



Towards a Methodology to Evaluate Multimodal Games for Cognition in People who are Blind

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Abstract. Multimodal serious video games are relevant tools to enhance orientation and navigation skills in people who are blind. We intend to propose a methodology for evaluating the usability and the cognitive impact of interface elements and interaction components in this kind of games. The results will allow us to analyse and discuss the impact of interface elements on cognition and propose guidelines for the better use of these elements.

1. Introduction

1.1 Research Problem

People who are blind face difficulties to complete tasks requiring spatial representation [2]. As a result, they tend to walk choosing the safer route rather than the most efficient one [4,9]. In order to navigate efficiently, this audience needs non-visual stimuli to perceive the environment and construct effective cognitive maps [3]. Multimodal interfaces can stimulate orientation and navigation skills in this population by using their complementary channels via audio-based interfaces or haptic/kinesthetic feedback [10, 11, 14]. Studies have shown that multimodal video games can stimulate cognitive processes such as tempo-spatial orientation and haptic perception [13,16]. Since children and young people widely use games as part of their daily routine [5], multimodal serious games are attractive tools to stimulate cognitive development and improvement.

A previous study [12] analyses the state of the art in design, evaluation and the existing technologies for multimodal video games, designed to enhance cognition of people who are blind. They state that it is necessary to identify the advantages and limitations of the evaluation methods for multimodal interfaces in this context. Regarding usability, the results show that there is no consensus about the elements to evaluate, nor the methodology and evaluation instruments. Besides, it is fundamental to ensure that these games can stimulate the cognitive development, but cognitive impact evaluations are still

scarce. Designers and developers need to understand how to use multimodal elements in a relevant and meaningful way, to create and to evaluate a serious game designed to enhance cognitive skills. In order to meet this need, the main objective of this work is to propose a methodology for evaluating interface elements and interaction components in multimodal serious games designed to stimulate cognitive skills in people who are blind.

1.2 Research Hypothesis

- We assume that it is possible to design a model for evaluating the usability and the cognitive impact of a serious multimodal video game, combining qualitative, quantitative and quali-quantitative approaches. The main goal of this research is to propose an appropriate and efficient methodology that suits these requirements.

The existence of such a methodology implies there are specific interface and interaction elements that are significant to the construction of cognitive maps, and thus cognition in people who are blind. Determining which are these elements will allow us to describe the best practices for their adequate use.

2. Methodology

- The methodology of this research consists of six main phases, as follows:
 - **Literature review:** We already executed a Systematic Review [8] in order to identify the design and evaluation approaches, and the technologies currently in use for multimodal serious games, designed to support the development of mental maps, cognitive spatial structures and navigation skills.

Selection of Games: From the 21 applications studied in the Systematic Review, we will select a set of six multimodal video games to compose the testing sample (three casual and three serious). We will work with existing applications.

Selection of Evaluation Methods: We will define a set of quantitative, qualitative and quali-quantitative methods and instruments for usability and cognitive impact evaluation, such as Cognitive Walkthrough [17], Heuristic Evaluation [6], End-user and Facilitator Questionnaire for Software Usability [15] and quasi-experimental designs [1] for impact evaluation [3, 14].

Evaluation of the Methods: In order to identify the advantages and disadvantages of the methods to evaluate the usability and cognitive impact in

this particular context, we will evaluate each selected video game with diverse qualitative and quantitative methods.

Results Compilation: The evaluation results will be interpreted according to statistical analysis, as well as with the observations of the comparison groups and cross-site analyses. As a result, we will propose an appropriate and efficient methodology for the evaluation of usability and cognitive impact of multimodal video games for people who are blind.

Proposal Validation: We will use our methodology to evaluate the usability and the cognitive impact of the selected games. We will compare the results of our proposal with the results obtained with the evaluation methods, in order to determine the effectiveness of the proposed methodology.

3. Solution and Contributions

The proposed solution, as well as our major contribution, will be an appropriate and efficient methodology for the evaluation of usability and cognitive impact of multimodal video games designed for the enhancement of cognition in people who are blind. Besides, the nature of the research allows us to state the impact of user interfaces and multimodal interaction for the construction of cognitive maps in these learners, through interaction with multimodal games. Thus, as a final contribution, we expect to supply the designers and developers with guidelines for suitable interface and interaction choice for the design of multimodal video games, in the context of the cognitive development in learners who are blind.

4. Discussion

Some issues related to the proposed methodology should be considered, in order to improve the research findings. The first one is related to what are the best criteria for the selection of the evaluation methods. Another important point is how many and which methods would be the most relevant to evaluate. Finally, we would like to consider whether including both usability and cognitive impact evaluation methods in the same evaluation methodology is actually the best approach.

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References

- [1] Campbell, Donald Thomas, Julian C. Stanley, and Nathaniel Lees Gage. *Experimental and Quasi-Experimental Designs for Research*. Boston: Houghton Mifflin, 1963.
- [2] Kolb, B and Whishaw, I. *Neuropsicología Humana* 5a edición. Editorial Médica Panamericana, 2006.
- [3] Lahav, O. and Mioduser, D. Construction of Cognitive Maps of Unknown Spaces using a Multy-Sensory Virtual Environment for People who are Blind. *Computers in Human Behavior* 24(3), 2008, pp. 1139-1155.
- [4] Lahav, O. and Mioduser, D. Multisensory Virtual Environment for Supporting Blind Persons' Acquisition of Spatial Cognitive Mapping – A Case Study. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications*. 2001. pp. 1046-1051.
- [5] Mayo, M. Games for Science and Engineering Education. *Communications of the ACM* 30(35), 2007, pp. 30–35.
- [6] Nielsen, J. *Heuristic Evaluation. Usability Inspection Methods*. New York: John Wiley & Sons, 1994.
- [7] Nikolakis, G. Tzovaras, D. and Strintzis, M. Object Recognition For The Blind. In *Proceedingf of 13th European Signal Processing Conference (EUSIPCO2005)*, Antalaya, Turkey, 2005.
- [8] Petersen, K., Feldt, R., Mujtaba, S. and Mattsson, M. Systematic mapping studies in software engineering. In *Proceedings of the 12th Intl. Conference on Evaluation and Assessment in Software Engineering*, Italy. 2008
- [9] Pressl, B. and Wieser, M. A Computer-Based Navigation System Tailored to the Needs of Blind People. *Lecture Notes in Computer Science*, Volume 4061, 2006.
- [10] Sánchez, J. User-Centered Technologies for Blind Children. *Human Technology Journal*, 45(2), November 2008, pp. 96-122
- [11] Sánchez, J. and Tadres, A. Audio and Haptic Based Virtual Environments for Orientation and Mobility in People Who are Blind. In *Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '10)*. ACM, NY, 2010.
- [12] Sánchez, J., Darin, T. and Andrade, R. Multimodal Videogames for the Cognition of People who are Blind: Trends and Issues. In *Proceedings of the 17th International Conference on Human-Computer Interaction (HCII'15)*, 2015. (*in press*)
- [13] Sánchez, J. and Sáenz, M.: Usability of Audio-Based Virtual Environments for Users with Visual Disabilities. In *Virtual Reality and Human Behavior Symposium*, Laval, France, 2007.
- [14] Sánchez, J. and Tadres, A. Audio and Haptic based Virtual Environments for Orientation and Mobility in People Who are Blind. In *Proceedings of the 12th international ACM SIGACCESS conference on Computers and accessibility (ASSETS '10)*. ACM, NY, USA. 2010

- [15] Sánchez, J. End-User and Facilitator Questionnaire for Software Usability. Usability evaluation test. University of Chile, 2003.
- [16] Sjostrom, C. Using Haptics in Computer Interfaces for Blind People. In Proceeding of the ACM CHI 2001, Seattle, Washington, USA, March 31 – April 5, 2001 pp. 245–246
- [17] Wharton, C., Rieman, J., Lewis, C., and Poison, P. The Cognitive Walkthrough Method: A Practitioner's Guide. In Nielsen, J., and Mack, R. L. (Eds.), Usability Inspection Methods, John Wiley & Sons, New York, 105–140. 1994.