Interactive Audio Tactile Maps for Pre-Navigation Improve Spatial Learning in Visually Impaired People.

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Abstract

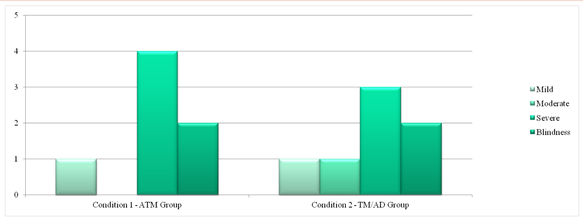
Pre-navigational tools can assist visually impaired people when navigating unfamiliar environments. We assessed the effectiveness of an interactive audio-tactile-map (ATM) in blind and visually impaired people. We found that participants exposed to an ATM recalled the map significantly better than those given a conventional tactile map accompanied by text description.

Introduction

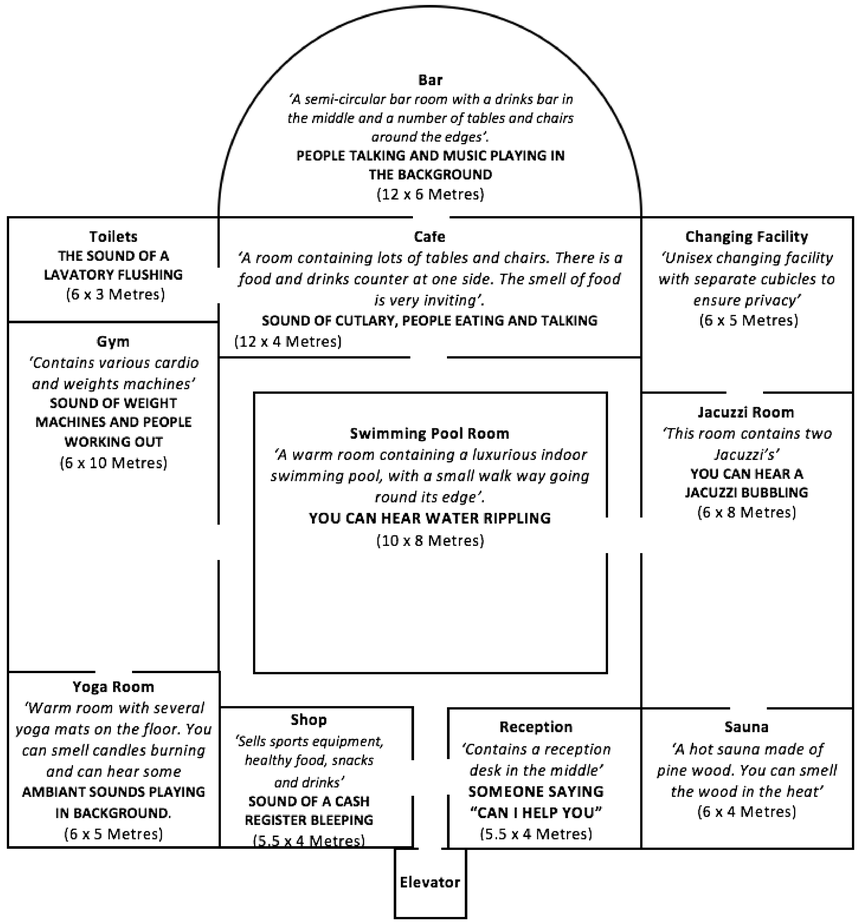
People with visual impairments can encounter many challenges navigating unfamiliar indoor and outdoor environments. Having previous experience or spatial knowledge of a location can provide valuable assistance. Assistive technology products (e.g. tactile maps or auditory simulations) can stimulate cognitive mapping processes to provide navigational assistance for blind and visually impaired individuals.

Methods

An audio tactile map (ATM) was produced with a tablet computer overlaid with a paper tactile map. The tablet provided touch-activated audio feedback in the form of context-specific background noise; text-to-speech auditory information about the space; or audio-click acoustic simulation feedback. Spaces were modelled using the CATT Acoustic (http://catt.se/) program to include elements such as room size, acoustic properties of the walls and floors plus objects in the room. The noises were reproduced in the virtual environments to simulate appropriate echo feedback and the audio was optimised for binaural headphone playback to give a strong sense of immersion in the environment. We compared how well blind and visually impaired people could learn a map presented via the ATM in contrast to a conventional tactile map accompanied by a text description. After a learning phase performance was assessed with a multiple choice test that quizzed participants on aspects of orientation and spatial awareness.



Bar-chart showing the numbers of individuals in each group reporting 'mild', 'moderate', 'severe' levels of visual impairment or 'blindness'.



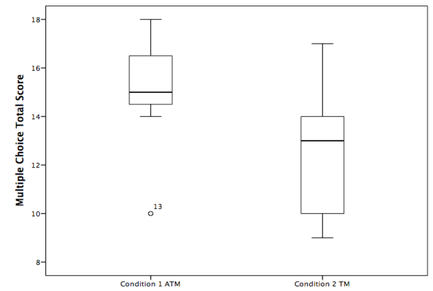
A representation of the map developed for this experiment including description of rooms and sound effects.

Acknowledgement

Thanks to Paul Thornton for helpful discussions about this project.

Results

A Mann-Whitney U-test identified that the overall scores for the 20 multiple-choice questions was significantly higher for the ATM group (Md = 15, n = 7) than the group using a conventional tactile map and text description (Md = 13, n = 7) U=11.500, z = -1.68, p= .042 (one-tailed) i.e. the ATM group performed better.



We then explored the experience of participants in both conditions through individual semi-structured interviews that were transcribed and analysed qualitatively by thematic analysis. Participants reported that ATMs helped them learn flexibly. They found the system enjoyable and easy to use. Participants reported the system gave them freedom to learn the map in several ways and did not restrict them to a sequential and linear approach to learning. Participants recommended that the system could be extended with global positioning system (GPS) technology.

Discussion

We conclude that this ATM administered through a tablet computer provides an effective, easy to use and comparatively cost effective way of enabling blind and partially sighted people learn a cognitive map. Performance with an ATM is superior both for encoding and retrieval of cognitive mapping compared with conventional tactile maps accompanied by text. An ATM provides flexible learning and can help people with disabilities be less challenged by their environment.

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