



# Impaired stress awareness in Spanish children with developmental dyslexia



Gracia Jiménez-Fernández <sup>a,\*</sup>, Nicolás Gutiérrez-Palma <sup>b</sup>, Sylvia Defior <sup>a</sup>

<sup>a</sup> Department of Developmental and Educational Psychology, University of Granada, Campus de Cartuja s/n, 18071 Granada, Spain

<sup>b</sup> Department of Psychology, University of Jaén, Campus Las Lagunillas, Edificio Humanidades y Ciencias de la Educación II (C5), 23071 Jaén, Spain

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## ABSTRACT

The role of segmental phonology in developmental dyslexia (DD) is well established (e.g., deficit in phonological awareness), but the role of suprasegmental phonology (prosody) has been less widely investigated. Stress is one of the main prosodic features and refers to the relative prominence of syllables (strong/weak) within a word. The aim of the present study is to examine stress awareness in children with dyslexia and the possible mediation of phonemic awareness on suprasegmental phonological skills. Thirty-one Spanish children with DD and 31 chronological age-control children participated. Two stress awareness tasks were administered, one with words and another with pseudowords. Results show that the children with dyslexia performed more poorly on both tasks than control children. The pattern of results in accuracy and reaction time suggest that, while children without difficulties use different strategies depending on the type of item, the children with dyslexia employ the same strategy to resolve the two tasks without any benefit of lexical knowledge about stress. Even so, this strategy did not work so efficiently as it did in the control group, which led the group with dyslexia to make a greater number of mistakes. It was also found that, when phonemic awareness was entered as a covariate, accuracy differences disappeared, but only in the word stress task. However, when lexical knowledge was not necessary (as in the pseudoword stress task) differences still remained statistically significant. Implications on the importance of suprasegmental processing in reading acquisition disabilities are discussed.

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## 1. Introduction

Developmental dyslexia (DD) is a specific learning disability characterized by difficulties with accurate and/or fluent word recognition, poor spelling and decoding abilities in spite of having average intelligence, an adequate education and remedial effort (Vellutino, Fletcher, Snowling, & Scanlon, 2004). Secondary consequences may be problems in general reading comprehension and reduced reading experience, which can impede the development of vocabulary and background knowledge (International Dyslexia Association [IDA], 2002; Lyon, Shaywitz, & Shaywitz, 2003).

The current and most widely accepted explanation of dyslexia is the phonological deficit hypothesis (e.g., Peterson & Pennington, 2012; Stanovich & Siegel, 1994; Vellutino et al., 2004). According to this assumption, individuals with dyslexia

\* Corresponding author: Tel.: +34 958245167; fax: +34 958248975.

E-mail address: [gracijf@ugr.es](mailto:gracijf@ugr.es) (G. Jiménez-Fernández).

have underspecified phonological representations and/or difficulties with phonological access (Elbro & Jensen, 2005; Griffiths & Snowling, 2002; Ramus, 2003; Stanovich, 1988). Poorly specified phonological representations lead to poor mapping between phonemes and graphemes, which consequently results in poor performance in reading and spelling tasks. There is ample evidence supporting this hypothesis which points to deficits in the main three areas of phonological processing: phonological awareness (Goswami & Bryant, 1992; Serrano & Defior, 2008), phonological short-term memory (Gathercole, Alloway, Willis, & Adams, 2006; Swanson, Zheng, & Jerman, 2009), and speed of access to phonological codes (Wolf & Bowers, 1999; Wolf, Bowers, & Biddle, 2000).

The role of segmental phonology in dyslexia is well established (e.g., deficit in phonological awareness), but the role of suprasegmental phonology has been less widely investigated and even less so in 'transparent' or phonologically predictable languages such as Spanish. Further research, therefore, is required to determine whether a deficit in suprasegmental phonology is also present in the Spanish-speaking population with reading disabilities. Segmental phonology refers to separable sound segments of spoken language, whereas suprasegmental phonology extends to units and features beyond the segments, and is primarily concerned with the overarching patterns of the speech stream, such as the prosodic features of speech. Prosody is a term which refers to suprasegmental features of speech, such as stress, timing, and intonation (Dowhower, 1991). This research focuses on one of the main prosodic features of speech, stress, which is closely related to the concept of rhythm (Arvaniti, 2009). Two related perspectives are lexical stress and metrical stress. Lexical stress refers to the most prominent syllable within a word, and metrical stress refers to syllable prominence across multiple syllables, i.e., speech rhythm. In the case of lexical stress, the most prominent syllable is pronounced with more emphasis (e.g., in terms of frequency, duration or intensity), and usually contains an unreduced vowel. In metrical stress, prominent (or strong) syllables have full vowels, whereas weak syllables are reduced (Słowiaczek, Soltano, & Bernstein, 2006). In Spanish all vowels are full, so stress is related mainly to syllable emphasis. Although suprasegmental phonology in dyslexia has received much less attention than segmental phonology, lately there has been growing interest in this subject. In line with this recent upsurge in interest in this area, our investigation focuses on suprasegmental phonology, specifically on lexical stress processing.

### 1.1. Developmental dyslexia and prosodic processing: Implicit and explicit awareness tasks

Most studies on prosodic processing in dyslexia have focused on testing deficits in lower-level auditory perception abilities. In particular, they have examined whether phonological deficits (e.g., phonological awareness) are a consequence of difficulties in rhythm perception (Boets et al., 2011). In line with these observations, Goswami et al. (2002) noted deficit in detecting changes in envelope rise-time (one acoustic parameter of rhythm perception) in individuals with dyslexia. This deficit has been found across several languages, including Spanish (Goswami et al., 2011).

According to Goswami et al. (2002, 2011), rise-time supports the identification of syllables and, in this regard, different studies have observed a link between the rise-time perception and the same-different syllable stress perception tasks in adults with dyslexia (Goswami et al., 2013; Leong, Hämäläinen, Soltész, & Goswami, 2011). Individuals with dyslexia might therefore display impaired identification of the stressed syllable in spoken words, due to problems in suprasegmental phonology processing.

Studies about stress processing in people with DD are not conclusive (Barry, Harbott, Cantiani, Sabisch, & Zobay, 2012; Holliman, Wood, & Sheehy, 2012; Leong et al., 2011; Marshall, Harcourt-Brown, Ramus, & van der Lely, 2009), since some of these studies have shown deficits in stress processing (e.g., Leong et al., 2011), while others have failed to report any such impairment (e.g., Marshall et al., 2009).

Some of the factors that may explain these inconclusive results might be related to methodological issues. Specifically, these studies have involved tasks that differ as regards the type or degree of meta-cognitive stress processing they require. Certain tasks require the participant to consciously break up the syllables in a word and to identify the stressed one, while other tasks require the participant only to detect or compare whether two words share or not a general stress pattern. The differences in the meta-cognitive demands of the task may be an important factor in explaining the inconsistent results of these studies.

Differences in the degree of meta-cognitive processing could be related to the widely employed and accepted distinction between implicit phonological awareness and explicit phonological awareness (see review in Duncan et al., 2013). We propose that the same distinction could be used to differentiate between implicit and explicit stress awareness. We use the term "implicit" (or epi-linguistic, following the nomenclature proposed by Gombert, 1992 for phonological tasks) when participants may perform the stress task according to their perception of holistic acoustic similarities at the whole-word level. In this kind of task, the participant must process the overall stress pattern of a word but not to detect specifically the prominent syllable in the word. An example of this type of task consists of presenting pairs of four-syllable words to participants who decide whether they share the same stress pattern or not (e.g., the pair Difficulty vs. Voluntary shares the same pattern, whereas the pair Difficulty vs. boTanical has a different stress pattern).

On the other hand, we use the term "explicit" (or meta-linguistic, following Gombert, 1992) for tasks that require participants consciously to detect the stressed syllable, and then to pay attention to a particular part of the word. For example, a task which may be considered explicit requires participants to indicate the syllable (first or last) which carries the stress in disyllabic spoken words.

According to this distinction, explicit tasks would be more complex than implicit ones because they demand deeper stress processing. For this reason, this differentiation is essential in the study of possible deficits in people with reading difficulties.

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