

# Persuasive Reminders for Health Self-Management

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## Abstract

*Health reminders are integral to self-managing chronic illness. However, to act on these health reminders, patients face many challenges, such as lack of motivation and ability to perform health tasks. As a result, patients experience negative consequences for their health. To investigate the design of health reminders that persuade patients to take action, we conducted six participatory design sessions with two cohorts: mothers of children with asthma, and older adults with type 2 diabetes. Participants used collages, storyboards, and photos to express design ideas for future health reminder systems. From their design artifacts, we identified four types of persuasive reminders for health self-management: introspective, socially supportive, adaptive, and symbolic. We contribute insights into desired features for persuasive reminder systems from the perspectives of patients and informal caregivers, including features that support users to understand why and how to complete health tasks ahead of time, and affordances for intra-familial and patient-provider collaboration.*

## Introduction

Reminders for health tasks, such as obtaining recommended lab tests and taking medications, are important for supporting patients who are living with chronic health conditions to manage their health. For these individuals and their families, reminders are a part of everyday life, helping patients to manage their health in the home rather than in the clinic or the hospital. Moreover, unlike acute care reminders for short-term health concerns, reminders for chronic illness care are often associated with making and maintaining significant changes in health behaviors, such as eating, exercising, and tracking health indicators over time. For these patients, simply alerting them to health tasks could be insufficient for supporting them to adopt and maintain medical and lifestyle changes. Rather, these individuals might benefit from reminders that are designed to be motivational, or even persuasive.

Strategies for supporting patients to change health behaviors and complete health tasks are well documented. In particular, increasing patients’ self-efficacy to solve problems through informational, emotional, and social support are key for catalyzing sustainable behavior change for health<sup>1-5</sup>. However, the use of these strategies to design reminder systems for preventive and chronic health tasks is underexplored. Health reminders are typically designed to trigger health behaviors at the right time<sup>6,7</sup>, but are not usually designed to employ persuasive strategies that can influence patients to adopt those behaviors. As a result, institutionalized reminders such as those coming from healthcare organizations likely do not live up to their full potential to support and encourage optimal self-care. Improving these reminder systems could enhance patient care, reduce disease burden, and potentially save health care costs for both patients and health insurers.

To inform the design of *persuasive* health care reminders, we explored desired persuasive strategies from the perspectives of individuals who are responsible for managing a chronic illness. Our goal was to understand how reminders could help patients to build self-management skills and engage in self-management tasks. We conducted six participatory design workshops with older adults who have type 2 diabetes and with mothers caring for children with asthma. Participants reflected on current reminder systems and designed future reminder systems that made it easier and more attractive to complete health self-management tasks. We found that the participants envisioned four types of persuasive health reminders: introspective, socially supportive, adaptive, and symbolic.

In this paper, we contribute empirical findings to inform the design of persuasive reminder systems based on the perspectives and expertise of patients managing chronic illnesses. We describe how persuasive health reminders are deeply personal, reflecting patients’ health values, relationships, and goals.

## Related Work

In this section, we discuss the background of persuasive technology design, including persuasive design frameworks, strategies, and ethics. We focus on the application of persuasive systems in the health domain, but acknowledge that persuasive technologies have been applied in other domains such as sustainability<sup>8,9</sup> and safety<sup>10</sup>.

### *Persuasive technology design*

Persuasive technology design emerged in the 1990s, and the health domain was identified early on as a key domain for such persuasive systems<sup>11,12</sup>. Several models for designing persuasive technologies have informed the design of systems that influence health behavior change<sup>13-15</sup>. One of the best known models is Fogg's Behavior Model<sup>13</sup>. Fogg's model emphasizes three factors that must be present at the same time to influence behavior change: (1) motivation, (2) ability, and (3) triggers (e.g. alarms). When people have both the motivation and ability to perform a behavior, reminders that trigger the behavior at the right time are more likely to be effective. Typical health reminders aim to trigger tasks at the right moment<sup>6,7</sup>. However, when lacking ability and/or motivation, people can benefit from triggers that facilitate and motivate them to perform a task. Fogg calls these triggers "facilitators" and "sparks," and differentiates them from "signals" that remind rather than persuade. We used Fogg's model to understand the significance of elements in participants' designs that increased both their motivation and ability to perform health tasks and achieve health goals.

Building on these behavior change models, persuasive systems designers often employ specific, empirically grounded persuasive strategies, including: feedback about performance, rewards, authority, progress monitoring, and social influence<sup>16-23</sup>. These persuasive strategies have been implemented in the design of systems that motivate health behavior change, including increasing physical activity<sup>24-26</sup>, water intake<sup>27</sup>, and engagement in diabetes self-care<sup>28</sup>. These strategies have also been employed to design persuasive health *reminder* systems. For example, Walji et al<sup>29</sup> used iterative design to explore the acceptability of persuasive appointment reminders using the strategies of commitment, liking, authority, and scarcity. Another example is Langrial et al's<sup>30</sup> e-mail reminder system that used feedback and social support to increase logging of fizzy drink consumption. Finally, Oliveira et al<sup>31</sup> created a socially competitive game to engage elders in medication adherence, and found that it improved the timing and accuracy of taking medications. These examples highlight approaches to persuading people to perform recommended health tasks. Our research adds insights into the persuasive ways in which individuals link health tasks to their broader health goals for self-care.

Health behavior change researchers have also explored the design of *personalized* persuasive systems for health. For example, Kaptein et al<sup>32</sup> designed a reminder system to reduce snacking that sent reminders tailored to each user's susceptibility to four social influence strategies: scarcity, authority, consensus, and commitment. They found that tailored persuasive reminders were more effective than random reminders. In another study, Kaptein et al<sup>33</sup> showed that persuasive reminders designed to increase physical activity and fruit intake were more effective when adapted to individuals' persuasion profiles. In contrast to personalized persuasive systems that targeted a prescribed behavior (e.g., physical activity), Baumer et al<sup>34</sup> supported the agency of users to define healthy behaviors. Their system, VERA, enabled users to post photos of their health behaviors to encourage persuasive open-ended social awareness. Our findings show that there may be a middle ground between prescriptive and open-ended persuasive systems wherein users can contextualize prescribed health tasks within personally significant health goals.

### *Ethics of persuasive system design*

Finally, the user's agency in defining the strategies and goals of persuasive systems is an important ethical consideration<sup>11,16,35,36</sup>. Davis<sup>35,36</sup> described how design methods can influence the ethics of persuasive systems. She advocated for the use of Participatory Design (PD), a method that emphasizes equal participation and mutual learning between designers and users<sup>37-39</sup>. PD is a human-centered design tradition that emphasizes the expertise of users, especially when designers have little first-hand knowledge of users' experiences. For example, PD has been used to design with and for cancer patients<sup>40</sup>, adults with amnesia<sup>41</sup>, and children<sup>42</sup>. Ethical dilemmas in persuasive systems can arise from the asymmetrical power relations between the persuader (i.e. the designer) and the user<sup>35</sup>. PD is well-suited to balancing power relations, and increasing the user's voice in the ways in which they are persuaded.

Our work contributes to this tradition of using PD to inform the design of ethical persuasive systems for health. In particular, we contribute insights into designing health reminders that align with patient's personal health values and attitudes and that increase their confidence as self-managers. We identified four types of health reminders designed by patients to increase their motivation and ability to adopt health behaviors: introspective, socially supportive, adaptive, and symbolic. These persuasive reminder types can inform new approaches to designing patient-centered systems that support health self-management.

## Participatory Design Method

The participatory design approach enabled us to engage patients and caregivers in designing future reminder systems that could support them to manage chronic illnesses. Participants used creative, hands-on design activities to embody their perspectives in design artifacts, including collages, storyboards, and cultural probes. These artifacts enabled us to capture participants' visions of future states of health and reminders.

### Participants

We sampled 23 participants from two populations of people who managed complex chronic illnesses: older adults with type 2 diabetes, and mothers of children with asthma. This sampling strategy enabled us to include the perspectives of both patients and caregivers involved in chronic illness management and a wide spectrum of ages (31 to 89,  $\mu=57$ ). Within these two distinct populations, we oversampled individuals from underrepresented minorities and low socioeconomic backgrounds to ensure a diversity of patient and caregiver experiences on the design teams [see Table 1]. Participants were recruited from Group Health Cooperative, an integrated care and delivery system in Washington State.

We grouped participants into three design teams, each with 8 participants: (1) mothers of children with asthma (A1-A8); (2) older adults with diabetes (D1-D8); and (3) a mixed team of mothers and older adults (A9-A11; D9-D12). Each team participated in two 90-minute workshops, one week apart. Two researchers (the first and second authors) facilitated each workshop. Participants did three types of activities: collages, storyboards, and cultural probes.

**Table 1.** Participant demographics.

	N	Age		Race/Ethnicity				Education Level			
		Range	$\mu$	AA	A	H	W	HS	SC	4YR	+4YR
<b>Mothers of children with Asthma (A)</b>	11	31-45	38	5	0	0	6	2	5	1	3
<b>Older adults with Diabetes (D)</b>	12	54-89	73	6	0	0	6	4	2	2	4

AA=African American; A=Asian; H=Hispanic; W=White; HS=High School; SC=Some College; 4YR=4-year degree; +4YR= more than 4-year degree.

### Collages

Collages are an ideal tool for helping people to “articulate experiences” using stimuli like images and words<sup>43</sup>. We provided participants with a set of images relevant to chronic illness management, such as health care providers, patients, medical equipment (e.g. glucose monitors and asthma inhalers), hospital and home spaces (e.g., clinic office, bedroom, kitchen), wellness activities (e.g., walking, aerobics), and reminder tools (e.g., mobile phones, sticky notes, email). We also provided materials for free-form expression, including pens, colored paper, scissors, glue, and health-related magazines. The research team pilot tested this collage toolkit to ensure that it provided a balance of structure and ambiguity to encourage creativity.

Participants created two collages. In Design Workshop 1, participants worked independently to create a collage representing a magical system that would help them to achieve a health goal, such as healthy blood glucose levels, weight loss, or asthma control. In Design Workshop 2, we handed participants their collages and collage toolkits from the first workshop, and invited them to build off of these to imagine explicitly how reminders for health tasks fit into the picture of health self-management. Participants worked in pairs for the second workshop.

### Cultural probes

Cultural probes are take-home materials that provoke participants to reflect on and capture aspects of their everyday environments—a common technique for stimulating design ideation<sup>44</sup>. In between the first and second workshops, participants completed short activities at home about reminders that had persuaded them, and that they had authored to persuade someone else. We also provided each participant with a Polaroid camera to take photos of personally significant health reminders. The cameras were loaded with 5 mini films for instantly printing color photos.

### Storyboards

In the second design workshop, after the paired collage activity, we asked participants to fill-in-the-blanks in a storyboard template. Storyboards and scenarios are common techniques for engaging users in the design process<sup>45,46</sup>. We provided participants with a 3-panel storyboard depicting a patient “before” and “after” the intervention of a magical genie. In the first panel, participants wrote their thoughts and feelings when they experience a challenging health task. In the middle, they wrote what the genie would say or do to help them overcome this challenge. Then, in

the final panel they wrote their thoughts and feelings after the genie’s intervention. The focus on thoughts and feelings gave us insight into the psychological and informational barriers people faced when completing health tasks, and the type and tone of support they desired for successful task completion.

## Analysis

Each workshop was video recorded and transcribed by an attending court recorder. The researchers analyzed the transcriptions, collages, storyboards, and cultural probe photos using a general inductive approach. The general inductive approach is a systematic way to develop a framework of underlying themes that connect clearly to research objectives<sup>47</sup>. Our analysis was guided by the research goal of understanding the ways in which reminders helped people to achieve their health tasks and goals. The first two authors iterated on a codebook, first establishing themes such as, “rewards of health,” and then clustering these into broader categories such as “symbolic reminder.”

## Findings

Participants designed persuasive health reminder systems aimed at provoking reflection on health priorities, increasing confidence in completing health tasks, tailoring the reminder mode and message, and symbolizing the rewards of good health. Below, we describe four types of persuasive health reminders envisioned by participants: introspective, socially supportive, adaptive, and symbolic.

### Introspective reminders

**Introspective reminders** triggered reflection on health goals. These reminders helped patients plan and prioritize their daily health tasks. A6 created a collage that centered on taking time to reflect (Figure 1a). She described that, “I know in order for me to be successful, sometimes I have to sit back and reflect on those [health] goals. You know, what I can do to keep me going towards my health. So that’s why I had the word reflect.” Her magical reminder was a kiosk at her front door where she could reflect on her goals and tasks: “I call it a self-check in. [...] I would have to do a check in [to get] daily reminders or affirmations to get you going, or remind yourself what you need to work on today.”



**Figure 1. Introspective reminders.** (a) self-check in reminder; (b) health road map; (c) weight loss visualization.

A4 also described a reminder system that helped her to reflect throughout the day on healthful behaviors. “So my magical system, is just kind of about balance and time [...] It’s hard to maintain balance with other elements in my life. Like the exercise element. The healthy diet element. Relaxation and sleep element. [...] It would be great to have some type of a system to help interface with all those different elements.” She phrased her reminders as questions that helped her to introspect on healthy behaviors: “Have I done enough stuff throughout the day? Have I eaten what I need to eat? Have I maintained enough sleep?” She explained why these types of reminders would be valuable, “When I get caught up in my work schedule, and go, go, go, do, do, do, sometimes those other elements in my life fall by the wayside and those are important for health too.”

Similar to A4’s daily, short-term introspective reminders, D7 and D8 designed a reminder system that supported self-monitoring over the short and long term. D7 and D8 worked together on their collage in the second workshop (Figure 1b). D8 described the introspective reminder system they created: “We liked the idea of having a health goals kind of road map, where there’s short and long term goals, and that somehow you have access to that information. And incorporated in it are like little daily, hourly, encouragements, and humor, and things like that.”

D5 also created a reminder system that supported awareness of past, present, and future states of health (Figure 1c). She explained the nested colors depicting her losing weight over time, “*So this [orange] is as I see myself now. This [green] is as I continue to work on these things. The smaller circles [yellow] are where I’m going to be—is where I’m going to.*” She pointed to the “1lb” water drops around her image, “*And these are the pounds just dripping off me as I do exercise; and these are some of the things that I do to help, you know, make that happen.*” This creative depiction of her health goal of “losing weight” shows the power of reminders that encourage reflection on desired future states of health. Participants described how these introspective reminders, featuring self-check ins, health elements, and road maps, would support them to connect their concrete health tasks to broader health goals.

#### *Socially supportive reminders*

In contrast to introspective reminders designed primarily for individual contemplation, **socially supportive reminders** involved motivational and mentoring relationships. Participants described persuasive health reminders that leveraged social support to not only remember tasks, but to increase confidence in performing them. These reminders were targeted at concrete health tasks like medication and exercise, rather than broader health goals.

One mother, A2, photographed a socially supportive reminder system that she was currently using to motivate her five children to take on more responsibility for their health. She described her system of collecting tally marks on the fridge to indicate a completed task, such as ‘Don’t forget to take your medicine’: “*And for every time you do something you get a tally mark. And the goal is on the day that we score the highest score as a family we get to do something fun as a family. So everyone is working to try to get more tallies.*” This system helped the mother to shift accountability for health self-management to her children, which benefited the entire family. This approach highlights the importance of designing health reminders for family units to change their health behaviors together. The mother added, “*It’s a good way because then they’re reminding me. ‘We need to take our medicine because we want our points.’*”

Many of the socially supportive reminders were exemplified in the storyboard activity. Participants were asked to depict how a magical genie would help them to overcome a health challenge. In her storyboard, D3 described the kind of social support that would help her to overcome obstacles to taking her blood sugar,

*“I was frustrated because I didn’t want to take my blood sugars. I was upset because I wasted the needles, I poked my finger and the blood didn’t come out and the machine said it wouldn’t work. I didn’t want to do it in the first place anyway, and so I was discouraged and upset. The magic person came in, showed me why it was helpful and how to be able to do it correctly. She infused in me confidence. She had an interest in knowing what the outcome was going to be and why it was important for me to be able to do that, and she infused in me the fact that it would be a great activity. After she did that, I felt much lighter. I also felt more energetic, positive, ready to get started.”*

Being reminded of the rationale for the task, the outcome expectations, and her capacity to complete it, were central to this participant’s vision of a system that would increase her confidence to perform a self-administered blood glucose test. Some participant’s socially supportive genies were less comforting, yet still instructive. For example, D6 envisioned a genie who would help her to set up a reminder system that would prevent her from forgetting to take evening medications,

*“So genie said, ‘Well, you like little reminders. Put a reminder in an obvious place.’ And she said, ‘The solutions are put one in the bathroom, put one in the bedroom, put one wherever you’re going to be before going to bed.’ So I put a sign on the mirror in the bathroom because I brush my teeth. And I usually have a cup of tea or something in the kitchen, so on the television I put a little small sign in red saying ‘Meds.’ So if I picked the cup up and looked at the screen, I would see the sign. And I said, ‘Thank you, genie,’ and genie said, ‘Think on your own.’”*

This reminder was not a just-in-time alert to the task, rather it was well ahead of time and targeted at *how* to remember the task. Moreover, the “tough love” tone of social support was designed to encourage independence from the system. D2 also emphasized the importance of being reminded of *how* to refill medications so that he could ultimately take care of it himself,

*“I don’t have a car, so to get my medications at the clinic is kind of a chore. I have to go on the bus. So a genie came along and offered to fly me there. He also told me that they do have a system [at Group Health] for medication, but*

*you can't wait to the last minute anymore. Just got to plan ahead and order ahead of time. So at the end I was thankful for the genie, but also I realized I could take care of this problem myself."*

This reminder helped D2 to understand the time horizon for medication refills using the online system, which was essential to his success with the task. These examples of socially supportive reminders demonstrate the importance of receiving certain reminders well ahead of time that explain why and how to complete health tasks.

#### *Adaptive reminders*

Participants designed **adaptive health reminders** that persuaded them by adapting to their personal health information. Some participants distinguished these personalized health reminders from standardized reminder letters provided by the health cooperative. For example, A2 and A3 worked together on a collage that emphasized this distinction. A2 explained, *"We all get that form letter every year that says, 'Hey, come in, your child is due.' And it's that generic form letter that's been the same for the last twenty years or whatever and you don't even read it anymore, do you? Like, 'Yep, whoosh.'"* The health tasks included in these standardized reminder letters are based on health conditions, gender, and age. Participants described how personalized letters would compel them to retain the information and act on it, as A4 said, *"It makes me focus on the reminder. I will remember it a lot more and be willing to follow through. [...] I'm not just a number."* A1 suggested that, *"maybe it would motivate us to get our health assessments done if we knew that we were going to get more personalized tips."*

Participants highlighted the importance of using tailored reminders to catch their attention and help them to prioritize health tasks. For example, A3 designed a system that anticipated health needs and made suggestions based on her and her children's personal health information. She explained, *"This one would be a super app, so it would have your medical goals and specifications. Like my daughter's asthma would be on there. And then I thought it would be cool if it helped you maintain an active lifestyle. If you're going to exercise, it asks you: 'How much time do you have to exercise today?'"* She continued, *"It might give you guidelines for how much sleep your kids need for their age group."* This example suggests that persuasive systems will use personal health information to tailor reminders that help people to choose highly relevant healthy behaviors. Moreover, designing for the family unit is an important feature of reminder systems envisioned by caregivers.

We also found that the personalization of health reminders applied to both the medium (*i.e.*, the technology) and the message (*i.e.*, the content) of the reminder. For example, in contrast to A3's design of a mobile phone application, D3 and D4 designed a reminder system for diabetes self-management that was embedded in a refrigerator—a device that was very central in their chronic illness. The system was designed to adapt health reminders and notifications based on data that it collects from the user. D3 explained, *"The refrigerator would see what his [glucose] numbers are, be concerned about the fact that his number is low or high, and would be able to tell him that his number is low, [and] he should probably not eat certain type of things."* The system also used the personal data to help the patient prepare for appointments. D3 continued, *"It reminds you, 'This is your appointment; this is your appointment day; this is the time; and these are the things that you need to discuss with the doctor,' based on the things that you've already inputted into the thing."* This example highlights the persuasiveness of embodying reminders in a medium that is relevant to the task, in this case, the refrigerator is directly relevant to healthy eating.

D1 and D2 created another example of a centrally located technology designed to gather personal health information. Similar to D3 and D4, their system highlighted the importance of enabling patients to coordinate care with their providers. They designed an information "hub" that automatically generated appointments and reminders in response to data inputted by patients and their providers. This system would enable patients to shift accountability for certain health tasks to their providers. For example, rather than patients initiating health appointments and reminders, this system helped providers to monitor health data so that they could create appointments and reminders as needed. D1 explained that after the provider inputs lab test results,

*"It goes back to the patient; and the patient, when we do all of our testing at home, you can put that in your computer, too [...] So all of that [personal data] will be in there; and it can help the doctor tell you when the next appointment is, when the next test is. And all of that goes into this one computer program which collects it all and generates it [reminder]."*

Adaptive reminders revealed patients' desire for shared accountability among provider, system, and patient. To simplify and engage with complex self-management tasks, patients designed reminder systems that reduced the burden of personalization while facilitating active patient-provider collaboration.

### *Symbolic reminders*

The final type of reminder we identified was **symbolic reminders**. Symbolic reminders motivated participants to do health tasks by reminding them of personally significant reasons for healthy behaviors. These reminders were exemplified in the cultural probes data, wherein participants were instructed to take photos of helpful reminders using a Polaroid camera. Their photos were often deeply personal, reflecting the relationships and values that helped them to put health in perspective. For example, A4 featured her son as her reminder (Fig. 2a), “*I took a picture of my son and I outside of the YMCA here, so it's just a reminder to me to keep fit and healthy and active.*” Similarly, D1 photographed her dog (Fig. 2b) who reminded her to walk every day, “*My puppy gets very annoyed if we don't go walking every day, at least once, so that's why I took a picture of her [...] She follows me around and I say, 'Do you want to go for a walk?' And she runs to the door. So, anyway, she's a reminder.*”



**Figure 2. Symbolic reminders.** (a) Child; (b) Dog; (c) Flowers; (d) Medications.

Some participants photographed symbols of the rewards of good health. For example, D7 described a reminder that symbolized enjoyment of the outdoors. He used his Polaroid camera to take “*a picture of being able to look outside and enjoy the day. [...] Just a reminder to myself, I'll get a chance to see another day.*” D9 also took a picture of the outdoors; hers focused on flowers (Fig. 2c). She explained how she was temporarily barred from sewing because of pain in her hand, “*I'm off limits now with this hand. It's driving me crazy, so I got to remember 'I'll get back to it, just relax.'* [...] *If I can't sew, I'll go out and smell the flowers and take it easy.*” In contrast to these positive symbols of good health, D6 reminded himself of the costs of poor health (Fig. 2d): “*I took a picture of all of my medications because whenever I look at them I'm reminded of how much poor health can cost you. They all add up, and so they remind me to try to watch my weight and watch what I eat so hopefully keep my problems under control—hypertension and diabetes and also my chemotherapy drugs.*” These symbolic reminders were part of patients' everyday lives, motivating them to seek the rewards of healthy behaviors.

### **Discussion**

Our participatory design approach to understanding persuasive reminders for health self-management revealed several implications for future systems. First, participants challenged the traditional conception of delivering reminders at the *right time*. Rather, participants emphasized the persuasive value of reminders that sparked behaviors well *ahead* of time. For example, introspective reminders were oriented toward helping patients to plan ahead and prioritize health tasks. Participants emphasized that being triggered well ahead of tasks was important for helping them to build awareness of their health trajectory and contextualize their health tasks within it. Introspection on the relationship between health tasks and goals enabled patients to reflect on cause-and-effect relationships between health behaviors and outcomes over long time spans. This reflection aided contemplation on the rationales—the *why*—for performing health tasks. Similarly, symbolic reminders that were embedded in everyday activities and relationships were not conceptualized as just-in-time triggers. Rather, the image of a child, a favorite



hobby, or an outdoor scene were omnipresent reminders that heightened awareness of personally significant rationales for being healthy. Thus, reminders that spark health behaviors well ahead of time enable persuasive messaging that increases self-awareness and motivation to perform health tasks.

We found that, in addition to systems that increased motivation, participants designed systems that increased their *ability* to perform them. While introspective and symbolic reminders helped patients to understand *why* they were doing health tasks, socially supportive and adaptive reminders emphasized *how* to perform tasks. Such systems provided them with information about resources, services, and instructions relevant to tasks that helped them to develop expertise. For example, some participants designed “divine interventions” by genies who reminded them of the skills and resources needed for tasks. The focus on skills mastery that characterized socially supportive reminders was designed to facilitate shifting accountability for health tasks from parents to children, and from patients alone to patient-provider collaboration. Similarly, the emphasis of adaptive reminders on anticipating needs and making recommendations created new opportunities for sharing accountability between patients and providers. Participants valued socially supportive and adaptive reminders for enabling them to reduce the burden and frustration of chronic illness management. They described how these reminder systems would help them have more confidence in their ability to be effective self-managers and to work together to remember and achieve health goals.

We also found that participants considered personalization to be crucial to persuasive reminders for health self-management. Participants linked personalization to feeling more engaged in health care and more willing to follow through on health tasks. They designed systems that were personalized in terms of both the *message* being delivered, and the *mode* of its delivery. For example, a mother designed a mobile-phone based application that delivered tailored messages about asthma care based on her child’s personal health information. The application would detect weather conditions and other information relevant to asthma to create reminders as the context changed. An older adult designed a refrigerator-based system that gathered information and delivered reminders relevant to nutritional management for patients with diabetes. These examples demonstrate that the technological embodiment of reminders for asthma require different affordances than those for diabetes care due to the unique contexts of certain health behaviors. Studies have demonstrated that persuasive health reminders personalized to individuals’ susceptibility to different persuasive strategies exceed the impact of generic reminders<sup>33,48</sup>. Our findings confirm and expand this finding by suggesting that patients are most likely to be persuaded by health reminders that are personalized to their health goals and values, *in addition to* their preferences for different persuasive strategies.

Finally, the four types of persuasive reminders that we identified—introspective, socially supportive, adaptive, and symbolic—had different affordances for individual, intra-familial, and patient-provider interactions. These different patterns of interaction influenced both the scope of persuasive strategies, and the roles of patients, caregivers, and providers in health self-management. For example, introspective reminders were primarily designed for individual contemplation, whereas socially supportive reminders aided families, and adaptive reminders featured collaboration between providers and patients. Designing for these different units of analysis offers new ways to innovate health reminders that promote shared accountability and social learning for health. Our findings point to the importance of designing persuasive health reminder systems that individuals, families, and patient-provider pairs can interact with.

## **Conclusion**

We used a participatory design approach to understanding patients’ and caregivers’ desires for health reminder systems that persuade them to manage the myriad and complex tasks of preventive and chronic illness management. Participants embodied their perspectives of desired futures in design artefacts that revealed four types of persuasive reminders for health self-management: introspective, socially supportive, adaptive, and symbolic. We contribute insights into implications for the design of persuasive health reminders including designing for the *how* and *why* of performing health tasks, triggering tasks well *ahead* of time, and personalizing both the message and the medium of reminders. Our contributions to persuasive system design are grounded in an ethical approach to engaging patients as authors of their own persuasive strategies that reflect their attitudes toward health self-management. This approach is significant for informing the design of patient-centered systems that empower people to adopt health behaviors in ways that are sensitive to their cultural, personal, and interpersonal values.



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