

# The Role of Audio in Two Accessible Vision–Rehabilitation Games for Blind Teenage Users

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## INTRODUCTION

Often computer (and other electronic) games are considered as an addictive way of entertainment for youngsters, with many disadvantageous effects. Yet, well designed computer games can have very positive effect on the players. In particular, computer games can be used for vision rehabilitation purposes. By definition, vision rehabilitation is concerned about giving blind and low vision people the ability to live independently and improve their quality of life. This includes training orientation and mobility skills and educational related issues, among others.

The advantages of training orientation and mobility skills with a game include the motivation that a fun environment can bring to the patient, and the possibility of training the skills in a safe environment. Also, the fact that a game can help the patient forget (or not think about) the real purpose of the game, can help surpass inhibition of these patients.

Computer games can also be used for educational purposes. In fact, well designed educational games can lead to an improvement on school performance. Educational games contribute to making students feel more motivated and engaged in the learning process. This promotes studying and influences the effort students put on learning the school curriculum.

Unfortunately, since most educational computer games are designed for sighted students and have a very strong visual component, blind students are not always able to take full advantage of these games and benefit from them. However it would be desirable that these students could have access to the games not only to guarantee that all students have equal opportunities but also because nowadays blind students attend inclusive schools. Ultimately, access to well designed educational computer games for blind students can contribute to the improvement on the quality of life of this special needs group, as good school performance is the key for more and better opportunities in the student's future.

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In this paper we focus on the role of audio in computer games accessible to visually impaired users. In particular we focus on two vision rehabilitation games we have designed for blind and low vision middle school users. One of these games was designed to help blind and low vision students on learning mathematics and the other for developing and training orientation and mobility skills.

In order to guarantee accessibility to blind users, we have designed games that can be played without the need to see the graphics. These games use speech and non-speech audio to convey information, and use 3D spatialized audio for orientation purposes. All the features, like questions and feedback, instructions, etc. are complemented with audio, and the games use audio localization cues for orientation. In particular, the game designed for developing mobility skills uses 3D spatialized audio obtained with head related transfer functions.

## BACKGROUND

Most computer games have a strong visual component. While the majority of these games also use audio, most (relevant) information is provided through images. This way, it is very difficult for low vision users, and impossible for blind users, to play the games independently. This is also true for serious computer games for education and health, which are usually designed for sighted users. Nonetheless, it would be desirable that these games would be accessible to visually impaired users, allowing these users to take advantage of these applications in the same way that sighted users do.

In order to allow visually impaired users to enjoy and take advantage of computer games, these must use non-visual modalities as means of interaction with the user. Some possibilities include using sound, touch screens, haptic equipment, and specially designed hardware. For example, the TIM project used a specially designed keyboard and a scripting language to adapt existing educational games for visually impaired children (Archambault & Burger, 2000).

The clock reference system is another possibility, which combined with voice, can be used to let the blind users know about the location of items in the screen and for orientation purposes. This technique has been used successfully to indicate the position of atoms in molecular structures in a molecular editor that helps chemistry students with molecules interpretation (Fartaria, et al., 2013). Another example that uses this system is the MOVA3D game, which was designed to help visually impaired children with their mobility skills (Sánchez, Sáenz, & Garrido, 2010). This game uses 3D spatialized audio and a special haptic controller (a digital clock carpet) that uses the clock reference system for orientation purposes. This game was tested by blind and low vision school children in over three-hour eight sessions during a period of three months. It was observed that children who played the game could better estimate their location and orientation in the navigated space.

Haptic screens can be used as input devices for applications to the visually impaired. Provided that the users understand what regions of the screen they have to touch and how to touch them, users can interact with the application in this way. AudioPuzzle is game for the visually impaired that uses the Android's haptic screen as an input device (Carvalho, Guerreiro, Duarte, & Carriço, 2012). It consists of an audio puzzle, more specifically, it is a musical puzzle, in which the pieces are music segments. The players have to place the music pieces in the correct order by touching the screen with sliding movements.

Sound can be used in many ways to convey information to the blind. That includes speech and non-speech sounds. Non-speech sounds can be used to give information about location of a destination, a target to catch, of something approaching, the presence of an object or character, etc. One interesting possibility is to use spatialized audio, in particular 3D audio. When listening to these sounds, the user

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