EVALUATING THE USE OF SONIFICATION AND MUSIC TO SUPPORT THE COMMUNICATION OF ALCOHOL HEALTH RISK TO YOUNG PEOPLE: INITIAL RESULTS

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ABSTRACT

The interdisciplinary research project, *Using Sonification to COmmunicate public health Risk data* (SCORe), aims to experimentally test how sonification, interactivity in combination with music, could increase the communicative potential of a visual presentation directed to young people and focused on health risk data of alcohol consumption. Specifically, we are studying how this type of presentation can support engagement with health information, and the effective interpretation and recall of data. In order to explore the possible influence of sound in understanding important health risk messages, a 3-arm pilot randomised control (participant-blinded) trial was designed. We compared a visual presentation augmented by sonification, music and interaction with a simple visual presentation and a visual presentation augmented by simple user interaction. This paper describes the most complex of the three health presentations (the audio-visual and interactive presentation) and presents initial findings that relate to this presentation only.

1. INTRODUCTION

Misuse of alcohol remains one of the significant health determinants in young people. Recent decades have seen the introduction of a variety of health educational interventions intended to increase awareness of harmful effects associated with alcohol consumption [1, 2]. The improved understanding has not, however, converted into significant reduction in young people's risky behaviors [3, 4]. For instance, within young people's alcohol drinking patterns, binge drinking (i.e. drinking large amounts of alcohol in a short time often with the intention to get drunk) remains one of the main public health concerns [5] as early onset of binge drinking forecasts the development of adult alcohol-use disorders [6]. Short-term consequences of alcohol intoxication [7, 8] are widely known. Long-term consequences of alcohol abuse, on the other hand, which develop over time, such as liver cirrhosis, cancer, and heart disease are rarely observable in young people [9]. Consequently, long-term consequences are seldom addressed in prevention campaigns despite some researchers suggesting that young people who are aware of long-term impact of alcohol misuse are less likely to engage in harmful drinking [10].

Given the inadequacy of the presently available prevention measures, it is clear that new ways of prevention of alcohol misuse in young people need to be proposed to tackle this important problem. To increase the effectiveness of these efforts, communication strategies have to be specifically designed for this segment of the population, for instance by considering the use of mobile devices such as the smart phones and tablets which are preferred tools of communication by young people [11]. The use of mobile technology in health care communication (e.g. to deliver recommendations to patients or appointment reminders) has been examined by Cohn and colleagues [12]. The authors concluded that the field of alcohol studies has yet to fully move into this domain as a method of preventing or treating alcohol problems, and highlighted the urgent need to engage with interactive media in supporting alcohol help-seeking and behavior change. Communication of alcohol-related health risks supported by interactive sonification combined with music may offer help in this respect as sonification is a novel tool and thus potentially interesting to young people. The interactive element can engage young people in a "game"-like exploration of data, potentially increasing their self-efficacy and control over their drinking habits (while at the same time the presentation could provide information on how and where to seek help). This way of presenting information can be combined with music, which many adolescents are interested in [13, 14], it relies on technology and can be easily adapted for modern mobile technology, and it does not require advanced numeracy skills and thus is available to a variety of audiences. Studies exploring sound communication interventions may be an important step forward in designing future prevention campaigns to manage alcohol misuse in adolescents. To the authors' knowledge interventions of this kind have not been implemented and tested to date. Indeed an extensive search of several research databases, with the help of the research librarian, was undertaken in 2014 and identified no results. In this project, we tested the hypothesis that a visual presentation augmented by interaction, sonification and music could increase the communicative potential of alcohol-related health and risk messages. To test this we designed a 3-arm pilot randomised control (participant-blinded) trial.

2. SONIFICATION IN HEALTH

Sound feedback approaches have been used extensively in medicine and for a long time [15, 16].

More recently, the use of auditory feedback has been tested in a variety of medical applications. Edwards et al. [17] investigated whether the visual microscopic diagnosis of cervical cancer cells could be supported by an auditory component. Cassidy et al. [18] have examined the possibility of sound generation (through a vocal synthesis model) from colon tissue scan data. Kagawa et al. [19] developed a technique which allowed for the generation of sound

information from diagnostic images in order to reduce the fatigue of the radiologist and, consequently, maintain accuracy in imaging diagnosis. Ballora et al. [20] have also tested the use of sonification as an alternative diagnostic tool to visual means. Mihalas et al. [21], who have applied sound feedback as a complementary technique to visual representation of heart rate (both in humans and rats), indicated that sonification may successfully be implemented for detection of arrhythmic events and comparisons between normal and abnormal signals. Jovanov et al. [22] have investigated the problem of fatigue during long duration biomedical procedures and analysis. The authors have proposed the application of tactical audio feedback as a means of supporting a surgeon in positioning surgical instruments without having to lose eye contact with the patient.

The usefulness of sonification for the analysis of multi-parametric data such as EEG has also been observed by Hinterberger and Baier [23] and Baier, Hermann and Stephani [24]. The researchers used a MIDI (a protocol which allows various digital music instruments or other musical devices to communicate with each other) device to map and sonify parameters extracted from the EEG data to different instrumental sounds. This type of parametric sonification in real time displays the rhythmic structure of human EEG signals, which, it has been suggested, may help the treatment of diseases such as epilepsy, attention deficit disorder, depression or dementia.

Hinterberger et al. [25] have explored the use of the auditory feedback for fully paralyzed patients with visual impairment. During the experiment, all visual feedback information was converted into audio signals, which facilitated controlling the TTD (Thought-Translation-Device) through auditory signals only. The authors indicated that self-regulation of brain signals can be learned with auditory and combined auditory and visual feedback, however, the achieved control over the TTD system is worse in comparison with the visual alone. Use of sound as information feedback for visually impaired people has also been investigated by Berndt-Schreiber et al. [26]. During the experiment, the images of several basic geometrical shapes (i.e. a circle, a square, and a triangle) were linked and represented aurally by different sound waveforms. Although the use of the system requires training, in time the user is able to recognize more complex graphical patterns conveyed by sounds.

Sonification has also been used for spatial localization monitoring of the arms and hands motions of patients who do not receive appropriate information from muscles and joints [27]. Pauletto and Hunt [28] have conducted an experiment to test the effectiveness of the sonification of electromyography (EMG) data of patients' muscles activity. Sonification was found to be useful as it allowed the physiotherapist to focus on the patient instead of monitoring the graphical representation of EMG data on the screen[17-19]. Vogt et al. [29] have also investigated the potential use of sonification in physiotherapy. The experiment with patients with limited shoulder mobility showed that sonic feedback provides satisfactory information on perception and awareness of a body movement.

3. SCORe RESEARCH PROJECT

The idea for the SCORe project (*Using Sonification to COmmunicate public health Risk data*) originated from a pervious collaborative effort, *Jane's story*, an immersive multimedia presentation [30], which aimed to exploit the communicative qualities of sound (i.e. music, voice, sound design and sonification) to portray health risk data, particularly to young people. The public received this type of presentation very well during the Conference of the Centre for Chronic Diseases and Disorders (C2D2) in 2013 and the York Festival of Ideas in 2014. The success of this work led us to hypothesise that a combination of sound design, film music methods and sonification may influence how effectively and accurately we recall information and increase engagement with the visual presentation of data. The starting point of the 3-arm randomised trial produced for the SCORe Project was a visual presentation (presentation 1) containing selected data on alcohol consumption by young people in the UK and Europe [31-33] and alcohol-related health risks. The presentation was then augmented with interaction only (presentation 2) and sonification, music and interaction (presentation 3).

The three versions of the prototype presentation were developed using PowerPoint 2011 and its interactive capabilities. This approach allowed us to create a prototype, appropriate for pilot testing, very rapidly. After the test, the presentation can be easily converted into an interactive application for mobile devices. Such an application will benefit from and integrate any useful observation and/or result coming from the pilot trial. We also envisage using this prototype and the results of the trial to inform the development of an educational, exploratory game for young people and a public interactive installation to be displayed in the University campus.

3.1. THE EXPERIMENT

The experiment took place at the Department of Theatre, Film and Television (TFTV) of the University of York between November 2014 and January 2015 in a sound treated research lab. Participants were sitting at a table about 1.5 metres away from the screen where the presentation was projected. The sonification and music was played through a stereo speaker system (Dynaudio). The user was given a wireless mouse to be able to interact with the presentation on screen. The trial was preceded by seven validity tests with students from TFTV. For the actual experiment we decided to primarily target students from disciplines other than music, health sciences or theatre, film and television, as these areas of study could potentially introduce a bias in the trial. 96 participants (age 18-25) were randomly allocated to three groups: 1) Group I (32 subjects) experienced the visual presentation; 2) Group II (32 subjects) experienced the visual presentation supported by simple user interaction; 3) Group III (32 subjects) experienced the visual presentation augmented by sonification, music and interaction. This design allowed us to determine which additional presentation component (interaction and/or sound) may influence health knowledge and risk perception. Participants were asked to fill in a pre-intervention questionnaire in order to test their knowledge and risk perception before the presentation. After the presentation participants were asked to fill in the same knowledge and risk perception questionnaire plus a number of questions to assess how effective they perceived the presentation to be. Finally, one month after the trial, participants were asked to fill in a knowledge and risk perception questionnaire to check which presentation helped them to recall the information more easily. We are currently analysing the results of the full trial. In this article we present initial results related to version 3 of the presentation, which includes visuals, interaction, sonification and music.

3.2. THE PRESENTATION

The data used in the presentation come from a variety of sources: Alcohol Concern Fact Sheet 2011 [34], the National Health Service (NHS), and a number of scientific articles and reports [32, 33, 35]. To make the presentation clear, concise, and coherent, a professional graphic designer was employed to create a unified style and colour palette. The design is minimalistic and in line with the recent trends in graphic representation. The colour palette is based on green, blue and white (see Fig. 1).

Figure 1: Slide 1 - The title page of the SCOR*e* presentation.

The presentation consisted of 11 slides. Each slide is accompanied by background music that creates an atmosphere for the slide and a background for the sonified elements.

Five slides used sonification to represent aurally specific information. A number of sonification techniques were utilised: parameter mapping, in which data points directly drive the selected sound synthesis parameters [36], auditory icons, in which sound samples are associated with particular data points through a metaphorical association [37, 38] and earcons, in which sound samples are associated to data in an abstract fashion [40].

The music component was inspired by the uses and functions of music in film and other media productions. Film/media music is widely accepted and understood, in particular by young people, and thus lends itself well for communication purposes. In terms of music style, it was agreed that the music would follow a subtle minimalistic, mainly electroacoustic, approach rather than follow an orchestral approach (Hollywood style). To summarise, the music was used in three distinctive ways: 1) as an overall support for the sonification, creating an emotional context; 2) as continuity component, binding the presentation together; and 3) as an interactive accompaniment, linked to sonification, and responding to participants' actions. The creation of the music is discussed in more detail in [39].

The music was composed using non-linear structures built from a number of interchangeable modular components. This, in turn, allowed the structural flexibility needed to fit the presentation and its interactive component. Modular elements were created and edited in Logic Pro and Pro Tools. In some instances the final form of musical pieces was achieved through improvisation in Ableton Live 9. The library of musical modules included drones, drones with a distinctive rhythmic element, percussion loops, short melodic phrases, and various ostinati structures. The final structure of the majority of the musical pieces was divided into larger self-contained modular blocks (i.e. arrangement variations) that could be applied to the succession of different slides. The majority of music contains a characteristic static-like noise either incorporated into the arrangement of the pieces or appearing independently in situations where there is no music in the background. The intention behind this practice was to maintain a sound component throughout the presentation as a binding element, but also to reflect the toxic nature of alcohol. Finally, the music in this experiment was conceived to primarily produce a background for this presentation. Similarly to what happens in film, the music is meant to affect the participants more on a subconscious level, rather than in an explicit way. However, in some instances (see in 3.3 the music created for the sonifications of slides 4 and 8) the music was designed to influence participants' perception in a more direct way. Interaction played an important role in facilitating users' engagement with the presentations of the data [40]. In this project we provided a number of simple ways to interact, through the mouse, with the music, sonification, visual objects and slides: 1) repeated listening (each sonification could be listened to more than once), 2) single data point listening (each data point of a bar graph can be heard separately), and 3) the choice of listening order (the user can decide in which order to listen to the sonification elements present in each slide).

3.3. THE SLIDES

The first three slides are linked together by the same musical accompaniment with a slightly different arrangement for each slide, which provides an illusion of development in the music. The first two slides, the title page (see Fig.1) and the definition of alcohol, do not contain sonification or interactivity. Their function is to introduce the topic of the presentation.

Figure 2: Slide 3 - Alcohol units and standard drinks.

The third slide (Fig. 2) provides information about standard alcohol units and links it to standard drinks in the UK. By clicking on the icon of the chosen drink (e.g. pint of cider, gin and tonic, etc.), participants reveal the alcohol unit content for the selected drink, and trigger the appropriate auditory icon. The auditory icons designed for the drinks reflect the type of alcoholic beverage and their duration is directly related to the alcohol unit content. Therefore, the first drink, a glass of gin and tonic (1 unit of alcohol), is three times shorter than a pint of cider (3 units of alcohol). The sounds of the drinks were created by blending the natural sound characteristic of a particular drink and appropriate

musical sounds that can fit with the music as well as symbolise the drink. For example, for a glass of whiskey the sound of the ice cubes in a glass are mixed with a glassy, bell-like percussive sound. The music arrangement of the piece used in this slide is less complex than in the previous slides. This is done intentionally so that the participant can focus on the sonification. Additionally, all drink sounds are in the "A minor" key, tuned to the background music.

Slide four (Fig. 3) provides information about binge drinking in Europe. As binge drinking is linked to clubbing and other types of young people's social activities, we used music inspired by recent trends in dance music (dub step style). The slide presented the map of Europe with countries marked by different colours, which reflected the binge-drinking levels expressed in percentages. By clicking on a country on the map, the participant triggers a musical sonification, whose complexity and amount of distortion are linked to the percentage of binge drinking for that country (the higher the binge drinking percentage the more complex and distorted the music).

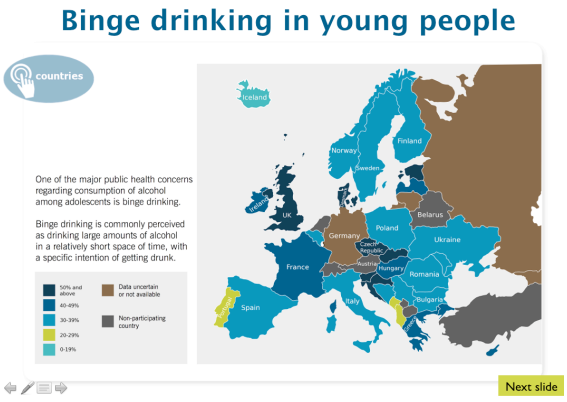

Figure 3: Slide 4 – Bing drinking for young people in Europe

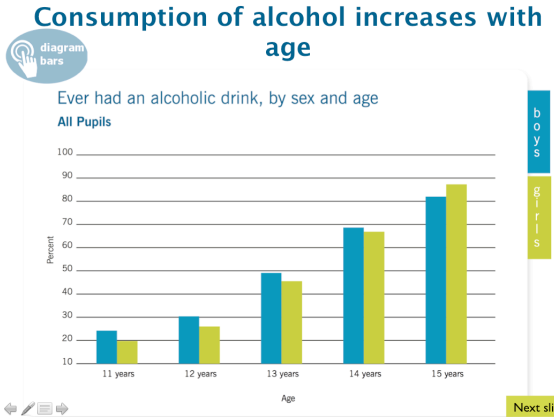

Figure 4: Slide 5 – Consumption of alcohol and age.

Slide five (Fig. 4) presents a bar graph comparing girls and boys alcohol consumption at different ages. The slide features a drone, which provides a neutral background for the sonification of the bar graph. The sounds used for the sonification of the bars combine two elements: a short sound with a fast attack and the reversed variant of the same sound. The bars showing boys' alcohol consumption are represented by a single piano note (A natural) in a low register, whereas girls' drinking is sonified with a violin sound (A natural) in a higher register. The length of the sounds reflects the increase of alcohol consumption with age. The sounds are triggered by clicking on the bars.

Slide six (Fig. 5) is dedicated to the short-term consequences of alcohol use.

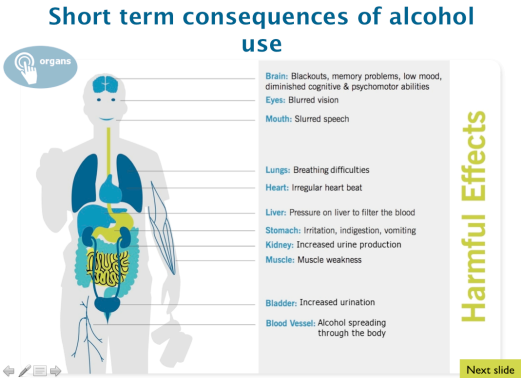

Figure 5: Slide 6 – Short-term consequences of alcohol.

The slide features a human body with visible organs. The idea for the sonification of this slide was to show what happens to the drinker's body when alcohol enters the organism. By clicking on the organs we can listen to a sonification of the impact of alcohol consumption on that organ. All the sounds used in this slide can be divided in two major categories: a) those directly connected to the organ, for example, heartbeat for heart, breathing for lungs, etc.; b) those indirectly connected to the organ function, e.g. kidneys or liver. The sounds belonging to the first category are created by selecting the natural sound associated with the organ and applying various processes to it (e.g. addition of a reverb or a flanger effect, etc.). The sounds from the second category are created by blending together various natural and synthesized sounds from sources that have a metaphorical association with the organ. For example, the sounds of organs such as liver, kidneys and the stomach are created by combining sounds of various home appliances, e.g. a blender or a washing machine, with watery sounds produced by boiling water or a pitch shifted running water sound. Organs such as the brain were sonified using different virtual synthesizers, i.e. Spectrasonics Omnisphere soft synthesiser and instruments available in Native Instruments Reaktor. Additionally, many of the internal organs feature static-like or metallic "drops" sounds to emphasise the toxic nature of alcohol. This type of sound is particularly noticeable in the sound representing alcohol spreading through the body through the vascular system.

Slide seven is dedicated to the long-term consequences of alcohol consumption such as dependency, cancer, mental disorders, among others, and features background music only. The undertone of this slide is rather grim, and thus the music matches this particular mood. The piece for this slide was combined from three major components: a) a major-minor seventh sustained and pulsating chord (a chord which is a staple attribute of many Bernard Herrmann's film music pieces), b) a melody in long note values (combined from two melodic lines shifted against each other in the time domain, obscuring the clear beginning and end of the phrase), c) a static-like noise present throughout the piece.

The eighth slide is also dedicated to the long-term effects of alcohol consumption, this time, however, it focused on the liver cirrhosis mortality in England and Wales, Scotland and European countries, between 1950-2002 (see Fig. 6).

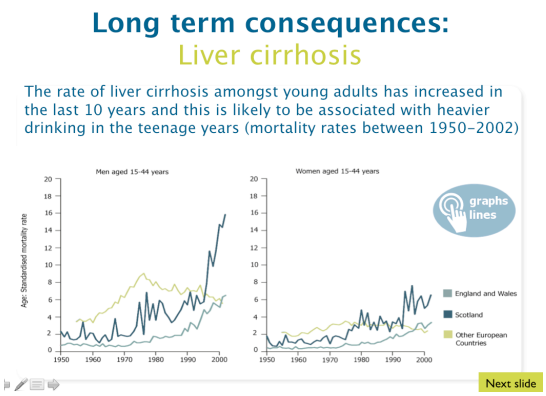

Figure 6: Slide 8 – Liver cirrhosis mortality.

The slide contains two graphs, one for men and the other for women. We first attempted to sonify the graphs using a precise one-to-one mapping between sound parameter and data point. This approach created abstract and rather unpleasant results. Our intention was to produce a musical and engaging sonification. So it was decided that the sonification should focus on the general trend and shape of the graph lines, rather than the specific data values. The final sonification uses a combination of sampled orchestral string drones, glissandi, accelerando/diminuendo percussive effects, and piano passages that roughly follow the lines of the graph. This approach produced short sonoristic[1] musical pieces, a few seconds long for each line. The pitch and the intensity of the sound were associated with the increase or decrease in the mortality percentages. This, in turn, resulted in what could be described as a "cinematic" effect, which was more musical than the previous, more precise, sonification attempts, but also represented well the message presented by the data, and gave "depth" to the traditional two-dimensional graph. As in slide 5, the low register is associated with men and the higher register with women.

Slide nine again features only music accompanying text describing the additional health risks associated with the consumption of alcohol. The music is a drone with an ambiguous mood. Finally, the last two slides (10 and 11) are connected together by a short musical piece with an optimistic mood based on a simple four-chord harmonic progression. This piece also features a more complex arrangement than the previous pieces.

4. RESULTS

For the purpose of this paper we focus on the preliminary results for experimental group III only, as this group received the full audiovisual interactive presentation and were asked to comment on the effectiveness of the music, sonification and interaction components.

The general feedback indicates that, thanks to the graphic design, music and sonification, the presentation is informative and engaging. All participants found the presentation educational. Participants reported that they learned a number of new facts regarding alcohol consumption, among which were, for instance, the alcohol content in various drinks; safety limits advised by the NHS for men and women; the specific effects of alcohol on the body; the fact that young people in some countries are exposed to a grater risk of binge drinking; the mortality levels due to liver cirrhosis; and that the UK has a significant problem regarding the consumption of alcohol as compared to other European countries.

The majority of the participants, 87% (28 out of 32) found the presentation effective in communicating alcohol-related risks. The following comments were provided:

> *"All the right things are in it; the comparison of effects in different countries, the risks, shocking ages that people start drinking at, etc." [Subject: 076]*

> *"I can definitely say that I learnt a lot [more] about alcohol in the span of approximately 20 minutes than I have since I began consuming alcohol. It was an easy-to-follow, highly informative presentation* […]". *[Subject: 124]*

The overall experience with the presentation was measured on the analogue scale 0-10 (with 10 being the best experience). The mean score was 7.3 (SD=1.2), indicating a good experience with the presentation. The participants commented on their experience in the following way:

> *"It was one of the best [presentations] I've seen for overall feel – nothing out of place, the tone was right and the graphics, and the sounds made it interesting." [Subject: 072]*

> *"Fun as well as informative." [Subject: 001]*

> *"I feel much more informed about alcohol misuse and the sounds have made the facts stay in my memory longer than if there was no sound." [Subject: 017]*

> *"I really enjoyed the slide with the body parts and related sounds." [Subject: 097]*

Participants were asked about what they liked the most about the presentation and reported that the sound design and music were particularly entertaining:

> *"I thought the sounds were fun and helped to demonstrate the graphs and pictures better than just looking at them." [Subject: 139]*

> *"The different music relating to the more dangerous/worrying facts helped me remember the worst facts/countries/ages". [Subject: 041]*

> *"The music made me more concerned about the effects of alcohol". [Subject: 027]*

> *"The sounds! Listening to the music follow the ups and downs of the line graph was amusing. I suppose it would sharpen my focus on the graphs". [Subject: 021]*

[1] The term "Sonorism" (coined by Józef Chomiński as "Sonorizm") is associated with a distinctive style within Polish concert music of the 1960s (Penderecki, Górecki, Kilar, Serocki, Szalonek, et al.) that explored contrasts of instrumentation, timbre, texture, articulation, dynamics, movement and expression as a primary factor of a composition.

There were also some negative comments regarding the overall sound and music used in the presentation, particularly in relation to the ability to focus on the presented data or the use of the sound component in some slides. For some participants the music interfered with concentration:

> *"Some* [sounds] *were excessively overdramatic and the music was used on information that was quite trivial". [Subject: 031]*

> *"When a slide had general background music it helped, but when each thing you clicked on had different effects I found that a bit distracting* […]." *[Subject: 081]*

> *"Some sounds were un-necessary and a bit distracting, particularly the background music on some slides with other audio content". [Subject: 070]*

There were also comments regarding the intensity of some sounds. This was usually related to the musical sonifications of the liver cirrhosis mortality graphs, which were reported to be:

> "[…] *at times the sound effects were quite intense". [Subject: 124]*

> *"The sounds on most slides are a little too intense- for example, the graph showing that Scotland had the biggest increase." [Subject: 001]*

The intensity of the sound used for the liver cirrhosis graphs was intentional, showing the changes in the trends. Some of the participants' comments reflect our intentions:

> *"Playing the sounds in increasing level of intensity makes the presentation more attention grabbing due to the increase in pitch / volume of the music." [Subject: 017]*

> *"The pitch mirrored line graphs over time, which was good, and the loud music was played when there was a high figure, and vice versa, which did make me think a bit more about the figures." [Subject: 012]*

> *"The cirrhosis bit I will remember for a long time, and the Europe map bit, as they used memorable techniques that portrayed the impact* […]." *[Subject: 072]*

The mortality levels caused by liver cirrhosis due to alcohol use in Scotland for men are particularly interesting. Illustration of this steep increase required application of the high pitch glissando effect of the violins, which could be perceived by some as uncomfortable. The views regarding the sound design/sonification of some particular elements of the presentation, for instance the sounds associated with different drinks in slide 3, were also divided:

> *"I like how the drinks make 'clink' sounds when you click on them." [Subject: 046]*

> *"The cheesy noises. The "ding ding" like on a quiz show that sounded for some of the buttons". [Subject: 036]*

The duration of some musical clips was perceived as too long, particularly the sonoristic pieces used for the liver cirrhosis mortality levels:

> *"Sometimes the length of the sounds were too long" [Subject: 139]*

> *"The sounds seemed a bit out of place and continued too long." [Subject: 064]*

We also asked the participants how much they thought sounds and music contributed to conveying the message. 72% (23 out of 32) of the participants indicated that the sounds/sonification helped in conveying the message. Similarly, 72% of participants felt that the music helped to convey the message. Some of the participants provided additional comments:

> *"The sounds often differed with regard to the severity of the consumption of alcohol for instance in the different ages groups. The music got more high pitched the higher the amount of alcohol* […]" *[Subject: 055]*

> *"The heartbeat, the blood vessels, the lungs…. The sounds of those organs in particular helped me to visualize the possible effects alcohol misuse." [Subject: 021]*

> *"The interactive sounds definitely had a great influence on the messages being portrayed, bringing the facts and figures to life." [Subject: 124]*

The questionnaire also included a number of specific sub-questions regarding the appropriateness of the sounds/musical clips associated with the specific elements of the presentation. For slide 3 "drinks", 75% (24 out of 32) participants felt that sounds were appropriate for this slide. For slide 4, "Binge drinking", 72% (23 out of 32) participants felt that the sound component (i.e. short musical clips) was appropriate. For slide 5, which showed the differences in alcohol consumption between boys and girls in different age groups, only 53% (17 out of 32) participants felt that the chosen sounds were appropriate. For slide 6, illustrating short-term consequences of alcohol on the body, 87% (28 out of 32) participants indicated that sounds were appropriate. For slide 8, reporting on liver cirrhosis mortality levels using sonoristic sounds, 75% (24 out of 32) of the participants felt the sound component was appropriate. In the additional comments section participants indicated that:

> *"The sounds of the short term consequences reflected what was happening in the body which I found quite memorable. The music for the binge drinking percentages was very dramatic in the high percentage" [Subject: 055]*

> *"Some of the sounds on the body organs page seemed really representative of the organs […]." [Subject: 134]*

> *"The sounds were cleverly collaborated and linked to the meaning and diagrams which was a clever and effective tool to use." [Subject: 124]*

It appears that slide 6, showing the human body and informing about the short-term consequences of alcohol use, was the most memorable. We were also interested in whether participants perceived the relationship between music/sonification and the displayed information/data. Overall, 61% observed this relationship in slide 3 "drinks"; 79% in slide 4 "binge drinking"; 63% in slide 5 "consumption of alcohol"; 90% in slide 6 "short-term consequences"; and 79% in slide 8 "liver cirrhosis".

Some of the participants additionally reported that:

> *"At some points I definitely felt the relationship stronger than at other points during the*

presentation, but nevertheless I recognized a relationship between the information shown on-screen and the music" [Subject: 124]

"[…] *the presentation had quite an obvious relation to the information being presented" [Subject: 001]*

"It was definitely successful in that it matched what was on the screen and I felt like I knew it was putting the seriousness of the information into sound […]" *[Subject: 125]*

However, one of the participants did not perceive any particular relation between the music and the data presented on screen:

"The music didn't seem connected. It felt like very generic background music that you would get in this type of self-service presentation and not particularly related to the subject matter." [Subject: 070]

5. CONCLUSION

In the SCORe project we designed an original health communication intervention prototype. This intervention focused on information about young people's alcohol consumption in Europe and the UK, and related health risks.

We designed a trial to compare the effectiveness of a visual-only presentation of data with two augmented versions of this same presentation: one with interaction and one with interaction, sonification and music.

We have presented in this article preliminary results related to the group of participants (32 in total) that experienced the full audio-visual and interactive presentation. The analysis of the overall trial is still in progress and it will be the focus of a future article.

From these preliminary results we observe that:

1) The majority of the participants' comments on the different aspects of the presentation were positive.
2) Slide 6 (i.e. the short-term effects of alcohol on the body) was particularly successful in engaging the participants with the health information. This slide is perhaps the most inventive and original of all the slides in the presentation, and the one with the potential to be easily reinterpreted as an interactive installation/game where a user could see and listen to what is happening to the body and to particular organs when excessive alcohol is consumed. Imagine, for instance, a 3D representation of the body with organs that can be listened to at different stages of intoxication, etc.
3) Some of the participants indicated that the music was "a bit" distracting. This comment highlights the importance of maintaining a balance when stimulating different senses (vision, hearing, etc.) during a presentation. We recommend that in interventions of this kind music accompaniment should be very simple and minimalistic, e.g. a neutral drone. This would allow for an easy transformation of the music in accordance with the selection of different sections of the presentation (e.g. different organs and the severity of the intoxication). The use of a musical underscore solely based on the timbre-orientated drones (which are free from harmony and rhythm) would also facilitate a homogenous blend of the music and sonification, allowing the latter to remain dominant and easily absorbed by the users.
4) We also suggest that some of the information could be delivered in the form of an audio narration/commentary rather than by text, thus minimising the need for focusing on reading while also listening.

6. ACKNOWLEGMENTS

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7. REFERENCES

[1] P. Finn and J. Brown, "Risks Entailed in Teenage Intoxication as Perceived by Junior and Senior High School Students" *Journal of Youth and Adolescence,* 10:1, pp 61-76, 1981.

[2] E. R. Weitzman, T. F. Nelson, H. Lee, and H. Wechsler, "Reducing Drinking and Related Harms in College Evaluation of the "A Matter of Degree" Program" *American Journal of Preventive Medicine,* 27:3, pp. 187–196, 2004.

[3] D. R. Foxcroft, D. Lister-Sharp, and G. Lowe, "Alcohol misuse prevention for young people: a systematic review reveals methodological concerns and lack of reliable evidence of effectiveness" *Addiction,* 92:5, pp. 531-537, 1997.

[4] C. S. Stockley, "The effectiveness of strategies such as health warning labels to reduce alcohol-related harms — an Australian perspective" *International Journal of Drug Policy,* 12:2, pp. 153–166, 2001.

[5] R. M. Viner and B. J. Taylor, "Adult outcomes of binge drinking in adolescence: findings from a UK national birth cohort" *Epidemiol Community Health,* vol. 61:10, pp. 902–907, 2007.

[6] J. C. Crabbe, R. A. Harris, and G. F. Koob, "Preclinical studies of alcohol binge drinking" *Ann. N.Y. Acad. Sci.,* vol. 1216, pp. 24-40, 2011.

[7] L. Oster-Aaland, M. A. Lewis, C. Neighbors, J. Vangsness, and M. E. Larimer, "Alcohol Poisoning Among College Students Turning 21: Do They Recognize the Symptoms and How Do They Help?" *Journal Of Studies On Alcohol And Drugs Supplement,* vol. 16, pp. 122-130, 2009.

[8] D. W. Zeigler, C. C. Wang, R. A. Yoast, B. D. Dickinson, M. A. Mccaffree, C. B. Robinowitz*, et al.*, "The Neurocognitive Effects Of Alcohol On Adolescents And College Students" *Preventive Medicine,* 40:1, pp. 23-32, 2005.

[9] D. Newbury-Birch, E. Gilvarry, P. McArdle, V. Ramesh, S. Stewart, J. Walker*, et al.*, "Impact of Alcohol Consumption on Young People: A Review of Reviews" *Institute of Health and Society at Newcastle University,* 2008.

[10] J. Beenstock, J. Adams, and M. White, "The association between time perspective and alcohol consumption in university students: cross-sectional study" *European Journal of Public Health,* 21:4, pp. 438–443.

[11] C. Clark and G. Dugdale, "Young People's Writing: Attitudes, behaviour and the role of technology" National Literacy Trust, London2009.

[12] A. M. Cohn, D. Hunter-Reel, B. T. Brett T. Hagman, and J. Mitchell, "Promoting Behavior Change From Alcohol Use Through Mobile Technology: The Future Of Ecological Momentary Assessment" *Alcoholism: Clinical And*

Experimental Research, 35:12, pp. 2209–2215, 2011.

[13] A. C. North, D. J. Hargreaves, and S. A. O'Neill, "The importance of music to adolescents" *British Journal of Educational Psychology,* 70:2, pp. 255-272, 2000.

[14] P. Nuttall, "Thank you for the music? The role and significance of music for adolescents" *Young Consumers,* 9:2, pp. 104-111, 2007.

[15] A. Roguin, "Rene Theophile Hyacinthe Laënnec (1781-1826): The Man Behind the Stethoscope" *Clinical Medicine & Research,* 4:3, pp. 230-235 , 2006.

[16] A. Vogl, "Six Hundred years of Medicine in Vienna: A History of THe Vienna School of Medicine" *Bull. N. Y. Acad. Med.,* 43:4, pp. 282-299, 1967.

[17] A. D. N. Edwards, A. Hunt, G. Hines, V. Jackson, A. Podvoiskis, R. Roseblade*, et al.*, "Sonification Strategies For Examination Of Biological Cells" International Conference on Auditory Displays, Washington, 2010.

[18] R. J. Cassidy, J. Berger, K. L. M. Maggioni, and R. R. Coifman, "Analysis Of Hyperspectral Colon Tissue Images Using Vocal Synthesis Models" Conference Record Thirty-Eighth Asilomar Conference on Signals, Systems and Computers, 2004.

[19] T. Kagawa, H. Kudo, S. Tanoue, H. Kiyosue, H. Mori, H. Nishino*, et al.*, "A Supporting Method of Medical Imaging Diagnosis with Sonification" International Conference on Complex, Intelligent, and Software Intensive Systems, Palermo, 2012.

[20] M. Ballora, B. Pennycook, P. C. Ivanov, L. Glass, and A. L. Goldberger, "Heart Rate Sonification: A New Approach to Medical Diagnosis" *Leonardo,* vol. 37, pp. 41-46, 2004.

[21] G. Mihalasa, S. Paralescub, N. Miricaa, D. Munteana, M. Hancua, A. Tudora*, et al.*, "Sonic Representation of Information: Application for Heart Rate Analysis" International Conference of the European Federation for Medical Informatics Quality of Life through Quality of Information, Pisa, Italy, 2012.

[22] E. Jovanov, D. Starcevic, K. Wegner, D. Karron, and V. Radivojevic, "Acoustic Rendering as Support for Sustained Attention during Biomedical Procedures" International Conference of Auditory Displays, Glasgow, UK, 1998.

[23] T. Hinterberger and G. Baier, "Parametric Orchestral Sonification of EEG in Real Time" *IEEE Multimedia,* 12:2, pp. 70 - 79, 2005.

[24] G. Baier, T. Hermann, U. Stephani, "Event-based sonification of EEG rhythms in real time", Clinical Neurophysiology, 118:6, pp. 1377-86, 2007

[25] T. Hinterberger, G. Baier, J. Mellinger, and N. Birbaumer, "Auditory Feedback Of Human EEG For Direct Brain-Computer Communication" International Conference on Auditory Displays, Sydney, Australia, 2004.

[26] M. Berndt-Schreiber, W. Lesiński, and Ł. Trzciałkowski, "Image Data Sonification In Medicine" *Journal of Medical Informatics & Technologies,* vol. 12, pp. 177-182, 2008.

[27] C. Ghez, T. Rikakis, and P. R. Cook, "An Auditory Display System for Aiding Interjoint Coordination" International Conference on Auditory Displays, Atlanta, Georgia, USA 2000.

[28] S. Pauletto and A. Hunt, "The Sonification of EMG Data" International Conference on Auditory Displays, London, UK, 2006.

[29] K. Vogt, D. Pirrò, I. Kobenz, R. Höldrich, and G. Eckel, "PhysioSonic - Evaluated Movement Sonification as Auditory Feedback in Physiotherapy" International Conference on Auditory Displays, Washington, USA, 2010.

[30] Mason-Jones A.J., Pauletto S., Walus B., *et al*., Chronic health issues of adolescents: Is the World Listening? Jane's Story. York: University of York, 2014: http://www.york.ac.uk/c2d2/outreach/adolescents/ (Last accessed: 31 May 2015).

[31] E. Fuller, Ed., *Smoking, Drinking and Drug Use Among Young People in England in 2012*. London: NHS Information Centre for Health and Social Care, 2012.

[32] B. Hibell, U. Guttormsson, S. Ahlström, O. Balakireva, T. Bjarnason, A. Kokkevi*, et al.*, "The 2007 ESPAD Report: Substance Use among Students in 35 European Countries" ESPAD, Stockholm2009.

[33] D. A. Leon and J. McCambridge, "Liver cirrhosis mortality rates in Britain from 1950 to 2002: an analysis of routine data" *Lancet,* vol. 367, pp. 52-56, 2006.

[34] Alcohol Concern, Ed., "Factsheet: Alcohol Concern's information and statistical digest", 2011, http://www.alcoholconcern.org.uk/wp-content/uploads/woocommerce_uploads/2014/12/Young-People-factsheet-Dec-2010.pdf (Last accessed: 31 May 2015).

[35] E. Fuller, Ed., *Smoking, drinking and drug use among young people in England in 2012*. Leeds: Health and Social Care Information Centre, 2013.

[36] F. Grond and J. Berger, "Parameter Mapping Sonification" in *The Sonification Handbook*, T. Hermann, A. Hunt, and J. G. Neuhoff, Eds., ed Berlin: Logos Verlag Berlin GmbH, 2011, pp. 363-398.

[37] E. Brazil and M. Fernström, "Auditory Icons" in *The Sonification Handbook*, T. Hermann, A. Hunt, and J. G. Neuhoff, Eds., ed Berlin: Logos Verlag Berlin GmbH, 2011, pp. 325-338.

[38] D. McGookin and S. Brewster, "Earcons" in *The Sonification Handbook*, T. Hermann, A. Hunt, and J. G. Neuhoff, Eds., ed Berlin: Logos Verlag Berlin GmbH, 2011, pp. 339-362.

[39] B. Walus, S. Pauletto, and A. J. Mason-Jones, "Sound and Music in Interactive Sonification: a Novel Way to Communicate Health Risk of Alcohol to Young People" in Proceedings of SoniHED - Conference on Sonification of Health and Environmental Data, 2014.

[40] A. Hunt and T. Hermann, "Interactive sonification" in *The Sonification Handbook*, T. Hermann, A. Hunt, and J. Neuhoff, G., Eds., ed Berlin: Logos Verlag Berlin GmbH, 2011, pp. 325-338.