Coaching Older Adults

Persuasive and Multimodal Approaches to Coaching for Daily Living

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ABSTRACT

In this work, we present our approach to designing a multimodal, persuasive system for coaching older adults in four domains of daily living: activity, mobility, sleep, social interaction. Our design choices were informed by considerations related to the deployment of the system in four pilot sites and three countries: Austria, Bulgaria and Slovenia. In particular, we needed to keep the system affordable, and design across divides such as urban-rural and high-low technological affinity. We present these considerations, together with our approach to coaching through text, audio, light and color, and with the participation of the users' social circles and caregivers. We conducted two workshops and found preference for voice and text. Participants in Bulgaria also showed a preference for music-based rendering of coaching actions.

KEYWORDS

Coaching, older adults, persuasion, daily living, multimodality.

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1 Introduction

Multimodal interfaces are a promising area for the development of ambient and assisted living (AAL) systems, as they offer additional "flexibility, efficiency and robustness". However, study results show older adults often remain constant with respect to their modality preferences [19]. Their choices are also informed by personal and system characteristics and interaction context [12]. Older adults are far from being a homogenous group [6,14,16] and do not generally fit the assumptions of being isolated, ill, unable or unwilling to learn new ways of interacting with systems [6]. Moreover, older adults have varying acceptance levels of AAL systems.

To answer these challenges, we present our approach to coaching older adults through an AAL system in four domains of daily living in three countries. Our design is based on considerations related to affordability and characteristics of users across nationality, cultural backgrounds and technological affinity. We provide an overview of our strategies for coaching in the domains of activity, mobility, sleep and social interaction. We detail our chosen modalities for sending coaching actions through two type of devices, three modalities and three persuasive strategies. Our findings from two workshops in Austria and Bulgaria suggest users have a preference for voice and text, although light and color were appreciated for redundancy, and for communicating with the hearing-impaired. Bulgarian participants also appreciated earcons as an attention cue, prior to voice-rendered coaching actions.

2 Coaching Approach

The system SAAM is installed in users' homes and is able to detect activities through a network of sensors. Based on these collected data, the situation is assessed and a coaching action is rendered to the user, in each of the four domains of daily life: sleep, mobility, activity and social interaction. While mobility refers to physical activity (walking, exercising), activity refers more generally to the user's distribution of daily activity (e.g. resting, cooking, cleaning). Our rule-based approach which is streamlined into four main

pipelines and makes use of hierarchical multi-criteria models has been previously described in detail by colleagues [21]. Participants choose which domain(s) they would like to be coached in and receive suggestions in parallel for all selected domain(s). For our purposes, we focus only on the rendering of the coaching messages, namely the content and the modalities for transmitting the information to the users. Each domain has a certain number of pre-determined coaching actions, selected together with domain experts. Examples per domain are presented in Table 1.

	Mobility	Activity	Sleep	Social interaction
Example coaching action	Walk more steps today	Keep going outside regularly	Avoid drinking 2 hours before sleep	Go out to an event or social place

For the moment, the system is focused on one-way interaction to the user, through the rendering of coaching actions. However, a user can validate whether a coaching action has been completed, through the mobile application. Additional models for verifying completion of the coaching actions are under feasibility consideration.

3 Rendering of Coaching Actions

The coaching actions are transmitted to the user through two devices: a mobile application designed for tablet and smartphone and an ambient sensor with rendering capabilities. The two devices support the rendering of the coaching actions through text messages, audio (earcons and voice), light and color. In selecting these, we had in mind the particular considerations of our target groups and pilot sites. The mobile application allows a high level of personalization. Users have an option to change their preferred modality if they so desire.

3.1 Design Considerations

Having defined the coaching actions for each of the four domains of daily living, we reflected on modalities for rendering them to the users. A first consideration was the set of available devices and interfaces in the project and the requirement of keeping the overall system affordable. This meant we could not purchase additional equipment. Apart from screen-based interfaces included in the system setup (mobile phone and/or tablet), we identified the ambient sensor as a potential output device. Matrix Creator includes a circular 35 RGBW (Red, Green, Blue, White) LED (Light Emitting Diode) array, capable of displaying programmable patterns. Raspberry Pi 3B+ hosting Matrix Creator shield allows for audio output via an auxiliary port. Therefore, the sensor could output messages through sound and light.

A second consideration was the diversity of target users across pilot sites. In Austria, we designed with older adults independently living at home, with no chronic health issues. The Slovenian participants are older adults with lower limb amputation, who have been prescribed a prosthesis and a rehabilitation program. Bulgarian users are living at home, in urban and rural areas. Some of them benefit from caregiving support from volunteer organizations Caritas and the Bulgarian Red Cross, others are actively engaged in their communities and provide caregiving support themselves. Part of them have chronic health conditions. The Austrian participants have the highest technological affinity, while the Bulgarian participants – the lowest. A subset of the Bulgarian target group is illiterate.

A third factor was customization. Each user, depending on preference to be coached for one or several domains, may receive one or more coaching actions, even within the same day, depending on behavior and data collected by the system. Frequent text notifications often become obtrusive, while rendering through the ambient sensor may increase cognitive load. The possibility of distinguishing between different domain areas could help users developmental models about the areas in which they are being coached.

Finally, we also took into account the possibility to coach users through their social circle (family, friends, neighbors) and caregivers. These actors are called "secondary users" in the system's language and they would receive coaching actions for the respective older adult, and then intervene directly, for example by calling or visiting them. For certain coaching actions, such as reducing loneliness, this direct approach could be more effective rather than confronting the users with information about their behaviors. For secondary users, only screen-based interfaces are available.

3.2 Text

Text notifications are sent to both primary and secondary users to inform them about coaching actions. For the older adults, notifications have to relay the coaching actions in a compelling way, as purely informational notifications can become less appealing over time. To this end, we chose a total of three persuasive strategies [8], based on literature search of effectiveness in previous studies: suggestion [2,3,17], self-monitoring [1,4,9,10,18] and commitment bias [7,15,20]. This selection was based on our approach of combining the theory of planned behavior and goal setting theory together with behavioral strategies used in persuasive technologies [8] for personalization in coaching. The first two strategies are implemented for the mobility, activity and sleep domains, while the latter is preferred for social interaction, coupled with the *suggestion* strategy. In essence, each participant receives one of two possible phrasings: either suggestion or self-monitoring (for sleep, mobility and activity); and either suggestion or commitment bias (for social interaction). For the secondary users, we distinguished between caregivers and the users' social circles. The former do not need to be persuaded to act towards the seniors and, therefore, can receive the information in a neutral tone. In the case of friends, neighbors and family, we decided on a single option to wording, combining a suggestion with information about the behavior of the older adult in question. Providing secondary users, from the older adult's social circle, with information and a suggestion to act on it creates informational social influence.

3.2.1 Suggestion. Suggestion has been widely researched as a way to improve cognition and behavior, and can have a long-lasting impact on the choices people make. Suggestion builds on existing motivations

and serves to cue a relevant behavior [8]. It is also aligned to the principle of personalization in designing our system, to offer advice based on sensed situational assessment. Personalization is a promising approach in the field of active and healthy ageing [2]. A suggestion-based coaching message to the user makes a personalized recommendation, such as "You might sleep better if you lower the temperature in your room before going to sleep".

3.2.2 Self-monitoring. Self-monitoring persuasive strategies have been demonstrated with consistent results in the health domain [1,9,18]. Self-monitoring can improve coaching efficiency through increased understanding of the individual's own health status, habits and routines, irrespective of domain. It is also aligned with the general wellbeing approach in designing our system, of personalized coaching for wellbeing in non-clinical, home-based settings [10,11]. In self-monitoring messages, users receive data about their behavior together with a recommendation. For example: "Your data from this week shows that your room temperature is *X degrees*. Try to reduce it. Open the windows for a while before you go to sleep.". In this case, "X" is replaced with the real value recorded by the system.

3.2.3 Commitment bias. According to Locke and Latham [15] goal performance is strongest when people are committed. In order for SAAM to render relevant coaching suggestions, the users are able to enter the desired nature and frequency of social interactions. The reason is that the frequency and intensity of social interaction is person-specific. Unlike the other domains of daily life, benchmarks are difficult to set. Therefore, users should be able to set their own goals in the form of frequency of social interaction with different circles – family, friends, community. An example for a phrased message based on this strategy is: "You have set a goal to invite friends over more often. You are able to meet your goal: You might want to invite SU over.", where SU is a designated secondary user who is a part of the social circle.

3.3 Audio

3.3.1. Voice. For sake of redundancy as well as accessibility, the language-based coaching is rendered not only as text, but also as voice via the ambient sensor. The voice coaching is an audible, and slightly modified, representation of the text renderings. We recorded the voice messages of the phrases in each of the pilot site languages: German, Bulgarian and Slovenian. We opted not to use text-to-speech computer-generated voice, due to possible difficulties in understanding synthesized speech, especially while experiencing hearing problems. It is also more difficult to convey naturalness and emotions and the need for dynamic voice synthesis in the project is low [13]. The voice messages follow closely the phrasings in the text messages and are also recorded using the different persuasive approaches. As discussed above, two out of the three selected persuasive strategies are employed in each domain. Within the SAAM project, older adults participating in long-term tests are assigned to receive coaching actions using only one persuasive strategy. This random assignment is valid for users who receive text notifications as well as voice via the ambient sensor.

3.3.2. Earcons. In order to attract the users' attention and prepare them for the following voice message, earcons were designed to be rendered also through the ambient sensor. We designed one specific earcon (short melody) for each domain, to explicitly inform them about the topic of the upcoming message, without the need or possibility to listen to the entirety of the message. Sleep is represented with a calm descending melody, representing the process of falling asleep. Activity is associated with a calm ascending melody. For mobility we chose a fast melody, motivating for physical activity. Finally, a slightly ascending, friendly melody was selected for social interaction, to suggest the eagerness of meeting somebody.

3.4 Light and Color

Similar as with the earcons, we chose light patterns and colors to be rendered through the ambient sensor, prior to the voice messages, to attract the attention of the user and signal the domain.

Figure 1: Rendering through light and color: two instances for social interaction coaching (above) and two instances for sleep coaching (below)

This modality was chosen also to support users with hearing impairments, or those who are not monitoring their screen-based interfaces, due to reduced familiarity with them. Particularly some participants with low technological affinity may not be used to monitoring their notifications. Therefore, the light and color sent through the ambient sensor reminds them to check their tablets or mobile phones for the text notifications, should they choose to enable these rendering modalities. The light patterns and color were designed so that they do not need to be learned, but can be associated with the respective domains. For sleep, we chose a slowly pulsating purple light. For activity, a spinning orange light.

For mobility, a blue half-circle, alternating sides. Social interaction is represented with two halves, green and blue, filling half circles on the Matrix Creator (see Fig.1).

4 Initial Findings

4.1 Method

In order to assess the acceptance of the different rendering modalities, we conducted two workshops in Austria and Bulgaria with older adults. The workshops were attended by ten and six participants, respectively, all above the age of 60. In Austria, the participants were asked to match the rendering through light, color and audio with the coaching actions, and were asked to explain their choices. In Bulgaria, participants were presented with three options and discussed their preference among these. Participants had no previous exposure to the modalities before the testing. The options were: (1) rendering through light, sound and mobile notification; (2) rendering through light and voice over message and (3) rendering through sound, followed by a voice message. The Bulgarian workshop was conducted after the one in Austria.

4.2 User feedback

4.2.1. Light and color. The light and color were perceived as a support or reinforcer modality, which was in line with our design approach: *"I do not believe that you can tell, what the system wants to tell you from the lights only."* Participants also believed that light interaction is useful for the hearing impaired, or when one has difficulty: *"But what if, I haven't turned on my hearing device? Then at least I would see the lights, if they would stay visible. Someone, who has hearing problems would respond to the lights."* However, some participants noted the design of the lights and color, making a connection to the coaching domains: *"But I saw some requests in the lights. When the light was red it's rather an order or instruction to me, and a lighter light meant something more pleasant. That's why with the sleep signals I started to pay attention to the lights and not so much to the sounds."* It was also suggested that the color coding on the Matrix Creator could be used for distinguishing between different social contacts, by assigning them different colors. This was an interesting perspective we had not considered, that the rendering could be used to "block" unwanted social contacts: *"if someone is calling, I don't want to speak to, I can tell in a moment from the color and don't pick up the phone."* Finally, participants noted that light requires physical presence in the vicinity of the device, while voice and earcons cover a larger physical area.

4.2.2. Audio. In Bulgaria, there was a clear preference for audio interaction (voice and sound). Participants perceived the earcons to be *"like an introduction"* and shared that hearing a melody predisposed them to listening further. The earcons at the beginning of the message would also help them not to get stressed when hearing the voice message that may follow. In the Austrian workshop, the gender of the speaker became a topic for discussion. Several female participants agreed that a male voice would be their preferred option and several participants expressed the importance of clear, articulate language when using voice as a modality. Participants also mentioned alternative uses for the voice interface, such as repeating words for those suffering from early cognitive decline: *"Another idea, which could be useful with regard to dementia, would be the system recording, what I'm saying. Because when you have incipient dementia, you forget about words, and then the system could repeat your own words to you."*

4.2.3. Text. Austrian participants had a strong preference for text messages sent through the mobile app and were comfortable with using the app to check on their data collected by the system. Some participants felt that, if they receive the messages through the app, the other modalities are not necessary. This perception was quite the opposite from Bulgaria, where users would prefer to be notified through earcons and recorded messages. However, participants noted that text notifications remain vital for rendering outside of the SAAM user's home.

4.2.4. Combinations of modalities. Redundancy between modalities was welcomed by Bulgarian participants. In their opinion, receiving the coaching advice in more than one way would reduce the possibility for the user to omit it. They also welcomed a combination of three modalities (earcon, voice and text), as they could be sure not to miss the coaching advice.

4.2.5. Concerns and suggestions. Some participants had concerns with respect to the placement and obtrusiveness of the system, for example to make sure that coaching actions would not be rendered during the night or nap time during the day. There were also suggestions for personalizing the Matrix Creator, for example by setting how many repeats one would receive of the same message. Finally, there were concerns for making sure the device is sturdy enough to be transported, could be placed on a wall, or be resistant when having it installed for longer periods of time.

5 Conclusions and Future Work

Designing for a heterogenous group of older adults and within affordability constraints implies a careful weighing of considerations. In this paper, we have shown how we balanced our approach to design for multimodal interaction through text, audio, light and color and using three persuasive strategies for older adults with diverse needs in Austria, Bulgaria and Slovenia. We found that Austrian seniors, who have a higher technological affinity, have a preference for text notifications and voice, while Bulgarian participants favored earcons and voice messages, as well as multiple options to draw attention. Light and color were perceived as useful for redundancy, especially when users might suffer from hearing impairments. There was also a perception of the correlations between the color and lights, with the domains of daily life. In the future, we will be testing the system in long-term pilots, ranging from three to six months with users living in single-member households. We will be able to assess whether preferences change over time, and whether users develop mental models, with respect to earcons, lights and colors. Heterogeneity of users will be more clearly displayed in the larger sample and any potential social agreement effect from the focus groups will be eliminated.

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