



What is Wrong with this Word?

Dyseggxia: a Game for Children with Dyslexia

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ABSTRACT

We present *Dyseggxia*, a game application with word exercises for children with dyslexia. We design the content of the game combining linguistic and pedagogical criteria as well as corpus analysis. The main contributions are (i) designing exercises by using the analysis of errors written by people with dyslexia and (i) presenting Spanish reinforcement exercises in the form of a computer game. The game is available for free on iOS and Android.

Categories and Subject Descriptors

K.3 [Computers in Education]: Computer Uses in Education—*Computer-assisted instruction*; K.4 [Computers and Society]: Social Issues—*Assistive technologies for persons with disabilities*

General Terms

Design, Experimentation, Human Factors

Keywords

Dyslexia, Pedagogical Exercises, Spanish, Game, Android, iOS.

1. INTRODUCTION

More than 10% of the population in Europe has dyslexia. Dyslexia is a neurologically based learning disability which typically results from a deficit in the phonological component of language. It is characterized by difficulties with accurate word recognition and by poor spelling, especially with new words, unfrequent words, very long words, complex words and phonetically and orthographically similar words [2].

To overcome dyslexia children undertake exercises with words, among other activities. Typically, these exercises appear in books with all the limitations of paper-based exercises, such as the added difficulty of writing on paper since dysgraphia¹ is comorbid with dyslexia. Moreover, these exercises are frequently repetitive and homogeneous thus making these tasks tedious.

¹Dysgraphia refers to a writing disorder associated with the motor skills involved in handwriting, among others.

*Dyseggxia*² was designed to integrate pedagogical exercises in a more appealing and up-to-date format: a game for mobile phones and tablets.

2. RELATED WORK

We divide work related to our application in two areas. (a) **Exercises for children with dyslexia.** Apart from the printed books with word exercises [1], we found resources in the Web containing exercises for children with dyslexia such as *El patinete*,³ with printable exercises and *Espacio Logopédico*,⁴ with an exercise book. (b) **Mobile and tablet applications related to dyslexia:** Most existing tools are devoted to text processing, spellchecking and word prediction. The most closely related applications are those that target children with learning disabilities such as: *Dyslexic like me*,⁵ with guidance for children with dyslexia, or *Dyslexia Quest*, with short games. We also found applications for improving spelling, such as *Word Magic*. In Spanish, we found only *Dislexia Ejercicios Prácticos*, with games.

To the best of our knowledge, *Dyseggxia* differs from previous work in two aspects. First, none of the existing applications for mobile or tablet in Spanish contains reinforcement word exercises inspired by pedagogical books. Second, *Dyseggxia* is based on different kinds of empirical data, such as the analysis of errors written by people with dyslexia.

3. CONTENT DESIGN

For the creation of the content we distinguish: (1) the selection of the word and the design of the exercise, (2) the choice of the specific word modification, (3) the assignment to the correct level of difficulty, and (4) the text layout.

(1) **Exercises:** To select the target words of the exercises, we establish linguistic criteria, e.g., we select only lemmas and existing words, and avoid pseudowords or foreign words. We design five types of exercises by taking into consideration existing pedagogical exercises to support dyslexia [1].

- a. **Insertion:** The user is given a word with a missing letter represented by a blank space and is asked to fill it with a letter from a set, e.g. **i_posible {n,s,r,p,m,b} → imposible, 'impossible'*.

²<http://www.dyseggxia.com>

³<http://www.elpatinete.com>

⁴<http://www.espaciologopedico.com>

⁵See <http://itunes.apple.com> for this and the following examples of mobile applications.

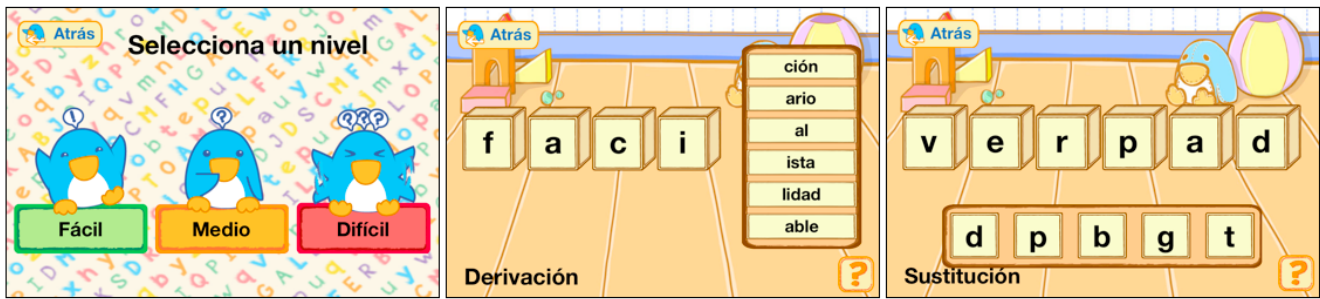


Figure 1: Dyseggxia: difficulty levels (left), derivation exercise (middle) and substitution exercise (right).

- b. **Omission:** The user is given a word with an extra letter and is asked to identify and remove it, e.g. **verdazd* → *verdad*, ‘truth’.
- c. **Substitution:** A word with a wrong letter is displayed and the user is asked to identify and substitute the wrong letter by the correct letter from a set, e.g. **verpad* {*d,p,b,g,t*} → *verdad*, ‘truth’ (see Figure 1, right).
- d. **Derivation:** The root of a word is displayed together with a set of suffixes, where only the correct one should be identified, e.g. **faci* {*lidad,al,ista*} → *facilidad*, ‘easiness’ (see Figure 1, middle).
- e. **Separation:** A set of words, normally composed of a lexical word and a small word or/and functional word is shown without spaces, where the user is asked to separate the character chain into different words, e.g. **osopanda* → *oso panda*, ‘panda bear’.

(2) **Word modification:** To determine the modification of the word for each exercise we manually analyzed the errors from a corpus of texts written by dyslexic children [3]. We extracted the most frequent errors and created linguistic patterns [5] to use them in the design of the tasks. For instance, similar letters representing similar sounds, such as occlusive consonants <d,b,p,g,t>, tend to be mistaken more, so we use them as distractors (see Figure 1, right).

(3) **Levels:** The levels of the exercises were designed by taking into consideration the difficulties of dyslexic people described in cognitive literature [2]. Therefore, we took into account five variables: (a) word frequency, (b) word length, (c) phonetic similarity, (d) orthographic similarity, and (e) the derivational difficulty of the word. There are three levels: easy, medium and hard (see Figure 1, left). As the difficulty level increases the target word is less frequent, longer, has a higher number of neighbors,⁶ more frequent neighbors, and has a more complex morphology.

(4) **Text Layout:** Since the presentation of text has an effect on the reading speed of people with dyslexia, we used recommended text layout parameters to present the exercises. These guidelines are based on the data extracted from a user study with a group of twenty-two participants with dyslexia [4].

⁶Neighbors are all the words with the same length as the target word which differ in only one letter.

4. IMPLEMENTATION

The application has been designed by using the Model-View-Controller pattern and a high abstraction of platform-dependent tools in order to make it easily portable from Android to iOS and later to any other platform as needed. The high abstraction allows us to reuse the logics of the application on all platforms and just reimplement platform-dependent layers, mainly data persistence and view controllers.

5. FIRST RESULTS AND FUTURE WORK

Dyseggxia can be downloaded for free from the Apple App Store for iPhone and iPad⁷ and the code is open source and freely available.⁸ So far, we performed a heuristic evaluation and a preliminary formative evaluation using the think aloud technique with seven children with dyslexia. The results are promising: all participants found the tool helpful and more appealing than performing the exercises on paper, the difference between levels were clearly perceived and we received some suggestions for improving the game. Future work includes an evaluation with a focus group to measure the impact of the game in learning words and the improvement of the application by extending the target words and by adapting it to more languages.

6. REFERENCES

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⁷<http://itunes.apple.com/es/app/dyseggxia/id534986729?mt=8>

⁸<http://dyseggxia.com/download>