THE DEVELOPMENT OF READING SKILLS IN A SAMPLE OF PORTUGUESE NORMAL READERS AND DYSLEXIC CHILDREN

LÉNIA SOFIA DE ALMEIDA CARVALHAIS &
CARLOS FERNANDES DA SILVA

University of Aveiro, Portugal

Abstract. The aim of this article is to discuss the theoretical issues behind reading processes, the relation between this skill and dyslexia, and to present some results from a pseudowords reading test with Portuguese children. Developmental dyslexia is a specific learning disability characterized by difficulty in learning to read, and there is strong evidence that dyslexia is related to underlying deficiencies in phonological skills. Phonological deficits establish robust differences between dyslexic and normal readers and, according to the theoretical background, phonological awareness can be assessed with pseudowords tests.
In this study, we applied the *Pseudo words Reading Test*, one of twenty tests of the *Battery of Tests to Assess Developmental Dyslexia (BADD)* constructed to assess dyslexia in Portuguese children between 7 and 12 years old. We gave the *Pseudo words Reading Test to* 555 Portuguese children, aged 8 to 12. Fifty-seven of these children had been previously assessed by other professionals as dyslexics. We tried to verify how factors like age, gender and learning disabilities influence the acuity in pseudo words reading and if this test can be used to assist in an early diagnosis of developmental dyslexia. The results prove that there are significant differences between dyslexic children and normal readers in reading pseudo words in Portuguese language.
Key words: reading; orthographies; pseudo-words; dyslexia.

Chinese
[Translation Shek Kam Tse]

葡萄牙正常读者与诵读困难儿童样本中阅读技巧的发展

摘要：本文旨在讨论阅读过程后面的理论问题，阅读技能与诵读困难之间的关系，以及呈现葡萄牙儿童假字阅读测试的一些结果。发展性诵读困难是一种特别的学习能力丧失，其特征为阅读学习的困难，有力证据表明诵读困难与潜在的语音技能缺陷有关。语音缺乏造成诵读困难与正常读者之间的重要差别。根据理论背景，音位意识可以通过假字测试评价。

在本研究中，研究者运用*假字阅读测试*，作为20个评价发展性诵读困难测试组合（BADD）之一，该测试组合为评价葡萄牙7-12岁儿童中诵读困难情况而构建。研究者向555名年龄8-12岁的葡萄牙儿童发出*假字阅读测试*，当中57名之前被专家评定为有诵读困难。研究试图考证年龄，性别，与学习能力丧失等因素如何影响假字阅读的敏锐性，以及确认该测试是否能够运用来辅助发展性诵读困难的早期诊断。

结果证明，在阅读葡萄牙语假字时诵读困难儿童与正常读者之间有显著差异。

关键词：阅读，正字法，假字，诵读困难

Dutch
[Translation Tanja Janssen]

TITEL. Ontwikkeling van leesvaardigheden in een steekproef van normale lezers en dyslectische kinderen in Portugal.

SAMENVATTING. Het doel van dit artikel is om de theoretische kwesties te bespreken rond leesprocessen, de relatie tussen deze vaardigheid en dyslexie, en om enkele resultaten te presenteren van een leestest met pseudowoorden afgenomen bij Portugese kinderen. Dyslexie is een specifieke leermoeilijkheid die gekenmerkt wordt door moeite met leren lezen. Er zijn sterke aanwijzingen dat dyslexie verband houdt met onderliggende tekorten in fonologische vaardigheden. Fonologische tekorten veroorzaken grote verschillen tussen dylectische en normale lezers en volgens de theoretische literatuur kan fonologisch bewustzijn vastgesteld worden met behup van pseudowoorden-tests. .

In dit onderzoek gebruikten we de *Pseudo words Reading Test*, een van de twintig toetsen van het *Battery of Tests to Assess Developmental Dyslexia (BADD)* dat ontwikkeld is om dyslexie vast te stellen bij Portugese kinderen tussen 7 en 12 jaar oud. We legden de *Pseudo words Reading Test* voor aan 555 Portugese kinderen, in de leeftijd van 8 tot 12 jaar. Zevenenvijftig van deze kinderen waren eerder door andere professionals als dyslectisch aangemerkt. We trachtten vast te stellen hoe factoren zoals leeftijd, geslacht en leermoeilijkheden de opmerkzaamheid bij het lezen van pseudowoorden beïnvloeden en of deze toets gebruikt kan worden voor een vroege diagnose van dyslexie.

De resultaten wijzen uit dat er significante verschillen zijn tussen dyslectische kinderen en gewone lezers bij het lezen van pseudowoorden in het Portugees.

TREFWOORDEN: lezen, orthografie, pseudowoorden, dyslexie

Finnish
[Translation Katri Sarmavuori]

TITTELI. LUKUTAIDON KEHITYS NORMAALEILLA PORTUGALILAISILLA LUKIJOILLA JA DYSLEKSIA-LAPSILLA

ABSTRAKTI. Tämän artikkelin tarkoitus on keskustella lukemisprosessin taustalla olevista teoreettisista kysymyksistä, taidon ja dysleksian välisestä suhteesta ja esittää joitakin tuloksia pseudosanojen lukemistestistä portugalilaisilla lapsilla. Kehityksellinen dysleksia on tietty oppimisvaikeus, jota luonnehtii vaikeus oppia lukemaan, ja siitä on voimakas evidenssi, että dysleksia on yhteydessä fonologisten taitojen puutteellisuuksiin. Fonologisilla puutteilla on vankat erot dykleksisten ja normaalien lukijoiden välillä, teoreettisen taustan mukaan fonologinen tietoisuus voidaan arvioida pseudosanatesteillä.

Tässä tutkimuksessa on sovellettu *Pseudosanojen lukutestiä*, yksi *Battery of Tests to Assess Developmental Dyslexia* (BADD) –testin 20 testistä, jolla arvioidaan dysleksiaa portugalilaisilta lapsilta iältään 7—12 vuotta. Teimme *Pseudosanojen lukemistestin* 555 portugalilaiselle lapselle, ikä 8—12. Viisikymmentäseitsemän näistä lapsista oli muiden asiantuntijoiden taholta aiemmin arvioitu dyslektikoiksi. Yritimme

verifioida, kuinka tekijät ikä, sukupuoli ja oppimisvaikeudet vaikuttavat pseudosanojen lukemistarkkuuteen ja voidaanko tätä testiä käyttää varhaisen kehityksellisen dysleksian diagnosointiin.
Tulokset osoittavat, että dysleksisten ja normaalien lukijoiden välillä on merkitseviä eroja pseudosanojen lukemisessa portugalin kielessä.
AVAINSANAT: Lukeminen; oikeinkirjoitus, pseudosanat, dysleksia

French
[Translation Laurence Pasa]

TITRE. DÉVELOPPEMENT DES COMPÉTENCES EN LECTURE DANS UN ÉCHANTILLON DE LECTEURS PORTUGAIS NORMAUX ET D'ENFANTS DYSLEXIQUES
RÉSUMÉ. Cet article aborde les questions théoriques relatives aux processus de lecture, la relation entre cette compétence et la dyslexie, et présente quelques résultats d'un test de lecture de pseudomots chez des enfants portugais. La dyslexie développementale est un trouble de l'apprentissage particulier caractérisé par la difficulté d'apprendre à lire qui, selon des preuves solides, serait lié à des compétences phonologiques insuffisantes. Ces déficits phonologiques induisent des différences importantes entre les dyslexiques et des lecteurs normaux. Or, selon la littérature relative à ces questions, la conscience phonologique peut être évaluée au moyen de tests de lecture de pseudomots.
Pour cette étude, nous avons utilisé un test de lecture de pseudomots, choisi parmi les vingt tests de la Batterie d'Evaluation de la Dyslexie Développementale élaborée pour dépister la dyslexie chez les enfants portugais âgés de 7 à 12 ans. Ce test a été administré à 555 enfants portugais, âgés de 8 à 12 ans. Parmi eux, cinquante-sept enfants avaient déjà été repérés par d'autres professionnels comme étant dyslexiques. Nous nous demandons quels sont les facteurs (âge, genre et difficultés d'apprentissage) qui influencent la réussite en lecture de pseudomots et si ce test peut être utilisé pour réaliser un premier diagnostic de la dyslexie développementale.
Les résultats montrent qu'il y a des différences significatives entre des enfants dyslexiques et des lecteurs normaux en lecture de pseudomots en portugais.
MOTS-CLÉS : lecture, orthographe, pseudomots, dyslexie

German
[Translation Ulrike Bohle]

TITEL.Entwicklung von Lesefertigkeiten in einer Gruppe normaler und dyslexischer portugiesischer Kinder
ZUSAMMENFASSUNG. Der Artikel diskutiert theoretische Probleme des Leseprozesses, die Beziehung zwischen Lesefertigkeiten und Dyslexie und präsentiert Ergebnisse eines Pseudowort-Lesetests mit portugiesischen Kindern. Entwicklungsdyslexie ist eine spezifische Lernunfähigkeit, die durch Schwierigkeiten beim Lesenlernen charakterisiert ist, und es gibt starke Evidenz dafür, dass Dyslexie mit Defiziten in den zugrunde liegenden phonologischen Fähigkeiten zusammenhängt. Phonologische Defizite verursachen robuste Unterschiede zwischen normalen und dyslexischen Lesern, und dem theoretischen Hintergrund entsprechend kann phonologische Bewusstheit mit Pseudoworttests erfasst werden.
In dieser Untersuchung wurde der Pseudowortlesetest verwendet, einer von 20 Tests in der Testbatterie zur Erfassung von Entwicklungsdyslexie (BADD), die zur Beurteilung von Dyslexie bei portugiesischen Kindern im Alter von 7 bis 12 Jahren entwickelt wurden. Den Pseudoworttest haben wir mit 555 portugiesischen Kindern im Alter zwischen 8 und 12 Jahren durchgeführt. 57 dieser Kinder waren zuvor von anderen Fachleuten als dyslexisch eingeschätzt worden. Wir versuchten zu überprüfen, wie Faktoren wie Alter, Geschlecht und Lernschwierigkeiten die Genauigkeit im Lesen von Pseudowörtern beeinflussen und ob dieser Test zur Unterstützung in der frühen Diagnose von Entwicklungsdyslexie genutzt werden kann. Die Ergebnisse zeigen signifikante Unterschiede zwischen dyslexischen Kindern und normalen Lesern beim Lesen von portugiesischen Pseudowörtern.
SCHLAGWÖRTER: Lesen, Orthographie, Pseudowörter, Dyslexie

Greek
[Translation Panatoya Papoulia Tzelepi]

Τίτλος. Ανάπτυξη αναγνωστικών δεξιοτήτων σε ένα δείγμα κανονικών αναγνωστών και δυσλεξικών παιδιών
Περίληψη. Ο σκοπός αυτού του άρθρου είναι να συζητήσει τα θεωρητικά θέματα πίσω από τις διαδικασίες ανάγνωσης, τη σχέση αυτήν των δεξιοτήτων με τη δυσλεξία και να παρουσιάσει κάποια αποτελέσματα

από ένα αναγνωστικό τεστ με ψευδολέξεις σε παιδιά από την Πορτογαλία. Η αναπτυξιακή δυσλεξία είναι μια ειδική μαθησιακή δυσκολία που χαρακτηρίζεται από τη δυσκολία μάθησης της ανάγνωσης και υπάρχει ισχυρή ένδειξη ότι η δυσλεξία σχετίζεται με υποκείμενες ελλείψεις σε φωνολογικές δεξιότητες. Φωνολογικά ελλείμματα δημιουργούν ισχυρές διαφορές μεταξύ δυσλεξικών και κανονικών αναγνωστών και σύμφωνα με τη θεωρία, η φωνολογική επίγνωση μπορεί να αξιολογηθεί με τεστ ψευδολέξεων. Σ' αυτή τη μελέτη χρησιμοποιήσαμε το τεστ «Αναγνωστικό Τεστ με Ψευδολέξεις» ένα από το 20 τεστ του Battery of Tests to Assess Development Dyslexia (BADD) που κατασκευάστηκε για να αξιολογήσει τη δυσλεξία σε παιδιά 7 έως 12 ετών στην Πορτογαλία. Εδώσαμε το «Αναγνωστικό Τεστ με Ψευδολέξεις» σε 555 παιδιά στην Πορτογαλία από 8 έως 12 ετών. Πενήντα επτά από αυτά τα παιδιά είχαν προηγουμένως αξιολογηθεί ως δυσλεξικά. Προσπαθήσαμε να επαληθεύσουμε πώς παράγοντες όπως η ηλικία, το φύλο και οι μαθησιακές δυσκολίες επιδρούν στην ακρίβεια ανάγνωσης ψευδολέξεων και αν αυτό το τεστ μπορεί να χρησιμοποιηθεί για την πρώιμη διάγνωση της αναπτυξιακής δυσλεξίας. Τα αποτελέσματα αποδεικνύουν ότι υπάρχουν σημαντικές διαφορές μεταξύ δυσλεξικών παιδιών και κανονικών αναγνωστών στην ανάγνωση ψευδολέξεων στην Πορτογαλική γλώσσα.

Λέξεις κλειδιά: ανάγνωση, ορθογραφικά συστήματα, ψευδολέξεις, δυσλεξία

Italian
[Translation Manuela Delfino, Francesco Caviglia]
TITOLO. Lo sviluppo di abilità di lettura in un campione di lettori portoghesi normodotati e in un campione di bambini dislessici
SOMMARIO. L'obiettivo di questo articolo è discutere alcune questioni teoriche connesse con i processi di lettura, discutere la relazione tra queste abilità e la dislessia, e presentare alcuni risultati tratti da un test di lettura di pseudoparole condotto con bambini portoghesi.
La dislessia evolutiva è una disabilità specifica dell'apprendimento caratterizzata dalla difficoltà di imparare a leggere e vi sono prove evidenti del fatto che la dislessia sia connessa con carenze di base nelle abilità fonologiche. I deficit fonologici sono alla base di differenze significative tra i lettori dislessici e quelli normodotati e, in base alle teorie correnti, la consapevolezza fonologica può essere valutata con test basati su pseudo parole.
In questo studio abbiamo utilizzato il *Test di lettura di pseudo parole*, uno dei venti test della *Batteria di test per diagnosticare la dislessia evolutiva* (BADD) sviluppato per diagnosticare la dislessia di bambini portoghesi di età compresa tra i 7 e i 12 anni. Abbiamo somministrato il test di lettura di pseudoparole a 555 bambini portoghesi di età compresa tra gli 8 e i 12 anni. 57 di questi bambini erano stati dichiarati dislessici da altri professionisti. Abbiamo provato a verificare come fattori come l'età, il sesso e le difficoltà nell'apprendimento influenzino la precisione nella lettura delle pseudoparole e se sia possibile usare questo test come strumento per una diagnosi precoce della dislessia evolutiva.
I risultati dimostrano che ci sono differenze significative tra bambini dislessici e lettori normodotati nella lettura di pseudoparole nella lingua portoghese.
PAROLE CHAIVE: lettura; ortografia; pseudoparole; dislessia.

Polish
[Translation Elżbieta Awramiuk]
TITUŁ. Rozwój umiejętności czytania portugalskich dzieci dyslektycznych i niedyslektycznych
STRESZCZENIE. Niniejszy artykuł ma na celu przedyskutowanie teoretycznych zagadnień dotyczących procesu czytania, relacji między tą umiejętnością a dysleksją oraz zaprezentowanie rezultatów testu czytania pseudosłów przez portugalskie dzieci. Dysleksja rozwojowa to specyficzne upośledzenie umiejętności uczenia się, charakteryzujące się trudnościami w uczeniu się czytania. Istnieją istotne dowody na to, że dysleksja jest powiązana z deficytami umiejętności fonologicznych. Deficyty fonologiczne stanowią istotną różnicę między czytelnikami dyslektycznymi i niedyslektycznymi i – zgodnie z teoretycznymi podstawami– świadomość fonologiczna może być oceniana poprzez testy pseudosłów. W niniejszych badaniach zastosowaliśmy *Test czytania pseudosłów*, jeden z dwudziestu testów *Zestawu testów do oceny dysleksji rozwojowej* (BADD) skonstruowanych do oceny dysleksji portugalskich dzieci między 7 a 12 rokiem życia. Przetestowaliśmy 555 portugalskich dzieci w wieku od 8 do 12 lat. 57 spośród nich było wcześniej zdiagnozowanych przez innych specjalistów jako dyslektycy. Chcieliśmy zweryfikować, jak czynniki takie jak wiek, płeć i rodzaj trudności w uczeniu się wpływają na umiejętność czytania pseudosłów i czy ten test może być stosowany we wczesnej diagnozie dysleksji rozwojowej. Wyniki potwierdzają istnienie istotnych różnic między dziećmi dyslektycznymi a niedyslektycznymi w umiejętności czytania pseudosłów w języku portugalskim.

SLOWA-KLUCZE: czytanie; ortografia; pseudosłowa; dysleksja

Portuguese
[Translation Sara Leite]
TITULO. DESENVOLVIMENTO DE COMPETÊNCIAS LEITORAS NUMA AMOSTRA DE EITORES NORMAIS E CRIANÇAS DISLÉXICAS PORTUGUESAS
RESUMO. O objectivo deste artigo é discutir as questões teóricas por trás dos processos de leitura, a relação entre esta competência e a dislexia, e apresentar alguns resultados de um teste de leitura de pseudo-palavras com crianças portuguesas. A dislexia desenvolvimental é uma dificuldade de prendizagem específica que consiste na dificuldade em aprender a ler, havendo fortes indicações de que a dislexia está relacionada com deficiências ao nível da competência fonológica. Os défices fonológicos estão na origem de profundas diferenças entre leitores normais e leitores disléxicos e, tendo em conta um quadro teórico de fundo, a consciência fonológica pode ser aferida por meio de testes com pseudo-palavras. Neste estudo, aplicámos o *Teste de Leitura de Pseudo-palavras*, um de vinte testes da *Bateria de Testes para Avaliar a Dislexia Desenvolvimental (BTADD)* concebida para avaliar a dislexia em crianças portuguesas entre os 7 e os 12 anos. Fornecemos o *Teste de Leitura de Pseudo-palavras* a 555 crianças portuguesas entre os 8 e os 12 anos. Cinquenta e sete destas crianças tinham sido previamente diagnosticadas por outros profissionais como disléxicas. Procurámos verificar de que forma factores como a idade, o sexo e as dificuldades de aprendizagem influenciavam a correcção da leitura de pseudo-palavras e se este teste pode ser usado para ajudar a diagnosticar precocemente a dislexia desenvolvimental. Os resultados mostram que existem diferenças significativas entre crianças disléxicas e leitores normais na leitura de pseudo-palavras em português.
PALAVRAS-CHAVE: leitura; ortografia; pseudo-palavras; dislexia.

Spanish
[Translation Ingrid Marquez]
TÍTULO. Desarrollo de las habilidades de lectura en una muestra de lectores portugueses de desempeño medio y de niños disléxicos
RESUMEN. El propósito de este artículo es discutir los temas teóricos detrás de los procesos de lectura y la relación que hay entre esta habilidad y la dislexia, presentando algunos resultados del examen de lectura de "pseudopalabras" con niños portugueses. La dislexia del desarrollo es una incapacidad de aprendizaje específica que se caracteriza por la dificultad en aprender a leer; hay pruebas contundentes de que la dislexia se relaciona con deficiencias de fondo que tienen que ver con las habilidades fonológicas. Las incapacidades fonológicas establecen diferencias robustas entre los lectores disléxicos y normales, de acuerdo con el fondo teórico; la conciencia fonológica se puede evaluar con los exámenes de "pseudopalabras".
En este estudio, aplicamos el *Examen de la Lectura de Pseudopalabras,* una de las veinte pruebas incluidas en el *Conjunto de Exámenes para Evaluar la Dislexia del Desarrollo (CEEDD)*, construido para analizar la dislexia de los niños portugueses de entre 7 y 12 años de edad. Administramos el *Examen de la Lectura de Pseudopalabras* a 555 niños portugueses de entre 8 y 12 años, 57 de los cuales ya habían sido clasificados como disléxicos por expertos en el campo. Intentamos averiguar de qué manera factores como la edad, género e incapacidades de aprendizaje influyeron en la precisión de la lectura de las pseudopalabras y si el examen se podrá usar para lograr un diagnóstico más temprano de la dislexia del desarrollo.
Los resultados demuestran que hay diferencias significativas entre los niños disléxicos y los lectores normales al leer las pseudopalabras en el idioma portugués.
PALABRAS CLAVE: Lectura, ortografías, pseudopalabras, dislexia.

1.   INTRODUCTION

Developmental dyslexia is a reading disability which affects literacy acquisition in 10% - 15% of school children (Lyon, Fletcher & Barnes, 2002). Considering that reading and writing are not the consequence of a natural process, but of learning, research has verified that most children learn to read and spell easily while others have extraordinary difficulties. In 1896, in the *Brain Medicine Journal*, Pringle

Morgan referred to Percy, an intelligent boy who was *"quick at games, and in no way inferior to others of his age. His great difficulty has been – and is now – his inability to learn to read"* (p.1378). The expression used to define this disability was *"congenital word-blindness"*. In 1937, Orton, one of the precursors of dyslexia investigation, presented the term *"developmental alexia"*. In his work with students in Iowa and New York, he found that dyslexics have a pattern of difficulties in learning and remembering printed words; letter reversals (b/ d), number reversals (6 for 9), changed order of letters in words, leaving out or inserting words while reading, and difficulty in writing.

The term "developmental alexia" was modified to "developmental dyslexia". Alexia consists in the loss of the ability to understand written language, previously acquired as a consequence of a cerebral injury. These wounds are frequently focal and are located in the left hemisphere. According to the French neurologist Dejerine (Dejerine, 1891), a portion of the left posterior brain region is critical for reading. Beginning with Dejerine, a large body of literature on alexia describes neuro-anatomic lesions most prominently centred in the parieto-temporal area (including the angular gyrus, supramarginal gyrus, and posterior portions of the superior temporal gyrus) as a region pivotal in mapping the visual percept of the print onto the phonologic structures of the language system (Damasio & Damasio, 1983; Geschwind, 1965). Based on Dejerine's investigations, a number of neurobiological studies using *post mortem* brain specimens and brain morphometry support the belief that there are differences in the temporo-parieto-occipital brain regions between dyslexic and normal readers.

Dyslexia is a specific learning disability that is neurobiological in origin, characterized by reading, spelling and also phonological awareness difficulties. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities. Considering phonological awareness and phonological decoding, Vellutino and Fletcher (2005) defined developmental dyslexia as a *"developmental disorder characterized by significant difficulties in learning to decode print"* (p.364). According to some investigators, most children with dyslexia have significant difficulty learning to map alphabetic symbols and decoding (Liberman & Shankweiler, 1979). Vellutino and Fletcher (2005) show that there are robust differences between dyslexic and normal readers on measures evaluating phonological awareness.

The awareness that words can be decomposed into phonemes allows the reader to decipher the written code. In order to read, a child has to understand that spoken words can be pulled apart into phonemes and that the graphemes represent these sounds. Being aware of the phonological structure of the word also means being aware of syllabic and onset-rime elements. This allows the child that is learning a language to better develop reading skills. One of the most important discoveries is the cause and effect relation between phonological awareness and the development of the reading skill (Goswami & Bryant, 1990).

According to authors such as Frith (1985) and Ehri (1991) there are three stages in learning to read: logographic, alphabetical and orthographic. The logographic stage is characterized by the capacity to recognize a whole word, predominately due to its graphic characteristics. The reader can recognize a word by using mainly con-

textual strategies and not by taking into consideration the order of the words and the phonological factors. Two- or three-year-old children can effectively read words they have seen in their environment. For example, they can "read" *McDonalds* by deciphering its logo. The child does not require any level of phonological awareness or knowledge of letters to recognize the word. The next stage presupposes the acquisition of alphabetical knowledge and of grapheme-phoneme correspondences. This stage is described as the alphabetical stage for the development of the recognition of the word. In this stage, the reader starts to learn about the connections between the written forms and the spoken ones. These connections are, at this stage, partial. Unlike the logographic stage, in which the connections are arbitrary, in the alphabetical stage the reader starts making systematic connections between letters and sounds. Finally, in the orthographic stage, children develop the ability to form a mental lexicon, taking into consideration the sequence of letters. Due to experience acquired in the alphabetical stage, readers start to recognize the patterns of the most common letters. This phonological awareness allows readers to become quick and effective in reading. The connections are now analytical and systematic.

According to Colheart, Patterson and Marshall (1980), to read aloud a skilled reader uses two routes to decode writing into speech: the phonological route and the lexical route. The first allows reading based on grapheme-phoneme conversions (GPC). Using this route, it is possible to read pseudowords and new words that are not in our lexical system, as well as regular words. The lexical route is used when we are reading irregular words, due to their familiar visual form. This route is like a dictionary that can store the most frequently used words. This dictionary allows us to know whether or not a word is correctly spelt. Within this route there are various threads, intricately woven together. The starting point is the orthographic level, where the word is recognized as being familiar, then the information is passed on to the semantic level, where its meaning is established. The semantic representation can, then, activate the phonological system.

Seidenberg and McCelland (1989) developed a computer-based reading model, as an alternative to the Double Route Model, which was presented in the 1980s by Coltheart and his team (Coltheart, 1993). This model is called the Triangle Model. According to this model, the development of reading skills depends on a series of interactions between three categories of representations in the brain. These three categories of representation are the meaning of words (semantics), the sounds of words (phonology) and the written word (orthography). These models developed two levels for reading isolated words: the phonological level and the semantic level. The former establishes a connection between orthography and phonology, in which the written word is transformed into speech. The latter links orthography and phonology semantically. In other words, the written word directly activates the meaning of the word, which then activates pronunciation, that is, the phonology of the word. In this way, in the initial stages of learning to read, a child uses the phonological level, whereas an experienced reader uses the semantic level, which is particularly important for reading irregular words. Although this model establishes the relation between various components, as in a network, it is still based on the two routes or levels previously used to explain reading development.

According to Share (1995), children, especially those in the initial stages of learning to read, use the sentence context to understand the message; this factor is not included in the previous two models. Notwithstanding the diversity of models, it is interesting to note that all of them consider reading and writing tasks complex tasks, which are based on modular processes that include various mechanisms and ambiguities.

These ambiguities are also related to orthographic systems. The effect of orthographies on reading strategies is crucial. Even in the case of alphabetic languages there are also degrees of phonic regularity. We understand deep orthographies as orthographies in which the correspondence of the grapheme and phoneme is not univocal, that is, when for each phoneme there is a group of corresponding graphemes and vice versa. According to Van Orden and Kloos (2005) "Dutch, Spanish, German and Italian minimize or eliminate ambiguity between phonology and spelling by staying closer to a system of grapheme-phoneme correspondence" (p. 76). The Portuguese language has a deep orthography, although not in the same degree as the English. However, in the Portuguese orthography there are some cases of consonants and vowels that have various phonemes corresponding to a single grapheme. According to Morais (1997), the Portuguese language is the deepest amongst the transparent languages and the shallowest amongst the deep ones, positioning it intermediately when compared with shallow languages, such as Spanish and Italian, and with deep languages, such as English. Following Seymour's (2005) investigations, we can expect that efficiency of reading acquisition and development differs between languages: "in the ranking (1) simple syllable shallow orthographies (Finnish, Greek, Italian, Spanish); (2) complex syllable shallow orthographies (German, Norwegian, Icelandic, Swedish, Dutch); (3) simple syllable deep orthographies (Portuguese, French) and (4) complex syllable deep orthographies (English)" (p. 315).

To assess reading done by children who are developing their ability to recognize words and, especially, to assess reading through a purely phonological route, various authors use pseudowords reading tests (Capovilla & Capovilla, 2000). A pseudoword is an invented word, which does not exist in the language and is deprived of meaning, but which maintains the structure of real words, making it legible. On the other hand, nonwords are letter groupings that have a difficult pronunciation because they do not respect the internal structure of the words of a specific lexis, as in, for example, "Hetzg" or "Mrzi". The use of pseudowords is a means by which we can check if readers can associate phonemes with certain graphemes without any help from the sentence context or images, as the word is shown isolated and without any possibility of being read through the lexical route. In his various studies, Stanovich (2000) established the relation between reading pseudowords and reading acuity. In this author's opinion, reading pseudowords is a task that helps distinguish the skilled reader from the poor reader. In short, when comparing children of the same age, we can verify that children with reading problems have great difficulties in reading pseudowords. In this way, reading pseudowords can foretell the difficulties of dyslexic children. The construction of reading tests is crucial, as argued by Seymour (2005): "In other instances (Portugal, for example), there may be no formally standardized measures of reading abilities at all. This lack of psychometric harmoniza-

tion across Europe means that the way in which literacy (and dyslexia) are operationally defined is not equivalent in different countries" (p.298).

Since we felt the need to use a psychometric instrument to assess developmental dyslexia, we began the construction of a battery of tests, for subsequent application in pupils aged between 7 and 12. The results of studies undertaken in other languages (English, Spanish, German, for example) led us to decide to test the hypothesis that dyslexic children have problems in phonological awareness tasks, short-term memory tasks and rapid naming tasks (Bradley & Briant, 1978; Porpodas, 1999). The construction of this instrument has as its methodological and theoretical basis the instrument created by T. R. Miles, the *Bangor Dyslexia Test* (Miles, 1993). This test has 10 items that will allow us to identify a child with developmental dyslexia, defined as a syndrome with positive indicators. In studies that followed the construction of this test, the research team aimed to simplify this instrument and divided it into two subgroups. The first of these subgroups, the Literacy Tests, consists of a word recognition test, a reading comprehension test (*Edinburgh Reading Test,* 1985), and a spelling test by dictation. In the second subgroup, the Supplementary Tests include those that clinical experience suggests as specific indicators of developmental dyslexia. Following the structure of the Bangor Dyslexia Test, we adapted the second subgroup of tests, the Supplementary Tests, namely the Left-Right Test, the Months Forward Test, the Months Reversed Test, and the Digit Span Test.

With regard to the group of Literacy Tests, it was not possible to translate and adapt to Portuguese the Polysyllabic Test from the *Bangor Dyslexia Test.* Due to this, and taking into account the lack of standardized reading and writing tests for the Portuguese population, the *Phonological Awareness Test*, the *Pseudowords Reading Test*, the *Words Recognition Test*, the *Reading Speed Test,* and the *Spelling Test* were created.

In this article we will focus our attention on the *Pseudowords Reading Test*, one of the tests that is included in the *Assessment of Developmental Dyslexia Battery*, which is being validated for the Portuguese population. With this test, we tried to verify how individuals read different pseudowords in the Portuguese language. We aimed specifically to uncover the words that receive more correct answers and the words that appear as more difficult, because they are not correctly read by the participants of our study. We also tried to check the relation between variables such as age, gender and learning disabilities and the total number of correctly read pseudowords. We decided to carry out this study because according to robust findings, dyslexic children are less able to recognize pseudowords (Rack, Snowling and Olson, 1992). Furthermore, according to Frith (1999), difficulties in pseudoword reading suggest that a child has not achieved the necessary competences to use the alphabetic strategy, which enables him or her to decode sounds and understand the meaning of words. We aim to find cut-points, which will allow us to evaluate children and be able to identify dyslexics.

2.   METHOD

2.1 Participants

The sample is made up of 555 children living in central Portugal. In table 1, the sample is distributed according to the children's ages.

Table 1. Distribution of the children
by age (n=555)

Age	Percentage
7	0 ,9
8	21,3
9	21,6
10	29,5
11	22,7
12	4,0

To verify sample distribution, we applied the Kolmogorov-Smirnov test and we verified that the sample was not distributed uniformly according to the variable age (.182, df = 554, p.001). The distribution of the sample according to gender was as follows: 287 (51.7%) male children and 268 (48.3%) female children. In a random sample of 555 children, 57 (10.3%) were pointed out by teachers as being dyslexic children (after the assessment made by doctors and psychologists) and 498 (89.7%) as children with no learning disabilities.

2.2 Measures

The *Pseudowords Reading Test*, which is part of the *Assessment of Developmental Dyslexia Battery,* created by Carvalhais, Silva and Miles (2006)*,* was used. The *Pseudowords Reading Test* is made up of twenty words, ten of which have misplaced phonemes, for example, "Raido"[1], and their reading (correctly or incorrectly) may indicate difficulties with phonological processing. The other ten words are not similar to any Portuguese words: for example, "Ducida". These latter ten words were chosen because it is necessary to assess reading done purely through the phonological route. Nevertheless, these words maintain the syllabic and alphabetical structure of the Portuguese language. The maximum score in this test is twenty.

2.3 Procedure

Before the application of the test, the tasks and two example words were presented to the child. The test was applied individually and lasted approximately 5 minutes.

---

[1] *Translator's note: the correct order of the phonemes would be "Rádio" ("radio" in English).*

We recorded the correct and incorrect answers. The ethical aspects were respected. We delivered requests of authorization with the guarantee of anonymity.

2.4 Data Analysis

We determined frequencies, percentages, means, standard deviation, and we compared the two sub-samples using Student t- test and ANOVA. We accepted α = .05.

3.   RESULTS

The *Pseudowords Reading Test* is part of a battery of tests to assess developmental dyslexia in Portugal. We verified the internal reliability of this test and the Cronbach's alpha is .916, with a correlation coefficient of .855. This result leads us to consider that this test has a high internal consistency.

In relation to the total scores of the 555 children in the sample, the mean of correctly read words was 18.35, with a standard deviation of 3.26. The minimum number of words read correctly was 0 and the maximum was 20. Three children of the sample were unable to read any word of this test, and 25 children read fewer than 10 words. More than half of the sample correctly read 20 words (52.6%). The distribution is very skewed as figure 1 shows.

Figure 2 shows the degree of difficulty each of the twenty words presented. According to the results obtained, we can say that the most difficult pseudowords were *"russato"*and *"biçamo"* (numbers 19 and 18). Number 1 presents the highest level of difficulty. However, it is going to be eliminated from the battery because it does not comply to the phonotactic constraints of the Portuguese language. The pseudowords number 2 *"raido"*, number 13 *"famisca"* and 11 *"pizua"* were read correctly by a large number of children from our sample.

For each pseudoword we also measured the discriminative power, using the results of correlation coefficients between item score and total score of the test (Figure 3). According to Cohen and Holiday (1982), we can consider that a correlation coefficient is very low if it is smaller than 0.19; low if it is between 0.20 and 0.30; moderate if between 0.40 and 0.69; high if between 0.70 and 0.89; and very high if larger than 0.89.

Analyzing each item, we identified the pseudowords number 2 "raido" with a correlation coefficient of 0.324. All the other items had a moderate correlation coefficient, between .40 and .69, except the pseudoword number. 9 *"onho"*, with a correlation coefficient of 0.70.

According to the objectives of this study, we analysed the relation between the different ages of the children and the total number of correctly read pseudowords. In relation to the 7-year olds (n=5), the mean of correctly read pseudowords was 15.80, a standard deviation of 6.38, with a maximum score of 20 and a minimum score of 5. The pseudowords number 2 *"raido"*, number 3 *"xardez"*, number 11 *"pizua"* and number 16 *"colade"* were read correctly by all the subjects. In relation to the 8-year-olds (n= 118), the mean of correctly read pseudowords was 17.47, a standard deviation of 4.48, with a maximum score of 20 and a minimum score of 0, and also

with an interquartile range of 2. Analysing the frequency and percent of incorrect answers, we found that number 5 *"borbota"*, number 18 *"biçamo"* and number 19 *"russato"* were more difficult for 8-years olds. Among the 9-year olds (n=120), the mean was 18.44, with a standard deviation of 2.83, a minimum of 4 and a maximum of 20, and also with an interquartile range of 2. The pseudoword number 19 *"russato"* was the most difficult for this age group. Among the 10-year-olds (n= 164), the mean was 18.92, with a standard deviation of 2.44, an interquartile range of 1, and a maximum of 20 and a minimum of 0. This group also had low performances in pseudowords number 1 and number 19. Among the 11-year-olds (n= 126) the mean was 18.60, with a standard deviation of 2.52, an interquartile range of 2, and a maximum of 20 and a minimum of 8. The pseudoword number 3 *"xardez"* was the most difficult for this age group. Finally, among the 12-year-olds (n=22), the mean was 17.45, with a standard deviation of 4.53, an interquartile range of 2, and a maximum of 20 and a minimum of 3. After analysing the frequency and percentage of incorrect answers, we found that number 19 *"russato"* was more difficult for 12-year-olds.

A comparative study of the age groups was done using ANOVA to check if there were differences in the correct reading of pseudowords amongst the age groups. We found significant results: (F =3,922; df =554; p= 0.002).

With regard to gender differences, in a sample made up of 287 male children and 268 female children, the mean of pseudowords correctly read by the male children was 18.34, with a standard deviation of 3.12, a minimum of 0 and a maximum of 20, and an interquartile range of 2. In relation to the female children the mean was 18.35, with a minimum of 0 and a maximum of 20, a standard deviation of 3.40, and an interquartile range of 1. The two groups had lower performances in pseudowords number 1 *"caebça"*, number 18 *"biçamo"* and number 19 *"ducida"*. The differences between means weren't statistically relevant (t= -0.34; df =553; p=0.973).

After comparing the group of dyslexic children (n=57) and the group without learning disabilities (n=498), in relation to the total pseudowords correctly read, we concluded that in the sample without learning disabilities, the mean of pseudowords correctly read was 19.22, with a standard deviation of 1.30, a minimum of 10 and a maximum of 20, and an interquartile range of 1. Whereas, in the sample with dyslexic children, the mean was 10.70, with a standard deviation of 4.85, a maximum of 19 and a minimum of 0 and an interquartile range of 5. We found highly significant differences between the two groups (F= 231.419, df=553, p. 001).
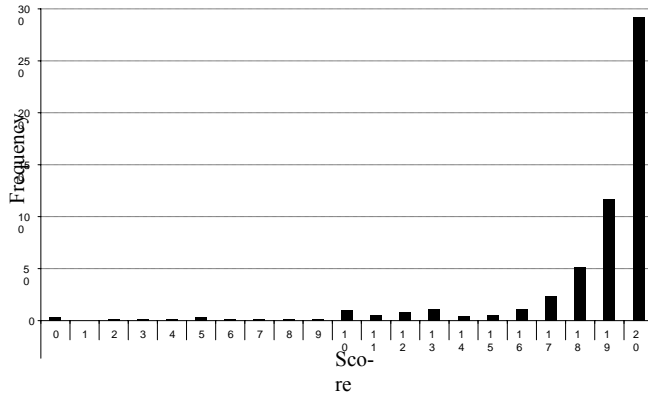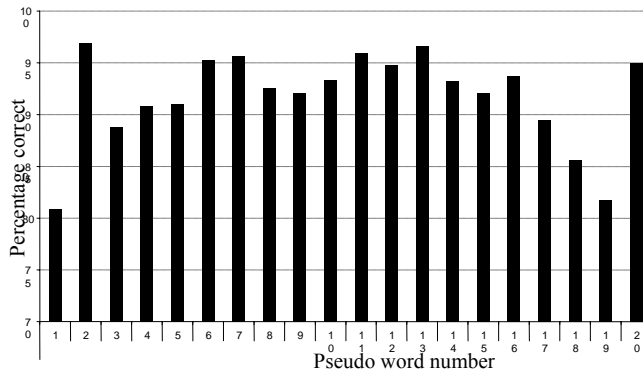
Figure 1. Distribution of scores.

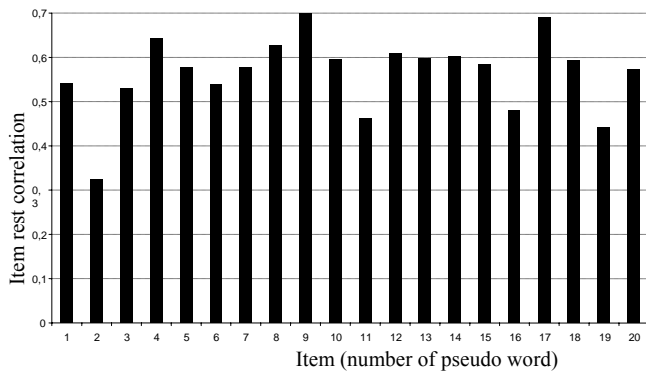*Figure 2. Percentage correct per pseudoword.*

Figure 3. Item-rest correlations.

4.   DISCUSSION

Our aim was to assess the proficiency of 555 children using this pseudowords reading test. After analysing the data obtained, we can conclude that 52.6% of the sample read 20 pseudowords correctly. This means that reading the 20 pseudowords was an attainable task for the majority of the sample, so the difficulty level was adequate for the age range, gender, and level of cognitive development of the children.

Looking at each word individually, the most difficult one, with n=106 incorrect answers, was the non-word number 1 "caebça"[2]. This non-word is one of the 10 words that had only a misplaced phoneme. So, we can conclude that the biggest difficulty in reading this non-word comes from the fact that it is very close to the real word "cabeça". This is the case with other pseudowords like, for example, pseudoword number 3 "xardez"[3]. However, another hypothesis could be that, from the group of pseudowords that were created by changing the position of only one phoneme, this invented word, "caebça", got the least number of correct answers because it has a consonant cluster "bç" that does not exist in Portuguese, although consonant clusters like "bc", /bs/, in "abcissa"[4] do exist in the Portuguese language. The second group of pseudowords (pseudowords number 11 to number 20), made up of pseudowords completely unrelated to real words, the pseudoword with the best score was pseudoword number 13 – "famisca". Its score was 536 (96.6%) correct answers, in 555 children. This word had a regular structure, with three syllabic groups "fa/mis/ca", without any irregular sound. After comparing the two groups of pseudowords, we verified that there were no differences in score.

With respect to age, we found significant differences in the mean of pseudowords read correctly. In fact, the 7-year-olds had a smaller average of correct answers than the children aged between 8 and 12. Nevertheless, it should be noted that 12-year old children had an average of 17.45, inferior to the mean obtained by 8-, 9-, 10- and 11-year- old children. This situation may be the result of the fact that 5 of the 22 subjects aged 12 were dyslexic children, so the mean decreases when compared to other age groups.

The relation established between dyslexic children and the number of correctly read pseudowords turned out to be quite significant. Seymour and Evans (1999) also use this type of pseudoword tests. Moreover, investigations show that "the lexicality effect (difference between familiar words and simple non words) was positive in some normal readers (word reading accuracy much higher than non word reading accuracy)[…]" (Seymour, 2005, p. 312). The results suggest that there are significant differences in reading accuracy between children with learning disabilities and children without these disabilities.

---

[2] *Translator's note: "caebça" with the phonemes in the correct order would read "cabeça" (head).*
[3] *Translator's note: "xardez" with the phonemes in the correct order would read "xadrez" (chess).*
[4] *Translator's note: "abcissa" is, in English, abcissa.*

5. CONCLUSION

We can conclude that dyslexic children experience difficulties in reading pseu-dowords, as a result of their decoding problems. The results of our study lead us to believe that the pseudowords reading test allows us to predict and distinguish normal readers from dyslexic children. In this way, this test, which is a phonological aware-ness exercise that assesses phonological reading, allows us to identify dyslexic chil-dren and can be used to define strategies to implement intervention programs. Therefore, this tool could be used at the national level in an effort to standardize tests used to diagnose dyslexic children across the country. It could replace informal assessments conducted by psychologists, teachers, speech therapists and pediatri-cians, which is how dyslexia assessment is currently carried out in Portugal.

REFERENCES

Carvalhais, L., Silva, C. & Miles, T. (2006). *Assessment of Developmental Dyslexia Battery* (BADD). The 1st Experimental version. PhD thesis. University of Aveiro.

Capovilla, A. & Capovilla, F. (2000). Problemas de leitura e escrita. *[Reading and Writing Disabilities]*. São Paulo: Memnon.

Cohen, L., & Holliday, M. (1982) *Statistics for Social Sciences*. London: Harper and Row.

Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and paral-lel-distributed-processing approaches. *Psychological Review*, 100, pp. 589-608.

Damasio, A. R., & Damasio, H. (1983). The anatomic basis of pure alexia. *Neurology, 33*, 1573-1583.

Dejerine, J. (1891). Sur un cas de cecite verbale avec agraphie, suivi d'autopsie. [About on case of verbal cecite with agraphie, followed by dissects]. *C. R. Societe du Biologie*, *43*, 197-201.

Ehri, L. C. (1991). Development of the ability to read words. In R. Barr, M. L. Kamil, P. B. Mosenthal, & P. D. Pearson (Eds.), *Handbook of Reading Research*, *2* (pp. 383-417). White Plains, NY: Longman Publishing.

Frith,U. (1985). Beneath the surface of developmental dyslexia. K.E. Patterson, J.C. Marshall, M Coltheart (Eds.), Surface Dyslexia. London: Routlegde and Kegan Paul.

Frith, U. (1999). Paradoxes in the definition of dyslexia. *Dyslexia, 5*, p. 199.

Geschwind, N. (1965). Disconnection syndromes in animals and man. *Brain*, *88*, 237-294.

Goswami, U., & Bryant, P. (1990). Phonological skills and learning to read. Hillsdale, NJ: Lawrence Erlbaum.

Liberman, I., & Shankweiler, D. (1979). Speech, the alphabet and teaching to read. In L. Resnick & P. Weaver (Eds.), *Theory and practice of early reading* (Vol. 2, pp 109-132). Hillsdale, NJ: Erlbaum.

Lyon, G., Fletcher, J., & Barnes, M. (2002). Learning Disabilities. In E. J. Marsh & R. A. Barkley (Eds.), *Child Psycopathology* (pp. 520-588). New York: Guilford.

Miles, T. (1993). *Dyslexia, the Pattern of Difficulties*, Second Edition. London: Whurr Publishers.

Morais, J. (1997). *Arte de ler. [The art of reading]*Lisboa: Edição Cosmos.

Morgan, W. (1896). A case of congenital word-blindness. *Brain Medicine Journal, 2*, p.1378.

Rack, J.P., Snowling, M. & Olson, R.K. (1992). The nonword reading reading deficit in developmental dyslexia. *Reading Research Quartely*, *I*, 71-83.

Seidenberg, M.S. & McCelland, J.L. (1989). A distributed, development model of word   recognition. *Psychological Review*, *96*, pp.523 –568.

Seymour, P. & Evans, H. (1999). Foundation level dyslexias: Assessment and treatment. *Journal of Learning Disabilities*, 32, 394-405.

Seymour, P. (2005). Early Reading Development in European Orthographies. In Snowling, M. & Hulme, C. (Eds.) *The Science of Reading, a handbook*. United Kingdom: Blackwell Publishing, 296-315.

Share, D.L. (1995). Phonological recoding and self-teaching: Sine qua non of reading acquisition. *Cognition, 55,* pp.151-218.

Stanovich, K. (2000). *Progress in understanding reading*. New York, NY: Guilford.

Van Orden, G., & Kloos, H (2005). The question of phonology and reading. In Snowling, M. & Hulme, C. (Eds.) *The Science of Reading, a handbook*. United Kingdom: Blackwell Publishing, 61-78.

Vellutino, F. & Fletcher, J. (2005). Developmental Dyslexia. In Snowling, M. & Hulme, C. (Eds.) *The Science of Reading, a handbook*. United Kingdom: Blackwell Publishing, 362-378.