# Jellys: Towards a Videogame that Trains Rhythm and Visual Attention for Dyslexia

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## ABSTRACT

This demo describes an ongoing research project that aims to develop a video game for the training of two independent cognitive components involved in reading development: visual attention and auditory rhythm. The video game includes two types of gaming activities for each component. First, a proof of concept was carried out with 10 children with dyslexia. The outcome of this proof of concept study served as foundation for the development of a prototype that has been assessed. Human-computer interaction, usability and engagement were measured in a user study with 22 children with dyslexia and 22 without dyslexia. Significant interaction differences between group were not found. Usability and engagement evaluation was positive and will be used to improve the video game. Its efficacy will be tested with a longitudinal training study in developing readers. A video of *Jellys* user testing is available in **https://youtu.be/T9oO9bZFdmM**.

## Author Keywords

Dyslexia, Training, Serious Games, Rhythm, Visual Attention, Treatment

## INTRODUCTION

Dyslexia is a developmental disorder affecting specifically reading acquisition, and observed despite normal IQ, adequate schooling, and the absence of sensory or global developmental disorders. We base our research on the observation that
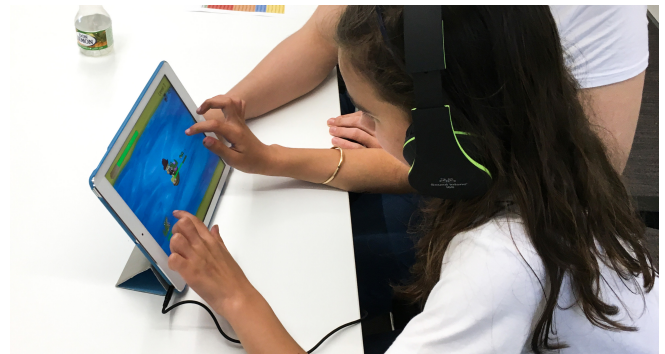
**Figure 1. User study: A child plays Jellys to test usability dimensions, such as learnability and engagement.**

the cognitive symptoms in the dyslexic population are highly heterogeneous [17], and that an efficient remediation of the deficit observed in these individuals would highly benefit from a training specifically triggering the cognitive component(s) impaired. However, most of the existing reading skills training tend to ignore the heterogeneity of the disorder, generally focusing on the phonological deficit on dyslexia. Here, we developed a unique video game aimed at training both phonological (through auditory rhythm) and visual attention skills will. These two types of gaming are complementary and are combined to help individuals with (or without) reading difficulties to maximize the chance of enhancing their reading skills.The phonological training developed will focus on improving one's synchronization to auditory rhythmic stimuli. Indeed, an increasing number of studies support the hypothesis attributing phonological deficits to a temporal auditory deficit [5, 9, 10, 11]. Importantly, preliminary evidence shows that rhythm training improves reading ability [4]. The visual attention training will be based on tasks tapping the processing of simultaneously presented stimuli, which has been linked to the Visual Attention Span and the reading abilities of children with and without dyslexia [1, 8].

## RELATED WORK

There are some computer-based training focus on improving literacy skills like FastForWords [14] or Abracadabra [2], and other that are designed specifically for children with dyslexia [7] such as DytectiveU [12] or Galexia [13]. It also relevant the research about the impact of playing action video games on reading [3] (which is visual attention related). Jellys advances previous work in mixing both dyslexia related strategies and visual attention games together with auditory rhythm.

## JELLYS

### Game Narrative

The main characters are two inexperienced but very enthusiastic adventurous archeologists who want become great explorers. In their first on-site exploration taking place in some ancient ruins, they find themselves mysteriously transported into a world where strange but cute creatures, called the jellys, live. There, they face many challenges while they are exploring this strange world and its creatures. The jellys are friendly and cute creatures with neither arms nor legs, and which communicate, by emitting some strange sounds (see Figure 1). After a narrative introduction, a non-linear game structure, i.e., a spatial map, become available to the user. The user navigates the different places provided in the map, that correspond to specific gaming activities. The activities in which the gamer engages will train auditory rhythm perception and synchronization or visual attention processing of simultaneously presented elements.

### Content Design

**Rhythm.** The auditory rhythm training focuses on two activities training the tapping in synchrony to a beat, and rhythm awareness. The first activity focuses on the enhancement of the ability to tap in synchrony to a beat. This ability has been shown to explain reading variance in young children [15]. The aim of the second activity is train the ability to identify, compare and reproduce different rhythmic patterns (Figure 2).

**Visual attention.** In order to train visual attention, we created two types of gaming based on visual search and motion object tracking. The aim of visual search is to find a specific target among different simultaneously presented distractors [4]. Motion object tracking consists in the tracking of moving objects presented simultaneously (Figure 2).

## USER STUDY

As a previous step we carried out a **proof of concept** through four simulations and questionnaires with 10 children with dyslexia (8 to 15 years old). The participants suggestions regarding the game theme, the characters and the gamification were materialized in the development of *Jellys* prototype.

**Participants & Design.** To test the impact of dyslexia when playing *Jellys* we conducted a user study with 44 participants (See Figure 1), 22 with dyslexia (M = 10.18, SD = 1.26 years old) and 22 without dyslexia serving as a control group (M = 10.18, SD = 1.26 years old). They were all were native speakers of Spanish and their ages ranged from 8 to 11. We used a within subjects design to compare the performance of
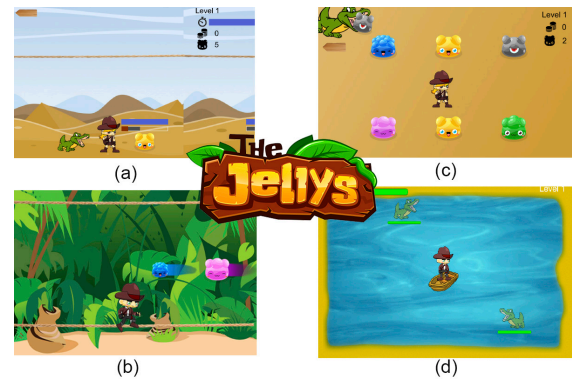


**Figure 2. Rhythm training activities: tap a beat (a) and rhythm patterns (b). Visual attention training activities: visual search (c) and motion object training (d)**

both groups, that is, all participants played the same game conditions including three levels of difficulty. For each difficulty condition, we collected (i) the total number of *Clicks* made; (ii) the total number of *Hits* (correct responses); (iii) the *Accuracy* defined as the number of *Clicks* divided by the number of *Hits*; and (iv) the *Efficiency* (*Accuracy* divided by time). In addition, usability was assessed with the *System Usability Scale* [16] and engagement with the *Game Experience Questionnarie* [6].

**Results & Discussion** A Shapiro-Wilk test showed that all except one of the data sets were not normally distributed hence we used dependent 2-group Wilcoxon Signed Rank test for non-parametric analysis to test differences between groups. We could not find significant differences between groups. These results were expected because Jelly's intervention is intended to improve the children performance through indirect training, while improving the rhythm and visual attention. But that does not mean that differences need to be found in rhythm and visuals discrimination on the first place. The mean score of the *System Usability Scale* was 86.25 (from 0 to 100 points). The *Game Experience Questionnaire* scores have 7 components rated from 0 to 4: competence (3.58 out of 4), sensory and imagination (3.2 out of 4), flow (3 out of 4), tension (0.13 out of 4), challenge (1.06 out of 4), negative affect (0.25 out of 4) and positive affect (3.73 out of 4). These results suggest that the game is highly engaging.

## FUTURE WORK

Future work includes a longitudinal evaluation of the training effect elicited by the video game in children with and without dyslexia (as human-computer interaction differences have not been found) on literacy skills (rhythm and visual attention performance will be also measured). *Jellys* will be improved taking into account usability and engagement results.

## ACKNOWLEDGMENTS

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