

DysMusic: Detecting Dyslexia by Web-based Games with Music Elements

Doctoral Consortium

Maria Rauschenberger
Web Research Group
Universitat Pompeu Fabra
Barcelona, Spain
maria.rauschenberger@upf.edu

ABSTRACT

The aim of this research is to show that a playful approach combined with music can detect children with dyslexia. Early detection will prevent children from suffering in school until they are detected due to bad grades. Our envisioned web application will contribute to 10% of the population by giving them a chance to succeed in life and find their skills to impress the world.

Keywords

Dyslexia; Detection; Gamification; Learning; Serious Games; Web-based Assessment.

1. MOTIVATION

In Germany, around 7.5 million people have dyslexia, a neurological learning disability which impairs a person's ability to read and write [12]. In a longitudinal study Esser *et al.* [1] showed that children with diagnosed dyslexia at the age of 8 achieved lower school performance and a higher rate of unemployment, than the control group measured afterwards at the age of 25. More recently, it was shown that children with dyslexia can be detected easily and cost-efficient with a web tool that, among other things, analyzed word errors from people with dyslexia. [9].

The main goal of my PhD research is the design and implementation of a tool called *DysMusic*, which aims to detect if a child aged 3 to 6 years has dyslexia. This will provide the child and the parent an early diagnosis and will prevent the child from failing school and life. There are three reasons motivating the decision to choose this research topic: (1) it is a research challenge; (2) the impact it will have on individuals; and (3) its relevance for society.

First, although similar tools and approaches have been developed for other purposes such as diagnose dyslexia [3], computer-assisted reading interventions [4] and error-based exercises [10], to the best of my knowledge, this is the first

approach to use music elements for detecting dyslexic children in an early age.

Second, early detection will provide children with support at an early stage in life to improve spelling and reading but also to improve confidence in their own skills.

Finally, a tool of these characteristics is useful as around 10% of the population has dyslexia [2] and has a considerable presence in the Web [8].

2. METHODOLOGY

The proposed ongoing PhD will be approached with a Human-Centered Design (HCD) Process. The five research questions below will be answered according to the four stages of the HCD Process.

1. Game content: How to create content for serious games targets for people with dyslexia?
2. Context of use: How are the syndromes of hearing difficulties?
3. User Requirements: What do children with dyslexia need to be detected with music?
4. Interaction Design: How should a (musical) serious game be for children with dyslexia?
5. Evaluation: Can a child be detected earlier with the application *DysMusic* then with current methods?

To answer each of the research questions we will perform a user study in collaboration with schools and associations of dyslexia from Germany and Spain. The *dependent variables* that we plan to use will be derived from the interaction with on-line games such as mouse tracking measures, several performance measures (hits, click, score, among others) extracted from the games, as well as other subjective measures that we will gather via questionnaires.

3. RESEARCH PLAN

Phase one is focusing on extracting the music attributes to distinguish between groups and creating the game design. Since people with dyslexia have short-term memory difficulties [5] questions like "Which sound did you hear first?" or "Which sound is pitched higher?" would determine the

groups. A specific task would be an adaptation of the already existing game *memory*¹. Instead of finding the same picture under various analog cards the child will try to find the same sound behind various digital cards.

In the second phase different elaborations for the music elements, tasks and design will be created to optimize the diagnosis threshold. Therefore, the existing Dyetective algorithm [9] for predicting dyslexia will be enriched adapted to use *DysMusic*. Dyetective methodology is multilingual [11] and using music elements will have also the potential of being valid for different languages.

We propose that it is possible to transfer the existing approaches and knowledge into a game that detects children at an early age to provide them with more time to practice. At the same time early detection will prevent children from failing and help them understand how to cope and establish a strong self-confidence about their skills.

4. PRELIMINARY RESULTS

I have already accomplished the first research question for my PhD research regarding the content creation of the serious games for both detection and intervention.

Intervention. Playing error-based exercises presented in a computer game was found to significantly improve the spelling skills of children with dyslexia in Spanish. Since there are no similar error-based exercises for German, we adapted for the initial goal the method to German. We collected more than 1,000 errors written by children with dyslexia from different schools. After that, we created a classification of dyslexic errors in German and annotated the errors with different language specific features, such as phonetic and visual features. For the creation of the exercises we took into account the linguistic knowledge extracted from the analyses and designed more than 2,500 word exercises in German that have been integrated in a game available for iOS. The game and the resource of dyslexic errors are available online² [6, 7].

Detection. We created a set of linguistic exercises to detect dyslexia for German. The exercises will be integrated in the tool *Dyetective* [9, 11] for German. *Dyetective* is a game to detect dyslexia with a web application. The first study results indicated already that it is possible to detect dyslexia with exercises on a web application. At the moment we are running a study with 30 participants to find the accuracy for the German version of *Dyetective*.

5. NEXT STEPS

The next step is to design a task for the game *DysMusic* combining (i) the linguistic game input already created with (ii) music content. We will perform a set of experiments to measure the threshold to distinguish between dyslexic and non-dyslexic persons. The result will have an enormous impact especially on children which feel unable to fulfill expectations, because the motivation and the skills they can gain out of the early detection will give them a chance to find their skills and to cope with their weaknesses.

¹Example of a memory game can be found on <https://goo.gl/vhWmYs>

²The online game is available on <https://itunes.apple.com/de/app/dysegxia/id534986729?mt=8> and the resource can be accessed on goo.gl/LRaUDA.

Acknowledgments

I would like to thank all people who already participated in my study and my advisors Ricardo Baeza-Yates and Luz Rello.

6. REFERENCES

- [1] G. Esser, A. Wyszkon, and M. Schmidt. Was wird aus achtjährigen mit einer lese- und rechtschreibstörung? ergebnisse im alter von 25 jahren. *Zeitschrift für Klinische Psychologie und Psychotherapie*, 4:235–242, 2002.
- [2] B. I. für frühkindliche Entwicklung. Lese-rechtschreibsschwierigkeiten (Irs). <http://www.bielefelder-institut.de/lese-rechtschreib-schwierigkeiten.html#1>, 2016. [Online; accessed 09-March-2016].
- [3] A. Höinghaus and F. Schönweiss. Ampelsignale zeigen förderbedarf – bundesweite lisa-bildungskampagne. http://www.lernserver.de/fileadmin/sitedata/pdfs/LISA_Kampagne_PM280710.pdf, 2010. [Online; accessed 09-March-2016].
- [4] H. Lyytinen, J. Erskine, J. Kujala, E. Ojanen, and U. Richardson. In search of a science-based application: A learning tool for reading acquisition. *Scandinavian Journal of Psychology*, 50(6):668–675, 2009.
- [5] K. Overy. Dyslexia, Temporal Processing and Music: The Potential of Music as an Early Learning Aid for Dyslexic Children. *Psychology of Music*, 28(2):218–229, oct 2000.
- [6] M. Rauschenberger, S. Füchsel, L. Rello, C. Bayarri, and A. Görriz. A game to target the spelling of german children with dyslexia. In *Proc. ASSETS’15*, Lisbon, Portugal, 2015.
- [7] M. Rauschenberger, S. Füchsel, L. Rello, C. Bayarri, and J. Thomaschewski. Exercises for german-speaking children with dyslexia. In *Proc. INTERACT’15*, Bamberg, Germany, 2015.
- [8] L. Rello and R. Baeza-Yates. The presence of English and Spanish dyslexia in the Web. *New Review of Hypermedia and Multimedia*, 8:131–158, 2012.
- [9] L. Rello, M. Ballesteros, A. Ali, M. Serra, D. Alarcón, and J. P. Bigham. Dyetective: Diagnosing risk of dyslexia with a game. In *Proc. Pervasive Health’16*, Cancun, Mexico, 2016.
- [10] L. Rello, C. Bayarri, Y. Otal, and M. Pielot. A Computer-based Method to Improve the Spelling of Children with Dyslexia. In *Proc. ASSETS’14*, ASSETS ’14, pages 153–160, New York, USA, 2014.
- [11] L. Rello, K. Williams, A. Ali, N. Cushen White, and J. P. Bigham. Dyetective: Towards detecting dyslexia across languages using an online game. In *Proc. W4A’16*, Montreal, Canada, 2016. ACM Press.
- [12] D. Ziegler, E. D. Rossmann, and O. Kaczmarek. 7,5 millionen funktionale analphabeten sind ein armutszeugnis für deutschland | spd-bundestagsfraktion. <http://goo.gl/QBM3M1>, 2012. [Online; accessed 09-March-2016].