A Game to Target the Spelling of German Children with Dyslexia

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ABSTRACT

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 the method to German and created 2,500 new word exercises. Since dyslexia manifestations are language dependent, the replication of the method required (i) collecting new texts written by German children with dyslexia; (ii) the annotation and the linguistic analysis of the errors; and (iii) the creation of exercises as well as their integration in the tool.

Keywords

Dyslexia; Serious Game; Spelling; Written Errors; German.

Categories and Subject Descriptors

K.4.2 [**Computers and Society**]: Social Issues—*Assistive technologies for persons with disabilities*; K.3 [**Computers in Education**]: Computer Uses in Education—*Computer-assisted instruction*.

1. INTRODUCTION

Motivation. In Germany, between 5 and 12% of students have dyslexia, a neurological learning disability which impairs a person's ability to read and write. Also in Germany, only 25% of the poor spellers achieve average spelling performance during primary school [7]. In a longitudinal study Esser *et al.* [1], showed that children who were diagnosed with dyslexia at the age of 8 achieved lower school performance and higher rates of unemployment than a control group (measured afterwards at the age of 25). Later, Schulte-Körne *et al.* [8] showed that it takes longer for a child with dyslexia to achieve school grades that are comparable to the others, even if they have an above-average socio-economic status and are given effective treatment.

Background Research. To support the spelling of children with dyslexia in Spanish, Rello *et al.* [6] designed a method to create exercises based on the linguistic analysis of the errors made by children with dyslexia. It is called an error-based method because it uses written errors as a starting point since (1) dyslexic writing errors are related to the types of difficulties that they have [10]; and (2) readers with dyslexia cannot consciously see errors in words [3]. The exercises were integrated in an iOS game, *Dyseggxia (Piruletras)* [5], which was subsequently evaluated in a school. Over eight weeks, the authors carried out a within-subject experiment with 48 children from 6 to 11 years old. The children who played *DysEggxia* for four weeks in a row had significantly fewer writing errors in the tests than those playing *Word Search* –the control condition– for the same time [6].

Solution. In this demo we present the German extension of that tool and explain the adaptation of the method to create word exercises for children with dyslexia. It is worth noting that despite the universal neuro-cognitive basis of dyslexia, dyslexia manifestations are variable depending on the degree of consistency and regularity of the language orthography. German has a semi opaque language, that is, the relationships between letters and sounds are not as regular as in other transparent languages as Spanish [9]. In addition, it also has more complex syllabic structure [9]. Hence, the adaptation of the method from Spanish was not straightforward, raising a number of challenges. To the best of our knowledge, this is the first approach to create German error-based exercises for people with dyslexia.

2. RELATED WORK

Specifically for German we found *Lernserver*[1], a tool to diagnose and provide support exercises. The tool was evaluated in 2008 with the *Landesinstitut für Schule*, where 78.2% of the students ($N = 3,798$) improved their writing by using this tool [2]. *Klex 11*[2] is a tool to practice vocabulary in German adapted to a certain school degree. The exercises of *Klex* are not error-based since only the correct words are presented. We could not find literature on how *Klex* was developed and how the exercises have been created. Similarly, *CESAR schreiben 2.0*[3] is a strategy and educational game, which includes listening, spelling and vocabulary exercises.

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[1]http://www.lernserver.de/home.html
[2]http://www.legasthenie-software.de
[3]http://www.ces-verlag.de/deutsch/Schreiben2_0/
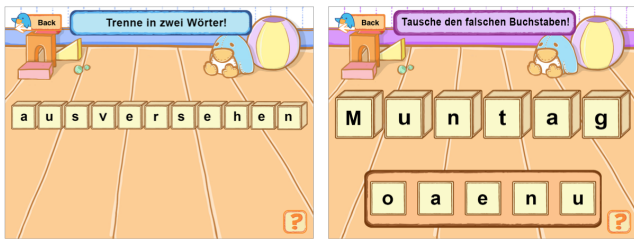schreiben2_produktinfo.php5

Figure 1: Screenshots for two types of exercises: *cut into words* (**left**) **and** *change a letter* (**right**).

To the best of our knowledge, there is no tool to support the spelling performance of children with dyslexia for German based on written errors that they make.

3. GERMAN ADAPTATIONS

Below, we explain the steps to replicate the method and describe the specificities added for German.

Texts Collection. The first step was the collection of dyslexic errors. We collected 47 texts (homework exercises, dictations and school essays) written by students with ages ranging from 8 to 17 years old. A total of 32 texts were written by children who have been diagnosed with dyslexia. The remaining 15 texts correspond to students with a high spelling error rate that were identified by their teachers. The students attended either primary school, comprehensive school (*Gesamtschule*), high school (*Gymnasium*) or a special school (*Förderschule*).

Error Annotation. We manually extracted the errors and annotated them with phonetic and visual features [4]. These features were specific to the German writing system and phonetics. For instance, German has letters and symbols, that do not exist in Spanish or English, *e.i.* ß, ä, ë, ö and ü. In addition to that, the handwriting systems broadly used in schools (*Lateinische Ausgangsschrift*) presents different letter forms, so the visual analysis of the letters was language specific.

Linguistic Analysis. Third, we analysed the errors linguistically. These analyses had to be specifically performed for German specific syllabic structure and semi opaque orthography, for instance, the group of letter <sch> are pronounced as only on phone [ʃ]. This resulted in different error categories as well as different linguistic criteria.

Creating the Exercises. We created exercises taking into account the previous linguistic analyses. As a result we had 8 types of exercise: (a) *add a letter*; (b) *remove a letter*, (c) *change a letter* (see Figure 1, right), (d) *choose the correct word ending*, (e) *cut into words* (see Figure 1, left), (f) *order the letters or syllables*, (g) *capital letter*, and (h) *wrong capital letter*. The last two exercises are specific to German where nouns are always written with capital letters, and missing capitalization is a frequent misspelling. Also, *cut into words* exercises included words and morphemes specific to German such as the *trennbare verben*, that is, verbs is that are preceded by prefixes.

Difficulty Levels: Thre are five difficulty levels: *Initial*, *Easy*, *Medium*, *Hard*, and *Expert*. Higher levels included less frequent words, longer words, and words with a more complex morphology. The criteria to define the levels were adapted to German. For instance, all levels presented longer words and morphology played a stronger role because German has a more complex morphology and longer words.

4. CONCLUSIONS AND FUTURE WORK

Using the adaptation of the method described above, we manually created 2,500 German exercises. The exercises were integrated into the iOS app *Dyseggxia (Piruletras)*.[4]

For future work we plan to carry out a longitudinal evaluation of this tool in a German school. Moreover, we will be able to compare how error-based games are more or less effective for certain types of languages.

Acknowledgements

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