

Name That Tune: Musicons as Reminders in the Home

Marilyn McGee-Lennon¹, Maria K. Wolters², Ross McLachlan¹, Stephen Brewster¹, Cordy Hall¹

¹Glasgow Interactive Systems Group, School of Computing Science, University of Glasgow, UK
(mcgeemr, stephen, cordy, mclachrd)@dcs.gla.ac.uk

²School of Informatics, University of Edinburgh
Edinburgh, UK
maria.wolters@ed.ac.uk

ABSTRACT

In this paper we argue that Musicons, short samples from pieces of music are a useful way to present private but memorable reminder messages. We investigated accuracy, memorability and response times for short, medium, and long Musicons. User performance on the Musicons was also compared to short spoken reminders. The study consisted of two sessions a week apart. Quantitative measures were augmented with qualitative questions about associations and memories. Overall, participants achieved a high level of accuracy (89%) on the Musicons. Recognition was stable at 90% or better across sessions for users who were able to construct meaningful links between Musicons and the associated tasks. Optimal response times were achieved for medium-length 0.5 sec. Musicons. We conclude that Musicons are a viable option for alarms and notifications that combine the high learnability of Auditory Icons with the more private nature of Earcons.

Author Keywords

Auditory reminders, Earcons, Musicons, memory.

ACM Classification Keywords

H5.2. [User Interfaces]: Auditory (non-speech) feedback.

General Terms

Human factors

INTRODUCTION

Prospective memory, the ability to remember to do something, is affected by factors such as age [11] or brain injury [10]. Reminder systems play an important role in allowing people with prospective memory loss to remain in their own homes. For example, reminders to lock the door at night greatly increase safety and reminders to take medication help people manage their own care.

User preferences for reminder delivery are highly varied [7]. It is even more crucial in the home than in the workplace to accommodate these preferences since the home is a private space that intimately reflects the owner's personality and habits. People who receive care at home often find it difficult to perceive themselves as "in need of

care". Therefore, it is important for home care solutions to be as unobtrusive as possible.

Even though hearing acuity declines with age, auditory reminders are still a key interface modality, because they do not require the user to attend to a screen and are effective if eyesight is poor. The design space for auditory reminders is vast. It ranges from simple beeps to explicit spoken messages, and from Auditory Icons to Earcons. Auditory Icons are familiar sounds of everyday events with an intuitive mapping between sound and meaning [5], while Earcons are musical sounds that only bear an abstract relation to their meaning [1].

When creating reminder systems for the home, designers need to balance ease of comprehension and privacy. Privacy issues arise when there are others in the home who can overhear reminders that are easy for anyone to understand. While Earcons ensure privacy, some users may find them more difficult to learn than Auditory Icons [5].

We propose to address this gap in the design space between Earcons and Auditory Icons with Musicons, extremely brief samples of well-known music. We argue that recall, recognition and emotive memories for music can be exploited to create reminders that are both sufficiently abstract to ensure privacy and sufficiently memorable to be easy to learn.

In this study, we compared the accuracy and learnability of Musicons to synthetic speech, which requires no learning and yields perfect performance. We also systematically varied a particular design parameter, Musicon length, hypothesising that accuracy would be higher for longer Musicons, while response time would be lower for shorter ones. Through interviews and questionnaires, we also investigated how users associate the different Musicons with different task-based reminders.

MUSICONS

People tend to have strong musical memories. Music imagery in the brain is uniquely powerful – it can be highly repetitive, resulting in strong associations with the original stimulus. Music can help people remember by triggering context-dependent memories. Smith [9] found that people performed best in a word recall task when they heard the same background music during training and testing.

Musical cues can be implemented in a way that causes minimal disruption to others. Jung [6] successfully embedded musical cues into ambient soundscapes to

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.

Copyright 2011 ACM 978-1-4503-0267-8/11/05...\$10.00.

provide multi-user auditory notifications that were more discreet and less disruptive than traditional auditory cues.

While music is certainly a promising method for implementing reminders, using long thematic clips may not be feasible. Fortunately, people can recognise extremely short clips of popular songs. This ability is demonstrated by game shows such as “Name that Tune” where contestants recognise and name a piece of music from a very short sample. Musicians are often trained to recognize extremely short samples from pieces of music. ‘Drop the needle’ tests are used in graduate musicology classes to test the ability of the student to recognise a piece of music from an extremely short snippet created by dropping the needle of a record player onto the record at a random point. Listeners can become very accurate at this task. But what is the minimum useful length of such a short sample?

Schellenberg *et al.* have shown that participants can identify popular chart songs from various different, very short snippets lasting 0.1 or 0.2 seconds [8]. Before being asked to identify the short snippets, participants underwent a short training phase where they listened to short, 30-second clips of the songs they had to identify.

Since the snippets that Schellenberg *et al.* used were too short to contain any substantial melodic and rhythmic information, the information that the participants used to identify the songs was timbral. The timbre of a piece of music refers to the overall sound of the elements that make up the melody, rhythm and pitch. The instruments used provide unique timbres and the accompanying harmonies add overtone combinations that can give the snippet of music a unique timbral signature.

We define Musicons as shorts clips of instrumental music used for information presentation. The key property of Musicons is that they are long enough to allow listeners to identify the original piece of music but too short to sound like a clip from the piece when played on their own without any context.

EXPERIMENTAL DESIGN

To discover if Musicons are a successful display technique, an experiment was conducted to compare them to speech and test their memorability over time. The study was a two-phase within-subjects repeated-measures design. The independent variable was the reminder type (Musicons Vs Speech) and the dependant variables were accuracy, as measured by the number of correct responses, and response time in seconds. Participants were invited back a week later to test memorability.

Qualitative data were gathered through a short questionnaire and interview after each session. These were analysed to explore the associations people had with the Musicons and the strategies they used for remembering the connection between Musicons and tasks.

Twelve university students participated in the study, 4 female and 8 male. All 12 participated in the first session, 11 returned for the second. Those who returned were paid £10.

Reminder Design

Four tasks were selected based on previous focus group work. For each task, speech and Musicon reminders were generated (available at www.multimemohome.com). Musicons were taken from popular and easily recognizable pieces of music. Tasks are listed in Table 1 together with their associated speech reminders and pieces of music.

| Task | Speech | Music |
|----------|----------------------|---|
| Bins | “Take out the bin” | Johan Pachelbel: Canon |
| Door | “Lock the door” | Rembrandts “I’ll be there for you “ (Theme from Friends) |
| Keys | “Take your keys” | Ray Parker: Ghostbusters |
| Medicine | “Take your medicine” | John Williams: Theme from Jurassic Park |

Table 1: Overview of reminders used in the experiment.

The pieces of music selected for the Musicons were chosen because they had strong thematic associations with UK popular culture and because they contained instrumental parts that could be recognisable by our sample of westernised younger adults.

For the training phase, a 20-30 second clip was used containing the part of the original piece that was deemed to be most recognizable by the researchers. For the testing phase, three Musicons were generated from a prominent musical phrase that strongly resembled the original training clip. Long Musicons (1-2s) consisted of the entire phrase; medium and short Musicons consisted of the first 0.5s (medium) and 0.2s (short) of the long version.

Spoken reminders were synthesized using the 2007 version of the HTS HMM-based synthesis toolkit [13] using a UK English male voice. Reminders were designed to be as succinct as possible to ensure their duration was similar to the long Musicons (1-2 secs).

Procedure

The first session consisted of a training and a testing phase. In the training phase, participants were given time to familiarize themselves with the mappings between tasks and the training clips. On average, people listened twice to each clip. In the testing phase, participants heard 64 auditory reminders (4 tasks (door, bin, keys, medicine) x 4 types of audio cue (long, medium, short, speech) x 4 presentations of each cue). Reminders were presented in a randomised order. On hearing a reminder, participants were asked to press the button corresponding to the correct task

on the experiment user interface. Response times were measured from the start of the reminder, and participants were instructed to react as quickly as possible.

In the second session (a week later) the testing phase was repeated but no further training given. The only change was the order in which the buttons appeared on the user interface to test if participants remembered the mapping between song and task and not just the position of the button on the screen.

Data were discarded if participants pressed the response button before the reminder had started playing. This was the case for 3 responses in Session 1 and 4 in Session 2. The remaining data set contained at least three repetitions of each combination of task and audio cue for all sessions and participants for a total of 764 data points from 12 participants in Session 1 and 695 responses from 11 participants in Session 2. The person who failed to return did not give a reason for missing the session.

RESULTS

Accuracy and Memorability

As expected, participants recognized all speech reminders correctly, while Musicons were recognized correctly around 95% of the time in Session 1 and 84% in Session 2 (Table 2). We found no effects of gender, age and musical ability on performance. This level of accuracy is very promising.

| Reminder Type | | Session 1 | Session 2 |
|---------------|--------|-----------|-----------|
| Speech | | 100% | 100% |
| Musicon | Short | 94% | 82% |
| | Medium | 96% | 85% |
| | Long | 94% | 84% |

Table 2: Accuracy by Session and Reminder Type.

All but one participant scored above 90% in Session 1. The participant with the lowest score, 75%, recognized none of the songs except for the Friends theme. He answered all of the reminders associated with this song correctly, but consistently confused the reminder for “keys” with the reminder for “bin”. This could be due to a location-based recognition strategy, because the buttons for “keys” and “bin” were next to each other in the middle of the screen.

All of the 11 participants who scored highly in Session 1 returned in Session 2. The decrease in accuracy seen in Table 2 is mainly due to three participants, who scored 43%, 63%, and 64% on their return. The person with the lowest score commented that he had used the position of the buttons in the user interface to remember the task in the first round. The other two lower scoring participants found it hard to distinguish between the reminders for “door” and “keys” (Friends and Ghostbusters).

Response times

Response times for all reminder types were very similar (see Table 3). Participants responded faster in the second session (Wilcoxon test, $p < 0.001$). The reaction time for accurate responses was significantly shorter in Session 1 (wrong: $M=3.9s$, $SD=2.5$, correct: $M=2.5s$, $SD=1.8$). In Session 2, reaction times for both accurate and inaccurate responses were similar (wrong: $M=2.2s$, $SD=1.2$; correct: $M=2.2s$, $SD=1.8$).

| Reminder Type | | M S1 | SD S1 | M S2 | SD S2 |
|---------------|--------|------|-------|------|-------|
| Speech | | 2.5s | 1.1 | 2.2s | 1.4 |
| Musicon | Short | 2.8s | 2.5 | 2.4s | 2.0 |
| | Medium | 2.4s | 2.0 | 2.1s | 1.9 |
| | Long | 2.5s | 1.5 | 2.1s | 1.6 |

Table 3: Response Times by Reminder Type and Session (M=Mean, S=Session number, SD=Standard Deviation).

We compared response times for the three musicon lengths using pairwise Wilcoxon tests with Bonferroni correction on a fully balanced subset of the complete data set, which was obtained by taking the first three reminders for each combination of conditions. Since the point at which the speech reminders could be uniquely identified varied depending on the phrase, they were excluded from this analysis. For Session 1, the differences between medium and long Musicons ($p=0.05$) and short and medium Musicons ($p=0.07$) were weakly significant; for Session 2, none of the pairwise tests reached significance.

Qualitative Results

Most people recognised the four original clips, and most stated that they could recognise all of the clips from all three Musicon versions. The long Musicons were perceived as being too long and the short Musicons were seen as being too short and difficult to recognise. This suggests that 0.5s (medium) is an optimal length for Musicons in terms of preference, accuracy and response time.

For each of the songs, participants who performed well used remarkably similar strategies for remembering the link between Musicon and task. Users with highly accurate recall used existing associations they had with the original piece of music to help them remember. The most common association was between the television show Friends, and the action “Lock your door”. Whenever characters in that show enter or exit a scene, they do so through a door. Seven out of 12 participants said they used this image to remember the reminder for “Lock your door”. Some users relied on the associations between Jurassic Park and science or the fact that some of the characters in the film are doctors to remember “medicine”. People also used the famous tag line from the film Ghostbusters, “Who you gonna call?”, to imply “Who you gonna call if you forget your keys?”.

After Session 2, participants were asked if they had

remembered the associations over the course of the week. While most people said that they never thought about it, some users mentioned that they heard one of the songs and thought of the reminder. For the most part, people were able to recall the associations between reminders and tasks easily by using the same strategies used in the first session.

DISCUSSION

We have shown that Musicons can be successfully used to present private but memorable reminder messages. If users can create strong, meaningful links between music and task, Musicons can be as effective as speech, as memorable as Auditory Icons and as abstract as Earcons. Our data suggests that optimum Musicon length is 0.5 seconds.

Since the Musicons used here were too short to contain any real melodic or rhythmic information, participants may have differentiated them based mainly on timbre, which is also one of the most effective parameters in Earcon design [3]. Thus, our results confirm that a rich timbre can be extremely effective in creating unique auditory cues.

The strategies people used to remember the meaning of Musicons are similar to those used for Earcons, where users construct meanings for abstract sounds to help them remember [2]. As we showed in our qualitative analysis, the high similarity of strategies across participants and the high recognition of the music confirmed our assumption that the original clips were musical ‘memes’ that contain a large amount of shared cultural knowledge. While we intended to create a completely arbitrary mapping between tasks and reminders, existing semantic associations clearly need to be carefully considered in Musicon design.

CONCLUSIONS AND FUTURE WORK

Musicons, very short clips of familiar music, can be highly memorable and robust auditory reminders. Since they can exploit highly personal associations and memories for music, Musicons are easy to recall, yet private as they contain no direct relation to the reminder they represent.

We are currently investigating the generation and personalisation of Musicons. Our aim is to let users choose their own music and then automatically identify clips from these pieces that are sufficiently memorable and distinctive to make a good Musicon. We will also examine the complexity of messages that can be delivered via Musicons, looking in particular at indicating meta-information such as urgency using properties like length, volume, or spectral shape.

In addition, we plan to compare Musicons to other auditory cues like Earcons, Auditory Icons, and Spearcons (radically time-compressed speech [12]). In order to ensure comparability of reaction times, care will be taken that all

cues can be uniquely identified within 0.2s. Finally, we will extend our pilot work to include older people and people with care needs.

In conclusion, we suggest that interaction designers who want to create usable and acceptable reminders should consider Musicons for their ability to combine the memorability of Auditory Icons with the privacy of Earcons.

ACKNOWLEDGEMENTS

This work was funded by the EPSRC (EP/G069387/1 and EP/G060614/1) and the SFC (HR04016, MATCH).

REFERENCES

1. Blattner, M. and Sumikawa, D. Earcons and icons: Their structure and common design principles. *Human-Computer Interaction*, 4(1), 1989.
2. Brewster, S. Using nonspeech sounds to provide navigation cues. *ACM TOCHI*, 5 (3), 2002.
3. Brewster, S., Wright, P. and Edwards, A. Experimentally derived guidelines for the creation of earcons. *Adjunct Proc. HCI*, 1995.
4. Garzonis, S., Jones, S., Jay, T., O’Neill, E. Auditory Icon and Earcon Mobile Notifications: Intuitiveness, Learnability, Memorability and Preference. *Proc. CHI*, 1513-1522, 2009.
5. Gaver, W. The SonicFinder: An interface that uses auditory icons. *Human-Computer Interaction*, 4(1), 1989.
6. Jung, R. Ambience for Auditory Displays: Embedded Musical Instruments as Peripheral Audio Cues *Proc. ICAD*, 2008.
7. McGee-Lennon, M., Wolters, M. and McBryan, T. Auditory Reminders in the Home Environment *Proc. ICAD*, 2007.
8. Schellenberg, E., Iverson, P. and McKinnon, M.C. Name that tune: Identifying popular recordings from brief excerpts. *Psychon Bull Rev*, 6 (4), 641-646, 1999.
9. Smith, S. Background music and context-dependent memory. *Am J Psych*, 98(4), 591-603, 1985.
10. Uttl, B. Transparent Meta-Analysis of Prospective Memory and Aging. *PLoS One*, 3 (2), 2008.
11. Walker, B., Nance, A. and Lindsay, J. Spearcons: Speech-based earcons improve navigation performance in auditory menus *Proc. ICAD*, 2006.
12. Zen, H., Nose, T., Yamagishi, J., Sako, S., Masuko, T., Black, A. and Tokuda, K. The HMM-based speech synthesis system (HTS) version 2.0 *Proc. SSW 6*, 2007.