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# Monitoring player attention: A non-invasive measurement method applied to serious games

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ABSTRACT

In this article, we report on an experiment to monitor user attention in the serious game *Le Village aux Oiseaux* (The Birds' Village). The primary motivation of this study was to explore the dynamic adaption of a game's scenario and challenges to the skills of individual players. The solution we developed is a real-time, non-invasive visual attention monitoring method, based on the evaluation of reaction time within an open and continuous space. Our results contribute knowledge that can be useful for automatically managing individual game sessions. In addition, this knowledge can benefit game designers as well, helping them to improve gameplay, manage the difficulty of game environments, and optimize the positioning of visual resources on screen.



## 1. Introduction

*Le Village aux Oiseaux* (The Birds' Village) is a project that aims to develop a therapeutic game for seniors who suffer from Alzheimer's disease. The game will allow users to train their attention in order to slow down the cognitive loss caused by this disease. According to [1], attention is a function of the ability to select an object or stimulus from among many others and then to decide whether it should be ignored or whether action must be taken. For example, a vehicle horn or a door slamming can attract attention (detection) but it does not necessarily require an action (interpretation). *Le Village aux Oiseaux* is guided by the following principles: highly interactive, fun and auto-adaptative.

Interactivity is the foundation of the therapy: by stimulating users' attention network we expect to improve retention of their cognitive abilities.

Fun will encourage people to play the game and replay it in the future; the more the user plays, the more she/he cares.

Adaptivity is necessary for the game system to propose relevant content to the users, depending on their remaining capabilities, mood, health, motivation, etc.

To provide effective training, the system must ensure that the player is focused on the game. A major challenge is to provide the system with a tool for monitoring the player's attention level. This is so that whenever the player loses concentration the game is able to help him or her to (re)focus by triggering special events, or stop the session if such special events are prove ineffective.

To know when the player has an attention gap, we need an approximation of their attentional skills to use for the purpose of comparison. Such data is also necessary for adapting game difficulty to player abilities – which is important for providing an adapted training, but also for fostering player motivation. Indeed, adapted difficulty is one of the key requisites for reaching the flow state.

Many measures of attention rely on physiological and behavioral manifestations, such as electrodermal activity, heart rate, respiratory rate, or eye movement. However, le Village aux Oiseaux will be played by elderly people at home without supervision. Consequently, we needed a method to measure attention that (1) is not invasive, (2) requires no IT skills, (3) costs as little as possible, (4) is able to detect in real time any changes in the attention level of the user.

In a video game, the user frequently moves the mouse cursor toward an object, whether it be to select an option or to kill an enemy. Our main hypothesis is that we can measure the reaction time (RT) of a user by doing a geometrical and temporal analysis of the movements made by users in real time. RT is easily computed as the difference between the time corresponding to the beginning of the user's voluntary movement and the time when the target appears. We can then evaluate the current user's attention level by comparing the current RT with the mean RT of the user.

The main challenge in our method lies in the fact that the system does not have any way of determining the beginning of a

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movement that is instigated by the appearance of the target (i.e. the user moves the cursor in order to select the target). Since the user is free to move wherever he or she wants regardless of the presence of the target on screen, the system cannot determine which movements are motivated by selecting the target and which ones are not.

Our first implementation of this method comprised three experiments. First, we conducted two experiments with simple pointing tasks within a non-game environment. Then, we conducted a third experiment in a simplified version of *Le Village aux Oiseaux* in which there is a maximum of one bird on the screen at any time, with the birds remaining static.

This article is organized as follows: Section 2 describes the overall design of the serious game *Le Village aux Oiseaux*; Section 3 presents related work; Section 4 describes our experiments; Section 5 summarizes our paper and provides an outlook for future work.

## 2. Game design

*Le Village aux Oiseaux* (Fig. 1) is a cognitive rehabilitation game for patients suffering from Alzheimer's disease. Therapeutic games, a category to which cognitive rehabilitation games belong, are serious games that aim to directly improve the health of their players [2]. By applying the definition of therapy to games [3], we can define therapeutic games as follows: games where the intended and expected effect is to heal, to alleviate, or to improve a particular health condition.

From a game design perspective, this real-life objective (or serious purpose) represents the main difference between an entertainment game and a serious game. By analyzing the main components of seven game definitions, Juul constructed a classical definition of games in which games are free activities with no impact on real life [4].

By contrast, most serious games definitions state that serious games are designed to have an effect on real life [5–8]. Some authors specify that the purpose of combining a game and a serious purpose is to enhance the user's motivation [9–12]. Other aspects of serious games are still under debate. For instance, as reported by Guardiola et al., there is still a debate concerning the necessity for serious games to be games.

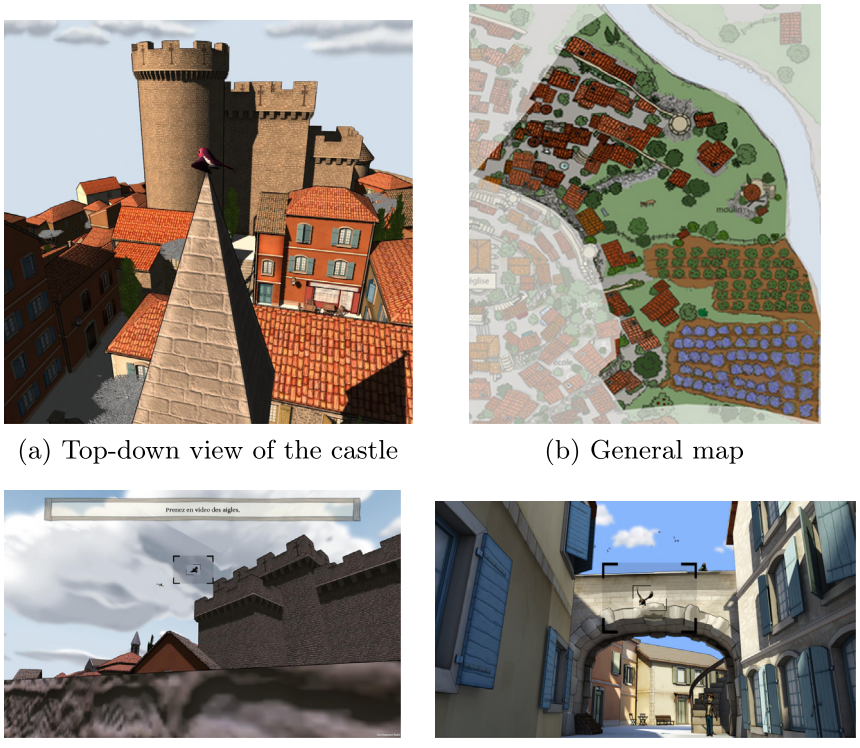
Our research, however, is game design oriented; thus we consider that a designer of serious games is attempting to design a game that has a real-life objective.

In *Le Village aux Oiseaux*, this objective is to provide cognitive training to patients suffering from Alzheimer's disease. The therapeutic hypothesis on which the project was founded is that by stimulating the attentional network of the patient we may be able to slow down the effects of cognitive decline caused by the disease's progression. Accordingly, the patient would retain a higher level of cognitive functioning from playing *Le Village aux Oiseaux*.

Video games have already been used to attain such objectives. Using video games leads to the improvement of cognitive functioning of elderly people [13]. Playing video games can improve the performance of players [14] and especially the performance of elderly people [15–17].

Using games in therapy is seen as a promising solution because they can motivate the player, motivation being a major challenge in a therapeutic context [11,18]. Indeed, therapies are often repetitive and boring, even provoking painful side-effects. As a result, patients tend to be less regular in terms of their participation in therapeutic protocols, and even sometimes drop out.

The video game is a type of application that attracts a large number of users across the world. According to Pew Internet and American Life Survey 2008 [19,20], more than half of all American adults play video games. Facing challenges and being immersed in an interesting game world are two of the main reasons why players play [21,22].



(a) Top-down view of the castle (b) General map

(c) In-game screen-shot (d) In-game screen-shot

**Fig. 1.** Screen-shots of *Le Village aux Oiseaux*: top-down view of the castle (a), general map (b), in-game pictures (c and d).