What Colour Is 'Exercise?' Designing Multimodal Reminders for the Home

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Abstract
When designing home care systems to keep individuals independent in their homes longer, multimodal interaction provides a compelling approach to creating an enjoyable and usable experience. Previous work in multimodal home care systems has looked at how reminders might be disruptive [1] or socially appropriate [5]. However, previous work has not looked specifically at how reminder **content** is paired with a multimodal **presentation,** especially when that presentation is not speech or text based, for example an abstract visual or olfactory presentation. In order to explore these issues, we completed a survey that focused on how the content of a reminder might affect a variety of factors such as appropriateness, importance and annoyance. Building on this survey, we are currently completing a series of focus groups that looks at how users pair reminders with multimodal presentations.

Author Keywords
Home Care Systems; Multimodal Interaction; User-Centred Design.

ACM Classification Keywords
H5.2. [Information interfaces and presentation]: User Interfaces - User Centred Design.

Survey Factors

Importance – $p < 0.001$
Urgency – $p < 0.001$
Privacy – $p < 0.008$
Clarity – $p < 0.001$
Helpfulness – $p < 0.001$
Politeness – $p < 0.001$
Directness – $p < 0.001$
Annoyance – $p < 0.0003$
Pleasantness – $p < 0.001$
Appropriateness – $p < 0.001$
Sensitivity – $p < 0.001$
Worrying – $p < 0.001$

Figure 1. Factors explored in the Reminders in the Home survey.

Introduction

The goal of many home care systems is to give individuals the resources they need to maintain their independence, retain a sense of control over their health care and their lives, and even create a better sense of social connectedness [6]. Home reminder systems aim to help users, in particular older adults, remain independent by reminding them of everyday tasks and allowing them to control when and how those reminders are delivered. Reminder systems are ideal for addressing issues of continued independence and control because they can be used and configured independently by the users themselves and by their very nature are integrated with sensors and monitoring systems that provide information and feedback to users.

Multimodal interaction techniques provide a promising approach to home reminder systems as a means of displaying information throughout the home in a variety of ways. Previous work in the area has looked at different factors that might influence how reminders are presented and experienced within a home environment. Arroyo *et al.* looked at the disruptiveness of different modalities [1]. Edworthy and Hellier studied the disruptiveness of alarms with respect to their design and use [3]. McGee-Lennon *et al.* explored how users could participate in the design of multimodal reminders [4].

However, much of the previous work in this area has failed to address **how** different reminders should be presented in the home given the variety of multimodal interaction possibilities. How should reminders be presented with respect to the **content** of the message? Should reminders of different importance or urgency be presented in a particular way? How should abstract modalities such as non-speech sounds or non-text visuals be designed? For example, when using ambient visual displays what colour best represents exercise? The survey and focus group studies presented in this paper seek to explore these issues by focusing on how the **content** of a reminder relates to the user-defined **presentation** of that reminder. The initial survey focuses on how users perceive the content of a variety of messages. The focus group study builds on this survey by using a subset of the survey reminders and exploring how users actually pair the reminders with multimodal presentations. The results of this work in progress demonstrate the importance of considering both the content and presentation of reminders when designing reminder systems for older adults.

Survey Study

In order to understand how reminders should be presented in the home, it is important to first understand how users might subjectively perceive the **content** of those reminders. For example, are some reminders significantly more helpful or important than others? Do different phrasings of the same basic message influence annoyance or privacy? These issues could significantly affect the preferred presentation techniques for reminders and must be considered early in the design of a multimodal reminder system. In order to explore reminder content, we ran a survey study that focused on the content of different reminders outside of the context of any multimodal presentation. Using a set of 19 reminders (Figure 2), survey respondents described each reminder based on 12 factors (Figure 1). Each of these factors represents an aspect of reminder systems that might influence acceptance in the home. The results of this survey describe how the content of reminders was perceived and how this could influence the preferred presentation of those reminders.

Reminders for Survey Study

"Pills"	"Plants"
"Take your pills"	"Water the plants"
"Please take your heart pills"	"Please water the plants"
"Please take your pills"	"Water the cactus"
"Have you taken your pills today"	"Have you watered the plants this week?"
"Take your heart pills at 4pm today"	"Water the cactus in the front room"
"Keys"	"Remember your keys"
"Have you locked the back door?"	"Please lock the front door"
"Remember to lock the door"	"Lock the door"
"Doctors"	"Doctors at 2:15pm on Thursday"
"Mrs. Smith next door has fallen and needs assistance"	"Remember to take a urine sample to the doctor"
"The nurse is coming to visit in 10 minutes"	"The nurse is coming to visit today"
"Take your umbrella"	"Have you got your bus pass?"
"Remember to charge your mobile phone"	

Figure 2. Full list of reminders used in the survey.

The Survey

The survey was administered over the Internet using a popular survey tool. The survey began by asking respondents for basic demographic and health information, including age, gender, and any known sensory impairments. The survey then continued by going through each of the 19 reminders individually. For each reminder, respondents were asked to state how well each factor described the reminder. These responses were on a 7-point scale ranging from 'Not at All' to 'Extremely.' The survey also included a free response section where respondents could add additional comments.

Factors of Acceptance and Usage

The 12 factors explored in this survey study are shown in Figure 1. These were selected as possible aspects or qualities of different reminders that could influence acceptance and usage of those reminders in the home. For example, the most important reminders might require an intrusive or disruptive presentation in order to ensure the reminder is noticed. The most private reminders might be best as an abstract presentation in order to keep the content of the reminder confidential. Exploring these different factors contributes to a better understanding of which factors are significant or related with respect to these reminders.

Reminders

Figure 2 lists the reminders that were included in this survey. One of the major goals of this survey was to determine how different phrasings of the same basic reminder affected users' perceptions of that reminder. For example, are shorter or longer messages perceived as more or less annoying in the home? If respondents consistently find one word reminders to be significantly more annoying than longer sentences then that must be considered when deploying these kinds of reminders in the home. To explore the perception of different phrasings of the same basic content, the reminder set includes the several basic reminders phrased as short sentences, one-word statements, detailed sentences, and questions.

Results

The results of the survey include responses from 60 respondents recruited through email lists and community health care groups. Of the respondents, 35% were below the age of 40, 14% were between the ages of 40 and 59, and 47% were over the age of 60. The survey was specifically targeted towards older users with some familiarity with technology in order to best capture our target user group. However, responses from users of all ages were included for increased breadth.

Significance tests were completed using the non-parametric Friedman test [2] in order to determine the significance of the chosen factors for this reminder set. All of the twelve factors were significant ($p < 0.05$) as shown in Figure 1. Figure 3 shows how different phrasings compared with respect to helpfulness (top), importance (middle), and privacy (bottom). For pill and plant reminders, 3 different phrasings demonstrate some interesting differences. For example, differences in helpfulness are most pronounced when comparing different phrasings. In contrast, differences in importance and privacy are most pronounced when comparing message content, in this case pill versus plant reminders. Many of the survey factors can be orga-

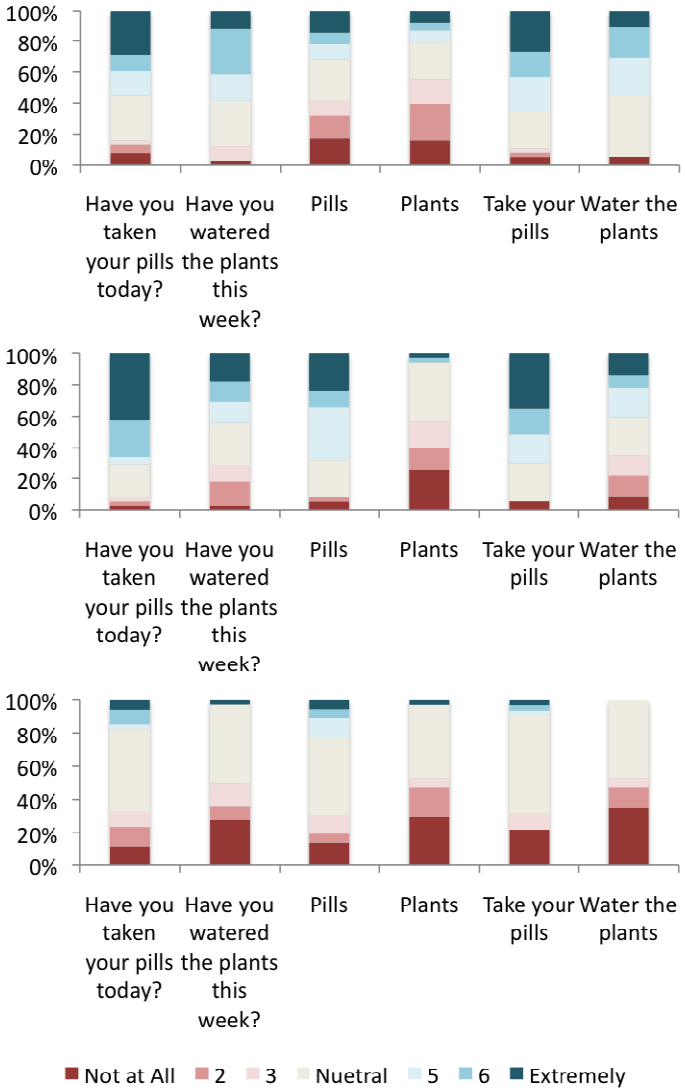

Figure 3. Likert ratings for reminders based on helpfulness (top), importance (middle), and privacy (bottom).

nized based on how they change user perceptions: those which divide the reminders by phrasing, such as helpfulness, clarity, and politeness, and those which divide the reminders by content, such as importance, privacy, and urgency.

The survey supported additional comments in a free form response section for each reminder. These comments begin to describe why phrasings of the same reminder were perceived differently. For example, when describing the "pills" reminder, one respondent described it as "factual, with no implied underlying message" while another respondent described this it as "unclear." When describing the "take your pills" reminder, one respondent described this as "bossy." These descriptions of different phrasings demonstrate how important it is to choose an appropriate phrasing and allow for customization of reminder content to support diverse preferences. When describing the reminders phrased as questions, respondents were often unsure as to how this would work as a reminder. For example, when describing the "have your taken your pills today?" reminder, one respondent stated that "It's a message but not a reminder because it has come too late." Other comments included "patronizing and imprecise" and "depends who's asking." Here, respondents were unsure when and how this would be presented and if they would be able to interact with or respond to the reminder.

Discussion

The results of this survey study demonstrate the importance of considering the content and phrasing of reminders before designing multimodal presentations. The way that content affected the perception of reminders was noteable for several of the factors, such as importance, privacy, and urgency, but also highlighted the importance of customization. What is considered private or urgent by one user may be completely different for another user. For example, although "take your umbrella" was one of the least important reminders in our set, 8% of respondents still rated this as "extremely" important. Different phrasings of the reminders also led to different perceptions. Short statements, such as "take your pills" were often described as unpleasant and controlling. Questions, such as "have you taken your pills today?" gave a very different experience. Respondents described how context would change the way a question-like reminder would be perceived, which was not an issue for the short phrase or statement reminders.

The results of this survey provide a solid baseline from which to design a focus group study to further explore these initial findings. However, further possible areas of inquiry with the survey results include additional pair-wise tests of the reminders for each factor, tests of correlation between factors and reminder phrasings, and comparisons between the different age groups.

Reminders for Focus Group Study

Private/Non-Important
Do some exercise today.
Have you done exercise today?
Private/Important
Have you taken your pills?
Take your pills.
Non-Private/Important
Remember your keys.
Do you have your keys?
Non-Private/Non-Important
Water the plants.
Have you watered the plants?

Figure 4. Reminders used in the focus group study.

Focus Group Study

Based on the results of the survey, we selected a subset of the survey reminders, with a few additions, for further investigation in a focus group study. The goal of these focus groups was to understand how users would map multimodal presentations to different reminders. An important issue in these groups was that some of the modalities, such a speech-based audio or text-based visuals, have a direct linguistic link to the content of the reminder. In contrast, abstract modalities such as non-speech audio, abstract or ambient visuals, tactile and olfactory output rely on social constructs or individuals' cognitions to create a link between to content of the reminder and its presentation. These focus groups seek to address how users might design reminders given these different modalities.

Reminders

For these focus groups, 8 reminders were chosen based on their relative privacy and importance as shown in Figure 4. These factors were chosen because of their significant results in the previous survey and their interesting implications for multimodal presentation. For example, are users willing to accept a more annoying or disruptive presentation if the reminder is considered important? Will users want to switch between modalities depending on which spectators are present if the reminder is considered private? Additionally, each reminder was phrased as a statement and a question in order to further explore the issues of phrasing and how this might affect different presentation techniques.

Presentation Modalities

Each of the focus groups looked at how the 8 reminders could be presented using 6 different presentation techniques or modalities, as described in Figure 5. These included 4 abstract or non-linguistic modalities (abstract visual, olfactory, tactile, and non-speech audio) and 2 language-based modalities (speech-based audio and text-based visuals). For each modality, focus group participants were given demonstrations of the capabilities and customizable features (described in Figure 5) and asked to imagine how they would use such reminders in their own homes. Although these modalities were investigated individually in this study, the modalities would be deployed together in a real-world evaluation to create a truly multimodal system.

Focus Group Design

Each focus group began with a basic introduction to the purpose of the groups and a worksheet collecting basic demographic information. Then participants went through each modality: participants were given a demonstration of that modality and asked to make a decision as a group as to how they would present each reminder in a home setting. After going through all of the modalities, participants were asked the rank their preferences for the modalities for each reminder. Thus, participants were required to design presentations for all modalities but could indicate which modalities were more or less desirable in their final rankings.

Results

These initial results are based on an on-going series of focus groups with older adults aged 60 and above, including 4 currently completed groups totalling 10 participants. The following themes are the emerging results of this work in progress.

Reminders Around the House – Participants described how and where different reminders should be presented, often with respect to different meaningful

Abstract Visual – Can be displayed anywhere in the house using a handheld projector, mobile tablet device. Can display pictures, icons, shapes, and colours. Brightness, intensity, and flickering/flashing can be controlled.

Olfactory – Can be displayed from a power outlet using fan/disk plug unit. Can display a variety of scents. Duration and intensity can be controlled.

Tactile – Can be displayed anywhere on the body using a vibration unit. Can display patterns of vibration. Pattern, duration, and intensity can be controlled.

Non-Speech Audio – Can be displayed from any speaker in the house (TV, radio, mobile device, etc.). Can display any non-speech sounds. Volume and duration can be controlled.

Speech-Based Audio – Can be displayed from any speaker in the house (see non-speech audio). Can display recorded, synthesized, or sped up speech. Gender, accent, voice, and volume can be controlled.

Text-Based Visual – Can be displayed anywhere in the house using a handheld projector, mobile or tablet device. Can display text of the reminder. Font, colour, size, and duration can be controlled.

Figure 5. Modalities used in the focus groups and the descriptions given to participants.

regions around the house. For example, one participant described how certain reminders should be projected onto a cabinet door because the to-do list was often kept there.

Unpleasantness and Motivation – Although participants described certain reminders as being unpleasant or annoying, this was sometimes seen as a benefit for important or urgent messages. For example, one participant described how an unpleasant odour in the hall would motivate her to get up and lock the door.

Phrasing of Reminders – Although the survey demonstrated that phrasing played a significant role in reminder perception, this only held true for language-based presentations. For the non-linguistic modalities, participants had difficulty imagining how a question versus a statement should be presented and often insisted on combining similar reminders when discussing non-linguistic modalities.

Configurability and Adaptation – Although configuration and user defined preferences were not meant to be included in these groups, participants naturally described how they would like the configure a system or asked questions about how the system could automatically adapt to their preferences.

Discussion and Future Work

Although these results are based on an on-going analysis, the initial findings are promising. By identifying which regions of the home are desirable or appropriate places to receive reminders we can better understand how different modalities will be able to work together in the home environment. The results also demonstrate the possibility of acceptable reminders that are highly disruptive or annoying. This builds on previous work that measures disruption by identifying situations where disruptive but highly accurate reminders might be desirable. Finally, these results will provide the necessary framework for developing a configurable reminder system by identifying which presentation techniques users find most desirable and how they would distribute these throughout their home. The development of configurable home reminder systems represents an important next step in this work.

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