

## Chapter 16

# Co-Designing Wearable Technology Together With Visually Impaired Children

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### ABSTRACT

*This paper presents the process and results of a set of studies within the ABBI EU project, with the general aim to co-design wearable technology (an audio bracelet) together with visually impaired children, starting at a young age. The authors discuss user preferences related to sounds and tactile materials and present the results of a focus group with very young visually-impaired children under the age of 5, together with their parents. They find that multisensory feedback (visual, tactile/haptic, auditory) is useful and that preferences vary - also the drastic and potentially unpleasant sounds and materials may have a role. Further studies investigate the possibilities of using the ABBI wearable technology for social contexts and games. In a series of game workshops children with and without visual impairments created games with wearable technology employing very simple interactivity. The authors report the created games, and note that even with this simple interactivity it is possible to create fun, inclusive and rich socially co-located games.*

DOI: 10.4018/978-1-5225-5484-4.ch016

## INTRODUCTION

The Audio Bracelet for Blind Interaction (ABBI) EU Project is aimed at developing new wearable technology (an audio bracelet) to improve sensory-motor rehabilitation for children with visual impairments. Children with visual impairments develop their kinesthesia slower than sighted children, since visuomotor feedback is fundamental for calibrating the perception of body and space (Gori, Sandini, Martinoli, & Burr, 2010). It has been verified that hearing can be used to substitute vision in this process (Cappagli, Cocchi, & Gori, In press). Therefore, in the absence of visual input, auditory feedback may be used as a replacement to provide the needed information about body movement. This has important implications at a clinical level: since blindness is characterized by the absence of visuomotor feedback, we expect that an auditory-motor training with audio feedback from a wearable device would improve the spatial skills of persons with visual impairments.

The ABBI bracelet will be used by persons with visual impairment (including blindness), and the interaction needs to rely on the non-visual sensory channels hearing and touch. The technology to be developed aims to support the space-perception calibration process by allowing a person with visual impairments to use their spatial hearing to locate the position of the bracelet. In this way, the wearer can “listen” to the location of their own body to calibrate spatial perception.

Since we aim at long-term use in rehabilitation we also need to produce designs that are pleasant or at least interesting enough for the users to keep using them. We started our design work by investigating the hedonic/aesthetic preferences of our prospective users (Magnusson et al., 2015). A specific challenge for the participatory work is that the end users are visually impaired. Co-design activities with children like the ones described in Walsh et al. (2010) are not uncommon, but typically make use of visual materials like drawings, images, screen displays etc. The same is true for the typical lo-fi prototyping materials like pen and paper.

The ABBI device is designed to be used by visually impaired children (under 6 years of age) and has mainly been used in spatial rehabilitation studies, but has good potential to be used in social and playful contexts. In order to explore these, a couple of game workshops were performed with children with visual impairments: one workshop with at the Chiossone Institute in Italy, and another one at Furuboda Association in Sweden. A focus group activity with a group of visually impaired children between 2 and 5 years of age and their parents was also performed.

### The ABBI Bracelet

The ABBI bracelet consists of a small circuit board (24 x 25 mm), which includes an ARM Cortex M3 processor, a 9-axis Inertial Measurement Unit (IMU), 16 MB Flash memory, a Bluetooth LE module and a sound amplifier. The circuit board, a 120 mAh battery and a speaker (Figure 1a) fit into a robust plastic enclosure (55 x 35 x 25 mm), which can be fixed on a wrist band (Figure 1b).

The ABBI bracelet goes into sleep mode when at rest and wakes up when the IMU detects movement. The processor can synthesize sound in real-time and play back sound stored in Flash memory. The sound can be triggered by or modulated by the IMU. The Bluetooth link is used to read and write ABBI settings from e.g., a smartphone or computer. In our game workshops, the ABBI device was configured to playback sounds when the velocity was above an adjustable threshold.

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