

## Child Friendly App for Spelling Training

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**Abstract**— Spelling skills are usually more difficult to acquire than reading skills. Nonetheless research based intervention proposals are scarce for spelling skills. In this study the impact of a child friendly spelling app on spelling skills is assessed. Results indicate an increase on spelling skills after training with the app.

**Keywords**—Spelling training, spelling difficulties, mobile assisted spelling

### 1 Introduction

Writing difficulties are one of the most frequent complaints among dyslexic adults [1] [2]. Spelling errors potentially affect the readability of the written composition as well as highly contribute for an image of academic incompetence [3] [4]. In fact, for as long as spelling is not automatized, instead consisting on a high cognitive demanding process, the individual is left with few resources for other cognitive processes important for writing such as text production fluency and quality [5] [6] [7].

Reading and spelling acquisition progress interactively. Reading supports spelling through better retention of written words in memory [8] [9]. On the other hand high-quality orthographic representations for spelling further support sight word reading [10]. Yet, whereas reading and spelling influence each other, spelling skills are usually more difficult to acquire than reading skills [11]. Children (and adults) who were once poor readers but at some point have compensated their difficulties, usually continue to struggle with spelling [12] [13] [14]. Whereas for reading partial cues or weakly specified orthographic representations may be enough to allow word recognition, spelling requires high-quality orthographic representations [15]. Spelling acquisition consists on the development of the ability to map sounds that are heard in words onto phonologically appropriate letters [16]. This mapping may be more or less straightforward, depending on the phoneme-to-grapheme consistency. If there is a one-to-one consistency, the spelling is unequivocal. If there is one-to-more-than-one mapping the spelling is inconsistent and thus more error prone. Relatively simple Phoneme-Grapheme Correspondences (PGC) are sufficient to decode most words and provide a potent

self-teaching mechanism to the development of a phonological representation of unfamiliar words [17]. Interventions focusing on phoneme-grapheme mapping are referred to as phonics interventions. A large body of research supports the efficacy of those interventions [18] [19] [20] [21].

Additionally, representing each phoneme with a phonologically plausible letter is not sufficient for skilled spelling. Interventions focusing on training children to deal with deviations from one-to-one mappings between phonemes and graphemes explicitly teach orthographic knowledge. Orthographic knowledge refers to the understanding of the rule system and patterns of written language. Children have to learn the constraints and orthographic rules that govern the positions, combinations and resulting pronunciations of letters within words. Interventions that foster orthographic skills mainly focus on phonological-orthographic regularities, with confirmed efficacy on spelling skills [22].

It is unanimous that spelling acquisition benefits from explicit instruction [23]. Recently, however, some results indicate that explicit instruction may not be sufficient, particularly regarding inconsistent PGC that depend on implicit cues [24]. For the child to develop sensibility to implicit cues an explicit and systematic instruction is crucial. Spelling acquisition should not only include explicit statement of orthographic rules but also massive repetition of similar PGC, in order for the child to become implicitly aware of not only orthographic rules but also most importantly orthographic statistical tendencies.

Educational software has been considered a highly valuable resource for children experiencing spelling and reading acquisition difficulties, as it has the potential to adapt to each individual learning rhythm. Intervention components such as immediate corrective feedback, various exercise opportunities modulated by algorithms that enable the implementation of specialized instructions and adaptive content and motivational aspects such as rewarding system and attractive graphic design are beneficial for spelling skills [25] [26] [27] [28].

Regarding research conducted with Portuguese speaking children, the adaptation of Graphogame for Portuguese and the positive results obtained with at risk first graders has exposed the need of another type of complementary game, with a more interactive nature and with a more pronounced focus on spelling, given the existing comorbidity between reading and spelling problems. Results presented in this article are part of a broader study, focused on the development of the spelling app, for which preliminary results obtained with a different sample have reported a high motivational potential, justified by its interactive nature [29].

Portuguese orthography is considered intermediately shallow. It is mainly consistent on the reading direction but relatively inconsistent on the spelling direction [23] (See Sucena Castro & Seymour for a thorough description of the Portuguese orthography). In result of this asymmetry Portuguese children become fluent readers before they become accurate spellers (and the more so across dyslexic population). Indeed orthographic errors tend to persist and to be seen as an educational difficulty that should be addressed. Currently there persists the need for (i) more interactive software and (ii) more pronounced focus on spelling [30].

In this study, we assessed a prototype of an interactive child-friendly software application focused on spelling, intended to promote sensibility to Portuguese orthographic rules. Specifically, four complex graphemes were trained, within the context of words. Words were presented orally in parallel with the constituent letters that appeared on the screen, shown in a non-sequential order (the grapheme <nh> corresponding to the phoneme /N/; the grapheme <lh> corresponding to the phoneme /L/; the grapheme <rr> corresponding to the phoneme /R/; the grapheme <in> corresponding to the phoneme /3n/).

As early intervention has the greatest impact on reading and spelling performance, compared to interventions performed with older children, it was our option to target this app to second graders, as to ensure the intervention occurs early in the spelling development [31] [32].

It is our aim to assess the impact of playing with the app regarding the motivational factor and the orthographic accuracy. Specifically, children were asked to assess the likeability of the app and were assessed (before and after the intervention) regarding the spelling of orthographically complex graphemes within the context of pseudowords. It is our expectation that playing with the app will have a positive impact on the spelling of complex graphemes.

## **2 Method**

### **2.1 Participants**

Participants in this study included 11 second graders, 7 boys and 4 girls, between 6 years and 8 months and 7 years and 8 months, attending schools in the northwest of Portugal. Nine (out of 11) children presented a normal cognitive development and did not show any sensory, motor or cognitive disturbances. Two children presented cognitive deficit (according to school records). All children played with the app.

### **2.2 Instruments**

Participants were assessed regarding the spelling of orthographically complex pseudowords. The assessment task consists on spelling four pseudowords dictated by the examiner. Before the four experimental items, one training item is presented. All items include one complex grapheme (the same trained within the app: <nh> /N/; <lh> /L/; <rr> /R/; <in> /3n/). The total score corresponds to the total number of pseudowords spelled correctly. At the end of the intervention, after the posttest, participants were asked to rate their degree of satisfaction with the app, adopting a range between 1 (not satisfied) and 5 (totally satisfied).

Regarding the app used in this study, the Piggy Bank is an Android game to be played by children by using both tablets and smartphones and making use of the hardware sensors embedded in those devices (figure 1).



**Fig. 1.** Child playing the app

The game development took into consideration the four design aspects referred by Schell [32] - aesthetics, story, technology and mechanics. Regarding the aesthetics, the game uses a scenario of a farm with animals, typically from children's entertainments. The story relates to a pig that should be moved by the user in order to collect dropping coins with letters (figure 2).

The technology of the game was kept simple, with the movement of the pig in only one direction (left or right, on the bottom of the user interface) by tilting the device accordingly, using the device embedded accelerometer. The mechanics of the game generates a stimuli from a database within the app, that is presented orally. Simultaneously, coins with random letters that compose the stimuli appear in pseudorandomized order. The child moves the pig to collect them, by the correct order, in order to spell the listened stimuli.

The user starts with 100 points and, for each correct pick of a coin with the correct stimuli, one point is added, and the sound of a dropping coin is played (figure 3). An incorrect pick reduces one point the score. The game proceeds (next stimuli is presented) if the answer is correct; the user is required to respell if the answer is incorrect. More details about the app can be consulted in [29].

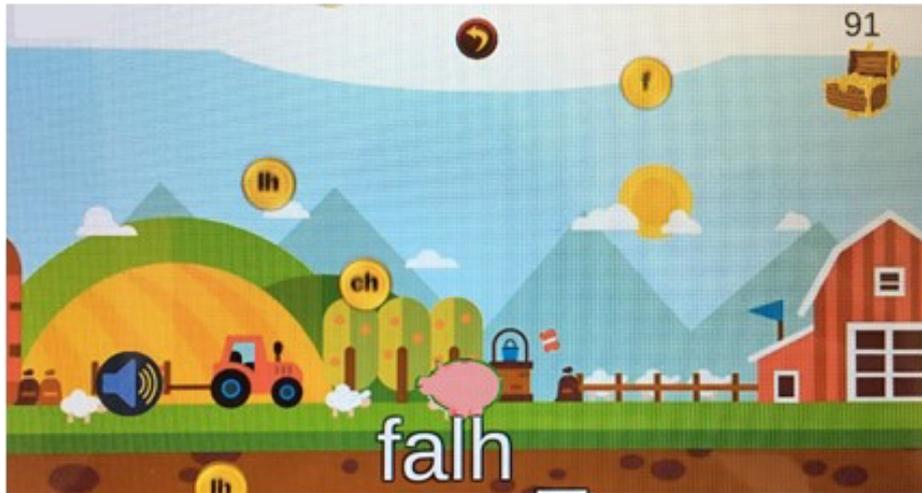


Fig. 2. Game screenshot



Fig. 3. Game score

### 2.3 Procedures of data collection

Authorizations were obtained from the school board and parents. The objectives of the assessment and training were presented, the confidentiality of the data processing was guaranteed as well as the volunteer participation of all children. Participants were assessed individually in two distinct moments: (i) before training with the app (pretest) and (ii) after training with the app (posttest). Both assessments took place within the school context in a silent and calm environment room. Children played the app around 10 minutes per session, during 5 consecutive days (5 sessions). At the beginning of the first session, the app was introduced as a game and the rules were explained.

### 3 Results

From the 11 children assessed on the pretest, only 7 were also assessed on the posttest. The spelling results of the 7 children in the two assessment moments (pre and posttest) are presented in table 1.

At the pretest the mean total score was 17% (5 correct spellings out of 28 spellings).

At the posttest the mean total score reached 50% (14 correct spellings out of 28 spellings). Results varied across the four complex graphemes: at the pretest all participants failed the spelling of <nh>, only one accurately spelled <lh> and <rr>, and three accurately spelled <in>. There was a positive evolution between assessments, with a rate increase ranging up until 57%.

The number of sessions playing the app ranged between 4 and 5. The number of sessions seems not to impact considerably, on the spelling results, as at the posttest the average spelling results are around 1.3 for those who played during 4 and for those who played during 5 sessions.

**Table 1.** Results before and after the app use, number of sessions and degree of satisfaction

Parti- cipants	Pretest					Posttest					Ses- sions	De- gree satis- -
	<nh>	<lh>	<rr>	<in>	Total	<nh>	<lh>	<rr>	<in>	Total		
1	0	0	1	0	1	0	1	0	1	2	5	3
2 <sup>a</sup>	0	0	0	0	0	0	0	0	0	0	4	5
3	0	0	0	1	1	1	0	0	1	2	4	5
4	0	0	0	0	0	1	1	0	1	3	5	5
5	0	1	0	1	2	1	1	0	1	3	4	5
6	0	0	0	1	1	1	1	1	1	4	4	5
7 <sup>a</sup>	0	0	0	0	0	0	0	0	0	0	5	5

Note: <sup>a</sup> cognitive deficit.

### 4 Discussion and Conclusion

In this study, a prototype of a child friendly spelling app was assessed with Portuguese speaking 2<sup>nd</sup> graders. It was our aim to assess the impact of playing with the app regarding motivation and orthographically complex spelling accuracy.

Educational software is a valuable resource for children experiencing spelling and reading acquisition difficulties. The use of this type of software contributes for intensive but playful training, thus reducing the frequent resistance of children to train skills that they feel are demanding. Throughout the training, children were highly involved thanks to the playfulness of the game – scenario and narrative story of the piggy bank collecting coins – immediate feedback and the reinforcement mechanisms included – money register sound following each accurate selection of letter and system of response cost, by subtracting points for each incorrect letter selection. Most importantly, the game contributed to the spelling acquisition by presenting stimuli with the same complex graphemes, thus promoting the consolidation of the orthographic rules.

Children assessed the app very positively, in line with previous results [36]. Regarding the impact on spelling accuracy, results indicate a consistent evolution after the training except for those with a cognitive deficit. In fact, this app was developed for average cognitive developing children, identified as at risk of developing difficulties in reading acquisition. The app was not developed for children with cognitive deficits, who apparently do not take any gain from it.

We believe that the development and extension of the app will be useful for average cognitive developing children experiencing spelling difficulties, in parallel with the teacher's pedagogical intervention.

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