technologies. Prescriptive persuasion *per se* is neither necessarily harmful nor undesirable, but persuasion alone is not the only possible means of facilitating healthy behaviors.

Specifically, we suggest that *open-ended social awareness*, grounded both in social theories related to social awareness and previous CSCW research on awareness systems, may serve as one such means of expanding this design space. The term "social" here refers to awareness of the activities and decision of other users as well as the relationship of ones own activities to the group. Health decisions, like other decisions, are not made in a vacuum, and much recent work has demonstrated the value of social support for health [6,14,18]. "Open-ended" indicates that the system does not prescribe specific actions for users or focus on any one health activity (e.g., physical exercise, eating, sleep). Such open-endedness allows the user to define what counts as health (for better or worse), moving beyond the prescription of specific activities to support a user experience driven by user needs, emotions, and attitudes, which may thus be more conducive to a state of complete well-being.

This paper describes a system called VERA, which serves as one example of a health system that uses open-ended social awareness as a central design principle. We present qualitative results from two different deployments of this system, focusing on users' experiences to build an understanding of both the benefits and drawbacks of designing a health system around open-ended social awareness. These

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results also point to some broader implications for technology designed to support healthy living.

The contributions of this paper, then, are two-fold. First, we provide a theoretically-grounded argument for the value of open-ended social awareness as a central design principle for mobile health technologies. Second, we provide empirical qualitative evidence about the possible impact on user experience of designing such a system focused on open-ended social awareness. These contributions can facilitate further exploration of the design space of mobile health technologies.

CURRENT APPROACHES TO MOBILE HEALTH

In response to the prevalence of broad and diverse health issues, researchers and practitioners have developed numerous technology-based approaches to *health persuasion*, i.e., systems designed to assist users in making healthier choices [39]. It has been argued that, for a variety of reasons, mobile technology can be particularly effective toward this goal [10,11,21]. Using examples from the literature, this section summarizes the strategies commonly employed by such persuasive technologies, moving generally from most prescriptive to least prescriptive. While increasingly popular, the use of games for health [e.g., 19,25,32] is beyond the scope of this paper and not discussed here.

Prompting

Many persuasive systems seek to promote health by telling the user what to do via prompts, e.g., delivered to their mobile phone [13]. Prompts are an intervention that involves sending messages, reminders, or feedback to the user, and have been used for a variety of purposes [5]. For example, mDIET, an SMS-based system, encourages healthier food choices by sending messages tailored to the day of the week, the time of day, and a participants' eating behaviors [30]. In another project, the Computerized Automated Reminder Diabetes System (CARDS) used messages that reminded participants to check their blood glucose levels and reply with their results [20]. Text messaging has also been used to support smoking cessation, supplying users with personalized smoking advice, support, and distraction [35]. Although this prescriptive use of technology provides specific directions that have proven effective in some situations, such specificity can cause a "boomerang" effect of resistance to the message [3]. Furthermore, this top-down approach to health intervention may limit the engagement of users by constraining their participation in the system.

Feedback and Reward

Another common persuasive strategy is providing the user with various forms of feedback in response to the health-related choices. Feedback mechanisms usually directly link a user's behaviors with affirmation, condemnation, reward, or punishment, although the relative effectiveness of positive versus negative feedback is the subject of much debate [12]. A study of Time to Eat!, in which users' eating choices cause a virtual pet to become either happy or sad, found that

both positive and negative feedback were necessary to promote healthier behavior [31]. On the other hand, a study of Fish'n'Steps, a system in which a user's fish in a shared virtual fishbowl grows in response to the number of steps s/he takes, found negative feedback off-putting [25]. Feedback also frequently includes reward, a fundamental extrinsic motivator [26]. For example, Ubitfit Garden rewards users' physical activity by adding new flowers and creatures to their virtual gardens as new milestones are reached [7].

Tracking, Logging, and Diaries

While most tools incorporating persuasion involve explicitly telling the user what to do, others focus instead on tracking users' behavior. Previous studies have suggested that simply tracking one's behavior can help improve weight loss [2], physical activity [23], disease management [9,27], and other health outcomes. Some tools involve entirely manual input [14], some combine automatic tracking with user input [44], and some use entirely automatic tracking [7]. Many of these systems also provide some functionality that represents back to users traces or trends in their tracked activities. Thus, tracking and feedback are often closely coupled in practice.

Social Influence

Yet another strategy in promoting healthy behavior, one which we incorporate in VERA, is leveraging social influence. Among the various relevant theories, the most commonly employed is social cognitive theory [1], which, in part, describes how individuals model their behavior based on that of those around them. Designers often employ social influence to reinforce a specific shared goal or common perception of health. In persuasive health systems, this can often mean simply placing users into peer groups and providing them with tools to share, comment on, and discuss specific healthy behaviors, with the hope that such groupings will improve those behaviors. GE's Pic Healthy iPhone app [healthymagination.com] is a prime example, providing users with tools to share health choices with friends and leader boards to highlight the healthiest individuals. Other systems provide tools for users with similar health goals to communicate with and support one another. For example, EatWell uses voicemail to allow users to share their experiences of trying to find and enjoy healthier food in low-income communities [18]. Aurora, a mobile-phone based social support system for cancer patients, has been found to make users more comfortable sharing emotion and engaging in socially supportive behavior [14]. These and similar systems are not explicitly prescriptive, i.e., they do not tell the user specifically what to do, but they are in a sense implicitly prescriptive. Pic Healthy and EatWell both focus specifically on eating healthy food. EatWell, though, represents an important exception to the prescriptive trend, focusing on users' stories about and experiences of health. In this way, EatWell is similar to the VERA system in this paper, but VERA is not specifically focused on food.

Summary

The above categories of persuasive health strategies are neither mutually exclusive nor completely exhaustive. However, they do point toward a general trend of prescriptive persuasion, telling the user, either explicitly or implicitly what to do. For example, prompts give very specific directions. Feedback, reward, and tracking systems, while they may not include such explicit instruction, provide implicit guidance by focusing on, rewarding, or tracking one specific set of behaviors.

We suggest that there is an opportunity to expand the design space of health technologies beyond solely prescriptive persuasion, cf. [18,33]. Specifically, this paper argues that there is value in drawing on the long-standing CSCW tradition of research in awareness [37] in the design of mobile health technologies. While some research has examined the value of awareness [e.g., 6,14], we suggest that, specifically, *open-ended social awareness*, can serve as a useful central design concept for health systems. The following section summarizes both social theories relevant to awareness and systems designed to support awareness.

AWARENESS: THEORIES AND SYSTEMS

Often, research in CSCW focuses on awareness as “the tacit and seamless integration of ongoing cooperative activities” [37:290]. That is, it focuses on how individuals “pick up on what is going on around them and make practical sense of it” [37:291]. Generally, this meaning is applied in the context of shared work activity. This paper applies a similar perspective but focuses on social awareness [34], that is, an individual’s knowledge of the activities of others in a group and the relation of her or his activities to that group. Our approach is grounded in two theoretical frameworks specifically related to open-ended social awareness: social cognitive theory and presentation of self.

As noted above, social cognitive theory [1], which describes how individuals model their behavior on that of those around them, has been useful in promoting healthy behavior. Modeling relates to specific features of the contextual environment, and social awareness of others is an important part of modeling [15]. Homophily, or the desire to connect with similar others, also plays a role in modeling; specifically, modeling is more likely to occur when viewing others perceived as similar to oneself [38]. Social cognitive theory has also been tied to greater participant agency [1] and relates to social facilitation theory, including notions of accountability [15,43]. Jacucci, Oulasvirta & Salovaara [22] tie social cognitive theory to the construction of social aspects of experience with respect to mobile media, noting the importance of active spectatorship.

Another theory that has been useful in promoting healthy behaviors is Goffman’s [17] notion of presentation of self. This theory acknowledges that we are consciously aware of ourselves as social actors and frame our interactions accordingly. Put simply, we disclose some elements of self, while choosing not to disclose others. Research has related

presentation of self to active forms of impression management and privacy in online environments [34] and to accountability [29]. Newman et al. [29] note how individuals use a specific set of strategies for impression management online. The relationship between the self and the group is also mediated by such factors as the composition of the group and the relative anonymity of group members; anonymity can lead to deindividuation [4], where users see the group not as a collection of individuals but as an undifferentiated whole. These theories informed the design of a new system, VERA, which both places users in a group and gives them great leeway in how exactly they choose to document and present health behaviors to the group.

SYSTEM DESIGN: VERA

In an effort to explore the design space of mobile health technologies, we developed VERA (Virtual Environments for Raised Awareness), a mobile phone application that allows a user to document health decisions and share them with other users. At the moment of making a health-related decision, the user opens the VERA app and takes a photo that in some way depicts their decision (Figure 1, left). Photos are used rather than text, audio, or video, as they afford both quick and expressive documentation. The system then prompts the user to identify whether they did or did not take the action depicted (e.g., the user might choose not to eat a piece of cake), rate the decision from -3 (most unhealthy) to +3 (most healthy), record their emotional response to the decision via PAM [32], and optionally enter a short caption (Figure 1, center). Once the user has completed her or his post, s/he is taken to a screen displaying recent photos posted by other users (Figure 1, right). This display also functions better with photos than with text, audio, or video. By tapping on a photo, the user sees a larger version along with information about who submitted it, when s/he sent it, and the caption s/he submitted. The post’s health rating and their emotion are not visible. Here, the user can also leave a comment on the post. This design makes VERA most similar to previous mobile health systems that employ tracking and social influence [14,18], but its focus on open-ended social awareness draws on recent critiques of persuasive health [33]. VERA was developed natively for Android OS 2.x, with PHP and MySQL on the server side. It was later ported to Apple’s iOS.

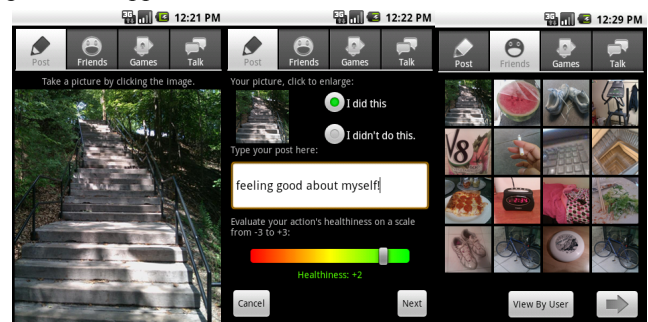


Figure 1: Screenshots of VERA taking a photo (left), posting details (center), and viewing others’ photos (right).

While smartphones are becoming more prolific, they are not yet as common among many populations, such as low- and mixed-income users, as traditional cell phones. Therefore, we also developed an MMS-based version of VERA. With this version, users take a photo of a health decision and then send it as an MMS with text that includes the same types of information as described above. The social component of the MMS version is provided via a website, which allows similar capabilities as the social portion of the mobile application. While not providing identical functionality, this version enables a similar experience for those who choose not to or cannot afford to own a smartphone.

This design foregrounds open-ended social awareness and draws on theory in several ways. First, users are not explicitly required to document a specific type of health behavior, but can be encouraged to take photos of anything that they feel is related to health, including good and bad decisions, as well as both things they do and things they do not do. Second, presenting users with photos posted by others facilitates social modeling, accountability, and other aspects of social cognitive theory [1]. Third, selection of activities to photograph, and the ways in which photos are taken, facilitate users' self-presentation [17]. The flipside of our focus on social awareness is self-presentation; leveraging both Goffman and Bandura helps us understand and design for both sides of these social phenomena.

Methods: Two Sets of Deployments

VERA was deployed in two separate field studies. The first was part of a larger project, referred to here pseudonymously as mMoms (Mobile Mothers), that examines how technology can be used to support health among new mothers. Mothers with children under two years of age were recruited from an urban area in western New York via newspaper ads, library flyers, social media, and snowball sampling. A total of 45 participants were placed into groups of 7 to 11 participants and used MMS VERA on their own phones and computers for two weeks; some participants previously knew others in their group, but most were strangers. As part of the mMoms study, some participants were assigned to a condition where they received simple health tips via text message, e.g., "Increase the amount of brightly colored fruits and vegetables that you eat." These tips were not explicitly directly connected to participants' use of VERA, and we did not see major differences related to open-ended social awareness between these groups, so we include data from all participants in the analysis below. All participants completed a survey at the beginning of the study, and 36 participants returned a post survey. Phone interviews were completed with 29 participants. Each participant was compensated \$50.

The second study focused on a wellness program for faculty and staff at Cornell University. Participants were recruited via two mailing lists: a general email list for all members of the wellness program (~4600), and a list specifically for individuals interested in weight loss (~125). We received a

total of 44 interested participants from the general list (21 of whom were placed in a control group and are not reported on here) and 10 from the weight loss list. As with mMoms, a couple dyads or triads were previously acquainted, but most participants were strangers. For various reasons, a number of participants dropped out, leaving 16 in the general group and 8 in the weight loss group. Participants who owned an Android or iPhone installed VERA on their own phone; those who did not were lent a 3G MyTouch Slide for the duration of the study. Each of these participants used the VERA app for four weeks, completing a survey both before and after. All participants except two from the general list completed an interview during the third or fourth week of the deployment. Each participant was compensated \$20 and entered in a drawing for a \$250 Amazon.com gift card.

This paper focuses on the experiential ramifications of our system design; quantitative assessment of health outcomes is left to future work. We analyzed audio recordings of the 51 interviews across these two studies using the constant comparative method [16]. The audio recordings were divided among a team of researchers, each of whom listened to and analyzed the recordings for emergent themes. The researchers then conferred about these themes and compared them across different sets of interviews. The next section presents those themes that emerged across both of these studies and were relevant to our open-ended social awareness design approach.

RESULTS

This section focuses on how open-ended social awareness as a central design principle impacted users' experience of the VERA mobile health system. These qualitative results are organized around the two central aspects of our design: open-ended awareness and social awareness. The results from our two data sets mostly aligned, but we also note areas of disagreement. (HW) denotes participants from the Cornell health and wellness program and (M) denotes those from Mobile Mothers; participant names are pseudonyms.

Ramifications of Open-ended Awareness

What is Health? As mentioned above, for most users VERA's openness allowed participants to define health for themselves, both in terms of what is healthy or unhealthy, and in terms of what counts as health-related. For example, Melonie (M) described how "some people have to eat three meals a day, some people have to eat six smaller meals." Betty (M) described posting photos of her evening glass of wine, saying that she counted that as healthy. Similarly, "there were times where [Melonie (M)] would take a picture of, you know, Hershey kisses or something, because you do need to eat food like that sometimes." Some participants identified activities that had previously been viewed as frustrating or annoying and reframed them as healthy. For example, Val (M) posted a photo of herself chopping wood, explaining, "this is not a chore, [I need to] stop thinking of it as a chore, it's healthy." Kelly (HW) realized

that “even little things throughout the day are still exercise, like walking the dog, is still being active, rather than just sitting on the couch.” Sally (HW) contemplated the notion of healthy choices, saying, “A health choice is not just what do I eat, but do I take time to have fun, do I have things in my life that make me happy or make me smile.”

There were, however, a few instances where our open-ended design led to some misalignments between how different participants defined health, as attested to by Tara (M). “You know what I seen [other people posted]? I seen some Dunkin Donuts, and it was something else in their pictures, but I know it was from Dunkin Donuts. Dunkin Donuts is not healthy.... They made it seem like it was good, but everybody knows, Dunkin Donuts is not good.” This idea was supported by Jan’s (HW) discussion on the different conceptualizations of health. She describes, “It’s a good bet that if you said, ‘You go girl’ to someone who didn’t eat the potato chips, there would be a common language, but if you say that to someone who is trying to gain weight, then they’re going to be like, ‘What?’” Whether or not Dunkin Donuts or potato chips are healthy for the particular individual, the openness of our system enabled differentiated definitions of health and encouraged participants to engage in reflective considerations of what health is, reflections that would not likely have occurred using a more prescriptive approach.

Despite intermittent misalignments, the openness ended up being seen as valuable for most participants. Ellen (M) described how her family was Greek Orthodox and had recently started Lent (a religious period preceding the holiday of Easter), which meant for them eating a mostly vegan diet. However, since she is nursing, she personally is deviating slightly from those dietary restrictions. Designing for this highly specific, cultural definition of health—mostly vegan during Lent but with key exceptions due to nursing—would be particularly difficult with a prescriptive approach, but the open-ended aspect of VERA allowed for this subtle flexibility. In another example, Sandra (M) considered posting images of steak or her breakfast of eggs, which are healthy for her because she is anemic, but she chose not to because they might be perceived by others as unhealthy. Even though Sandra ended up not posting these photos, the system helped promote this nuanced consideration of what is healthy. As Melonie (M) put it, “food isn’t just food, it’s the emotion, and it’s being social, and it’s family, and it’s culture—I mean, it’s everything.” A prescriptive system design would likely have difficulty in accommodating for and allowing participants to enact such situated and varied definitions of health.

Flexibility, Selectivity, and Creativity: The open-ended aspect of the design afforded flexibility in terms of exactly what types of behaviors to post, but this flexibility was not universally embraced and, in some cases, caused confusion. Lynn (M) was not sure if she was “unnecessarily limiting it to food and exercise.” Tara (M) was unsure why “every-

body was putting how they was shoveling or how they was driving,” as she did not understand what these activities had to do with the ostensible purpose of the system. At first, Carrie (HW) thought it “weird” that members of the group would post items such as dogs and cats, antibiotics, or their son’s baseball games, but after seeing these types of posts frequently, she started to consider and subsequently include similar postings. After seeing such “pet posts,” Kelly (HW) increasingly added pictures of her dog when she invited him to join her during exercise activities.

Another point of confusion was around the posting of decisions *not* to do something, or what has been called “negabehaviors” [36]. While potentially interesting, most participants did not include such negabehaviors. As Betty (M) explains, “I wouldn’t have taken the time to think, oh, well I’m not going for a run, let me take a picture of my shoes and post it. It doesn’t make any kind of logical sense to me to post something I’m not gonna do.” As Jess (M) put it, “I was always just trying to take pictures of the healthy things I did; it didn’t even cross my mind to think of the things I didn’t do.” Melonie (M) also expressed skepticism over the value of documenting the avoidance of unhealthy behaviors. “Sometimes it seemed kind of silly to take a picture of something you weren’t doing.... You choose not to eat a million unhealthy things all day.” These experiences align with the open-ended definition of health described above.

The openness of the system also enabled participants to be selective about what they chose to share. While participants overwhelmingly insisted they were honest with the system, many also revealed a preference to share healthier choices. Mindy (M) “took pains to include” the healthiest decisions she made. Melonie (M) said that she made an effort to take a photo of the healthy things she did. This selectivity also relates to presentation of self [17], discussed further below.

In addition to content flexibility, the flexibility of when to post was also important, especially for the Mobile Mothers, many of whom “buffered” their photos—taking pictures throughout the day and submitting them all in the evening when they had free time and when their children did not need their attention. This temporal flexibility afforded an additional benefit: reflection. As explained by Betty (M), “the days that I did send them all at once, I guess I always noticed a theme.”

Finally, allowing participants to take their own photos and express their health decisions in their own ways ended up being a pivotal design feature in VERA that promoted a high level of creativity and novelty. Kendra (M) appreciated that VERA gave her “the opportunity to take pictures, to be a little more creative.” Jan (HW) mentioned, “I saw people on there taking pictures of their tennis shoes and it was like, well how do I communicate my food in a more artsy way?” Ellen (M) described it as a “creative challenge.” Chrissy (HW) described wanting to give things an artistic sense and incorporate photographic techniques such as perspective and colorful highlights. Although it may have contributed

in part to some early confusion by users who favored more traditional posts, the opportunity for creative posting generally appealed to users and allowed for greater control over self-presentation (discussed further below).

Habits, Awareness, and Reflection: Many participants noted becoming more aware of, and consequentially more reflective about, their own health habits. As Melonie (M) put it, “I realized how much I eat the same foods.... I can’t take a picture of yogurt every single day. I really need to increase the variety in my diet.” Val (M) described how VERA “put it up in your face that you need to be healthy, you need to start doing this for yourself.” Chrissy (HW) remarked that the social aspect, being aware of others’ posts, allowed members to inspire each other to be healthier. For Regina (M), taking photos was key to making her “mindful of what [she] was eating.” As she put it, “taking the pictures really made me pause, and really showed just how full that plate was.” This notion of raised awareness emerged repeatedly throughout the interviews.

However, the openness of our design was again a double-edged sword. While it enabled participants to become more aware of their habits and routines, they were less interested in posting routine decisions. Mary (M) noted that “by the end it became kind of redundant” as “[she] got bored of posting the same things.” Some participants therefore stopped posting habitual decisions, which is a concern, since some research has documented the link between health and regular habits [28]. Lisa (HW) suggested a future design that would enable users to post an icon for routinized behaviors and a photo for non-recurrent decisions. “So, I don’t have to actually take a picture of breakfast every morning because it’s the same, but when I do pass by the cookie jar and I want it, I have to take a picture.”

Behavior Change: While VERA was designed to support healthy decisions, it was not intended as a means of effecting specific behavior change. As mentioned above, some of the mMoms participants received text messages with healthy tips, but these were not associated with their use of VERA. However, participants did describe some instances of changing their health behaviors. For example, participants described making such changes as choosing salad over a hamburger, water over soda, or adding fruit to breakfast. As Sandra (M) put it, “I knew I had to post anyway and it seemed like a better decision.” Mindy (M) noted a shift during her use of the system. Initially, she would make a decision and then take a photo, but as she continued using VERA she found herself thinking about the need to take a healthy photo before making the decision, and she said using VERA steered her toward better decisions.

Such changes were not universal. Sally (HW) discussed VERA as a mechanism for change in her thoughts, but not her actions. She shares, “The application does not change what I do, but it changes what I think about what I do.” Betty (M) describes an instance of recognizing the Chinese food she was about to eat was unhealthy but eating it and

posting it, anyway. “When I was doing it,” she explains, “I was like, wow, this is not good. I was conscious that it wasn’t good but it didn’t change that I did it.” Ben (HW) explained, “I really don’t think I’ve changed any dietary habits off of [VERA] because there are some people here that eat some really weird crap, and you know, I’m a more generic food kind of person.”

Several participants mentioned maintaining their behavior changes. For example, Ellen (M) noted two weeks after the final survey that she “was still keeping up with a number of good habits that [she] started during the [study].” These general health impacts may have been due to the fact that all participants across both studies were drawn from populations that were already committed to making health improvements; results might differ with participants who did not have a prior commitment to health.

Summary: The open-ended design approach allowed users flexibility, control, and ownership over their health decisions, their health goals, and even the very definition of health. In some cases, this openness was detrimental, as it led to confusion over standards or expectations. However, it also enabled creativity in self-expression, and it promoted awareness of and reflection on patterns in health decisions.

Ramifications of Social Awareness

Social Interaction and Connection: Participants’ social experiences with VERA predominantly revolved around the interactions that occurred while looking at and commenting on each others’ posts. Val (M) describes how another user posted cheese and crackers with the caption “healthy snack for breastfeeding mom.” Val saw this and felt more connected, thinking, “she does that, too.” The make-up of the groups (i.e., new mothers with other new mothers, members of a health and wellness program in groups together) specifically fostered such homophily [1,38].

However, there were also instances where participants were unsure how to approach interacting with one another. Betty (M) explained this with respect to a photo of grapefruit: “I didn’t really know what to say to that, like, awesome grapefruit?” Alexa (HW) described a similar experience upon seeing someone post a McDonald’s Big Mac. “It’s such an impersonal interaction already and I didn’t feel comfortable saying, ‘Dude, that sucks’.”

Imitation and Influence: Many participants described how other participants’ posts often influenced their decisions, both healthy and unhealthy, consistent with social cognitive theory [1]. For example, when Sheila (HW) saw that another user “got up and went to the gym in the morning,” she said, “that really reminds me, I’ve got to start doing that again.” Not all such instances were positive. Barb (M) saw another user posting that they had chosen not to eat a vanilla Oreo cookie, “but I was like, ‘hmm, a vanilla Oreo, I haven’t had one of those in a while,’ so I picked them up.” Instances of imitation happened not only in terms of the substance of health decisions but also in terms of the style

of posts. The section above on creativity and flexibility described how many participants, when they saw other users posting photos of activities not traditionally related to health, began posting more creative photos themselves. Thus, we see that the social aspect of VERA compounded the benefits of the open-ended design.

Self-Presentation: As noted above, while many users included predominantly healthy photos, they also included photos that were unhealthy. Conscious of their status as social actors in the system [17], users did not want to present a completely positive picture of themselves, but rather an accurate picture. As Melonie (M) put it, “I would try to mix some bad choices in their too so I don’t seem super virtuous, ‘cause I’m not.” Chrissy (HW) mentioned that she wanted to post unhealthy behaviors that were significant. She described that “Sitting in the car is not a remarkably ‘bad behavior,’ and I wanted to post things that really stuck out.” Many participants described similar decisions, intentionally including photos of dessert, e.g., an ice cream cone.

A few participants were not particularly conscious of other users. As Ellen (M) said, “It kind of surprises me that other people were looking at my posts.” This attitude resembles the “security through obscurity” some social media users feel [41]. However, this phenomenon’s occurrence in VERA is somewhat surprising, as there is not a massive crowd within which to feel obscure. Some were conscious of other users but indifferent. “I didn’t really care what they thought,” said Tara (M), “‘cause it’s not like they know me or anything.” However, participants who claimed not to care what others thought often shared examples of behaviors that indicated otherwise. For example, many of these participants were also those who avoided posting photos of the same thing so as not to be boring, or who described trying to make their posts more interesting and more creative. Although they denied it when directly asked, these participants’ actions suggest that they did in fact take the presence of others into account when posting.

Many users, however, explicitly noted being keenly aware of others. Patty (HW) described crafting posts with her audience in mind; despite being “one-liners,” she was quite cognizant that other people might read them and respond. Similarly, Chrissy (HW) “posted [her] horse because it was different and it would stand out” and be noticed. Vivian (HW), a semi-professional cyclist who follows a strict training regimen, was hesitant to post with a high level of specificity. “I don’t want people to think that this is all a piece of cake for me to train 15 hours a week... It could have a negative impact.” Others described similar difficulties, attributing them to the fact that most users did not previously know each other. Ultimately, Vivian chose to self-censor her posts to avoid such negative impacts on others, a choice which was based on her perception of her group.

Group Identity: Participants’ impressions of other users in their group were of two types, either of other specific users (i.e., individual) or of the group as a whole (i.e., deindividuated)

[4]. As noted above, the relative anonymity of a group can initially contribute to such deindividuation. Tara (M) describes how a series of posts from one user, with “everything all together..., helps you kind of build the picture of the person.” Impressions of specific users often arose from photos that were either repeated or noteworthy. For example, the regular photos of running shoes posted by wellness participants such as Vivian and Ben became a point of conversation for other users. Sheila (HW) described getting to a point “where certain pictures were appealing... certain ones drew you to them, like the colorful ones and other ones it was like ‘Ooh.’”

While participants did occasionally form distinct impressions of some other members of their group, many perceived their group entirely as a deindividuated whole. For example, Val (M) said that while posting pictures she was aware of her individuality, but while looking at others’ pictures “you felt like a group, because then you saw everyone, what everyone was doing, and what they were taking pictures of.” Many participants had a sense of what decisions were being made, but not of the distinct individuals making them. These experiences may have reinforced the feeling mentioned above where some users did not think about others viewing their posts. This deindividuation may also have been compounded when participants did not realize that they could see all the photos posted by a single individual user; this was a feature that participants commonly requested, despite the fact that the system provided a button to “View Posts by User.” While the deindividuation may have prevented connecting to specific individuals, there was still a general “other” to which participants felt accountable.

Accountability and Who’s Watching? As one might expect based on previous research connecting accountability to both social cognitive theory [15,43] and perception of self [29], participants indicated that sharing photos with others made them feel more accountable. Carrie (M) noted that “you think about it a little more when someone is watching... you’re being more accountable.” Chrissy (HW) built up a sense of competition with ambiguous others because she saw five sets of running shoes in one day. Kendra (M) said that “having to broadcast like the pizza box made [her] super aware... they don’t know anything about me, but they still know what I’m eating.” Jan (HW) suggests, “If you’re in it by yourself, you’re also not accountable to anyone.”

For some participants, though, it was not abundantly clear exactly to whom “they” referred. In the cases described above, participants were clearly referencing other users. Others, such as Lynn (M), described being more accountable to the computer system itself, even though “VERA’s not even a real person,” than to anyone in her user group. Many participants, however, were keenly aware of the researchers conducting the study. In some cases, participants thought about these nebulous researchers when submitting their photos, particularly trying to make sure to do “what would help with the study” or that they were “giving us

what we wanted.” This awareness of and attention to the researchers raises both interesting and challenging questions for health technology research, discussed further below.

Summary: VERA’s social aspect enabled it to leverage existing social processes, such as accountability and self-presentation, to facilitate healthy behaviors. In many cases, these accentuated the impacts of the system’s openness. Social comparison and observation also played important roles, though users varied in whether they focused on other users as individuals, a deindividuated whole of users, the VERA system itself, or the researchers behind the system.

DISCUSSION

This paper is intended primarily as a means of expanding the design space of mobile health technologies to move beyond prescriptive persuasion. However, the findings presented here also offer an opportunity to reflect on the role that technology plays in defining, documenting, sharing, and assessing health behaviors.

VERA was designed intentionally to put the onus of health decision making on the user, from the point at which a behavior is deemed to be health related to the point at which a user decides to document a behavior and share it with others. This coupling of self-definition and self-reporting helps avoid problems where, e.g., a pedometer might not register exercise done on a gym’s cardiovascular machine [6].

At the same time, such extreme openness can also lead to questionable assessments of healthiness. Most of the examples here, such as considering an occasional Hershey’s kiss or a nightly glass of wine as healthy, were rather innocuous. However, it is possible that, say, the nightly glass of wine may expand to become a nightly bottle of wine; would the user still consider this activity healthy? Our results suggest that the social component of the system kept people slightly more accountable with regard to what is healthy. However, there is still a possibility for discrepancy between what medical and health professionals deem “healthy” and what users deem “healthy.” On the one hand, VERA’s openness does little to control for such discrepancies, which is a possible shortcoming of the system. On the other, we hope that this shortcoming is balanced by the fact that the data from such systems may provide “behind-the-scenes” access into perceptions of health, and the sociological processes by which those perceptions are formed, that can allow for greater accommodation of these varied definitions of health.

This issue of varying definitions and accuracy of health assessments raises a deeper underlying question: Did it work? Were participants healthier? On the one hand, this question is beyond the scope of the current paper. Our focus here is on user experience, i.e., “understanding use” [24], and we leave quantitative assessments of health outcomes to future work. On the other hand, our results call into question what exactly it means for a technological health intervention to “work.” While some participants reported changing certain health behaviors, far more experienced greater health

awareness. Users were not simply attending to specific behaviors pre-determined by health experts, but rather were empowered to make their own assessments of health.

The design principle of open-ended social awareness, then, is not meant to be yet another tool in the kit for health technology designers. Rather, it represents a reconceptualization of how technological health interventions are conceived, designed, implemented, and evaluated. With a few exceptions, e.g., [18,33], questions of “what is health?” and “who is empowered to define health?” are rarely interrogated deeply by current research in this area. Just as VERA was designed in part to promote consideration and discussion among users about how health is defined, we hope that this paper will promote similar discussion within the health technology community.

FUTURE WORK

While VERA represents one possible instantiation of the design principle of open-ended social awareness, there may be other ways to implement it. For example, this study used a convenience sample to form user groups, but there are many possible network formation methods. Future research should explore alternative implementations to help determine more specifically the ramifications of this principle.

The studies reported on here lasted either two or four weeks. Even in this short time period, we saw some evidence of user fatigue, in that participants began to lose motivation or became disinterested in repeatedly posting similar photos. Future work should examine whether or not users continue to use VERA or similar systems and, moreover, why or why not. Furthermore, are the benefits in terms of reflecting on the definition of health due largely to the novelty of the system, or would such reflection persist over longer time periods of system use?

Although the focus here is on health, we believe that this open-ended social awareness approach may be valuable in other contexts. For example, interest has recently increased in sustainable HCI, with much work focusing on persuasion and behavior change [8]. The reflection observed here may be particularly valuable in the area of sustainability. Since there is contention even among experts over what is sustainable, rather than tell users what to do, one might instead encourage users to consider what sustainability means.

Our results also showed that users were keenly aware of their status as participants in a research study, an awareness which impacted their use of the system. It may be possible, say, to make a system similar to VERA publicly available, allow users to create their own groups, and then ask them after they have used it whether they would participate in a study. While such an approach may be attractive, it raises numerous issues, not least of which being informed consent and the relationship between researcher and subject. Moreover, it sidesteps the primary issue raised here. If current understandings of health technologies come primarily from research studies, but the very status of being in a re-

search study factors into participant behavior, we should perhaps be cautious about how the results of such studies are translated into more general prescriptions for more widely deployed technologies, policies, or health programs.

Finally, many of the themes described in the results—imitation, social interaction, defining what health means—relate to social norms, the rules that govern behavior and interactions in groups. As suggested above, the data collected during this study provide a unique opportunity for health researchers to examine how perceptions of health are formed and negotiated on an everyday basis. Future work should examine the content of photos, captions, and comments to understand better the formation and interpretation of norms in such systems and, perhaps, of health norms in general.

CONCLUSION

Despite abundant research on the use of mobile technologies to support health, work in this area has thus far been relatively constrained, with most work focusing exclusively on prescriptive persuasion. This paper expands the design space, examining the use of open-ended social awareness as a central design principle for mobile health. The results show that the openness of the system allowed users to adapt and tailor it to their situated, contingent, everyday definitions of health. However, this same openness became a stumbling block for some, in that they occasionally experienced difficulty deciding what counted as a health oriented-decision. Both of these perceptions were amplified by the social aspects of the system; users' creativity in defining and representing health was inspired by the creativity shown by other users. However, concerns over what was healthy were also exacerbated by the social aspect when users saw posts from others that were either confusing or contradictory to their views of health.

This paper makes two primary contributions. First, it draws on previous theoretical and empirical work to expand the design space of mobile health technology, creating an opportunity for other, similar explorations [18]. Second, it uses empirical qualitative data to provide an understanding of how this design exploration impacts the user experience of health technologies. These contributions carry significance for the design of health systems, not only those that are open-ended or those that focus on social awareness, but more generally. The work presented here represents a viable and promising approach to designing technologies that can encourage and support “a state of complete physical, mental, and social well-being” [42].

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REFERENCES

1. Bandura, A. *Social foundations of thought and action*. Prentice-Hall, Inc, Englewood Cliffs, 1986.
2. Brown, B., Chetty, M., Grimes, A., and Harmon, E. Reflecting on Health: A system for students to monitor diet and exercise. *Proc CHI EA*, (2006), 1807-1812.
3. Byrne, S. and Hart, P.S. The Boomerang Effect: A Synthesis of Findings and a Preliminary Theoretical Framework. In C. Beck, ed., *Communication Yearbook 33c*. Lawrence Erlbaum Assoc, Mahwah, NJ, 2009, 3-37.
4. Cialdini, R.B. and Goldstein, N.J. Social influence: compliance and conformity. *Annual Rev of Psych* 55, 1974 (2004), 591-621.
5. Cole-Lewis, H. and Kershaw, T. Text Messaging as a Tool for Behavior Change in Disease Prevention and Management. *Epidemiologic Revs* 32, 1 (2010), 56-69.
6. Consolvo, S., Everitt, K., Smith, I., and Landay, J.A. Design requirements for technologies that encourage physical activity. *Proc CHI*, (2006), 457.
7. Consolvo, S., McDonald, D.W., Toscos, T., et al. Activity Sensing in the Wild : A Field Trial of UbiFit Garden. *Proc CHI*, (2008), 1797-1806.
8. DiSalvo, C., Sengers, P., and Brynjarsdóttir, H. Mapping the landscape of sustainable HCI. *Proc CHI* (2010), 1975-1984.
9. Eastwood, C.A., Travis, L., Morgenstern, T.T., and Donaho, E.K. Weight and Symptom Diary for Self-monitoring in Heart Failure Clinic Patient. *J of Cardiovascular Nursing* 22, 5 (2007), 382-389.
10. Eslambolchila, P., Wilson, M.L., Oakley, I., and Dey, A.K. PINC: Persuasion, Influence, Nudge, and Coercion through mobile devices. *Proc CHI EA*, (2011), 13-16.
11. Fogg, B.J. *Persuasive technology*. Morgan Kaufmann, San Francisco, 2003.
12. Fox, J. and Bailenson, J. Virtual Self-Modeling: The Effects of Vicarious Reinforcement and Identification on Exercise Behaviors. *Media Psych* 12, 1 (2009), 1-25.
13. Fry, J.P. and Neff, R. Periodic Prompts and Reminders in Health Promotion and Health Behavior Interventions: Systematic Review. *J Med Internet Res* 11, 2 (2009).
14. Gay, G.K. *Context-Aware Mobile Computing*. Morgan & Claypool, San Rafael, CA, 2009.
15. Gay, G., Pollak, J., Adams, P., and Leonard, J.P. Pilot study of aurora, a social, mobile-phone-based emotion sharing and recording system. *J of diabetes sci and tech* 5, 2 (2011), 325-32.
16. Glaser, B.G. The Constant Comparative Method of Qualitative Analysis. *Social problems* 12, 4 (1965), 436-445.
17. Goffman, E. *The Presentation of Self in Everyday Life*. Doubleday, New York, 1959.

18. Grimes, A., Bednar, M., Bolter, J.D., and Grinter, R.E. EatWell: sharing nutrition-related memories in a low-income community. *Proc CSCW*, (2008), 87–96.
19. Grimes, A., Kantroo, V., and Grinter, R.E. Let's play!: mobile health games for adults. *Proc UbiComp*, (2010), 241–250.
20. Hanauer, D. a, Wentzell, K., Laffel, N., and Laffel, L.M. Computerized Automated Reminder Diabetes System (CARDS). *Diabetes tech & therapeutics 11*, 2 (2009), 99-106.
21. Intille, S.S. A new research challenge: persuasive technology to motivate healthy aging. *IEEE Trans on Info Tech in Biomedicine 8*, 3 (2004), 235-257.
22. Jacucci, G., Oulasvirta, A., and Salovaara, A. Active construction of experience through mobile media: a field study with implications for recording and sharing. *Pers and Ubi Comput 11*, 4 (2006), 215-234.
23. King, A.C., Ahn, D.K., Oliveira, B.M., Atienza, A. a, Castro, C.M., and Gardner, C.D. Promoting physical activity through hand-held computer technology. *Amer J of Prev Med 34*, 2 (2008), 138-42.
24. Klasnja, P., Consolvo, S., and Pratt, W. How to evaluate technologies for health behavior change in HCI research. *Proc CHI*, (2011), 3063–3072.
25. Lin, J.J., Mamykina, L., Lindtner, S., Delajoux, G., and Strub, H.B. Fish'n'Steps: Encouraging Physical Activity with an Interactive Computer Game. *Proc UbiComp*, (2006), 261-278.
26. Malone, T.W. and Lepper, M.R. Making learning fun: a taxonomy of intrinsic motivations for learning. In R.E. Snow and M.J. Farr, eds., *Aptitude, Learning and Instruction III*. Erlbaum, Hillsdale, NJ, 1987, 223-253.
27. Mattila, E., Pärkkä, J., Hermersdorf, M., et al. Mobile diary for wellness management--results on usage and usability in two user studies. *IEEE Trans on Info Tech in Biomedicine 12*, 4 (2008), 501-12.
28. Monk, T.H., Reynolds, C.F., Buysse, D.J., DeGrazia, J.M., and Kupfer, D.J. The Relationship Between Lifestyle Regularity and Subjective Sleep Quality. *Chronobiology International 20*, 1 (2003), 97-107.
29. Newman, M.W., Lauterbach, D., Munson, S.A., Resnick, P., and Morris, M.E. "It's not that I don't have problems, I'm just not putting them on Facebook": Challenges and Opportunities in Using Online Social Networks for Health. *Proc CSCW*, (2011), 341-350.
30. Patrick, K., Raab, F., Adams, M.A., et al. A Text Message-Based Intervention for Weight Loss: Randomized Controlled Trial. *J Med Internet Res 11*, 1 (2009).
31. Pollak, J.P., Adams, P., Gay, G., and Ave, C. PAM: A Photographic Affect Meter for Frequent, In Situ Measurement of Affect. *Proc CHI*, (2011), 725-734.
32. Pollak, J., Gay, G., Byrne, S., Wagner, E., Retelny, D., and Humphreys, L. It's Time to Eat! Using Mobile Games to Promote Healthy Eating. *IEEE Pervas Comput 9*, 3 (2010), 21-27.
33. Purpura, S., Schwanda, V., Williams, K., Stubler, W., and Sengers, P. Fit4life: the design of a persuasive technology promoting healthy behavior and ideal weight. *Proc CHI*, (2011), 423–432.
34. Raento, M. and Oulasvirta, A. Designing for privacy and self-presentation in social awareness. *Pers and Ubi Comput 12*, 7 (2008), 527-542.
35. Rodgers, A., Corbett, T., Bramley, D., et al. Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging. *Tobacco control 14*, 4 (2005), 255-61.
36. Ross, J. and Tomlinson, B. Negabehaviors and Environmental Sustainability. *J of Sust Edu 2*, March (2011).
37. Schmidt, K. The problem with 'awareness'. *Computer Supported Cooperative Work 11*, 3 (2002), 285–298.
38. Slater, M.D. and Rouner, D. Entertainment-Education and Elaboration Likelihood. *Comm Theory 12*, 2 (2002), 173-191.
39. Suggs, L.S. A 10-year retrospective of research in new technologies for health communication. *J of Health Comm 11*, 1 (2006), 61-74.
40. Tahnk, J.L. 10 iPhone Apps for a Better Night's Sleep. *Mashable*, 2010. <http://mashable.com/2010/06/25/iphone-better-sleep/>.
41. Viégas, F. B. Bloggers' expectations of privacy and accountability: An initial survey. *JCMC 10*, 3 (2005).
42. World Health Organization. Preamble to the Constitution of the World Health Organization. 1946.
43. Zajonc, R.B. Social Facilitation. *Science 149*, 3681 (1965), 269-274.
44. Årsand, E., Varmedal, R., and Hartvigsen, G. Usability of a Mobile Self-Help Tool for People with Diabetes. *IEEE Conf on Autom Sci and Engr*, (2007), 863-868.