Personalized Music Recommendation for People with Autism Spectrum Disorder

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Abstract

The project "ACCESS: Accessibility to Clinical Care for People with ASD through Anxiety Management Using Personalized Applications and IoT" aims to develop innovative technologies to manage anxiety in individuals with Autism Spectrum Disorder (ASD) when they undergo dental and otolaryngology treatments. The premises of this project are the potential of multimedia content to help people with ASD relax when exposed to stressful conditions in healthcare. The result will be an app that personalizes the selection of music tracks and videos to be played before and during the treatment to help the patient distract and cope with stressful conditions that might cause anxiety. For this purpose, the app will receive information about the patient's arousal state collected by physical sensors and/or the clinical staff. The app will use this data to personalize the selection of multimedia content based on the patient's preferences, arousal level, and level of noise around her or him.

Keywords

Personalized healthcare services, recommender systems, autism

1. Introduction

In this paper, we present the project ACCESS, "Accessibility to Clinical Care for People with ASD through Anxiety Management Using Personalized Applications and IoT". The project aims to develop ICT technologies that support the management of anxiety in individuals with Autism Spectrum Disorder (ASD) before and during clinical treatments, with specific attention to dental care treatments and otolaryngological examinations. Given the peculiarity of ASD, which induces different sensitivities to external stimuli, these treatments challenge patients through stimuli concerning hearing and touch, a social context that includes unknown people, and a possibly high level of surrounding noise. Patients thus need help in coping with anxiety.

ICT offers a powerful means to assist individuals with autism in everyday life, including healthcare support [1, 2]. However, for these tools to be effective, efficient, and satisfactory, they should be (i) accessible and user-friendly for individuals with autism, and (ii) seamlessly integrated into clinical protocols, which need to be adapted to incorporate and leverage this technology. Recent studies [3, 4] show the potential to personalize healthcare for people with autism. However, current ICT-based solutions to healthcare support adopt a one-size-fits-all approach to all patients.

The ACCESS project investigates the benefits of integrating digital personalization techniques to help patients with ASD undergo treatments adapting to individual needs, sensitivities, and the noise in the surrounding context. The project builds on findings showing that people's preferred music is effective in anxiety treatment [5] and custom multimedia content administration has positive effects in dental care [3]. However, in these works the selection of the content to be delivered is not automated. Differently, ACCESS aims to develop an application that plays music and multimedia content to calm patients with ASD by adapting content in real-time based on their arousal level and the surrounding noise, and exploiting their preferences for content selection.

Our work in this project concerns the development of the multimedia content selection module. For this purpose, we will develop a novel interaction model to adapt the elicitation of content preferences to ASD people with different functioning levels. Moreover, we will develop a recommender system that

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combines context awareness (to consider the patient's preferences, arousal state, and the level of noise in the environment) with constraints imposed by the type of visit to be carried out and the patient's sensitivities.

2. Related Work

Music is considered a powerful relaxation tool. Both the acoustic features of the music and individual user preferences play crucial roles in relaxation [6]. In the clinical domain, Lai-Tan et al. report that the best results in applying music therapy to face depression and anxiety are obtained when people listen to their preferred songs because this induces enjoyment [5]. For instance, some people find heavy metal music (that typically has 100-150 Beats Per Minute (BPM)) relaxing while, according to [7], sedative music used in music therapy is characterized by a slow tempo of 60-80 BPM. Thus, knowing the contents that the patient likes, and her/his musical preferences, is key to selecting promising tracks for relaxation.

Personalized technologies for autism are scarce in healthcare contexts [8]. Few works provide personalized support to people with autism (as well as their caregivers and physicians) in managing medical care [9]. Nicolaidis et al. [10] developed a tool that allows patients to create a personalized report for their healthcare provider, improving communication with healthcare operators. Personalized interventions proved to be very effective, especially in the management of anxiety in people with autism [8, 11].

Bondioli et al. [3] developed personalized digital tools such as photos, videos, and interactive PDFs to familiarize ASD children with dental procedures and environments and teach them to perform proper oral hygiene at home. The results confirmed the potential to personalize the selection of ICT tools to reduce anxiety in professional settings. However, in that work, the creation and selection of the multimedia material was carried out by the medical staff in collaboration with the patient and her/his caregivers, without any automated personalization support.

The ACCESS project differs from the previously cited works because we plan to develop an app that dynamically selects and plays multimedia content based on the patient's preferences, sensitivities, and arousal level, and considering the specific treatment to undergo and the presence of noise in the surrounding environment.

Notice that, concerning music selection, our work differs from musical biofeedback, where sounds are exploited as interaction means to convey positive or negative feedback to patients while they carry out tasks in contexts such as relaxation assistance [12] and stroke rehabilitation [13]. In our case, the patient is expected to listen to the music passively, and we aim to select music tracks that can make her/him relax to cope with a clinical treatment.

3. The Project

ACCESS focuses on dental care and otolaryngologist treatments. It is a 2-years project that involves the University of Pisa (development of the main ACCESS tools), the Polytechnic of Milan (development of sensors to monitor patients' anxiety and stress levels), the University of Torino (development of the multimedia content selection system), and the National Research Council (participatory methodology for the project's design, development, and assessment).

As the literature suggests the benefits of music and videos in helping people with ASD cope with medical treatments, the project will target both media. However, we will first focus on delivering music. For this purpose, we are developing a web app to acquire the patient's musical preferences and support her/him during the medical treatments. The app is used in three separate phases:

1. The patient will be instructed to use the app at home to explore and play the preferred multimedia content. The app will adapt the level of guidance in preference elicitation and content exploration to the patient's autonomy, considering different ASD functioning levels. Given the patient's interaction with the app, the system will collect her/his music preferences regarding genres,

authors, and individual preferred tracks. Moreover, it will analyze the acoustic features of the preferred tracks through the Spotify API.[1] As people with ASD have individual tolerance levels to acoustic features, this analysis is key to building an individual user profile that specifies the ranges of values compatible with the individual user and can be used to select the tracks to play before and during medical treatments.

2. Before the medical treatment, e.g., in the waiting room, the app will help the patient listen to her/his favorite multimedia content or guide her/him in the exploration of new content. The goal is to keep the user relaxed by suggesting content that reflects the preferences collected in the previous phase and having features that do not agitate her/him.
   The app will sense the surrounding environment to estimate the noise level. Based on this information and the user profile, it will select the content to be administered (e.g., whether playing music or showing mute videos to avoid adding further disturbing factors for the patient). For music selection, we plan to steer the invocation of the Spotify API concerning the recommendations[2] to retrieve music tracks compatible with the patient's musical preferences and sensitivity, and with the surrounding environment. We will do this by feeding the API with data about authors, genres, and the minimum and maximum values of the acoustic features stored in the patient's user profile.
3. During medical treatment, the app will receive information about the patient's arousal state (e.g., heart and respiration rates collected by sensors, or information provided by the medical staff). Moreover, it will sense the surrounding environment to estimate the noise level and play the appropriate multimedia content based on this data and the user profile. In this case, the type of content selected by the app could change to reflect the patient's arousal state.

The app will be tested in collaboration with the Audiology and Phoniatrics Clinics (OPC) at AOUP Pisa to measure the user experience during the interaction with it, and its effectiveness in supporting patients during medical treatments. So far, we participated in a focus group with 2 caregivers, 1 psychologist, 1 speech therapist, 1 otolaryngologist, 6 researchers and 2 technologists to gather stakeholders' requirements and needs. The focus group confirmed that the use of technology can help the user to prepare before the medical treatment and could also be useful while the treatment is performed. In addition, a personalized approach could improve the user experience if a strong weight is given to user preferences.

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[1] https://developer.spotify.com/documentation/web-api/reference/get-audio-features. This API allows data to be recovered on the acousticness, danceability, energy, instrumentality, liveness, loudness, speechiness, and tempo of each track.
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