Affecting User Behaviour and Experience with Music: A Research Agenda

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Research into auditory interaction within a human-computer interaction (HCI) context has focused predominantly on using sounds to communicate information to users in the form of short, auditory messages. We propose that music could be included in interactive technologies with the objective of affecting users’ behaviour and their experiences, rather than simply to communicate information. This paper aims to explain how and why music can affect user behaviour and experience by considering how other fields exploit the affective properties of music. A research agenda is proposed that poses questions for investigation in relation to exploiting the affective qualities of music in interactive technologies. An initial empirical study has been undertaken to investigate how a musical email client affect users’ felt emotions. This study yielded some interesting results that are presented here, with a discussion about why these results may have occurred.

Music Interaction; Affective Interaction

1. INTRODUCTION

At the highest level of abstraction, the principal objective for using sounds in interactive technologies is usually to communicate information to users in the form of auditory messages. The specific incentives for using auditory messages can vary widely, but some examples include:

- improving usability of mobile phone interactions by informing users that they have clicked on an icon (Brewster, 2002)
- presenting data in an auditory format to aid domain-specific understanding and interpretation, for example with seismic data (Quinn and Meeker, 2001) or algorithms (Brown and Hershberger, 1992)
- alerting users to the occurrence of a particular event, for example alarms on medical devices (Sanderson, 2006)
- making graphical interfaces (Edwards, 1989) and data (Mansur et al., 1985) accessible to people with visual disabilities.

Although the scope of information portrayed to users audibly varies, the clear objective is to communicate information. We suggest that alternative objectives can be realised by exploiting the auditory mode in different ways. For example sounds can be incorporated to affect how people act when using a particular technology (i.e. the user's behaviour) as well as affecting their experiences, including felt emotions and mood. To affect users through the auditory mode, a type of audio source that has been somewhat overlooked in human-computer interaction (HCI) can be used, that of music.

This paper describes how other fields already exploit music for its affective qualities (both behavioural and experiential). Inspired by the work in other areas, a research agenda for investigating affective musical interaction is presented. In particular, considering what aspects of user experience and behaviour might be affected with music, how we can measure the impact of music on users and which musical parameters can be manipulated. Details of the first empirical study into musically affective interaction in an email-monitoring context are presented, with some interesting results, which are discussed.

2. HCI AND THE AUDITORY MODALITY

Communicating messages to users using sound is not a new concept in HCI. Auditory HCI research has concentrated on three types of sounds; speech, sound effects, e.g. Auditory Icons, (Gaver,
games designers already exploit music, sound effects and speech to create the optimum game playing experience. Researchers have started to consider the impact that music has on gamers’ levels of immersion (Lipscomb and Zehnder, 2004; Sanders and Cairns, 2010) but other affective qualities (such as enjoyment or concentration) are still largely being ignored. It seems that music is incorporated in computer games on artistic merit and the anecdotal suggestions that music improves game-playing experience, rather than as a result of scientific verification of a hypothesis.

Beyond a technological context, music is becoming ubiquitous in modern society, but not solely as a means of communication. People spend a large proportion of their time listening to music, whether this is focused, attentive listening (e.g. listening to an album to relax or going to a concert), accompanied listening where music is purposefully chosen to accompany an activity (e.g. choosing to listen to music on an mp3 player while exercising) or incidental listening (e.g. hearing background music in shops). Actively listening to music, or incidentally hearing music, rarely has the purpose of communicating a message; music is played for enjoyment or to provide a particular atmosphere. Given that people tend to listen to music for reasons other than receiving information, should auditory HCI research give more attention to alternative motivations when including music within interactive technologies?

3. MUSIC AS AN AFFECTIVE MEDIUM

While there has been limited research in HCI relating to the exploitation of music for its affective properties, other research domains have shown that music can change how people act and how they feel.

3.1 Music Affecting Behaviour

A growing body of evidence supports the argument that music can affect how people behave. For example, Marketing research has shown that the speed people walk around supermarkets and the amount of money that they spend is affected by the tempo of the background music (Milliman, 1982). Does this result extend to an HCI context? Would the tempo of background music affect the speed that people browse when online shopping and the amount of money that they spend?

3.2 Music Affecting Experience

In addition to music having an impact on behaviour, peoples’ experiences are also affected when listening to music. Music psychologists have been researching if and how music can elicit an
emotional response in listeners for some time. There is some disagreement within the field as to whether listeners can perceive emotions from music (the cognitivist view) or if music can change listeners’ felt emotions (the emotivist view) (Krumhansl, 1997). Our research takes the latter, emotivist viewpoint, which is supported by a growing body of empirical evidence (Livingstone et al., 2007). Extending this viewpoint to an HCI context, we ask if music can be included in interfaces to positively enhance users’ felt emotions, particularly in stressful or boring situations?

Alongside the work investigating how music affects emotions, music has also been shown to impact on other experiential elements, such as time perception. Shoppers reported a longer perceived duration when accompanied by background music in a major key and shortest perceived duration with atonal music (Kellaris and Kent, 1992). When conducting boring, time consuming tasks on a computer (e.g. data entry) should the interface include atonal music to make users’ perceive the duration as shorter and thus relieve their boredom?

By briefly reflecting on how other fields consider the affective nature of music, this paper aims to show that the HCI field is lagging behind others when investigating music in interactions. In considering how HCI can learn from music interaction it is not necessary to constrain the interactions to those of a physical nature, such as when playing an instrument. Instead, the act of listening to music is an interaction in itself that can be exploited in HCI. Music interaction can certainly inform HCI research from a performance standpoint. However, further attention should also be focused on how listening to music can affect users’ experiences and behaviour when interacting with technologies.

4. RESEARCH PROPOSAL

The broad aim of our research is to investigate if music can be included in interface designs to positively affect user experience and behaviour. The first challenge is to refine this broad statement by identifying what elements of experience and behaviour we aim to affect with music (i.e. the dependent variables) and what characteristics of music are to be manipulated (i.e. the independent variables).

4.1 Dependent Variables

There are a vast number of dependent variables that might be appropriate to research in this context. For example, does music affect accuracy when completing repetitive, boring tasks such as data entry? Can musical interfaces make stressful situations become more pleasant? Or can musical interfaces make mundane tasks more enjoyable? Generally speaking, behavioural characteristics can be measured objectively using quantitative methods, such as comparing time taken to complete tasks. While experience variables can either be measured subjectively by asking how the participant feels or objectively by taking measures of physiological responses such as heart rate.

4.2 Independent Variables

The independent variable may simply be two conditions, music versus non-music. Or, the independent variables may focus attention on particular parameters of the music. There are numerous elements of music that can be altered as independent variables. These elements include tempo, pitch range, key, modality, dynamics and lyrical or instrumental as well as stylistic elements such as genre. Alternatively, properties of the listener’s engagement with the music can also be manipulated. For example, do they like or dislike the music? Is it familiar? Is the style of music one that they regularly listen to?

5. THE FIRST EXPERIMENT

The first experiment that we conducted in the area of musically affective interaction aimed to positively enhance users’ emotions when monitoring an email account and verify the methodology. A prototype for an Ambient Music Email (AME) client extension was developed and tested empirically. Ambient music “is intended to induce calm and a space to think” (Eno, 1978) making it particularly appropriate for an email application that aims to exploit music to calm stressed users.

The music for the AME was created by recording directly from the Bloom iPhone App (Eno and Chilvers, 2009). The Bloom App has two modes; Listen and Create. In the Listen mode the App plays evolutionary Ambient-style music that changes and develops over time without requiring an input from the user. In the Create mode the user has some control over the sounds and in essence plays the iPhone as if it were an instrument. It is not possible to export recordings from the App directly, so the iPhone’s headphone jack was connected to a computer using the microphone input. The Audacity (Open Source, 2000) application was then used to record the output audio feed from the iPhone. The background music came from a 20-minute recording taken directly from the App’s Listen mode while the Create mode was used to record a number of different notification phrases.
5.1 Method

A preliminary study was undertaken with 12 participants to choose the most appropriate notification phrase for use in AME prototype. To be suitable for use in the main study the notification phrase needs to be easily identifiable and aesthetically pleasant when played with the background ambient music. Following the preliminary study, a rising chromatic scale pattern was chosen as the notification phrase for the main study.

In the main study 13 participants (none of whom were involved in the preliminary study) were asked to monitor an email account whilst undertaking an occupying task to copy passages from a children’s book into a simple text editor. At random intervals the participants’ received an email that contained a link to an online survey. The survey asked the participants to rate how they felt according to 12 emotion words (6 positive and 6 negative) on Liker scales from 1 = Not at all to 7 = Very.

A within participants design was adopted with two experimental conditions, with ambient music and without ambient music. In the “with ambient music” condition the participants monitored the email account using the AME prototype and in the “without ambient music” condition the same email account was monitored using sounds employed by a typical email client. The order in which participants completed the study, either with ambient music first or without, was randomized. The participants received 5 emails in each condition. The time between emails was random with the whole study taking 40 minutes.

Ten of the emotion words came from the Emotion Word Prompt List (Petrie and Harrison, 2009) used to assess emotional reaction to websites. The negative emotion words were: awkward, bored, confused, foolish and frustrated while the positive words were: calm, creative, interested, pleased and surprised. “Annoyed” was added as it frequently appears in literature relating to audio interaction while “happy” was also included to balance the number of positives and negatives. The order in which the emotion words appeared in the survey was randomized.

5.2 Results

Two 3-way ANOVAs were performed on the ratings of emotions words, one on the positive emotion words and one on the negative emotion words. The independent variables were ambient music condition (2 levels: with ambient music vs without ambient music), email number (5 levels: 1 - 5) and emotion word (6 levels: one for each positive/negative emotion word).

The presence of ambient music did not have a significant overall effect on ratings for either the positive or negative words (positive words: F = 0.05, df = 1, 12, n.s.; negative words: F = 2.85, df = 1, 12, n.s.). Thus, the use of ambient music did not have the overall effect we were expecting – to create less negative and more positive emotions in the participants.

However, there were several interesting interactions. For the positive emotion words, ratings significantly decreased as the condition progressed (from Email 1 to Email 5) (omnibus F = 6.05, df = 4, 48, p < 0.001, linear component F = 13.99, df = 1, 12, p < 0.003) and there was a significant interaction between email number and ambient music. This is illustrated in Figure 1. Without ambient music, positive emotions start at somewhat below the mid-point on the rating scale (3.5 on a 7 point scale) and decrease as the condition progresses – participants are feeling less positive as time goes on, reaching a low on Email 4, probably because they are undertaking a boring task. At the last email, participants become more positive, probably because they realize this is the end of the task. In the ambient music condition, the dip in positive emotions is less, so it may be that...
the music has kept their emotions more positive. For the negative emotion words (see Figure 2), ratings correspondingly increased as the condition progressed (omnibus F = 2.58, df = 4, 48, p < 0.05, linear component F = 5.01, df = 1, 12, p < 0.05), but in this instance there is no interaction with ambient music.

A further ANOVA combined ratings of both positive and negative emotion words into one analysis. This showed that there was a significant difference between the ratings of emotion words between the with ambient music and without ambient music conditions (F = 6.29, df = 1, 12, p < 0.05) and a significant difference between the ratings of positive and negative emotion words (F = 9.18, df = 1, 12, p < 0.01), but no significant interactions. Participants gave higher ratings to positive emotion words than negative ones (mean for positive emotion words: 3.11; mean for negative emotion words: 1.96) showing their positive emotions were felt more strongly than their negative ones. However, their ratings of both positive and negative emotion words were both higher in the ambient music condition than in the without ambient music condition (mean for with ambient music condition: 2.66; mean for without ambient music condition: 2.41). Thus the ambient music appears to have made them feel both more positive and negative emotions, rather than more positive and less negative emotions.

In addition to the ratings of emotion words, participants were asked a number of questions about their perception of the AME. The mean rating of how much they enjoyed listening to the ambient music was 4.2 (on a 7 point scale). No significant effect was found for enjoyment according to whether they were a musician or not (F = 1.412; df = 1, 11; n.s.). The mean rating of how easy it was to detect the email notification phrase in the ambient music was 2.66, significantly less than a rating of “very easy” (t = 5.4, df = 11, p < 0.001). Therefore, no overall subjective preference for condition was identified and there was no consensus as to the participant’s actively enjoying or not enjoying the music. However, the notification phrase was surprisingly difficult for participants to detect.

5.3 Discussion
In this study, the music had a significant effect on both positive and negative emotions, increasing the strength of both. We would normally expect to find an increase in strength of positive emotion would correspond with a decrease in the strength of negative emotions, but that has not been the case. So why did the ambient music cause this unexpected result?

There are two possible explanations for the increase in negativity which warrant further investigation. Firstly, the perceived difficulty in identifying the notification phrase may have added undue stress on the participants. The preliminary study to choose an easy to identify notification phrase was clearly not successful in this instance. There is insufficient data to complete a direct comparison of ease ratings between the preliminary and main studies, however it seems that the participants in the main study found it notably harder to identify the notification phrase than those in the preliminary study. The only difference in experimental design between the studies was the time between notification events, which was set at 15 seconds in the preliminary study and ranged between 1 and 7 minutes in the main study. It is possible that as the participants in the main study spent more time undertaking the occupying task between instances of hearing the notification phrase they became more involved in the task and found it harder to split their attention.

By conducting a preliminary study to find an easy to identify notification phrase we had hoped to eliminate the problem of split attention, but this was not successful.
The second reason for increased negativity relates to the choice of background music itself. On completion of the main study, one of the musical participants commented that although they enjoyed the background music, they felt it contained quite a lot of "unresolved dissonance". In Western musical tradition, listeners expect that dissonant sounds, those that feel unstable and do not fit coherently in the music, are followed by stable, consistent sounds to resolve any tension created through the use of dissonance. Musical expectancy has been identified as a factor for inducing emotions in listeners when a specific feature of the music violates, delays, or confirms the listener's expectations about the continuation of the music (Juslin et al., 2010).

Further listening to the background ambient music confirms that there are multiple instances of unresolved dissonance throughout the recording, which may have impacted on the negative emotions of participants through increased tension and violations of musical expectancy. The musical dissonance may have had a subconscious rather than conscious effect on the participants, which could explain the peculiar result that positive emotions increased along with the negatives.

6. FUTURE WORK

Given the wide scope for research in the area of affective musical interfaces, we are not keen to limit this work to a specific domain. However, our initial experiment in an email account-monitoring context had interesting results. This study has shown that music can be included in interaction with a dual purpose of communicating a message while also affecting users' felt emotions. In this instance, the music kept positive emotions higher during a boring task, which is a promising result. However, the corresponding increase in negative emotions is cause for concern. Further work must be done to verify our understanding of the reasons behind this effect and hopefully eliminate the cause of the increased negativity.

It will be important in our future work to ensure that the chosen notification phrases are easy for participants to identify when they have spent considerable time undertaking an occupying task. Therefore, in future experiments it is important that the time between notifications in the preliminary study is of a similar magnitude to that employed in the main study.

There are two important questions that should be addressed in future studies. First, why did the ambient music significantly intensify both the positive and negative emotions? Second, why did the music keep the intensity of positive emotions higher over time?

Are we correct in explaining the intensity of negative emotions through the selection of background music that contained too many instances of unresolved dissonance and a musical notification phrase that was too difficult to identify? While this explanation appears to make sense on an intellectual level, more evidence is required to validate this justification. Therefore, the next studies will need to use easy to identify notification phrases and background music that retains the style of ambient music in terms of sparsity of soundscape and lack of distinct melodic phrases, but crucially does not achieve this affect through unresolved dissonant sounds.

7. REFERENCES


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