Music and Emotions - A tool to create new playlists for a musical listening device in seclusion rooms in psychiatric hospitals

1st Cédric Bornand
Univ. of Applied Sciences HES-SO
REDS Institute, HEIG-VD
1400 Yverdon-les-Bains, Switzerland
cedric.bornand@heig-vd.ch

2nd Angelika Güsewell
Univ. of Applied Sciences HES-SO
Haute Ecole de Musique, HEMU
1000 Lausanne, Switzerland
angelika.gusewell@hemu-cl.ch

3th Emilie Bovet
Univ. of Applied Sciences HES-SO
HESAV School of Health Sciences
1000 Lausanne, Switzerland
Emilie.Bovet@hesav.ch

4th Gilles Bangerter
Univ. of Applied Sciences HES-SO
HESAV School of Health Sciences
1000 Lausanne, Switzerland
Gilles.Bangerter@hesav.ch

5rd Alexia Stantzos
Lausanne Univ. Hospital, CHUV
North Psychiatry Department
1400 Yverdon-les-Bains, Switzerland
alexiastantzos@gmail.com

6rd Goutam Chakraborty
Iwate Prefectural University
Faculty of Software and Info. Science
Takizawa 020-0693, Japan
goutam@iwate-pu.ac.jp

Abstract—This article presents research designed to demonstrate the impact of a musical listening device in psychiatric intensive care. The results described in this work are based on statistical data on the effect of listening to music, and on interviews with patients and caregivers. This contribution focuses on patients' listening strategies, as well as on the way caregivers appropriate the device. We elaborate the case study first. Finally, the article points out several improvements to the system suggested by the research findings, particularly through the use of artificial intelligence.

Index Terms—Music listening, Tool for categorization, Emotional content, Seclusion, Psychiatric inpatient

I. Introduction

The kTell music-listening device is a product of the AMENHOTEP research project (2012-2016) which aimed to rethink care in ICUs through the contribution of music [6]. kTell is a technical device that enables patients in a psychiatric hospital to listen to music during their isolation in an intensive care unit (ICU). Isolation [1] [2] [3] is a controversial therapeutic measure, from ethical aspect, its efficacy, and its underlying side effects [4] [5]: ICU aims to reduce sensory stimulation, which present risks for patients' mental health. The prescription of isolation makes it difficult to establish a patient/caregiver relationship based on dialogue.

The creation of the musical listening device results from the AMENHOTEP research project, which highlighted music listening as a promising avenue for reducing patients' feelings of loneliness and abandonment, and the possibility for them to regain a degree of autonomy [7].

Once the kTell device had been developed and implemented in a dozen hospitals, new research by the group known as AMENHOTEP [1] examined and analyzed its use by patients and care-givers (2018-2020).

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II. kTell description

The kTell device is more than just a platform for listening to music, devices found in supermarkets. It is distinguished by the fact that its design must meet strict safety standards in terms of impact, chemical and fire resistance, since it is used in isolation rooms. In addition, it includes a selection of music pieces chosen according to specific criteria, such as emotional content, duration and rhythm. It also features a listening statistics storage function.

Inside these chambers, a glass touch interface is integrated into the wall (for more details, see [10]). In addition, waterproof speakers are installed, usually on the ceiling and protected by metal grilles. Health-care professionals have an interactive tablet that allows them to reasonably manage the playlist offered to the patients, adjust the volume, and start or stop the device. Patients can choose from four categories of tracks, each containing around five to eight musical compositions, and have continuous access to the device 24 hours a day. The playlist contains instrumental music of various styles and genres (classical,

[1] https://amenhotep.ch/en

jazz, film, folk), ranging in length from 5 to 10 minutes and categorized according to the emotional content it conveys. There's no screen where song names are displayed, just a touch-sensitive interface with the four categories within which one can move forwards. The order of the tracks is therefore fixed to enable patients to navigate and orient themselves in the playlist. It enables caregivers to compare the statistics obtained for the same playlist in different establishments.

III. Playlist creation

The following method was used to create our playlist. To define the categories into which they should be classified, a scale of 9 emotions referenced by the Geneva Emotional Music Scale [8] was used: joyful activation, wonder, power, nostalgia, sadness, tenderness, transcendence, calm, and tension. Fifty pieces of music were selected by the research team, followed by a survey of forty people from different cultures, genders, and professions. Each respondent was asked to indicate no more than 2 emotions they felt when listening to each of the fifty pieces. The 20 pieces of music selected were those categorized in the same way by all participants. For the sake of simplicity, as patients would be lost if they had to navigate between 9 categories of tracks, the 9 emotions Geneva Emotional Scale was replaced by a scale composed of the following 4 emotions:

1 Joy
2 Nostalgia, Sadness
3 Calmness
4 Tension

IV. A Mixed Methodology

To measure the impact of the music listening devices, the following method was developed: for the duration of the research (from October 2018 to January 2020), a music database was frozen in order to be identical for all music listening devices. This was necessary to compare the data produced by different institutions : Lausanne University Hospital (Switzerland, Yverdon-les-Bains and Prangins), Nant Hospital (Switzerland, Vevey), St Cyr-au-Mont d'Or Hospital (France, Lyon). In each of these institutions, two groups were formed; the experimental group had a room equipped with the device, while the control group had an unequipped room. The total population comprised 83 patients, 48 in the experimental group and 35 in the control group, and 76 caregivers, 39 in the experimental group and 37 in the control group. The following data were collected:

- Patient choices, i.e. all patient actions on the device, were recorded automatically, to highlight listening strategies and device usage times.
- Patient volunteers were asked to fill in short questionnaires on their experiences of the CSI stay, their interactions with caregivers and the place of music in their lives, and 20 patients, 10 of the experimental group and 10 of the control group, took part in in-depth interviews. Those 20 patients had expressed an interest in talking to a member of the research team. These interviews focused mainly on their experiences of restraint, the musical device and the caregiving relationship. This enabled us to highlight the impact of the musical device on their experience of their stay in the ICU.
- Caregivers first completed a questionnaire on their professional values and their relationship with music, followed by another questionnaire on their perception of the patient's ICU experience. In addition, 20 in-depth interviews were conducted with caregivers.

The following questionnaires were translated from English to French and used for the purposes of the study: Barcelona Music Reward Questionnaire (BMRQ; Saliba et al. 2016) for the patients; Survey of Nurses' Attitudes to Seclusion (SNAS; Heyman 1987) and Nursing Students Questionnaire (VSI-NS; Rask et al. 2018) for the carers.

The SNAS questionnaire consists of a list of positive and negative emotions. Using a rating scale from 1 (minimum) to 3 (maximum), patients were asked to indicate whether and to what extent they had experienced these emotions during their stay in the isolation room.

Data were collected over a period of 18 months.

V. Results

First, the results concerning the use of the music listening device are presented. Secondly, some key findings from the interviews carried out with patients and caregivers are put forward.

A. Use of the Device

Patients who agreed to participate in the study spent between 1 and 38 days in the ICU, with an average of 4.5 days for the experimental group and 5.7 days for the control group. Overall, individuals who benefited from the music listening system spent between 0.1 and 29.1% of their time in the ICU listening to music, with an average of 11% of their stay. Over a 24-hour period, this represents an average of approximately 160 minutes of listening. The most listened to category is "Tension" with an average of 29%, "Nostalgia" with 25%, "Calmness" with 24% and "Joy" with 22%.

Listening statistics showed that patient-monitored listening is a selective process. Patients make listening choices, meaning that certain tracks are listened to repeatedly, while others are ignored altogether, or that one category of tracks is clearly preferred. These choices often evolve over the course of the session, which typically lasts 2-3 days.

B. Interviewees's experience

Table 1 presents descriptions of the experiences of patients in the experimental and control groups during their stay in the intensive care unit.

Data analysis reveals that the negative emotions reported by patients in the experimental group have a lower mean than those expressed by patients in the control group. This difference, noted Δ, is particularly pronounced for anger ($\Delta 6 = 0.44$) and less marked for fear ($\Delta = 0.22$). The opposite trend was observed for feelings of disempowerment, which seemed to be felt more intensely by patients in the experimental group than by those in the control group ($\Delta = 0.57$). This result is all the more interesting given that patients with access to music also reported feeling less controlled than those who did not benefit from this opportunity. This relative autonomy conferred by the system on CSI patients could accentuate their perception of dependence on the rhythm imposed by the care teams. Conversely, patients who were able to listen to music during their stay reported higher average positive emotions than those who did not have this opportunity. This difference is particularly noticeable for relief ($\Delta = 0.46$), calm ($\Delta = 0.32$) and sense of security ($\Delta = 0.29$). It should be noted that, due to the small sample size, none of these differences reached statistical significance. But we see clear trends.

TABLE I
Means for the experimental group (N = 48) and the control group (N = 35) for each of the 17 items (11 negative experiences, 6 positive experiences; min = 1, max = 3), from Survey of Nurses' Attitudes to Seclusion (SNAS; Heyman, 1987).

Negative feelings	Experimental Group	Control Group
1. frightened	1.62	1.84
2. angry	2.04	2.45
3. confused	1.96	2
4. helpless	2.22	2.15
6. depressed	2	2.12
11. disgusted	2.04	2.17
13. punished	2.04	2.05
14. disempowered	2.24	1.81
15. no self-control	1.52	1.67
Positive feelings	Experimental Group	Control Group
5. relieved	1.96	1.5
7. self-controlled	1.79	1.74
8. calm	1.88	1.56
9. safe	2.35	2.16
10. satisfied	1.7	1.63
12. happy	1.41	1.32

The analysis of the interviews revealed a positive trend towards the music listening device. It also clarified the meaning that patients ascribed to the music interface. Overall, they appreciated the opportunity to use the music interface during their stay in the ICU. Interviews showed that the device gave them a degree of autonomy in an environment where they had no control and very limited ability to act.

Listening to music in the ICU produced several types of effects on patients' subjective experience, two of which appeared to be predominant. The first is the calming effect of music. A number of patients interviewed said that music helped them to calm down in moments of psychological crisis. The device can also provide emotional support during the difficult situation of an ICU stay during a psychological crisis. In these conditions, where ICU patients generally find themselves with limited furniture and equipment, consisting essentially of a bed, a sofa, and a window, they often described feeling a profound sense of loneliness, as was evoked during the interviews. Confronted with themselves and the circumstances that affect them, these individuals often find themselves unable to mentally distance themselves from their concerns. In this context, music seems to play a role in helping them to feel less isolated and to prevent constant rumination on the same events.

Contrary to expectations, interviews with healthcare professionals revealed that the musical interface had little impact on their interactions with patients. Caregivers indicated that the device was primarily for the benefit of the patient and did not really elicit meaningful interaction with healthcare professionals. Caregivers also expressed concerns about their ability to ask relevant questions and structure a conversation around music, which may have discouraged them from exploring interactions different from those typically seen in the isolation room. With few exceptions, the caregivers interviewed did not appear to view the device as an "transitional object" in the therapeutic relationship ([9]). Indeed, the comments of some patients also accounted for a lack of commitment to the device on the part of caregivers. The assumption that the music listening device would be beneficial for the patient-caregiver relationship was not confirmed so far.

VI. Discussion

These results lead us to believe that the challenge for the future lies in finding ways to encourage greater involvement of healthcare professionals in the use of this (or other) music listening devices. As a result, first adjustments and actions have been launched since the end of this research in 2020.

kTell has become a framework that provides practical and secure services for patients and caregivers. It is also an attractive environment for administrators, researchers, and content contributors. The development that were driven by our research for each of these groups are presented below.

A. kTell for Patients: "Patient User Interface (PUI)

For the patient, the services provided by the kTell environment boil down to simple functions: the Play/Stop, Next, Volume + and Volume - buttons. In addition, patients have four buttons to select each of four categories of music pieces. Their feedback highlighted the response time of the interface, which was about 2 seconds. Furthermore, users expressed a unanimous desire for the addition of a "previous button". Substantial changes were made to reduce the response time to an imperceptible level, integrate the previous button, and improve tactile sensitivity.

B. kTell for the carers: Medical Unit Interface (MUI)

From the caregiver's perspective, a tablet gives them control over the operation of the device. They can start or stop the music, adjust the light intensity of the touch screen, or limit the maximum volume. Now, the maximum volume can be easily changed from the tablet and can automatically vary based on the time of day.

To fully integrate the device into the care process, caregivers now benefit from a critical tool: access to patient listening statistics in the form of graphs, that is data previously reserved for research. At a glance, they can get an overview of the patient's listening history, for example, by examining listening time by category or seeing the current track just before the start of an interview.

C. kTell for administrative staff

Among design considerations, the notion of cost, under the responsibility of administrative staff, is of great importance. In fact, mental health facilities generally have limited operating budgets and are constrained in their ability to invest in expensive equipment.

Access to the listening statistics for all devices in the institution has been set up for administrative staff, but only aggregated statistics are involved, to preserve confidentiality. By reviewing these statistics, they can verify that the equipment they have invested in is being used appropriately. In the case of under-utilization, this may indicate a need for team training, especially since these teams tend to rotate frequently.

D. kTell for research teams

Research teams now have access to aggregated statistical data about devices in service, obtained from hospital departments that have agreed to their data being used in this way. Overall listening statistics, broken down by playlist, category or track, as well as listening times and trends in these parameters, are made available easily for research projects. This information remains anonymous to protect the confidentiality of the data.

VII. Future work

A. Ideas for future development

The discussions that followed our research highlighted the frequent desire of patients' care-givers to be constantly involved, particularly by participating in the process of creating new music playlists.

To meet this demand, we created ktellaudio.com, a website with a database that any user of the music listening device can access after answering a few questions to better identify the person and their perception of the music tracks. Users can upload tracks, and listen to tracks uploaded by others, after the approval from the ad hoc committee. The committee approves the accessibility of a musical piece depending on several factors regarding its suitability.

Currently, the selection process is complex and time-consuming. To speed up the validation of musical tracks, we intend to use machine learning algorithms for automatic analysis of the musical pieces (tracks). These tools will automatically add indicators to the database, such as genre, rhythm, tessitura, harmony, instruments, intensity, and even the consistency of these characteristics throughout the piece. The software will also suggest clues to guide classification into the appropriate category. In this way, information about the perception of the submitted pieces is used to train the machine learning models (cf ktellaudio.com).

Automatic categorization of music is not a new field of research [11]. Several projects use artificial intelligence, with interesting results. These include DEAM (Database for Emotion Analysis using Music) [12], 1802 excerpts and full songs annotated with valence and arousal values, MERP Music Emotion Recognition with Profile information dataset [13] or the AMG1608 dataset (1608 30-second music clips annotated by 665 subjects) [14]. We planned to do this for the sake of psychiatry: not so many pieces of music, but over 10,000 comments from people interested in music and care.

B. Collection of labelled data

We created a website, ktellmusic.com, to collect the emotional experience of an individual after listening to a piece of music. The length of the musical piece is 60 seconds. Various pieces of music are uploaded to the ktellmusic website. The subjects (volunteers) are offered a piece of music, randomly selected from the website archive. The subject has to decide her/his emotion after listening to the piece, from a fixed menu of 4 emotions, namely joy, nostalgia,calmness, tension. We ignore any pre-conceived ideas about the association of music with a particular emotion, such as "joy" or "nostalgia." The musical pieces are offered to the subjects randomly. The pieces of music are not labelled according to the emotion they might arouse in the listener. We therefore have a set of musical pieces, whose emotional labels are added by the subjects on the basis of their emotional experiences.

From the subjects, we also collect personal profiles which may influence their emotions. For example, an old man may not experience the same emotion as a young girl after listening to the same music. For the subjects, we collect the following information:

- Gender
- Age
- ethnic background
- musical training or listening experience
- season
- time of the day

These are some basic characteristics of the subjects. The first question we ask is whether or not the emotional content perceived by the subjects depend on the subject's profile. In other words, whether (1) the music features

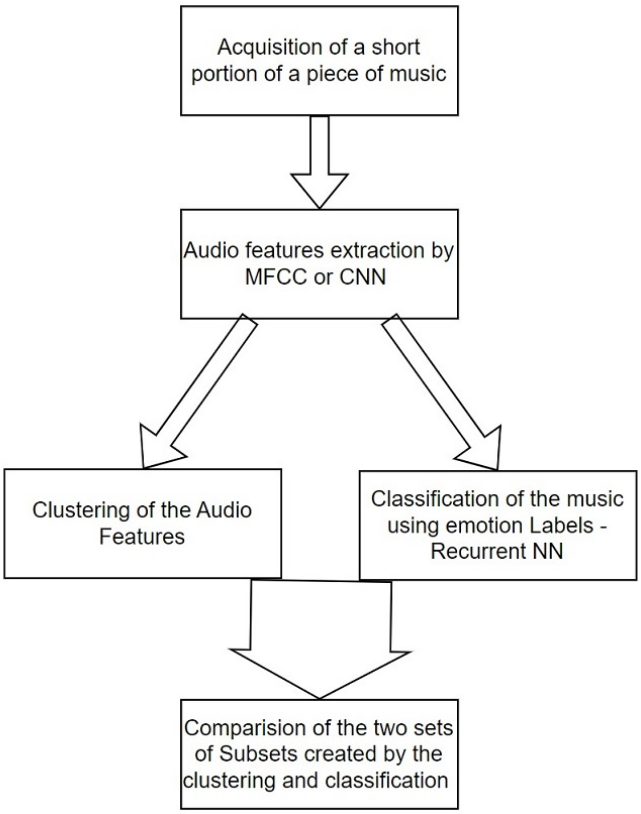

Fig. 1. Steps of the experiment

are solely responsible for conveying various emotions, (2) or whether the emotions felt by the subjects also depend on their profiles. Whether music that conveys a feeling of tension is perceived by a septuagenarian as power, and is perceived either the same way by a teenager or, for example, as joy.

A simple way to test the robustness of the emotions from different subjects, independent of their profile, is to look at the histogram of different emotions for a piece of music. If the emotion solely depends on the musical features, there should be no variance between the emotions labeled by subjects of different profiles. If there is a variance in opinion, we need to investigate how they are related. Assuming that there is no variance or the variance is negligible, we can label the musical piece with the emotion that has the highest frequency label. For a formal way to analyze the robustness of the labels, we plan an experiment explained in Figure 1. The different steps of the analysis are detailed as follows. Step 1 - Acqusition of a short portion of a piece of music. Step 2 - Acquisition of the MFCC features of the piece of Music are extracted. Considering MFCC window size of 25 milliseconds, and the length of the music as 60 seconds, we have a sequence of 2400 MFCC feature vectors. Step 3 – We train two RNN models, one performing Clustering [16], and the other Classification [15] as shown in the diagram. Clustering is the result of putting similar MFCC features in the same group, whereas classification will force in the same group pieces with the same label. Step 4 – The two subsets of the clustering and classification results are compared using the Rand Index. (1) If the Rand Index is close to 1, we conclude that the labels are robust, independent of the subject's profile. (2) If not, we conclude that the labels also depend on the listener's profile. In case of (1), mapping of a music to an emotion will be an easy task. In case of (2), the problem of mapping a music to an emotion becomes more complex. Once we could affirm case (1) with confidence through the experiment, it will open up a plethora of applications such as generating music of specific emotions. In addition, we will be able to offer the patients confined to seclusion rooms the opportunity to explore new playlists. If case (1) proves to be untenable, we must also include the user profile as part of the input feature, to map to specific emotions. In this case, we need an enormous amount of data to explore a meaningful mapping.

VIII. Conclusion

The kTell music listening device was introduced and its use analyzed through a patient experience and perception study of both patients and caregivers.

As a result, the system was redesigned and the software adapted to better meet the needs of the various stakeholders, especially patients and caregivers. In addition, it was designed to be useful for administrative staff and costs were reduced to take account of tight budgets. Future developments were presented, providing an opportunity to consider the contribution of AI and the ktellmusic.com platform to playlists, always with the aim of improving the patient and caregiver experience.

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