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Syllabic Schemes and Knowledge of the Alphabet in Reading Acquisition: *Onset* or *Nucleus* Variation

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Abstract

Although there is a growing consensus that, in reading acquisition, it is essential to provide children with learning activities that promote the development of reading cognitive schemes, particularly intra-syllabic related patterns, there is no agreement on which kind of syllabic schemes should be worked out in the first place. The main aim of the present study is to analyse the readings of preschool Spanish-speaking children showing the development of syllabic schemes in the early stages of reading acquisition. Basically, we analyse their responses in relation to their previous knowledge of Spanish grapheme-phoneme correspondences (GPCs) or alphabet knowledge. Our results show that children's recognition and construction of syllabic schemes, from the very first steps in preschool reading acquisition programmes, is facilitated by reading activities presenting shell-nucleus syllabic patterns, for which the only requirement, although not indispensable, is to know the five or six Spanish vowel GPCs. This kind of activity seems to be more adequate than reading drills involving onset-rhyme syllabic analogies that require previous knowledge of consonant GPCs. The conclusion we have reached is that the development of onset-rhyme syllabic reading schemes shows a stronger relation to alphabet knowledge that shell-nucleus syllabic reading schemes, at least in the early stages of reading learning.

Keywords: syllabic schemes, alphabet knowledge, reading acquisition, cognitive patterns, scheme construction

1. Introduction

The essential task in reading education is to present printed texts in a systematic mode so that children cognitively structure spelling patterns (e.g., Cunningham & Allington, 2003; Ehri, 2005; Gaskins, Ehri, Cress, O'Hara, & Donnelly, 1997). Discovery of the spelling patterns and phonemic segmentation is sometimes difficult for children to pick up on their own, but systematic sequential presentations of reading texts give children the opportunity to generate and apply their discoveries on the correspondence between a specific string of phonemes and a string of letters (Adams, 1990; Gaskins et al., 1997; Treiman & Rodriguez, 1999). The reading preschool curriculum is intended to help students mechanise their graphemes–phonemes conversion skills for reading and spelling words (Kyle, Kujala, Richardson, Lyytinen, & Goswami, 2013). Reading acquisition is a social process and therefore it depends on social practices such as teaching. It is traditionally assumed that children need to acquire a minimum knowledge of the alphabet in order to learn reading (Ecalle, Magnan, & Biot-Chevrier, 2008). Consequently preschool reading activities are heavily orientated towards alphabet knowledge. The expected end result is that children would be able to recognize letters, understand that those letters have sounds, and would be able to blend those sounds together to make a word (Drouin, Horner, & Sondergel, 2012).

In view of this in the early stages of reading development, children usually learn to associate a letter to a phoneme and most of them believe each letter represents a phoneme. According to Murray (1998) the critical task for attaining alphabetic insight is to identify phonemes, that is, to perceive them as the same vocal gesture repeated across different words and then to discover the grapheme-phoneme correspondences (GPCs) in written language. This procedure accords with the theoretical perspective that an approach of "small units first" is most effective for learning English phonics (e.g., Hulme, Hatcher, Nation, Brown, Adams, & Stuart, 2002; Worden &

Boettcher, 1990). Although it seems to be that way, it is not always the case. For example, the letter *c* is found in words such as *cat*, *cell*, *ocean*, or *cello*. We can find corresponding examples in Spanish: *caro*, *célula*, *china*. But what are the rules or procedures children learn from this? How do they organise the grapheme-phoneme associations?

1.1 Grapheme-Phoneme Correspondences Schemes

Research conducted in the past shows that people generally striveing to interpret situations and they can accomplish this by constructing and applying cognitive *schemes* (Díaz-Cárdenas, Sankey-García, A. Díaz-Furlong, H. A. Díaz-Furlong, 2014). These cognitive structures are built from those features and characteristics that can be generalised from one object, situation or event to others (Piaget, 1969). In reading acquisition children must discover GPCs schemes like:

$$c \rightarrow \left\{\begin{matrix} /k/ \\ /s/ \\ /\text{ʃ}/ \\ /t\text{ʃ}/ \end{matrix}\right\}$$

which means that the letter *c* can be read as /k/, /s/, /ʃ/, or /tʃ/. Teachers usually say: "this (*c*) is the letter /siː/, the letter *c* sometimes sounds /k/ (as we can observe in the words: *card*, *crucial*, *speculation*), sometimes sounds /s/ (*cell*, *concert*, *specific*), sometimes sounds /ʃ/ (*ocean*, *sufficient*, *crucial*, *facial*, *precious*), and sometimes /tʃ/ (*cello*, *concerto*, *Cellini*). The problem with these GPCs is their ambiguity. They do not specify the contexts where these different GPCs apply or when the child must read the letter *c* as /k/, /s/, /ʃ/, or /tʃ/.

Clearly children can find a variety of phonemes associated to a letter. The correspondence between letters and sounds is not made on a one to one basis. So the task of teaching children the correct sound for each letter becomes quite complex. Instead of teaching 26 grapheme-phoneme correspondences, teachers must teach over 40 phonemes (in the English language) associated to 26 individual letters, and over two hundred different spellings for the forty-four phonemes of English (Kamhi & Catts, 1999).

1.2 Phoneme Clusters and Syllabic Schemes

Both children and adults can alternatively do activities that organise strings of letters into phoneme clusters (Burani, 2009). A very important linguistic scheme is the syllable as a phoneme cluster (e.g., Chetail, Treiman, & Content, 2015; Goikoetxea, 2005). From the beginning, teaching can be centered on a set of activities to discover and to use those syllabic patterns that constitute an essential component in the acquisition of reading (Ávila-Ramírez, Díaz-Cárdenas, Sankey-García, Mazzoco-Segura, Díaz-Furlong, & Estévez-Barba, 2002; Díaz-Cárdenas, Sankey-García, Díaz-Furlong, Cortés-Flores, Ávila-Ramírez, & Meléndez-Ponce, 2010). As a result of this approach, students can hypothesize about different syllabic patterns in specific settings and contexts. Consequently, developing syllabic schemes as cognitive structures plays a key role in the reading acquisition process.

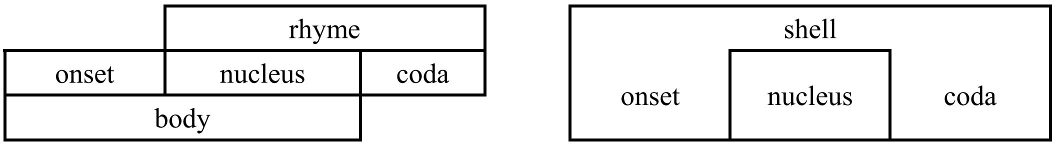
The syllable can be considered a linguistic theoretical unit. As Halle (1998) recognises, syllables were excluded as an entity in phonological rules, because of Chomsky and Halle's fundamental assumption of the linearity of the phonological sequence proposed in their important breakthrough work *The Sound Pattern of English* (1968). Once the assumption of linearity was abandoned, and proposals such as the autosegmental conception appeared, the syllable was incorporated as an important unit in phonological theory and it was proposed that syllables could be projected on a separate autosegmental tier, as words and morphemes (Halle, 1998; Hualde, 2014).

In short, we can describe five common syllabic patterns:

1) constant onset - variable rhyme (*crew*, *cry*, *crow*)
2) constant shell - variable nucleus (*bat*, *bet*, *bit*, *but*)
3) variable onset - constant rhyme (*say*, *day*, *pay*, *way*)
4) constant body - variable coda (*cat*, *car*, *can*, *call*)
5) variable body - constant coda (*pat*, *put*, *dot*, *met*)

In keeping with the onset-rhyme division of the syllable, this can be considered to be made up of two immediate constituents: the onset and the rhyme (Ewen & Hulst, 2001). The rhyme of a syllable comprises the vowel (nucleus) and any subsequent consonant phoneme(s) (coda). Although Spanish syllables only have vowel nuclei, English syllables can have consonant nuclei. The English word *sin* (as the Spanish word *sin*: "without") is organised into *s-in*, where *s* stands for the onset and *in* for the rhyme. The rhyme is built of *i*, the nucleus, and *n*, the coda.

The union onset-nucleus is defined as body. Finally, everything around the nucleus characterises the shell. In the previous example, *si* composes the body and *s_n* makes up the shell (Hualde, 2014; Vennemann, 1988).



Spanish syllabic nuclei are comprised mainly of five vowels (Stockwell & Bowen, 1965), whose duration is not used for distinguishing divergent phonemes (Iverson & Evans, 2007): two simple front vowels (/i/, /e/), two simple back vowels (/o/, /u/), and one central vowel (/a/). The most frequent Spanish syllables are CV (~50%), CVC (~20%), V (~10%), and VC (~9%) (Moreno-Sandoval, Toledano, Curto, & Torre, 2006).

1.3 Syllabic Schemes and Knowledge of the Alphabet

Although there is a growing consensus that, in learning to read, it is essential to provide children with learning activities that promote the development of reading cognitive schemes or patterns (Crawley & Merritt, 2009; Cunningham & Allington, 2003; Ehri, 2012; Gaskins et al., 1997; Goswami & East, 2000; Kyle et al., 2013; Rueda, Sánchez, & González, 1990) there is no agreement on which kind of syllabic schemes must be worked out in the first place (Savage, Blair, & Rvachew, 2006; Savage, Carless, & Stuart, 2003). Savage (2001) emphasises the need for solid research on the nature and relevance of sub-syllabic units and their use in early reading.

Consequently, we conducted a study involving reading in Spanish in order to examine the development of syllabic schemes in relation to knowledge of alphabet, in order to evaluate which kind of syllabic schemes makes fewer demands on children. Our main hypothesis is: Spanish-speaking children without previous knowledge of consonant GPCs can successfully read novel words based on the construction of constant shell - variable nucleus syllabic schemes.

Accordingly, we assessed children's ability to read novel words based on constant shell-variable nucleus syllabic schemes and examined their responses in relation to previous knowledge of Spanish GPCs.

We analysed whether learning sounds and/or names of letter correspondences is essential for learning to read, especially in instructional activities of construction and recognition of syllabic patterns. We presented a microgenetic study that focuses on specific proximal influences in cognitive change (Siegler & Chen, 1998). Proximal influences on learning are processes that occur within the learning situation. For that reason, we focus our study on the comparison between the following contrasting procedures:

a) Reading acquisition activities centered in onset-rhyme syllabic schemes (De Cara & Goswami, 2002; Duncan, Seymour, & Hill, 1997; Goswami, 1993, 1999; Wyse & Goswami, 2008). These activities require previous knowledge of consonant GPCs because children must be able to identify onset variations from the very beginning of the process. This connection has been widely studied and researchers have found a relationship between the development of syllabic awareness and learning sounds and names of letters (Ecalle, *et al.*, 2008; Murray, 1998; Treiman & Rodriguez, 1999; Worden & Boettcher, 1990).

b) Educational exercises designed to encourage the recognition and construction of constant shell - variable nucleus syllabic schemes. These reading practices are not based on the assumption that children need to learn the specific correspondences of phonemes to every symbol of the alphabet from the first steps of reading. The minimum requirement is the knowledge of all possible Spanish nucleus variants (vowels GPCs). Therefore alphabet knowledge is not required to develop shell - variable nucleus syllabic schemes for reading.

2. Method

2.1 Participants

The participants were 99 children (52 girls and 47 boys). They were 4 year olds (n = 1), 5 year olds (n = 73), 6 year olds (n = 25). They attended two preschool institutions. One school pertains to the public school system and the other one is a private school. The students were native Spanish speakers. Children were assessed individually in their own preschool centre. During a previous meeting, the study was explained to the parents and their children, and parents' consent for their child's participation was obtained.

2.2 Procedure

The assessment procedure was implemented two to three months after the children had begun a reading acquisition preschool programme that was based on activities which contrast constant shell-variable nucleus monosyllabic Spanish words. For the first three months consonant order presentation was *m-vowel*, *y-vowel*, *p-vowel*, *s-vowel*, *l-vowel*. Our preschool programme does not involve the learning of consonant letter names or sounds, although some parents inevitably taught their preschool children the alphabet at home.

2.3 Data Collection

First, the researcher asked the child to recognise by name or sound 28 Spanish letters (including *ñ* and *ch*) in order to determine their letter naming abilities. The number of recognised letters constitutes the ability parameter in our computation of the item response curve.

This test of alphabet knowledge was followed by a series of tasks which evaluated the use of syllabic schemes to read words. A variant procedure of the written "clue" words presentation (Goswami, 1986) was used in order to assess the use of reading syllabic patterns or schemes. We selected words which included consonant letters that are not usually taught in the first phases of the Spanish reading acquisition programmes used in the preschool institutions participating in the study. Learning of those consonants is delayed either by their context dependence (*r*, *c* and *g*), by their low frequency (*v*, *f*), or by their inclusion in a complex onset (*gr*).

In the assessment session children were shown a written word (*re*, *fe*, *grapa*, *ves*, *cana*, *gama*). For each one of these words children were asked about the names and sounds of the letters contained in them (see the Appendix). They also must give the meaning of the word presented. Immediately afterwards, we taught only those children who could not read the first words how to read them, without any reference to the letter names or the sound(s) associated to the letters contained in these words. Using first word as a "clue" word, a series of subsequent words were presented in the same way. These target words differed on the basis of nucleus variation. The researcher read aloud the first word and she asked the children to read it as well. A second word was presented to be read by children with the first word still visible. The basic syllabic structure was CVC, comprising CV and CCV as related variants in terms of nucleus or rhyme.

The first three word groups, comprising *r*, *f*, and *gr* onsets, were used basically to evaluate reading based on constant shell - variable nucleus schemes. To compare the ability to read words based on onset-rhyme patterns and shell-nucleus schemes we used the *v* word groups (*vas*, *ves*, *vos*, *vis*; and, *vas*, *gas*, *has*, *zas*). During the assessment, if children could not read every successive word we told them how to read the new word before we showed the subsequent word. The same variant procedure of the written "clue" words presentation was used.

2.4 Data Analysis

Odds ratio (OR) was calculated to examine possible associations between explicit knowledge of letter names or GPCs and the successful reading of our test target words (Pardo & San Martín, 2010). Item answers were scored on a binary base: 1 for correct answers and 0 for any wrong answer. OR analyses were conducted with the program IBM SPSS Statistics version 20.

Item responses were also analysed with an item analysis program designed by three of the authors of this paper. This program can be used with the Microsoft Excel application. With this tool, preschool teachers or researchers can perform basic item analysis in relation to an ability parameter based on academic grades or performance on a knowledge measure (a copy of this macro can be obtained freely by request from the authors). The logistic function describes the relationship between an examinee's specified ability and the corresponding probability of correctly answering an item (Baker, 2001). The knowledge of letter names was taken here as our ability parameter. The item response curve depicts the probability of success in an item as a function of a person's ability. We get as a result an item response curve, a difficulty parameter, and a discrimination parameter, calculated according to a logistic function, and related to children's knowledge of letter names. The unit on the ability parameter scale is known as logit (abbreviation for "log of odds unit" or logarithm of the odds). Higher values of logit represent a higher level of the attribute (children's knowledge of letter names) related to the correct answer probability (DeVellis, 2017).We employ here the two-parameter logistic model based on the following function, where θ is an ability parameter, a stands for the item difficulty, and b is the item discrimination:

$$P(\theta) = \frac{1}{1 + e^{-a(\theta - b)}}$$

Additionally the percentage of children's answers based on response categorization in the reading task of the words clustered by syllabic schemes is depicted in pie charts adapted and generated by the Microsoft Excel application.

3. Results

3.1 Successful Reading and Letter Name Knowledge

The first presented "clue" word was *re* and 57.6% of the children read it correctly while 42.3% of them could not read that word. The interviewer then explained that that written word *re* is read as /re/ to children that could not read it. Immediately after children answered on the meaning of the word *re*, the word *ra* was presented. The analysis revealed a positive association of letter name knowledge and success in the *ra* reading task, i.e. children who know the *r* name are in a better position to read the word *ra*. Participants' responses as a whole resulted in OR = 3.825 (95% confidence interval (CI): 1.432-10.217) between knowledge of *r* name and correct *ra* reading. This value was obtained including children who read the word *re* correctly and those who could not read that word. Therefore, this result implies that children's ability to read interacts with their alphabet knowledge.

Interestingly, as can be seen in Figure 2B some children unable to read the "clue" word of every word group know the name and/or the sound of the letters contained in the "clue" word. For this reason it is important to analyse in detail the association between knowledge of letter names and success in the "non-clue" consecutive words reading task for the group of children unable to read the "clue" word.

Accordingly, we analysed only the answers of children that could not read the word *re* and we find a different and interesting outcome. In relation to the development of a syllabic scheme based reading we found that learning to read *re* and *fe* results in an increase of successful reading of the words *ra* and *fa.* The *ra* reading task was successfully accomplished by 58.3% of those children who originally could not read the word *re*. Likewise, 52.9% of students that read incorrectly the word *fe*, eventually could read the word *fa*. In this case we get an OR = 1 (C.I.: 0.194-5.154) which means that there is no advantage in knowing the *r* name in order to read the word *ra*. In a similar way, children who could not read the word *fe* produced responses that show no advantage in knowing the *f* name (OR = 0.714, CI: 0.120-4.253) or *f* sound (OR = 0.636, CI: 0.136- 2.969). For these children, ignorance of the *f* GPC or the *g* GPC does not explain the increase response rate of accurate reading of the words *ra* and *fa*, correspondingly.

In short, some children could not read *re* or *fe* although they knew the *r* or *f* names and/or the phonemes associated with them. Conversely some children could read *ra* or *fa* without any knowledge of the *r* or *f* GPCs or their corresponding letter names. These consecutive readings beginning from a "clue" word focus the study on the proximal influences on learning.

3.2 Item Response Probabilities and Item Response Curves

Item response curves depicting the probability of success for the *fa* and the *gripa* item show increments in the probability of success compared to the *fe* and the *grapa* items, particularly for those children with the lower levels of knowledge of letter names (see Figure 1). They only need to learn how to read a word to be able to read an analogous word that differs in its vowel nucleus.

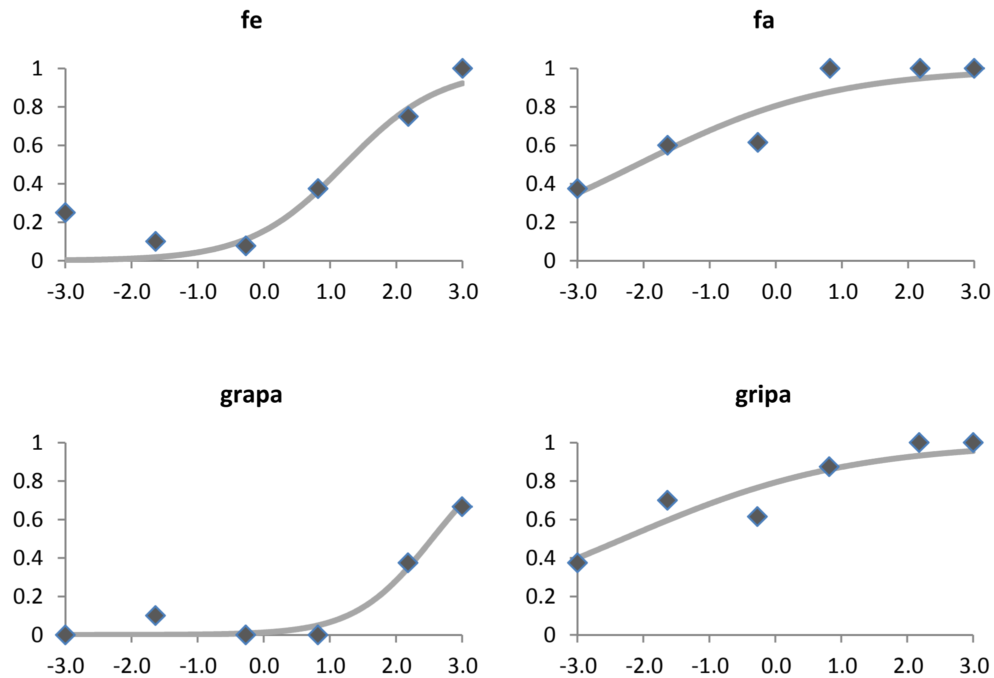


Figure 1. Item response curves depicting the probability of success on the *fe*, the *fa*, the *grapa* and the *gripa* items as a function of children's knowledge of letter names, taken as our ability parameter. The horizontal axis is the ability level: from the left to the right, the ability level goes from lower (-3) to higher (+3) levels. The unit on this scale is known as logit (abbreviation for "log of odds unit"). Results for the *fa* and the *gripa* item show increments in the probability of success related to the *fe* and the *grapa* items, even for those children with the lower levels of knowledge of letter names

3.3 Reading of Words with A Binary Onset

Most children could not read *grapa* (87%), and more than a half of them (66%) didn't know the *g* letter name or *g* GPCs (see Figure 2). Nevertheless most of them were able to read *gripa* once they learn how to read *grapa* (see Figures 1 and 2). The odds ratio between letter name knowledge and *gripa* reading was 3.908 (C.I.: 1.062-14.377) for all children, while, by contrast, the odds ratio was 2.533 (C.I.: 0.667-9.624) for those who could not read the word *grapa*.

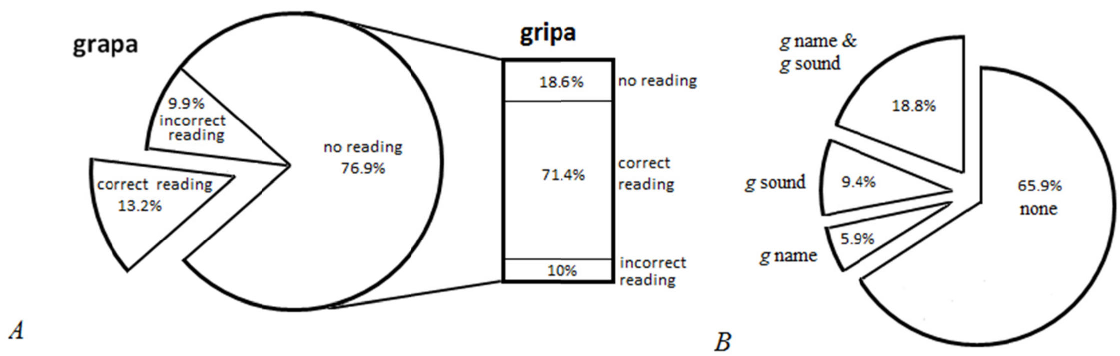


Figure 2. *A*. Response rate throughout the reading task of two subsequent words. Percentage of children's answers based on response categorization in the reading task of the word *grapa* (left) and the word *gripa* (right). The *gripa chart* corresponds only to responses of children who could not read *grapa* (86.8%); *B*. Percentage of the children unable to read *grapa* according to their knowledge of the *g* letter name or its associated sound

3.4 Word Sequences Contrasting A Variable Nucleus Syllabic Scheme with A Variable Onset Syllabic Scheme

The *v* words sequence was designed to contrast word reading based on the constant shell-variable nucleus syllabic scheme versus the variable onset - constant rhyme syllabic scheme. As it can be seen in Figure 3 children show real progress in the sequence based on the shell-nucleus syllabic scheme. Correct answers increased from *ves* (54.8%) to *vis* (78.6%). In contrast children did not increase in a meaningful way their correct readings in the onset-rhyme sequence *gas* (11.9%), *has* (4.8%), *zas* (7.1%). The observed decrease in the number of correct answers maybe due to the fact that the letters *v*, *g*, *h*, *z* have no obvious connections between them, it may be the case that children require previous knowledge of the *g* GPC, the *h* GPC, and the *z* GPC.

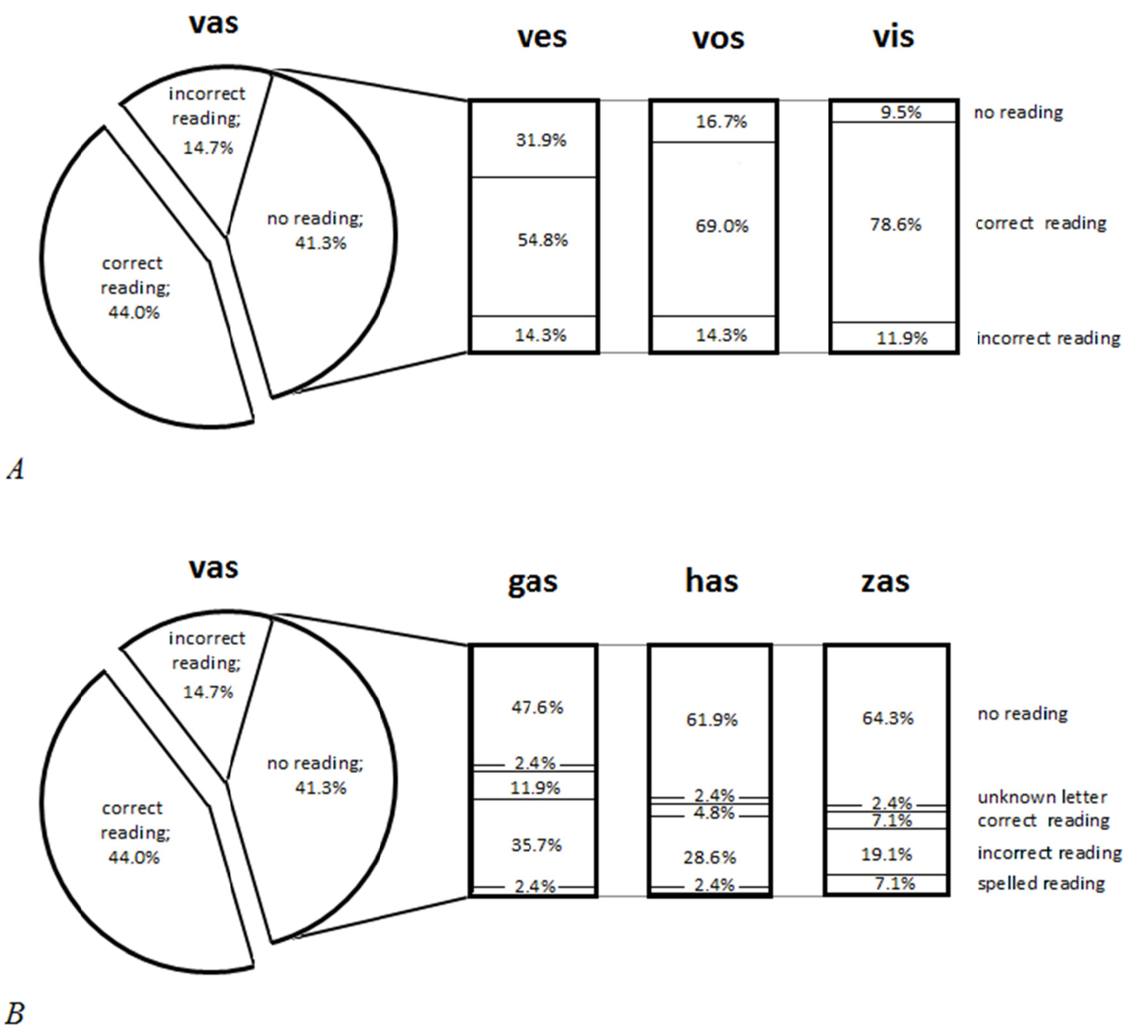


Figure 3. Response rate throughout the reading task of the words sequence: *A) vas*, *ves*, *vos*, *vis* (*nucleus* variation); and, *B) vas*, *gas*, *has*, *zas* (*onset* variation). The sequence represents only the response rate of those children unable to read *vas.* Percentages are drawn according to the reading response categorization. Correct answer percentage increases in the *nucleus* variation sequence but not in the *onset* variation sequence

Item response curves corresponding to the onset-rhyme sequence *vas*, *gas*, *has*, *zas*, show that the probability of correct reading does not increase through the consecutive presentation of those words, even though the researcher reads aloud every word after each child's failed attempt (Figure 4).

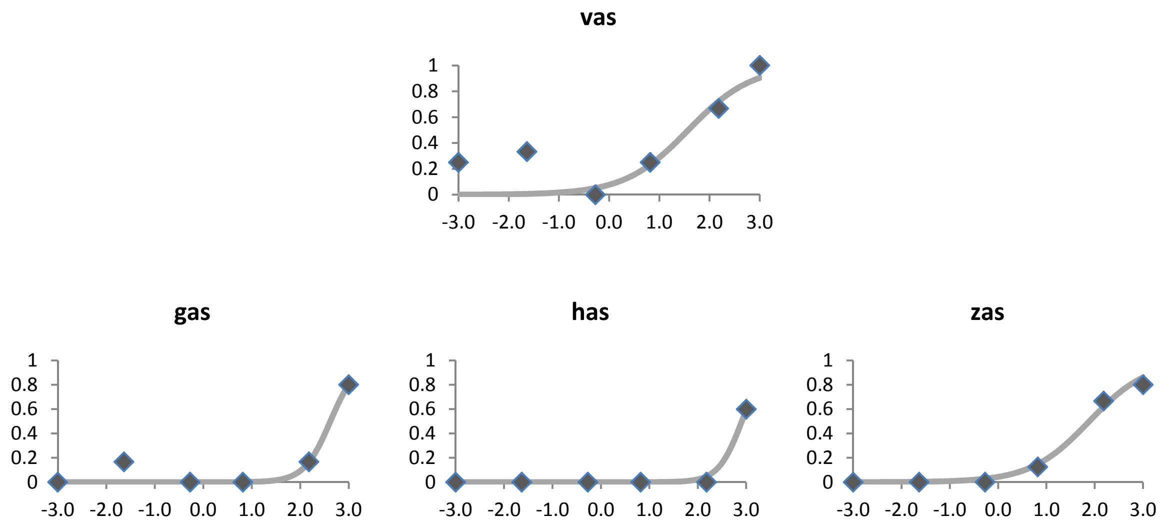


Figure 4. Item response curves depicting the probability of success, as a function of children's knowledge of letter names, taken as our ability parameter, on the sequenced reading task (*vas*, *gas*, *has* and *zas*) related to the syllabic scheme: variable onset - constant rhyme

4. Discussion

We have found that the Spanish speaking preschool children can learn to read based on shell-nucleus syllabic patterns, i.e, words that have a variable nucleus and a constant shell, without previous consonant knowledge. We describe here how children can read words with different vowels using a "clue" word without any former knowledge of consonant GPCs or letter names. Programmes based on introducing onset-rhyme syllabic analogies require previous knowledge of at least consonant GPCs. Introducing shell-nucleus syllabic patterns from the very first steps in preschool reading programmes seems to be more adequate at least in Spanish. The development and recognition of these syllabic schemes do not require that children previously learn the alphabet. The only requisite, although not indispensable, is to know the five or six Spanish vowel GPCs (*a* /a/, *e* /e/, *i* /i/, *o* /o/, *u* /u/, and *y* /i/ a Spanish conjunction).

Although it is not described here, we have observed that children evolve from one stage where they read in a non-schematic way to a stage where they show a systematic reading of CV, VC, or CCV combinations. In the first stage children use nonsystematic strategies to read CV combinations where we change the vowel with a constant consonant and they probably read from memory words like: *mi*, *me*, or *ma*. At this stage children cannot relate these words as different vowel combinations with a constant consonant onset. In the second stage, discussed in this paper, children read in a way which shows they have developed cognitive schemes of syllabic combinations.

Once they are able to read the first *CV* or *CVC* combination presented, children are able to compare the new *CCV* combination to the initial one learned. So when they encounter a new combination, *gra* for instance, they directly read it as /gra/ and they can accurately read, without any spelling-out strategy words like *grata* (pleasing, acceptable), *grita* (cry), *gruta* (cavern). Reading, being a complex cognitive competency, involves a variety of content and procedural knowledge (Rueda, 1995).

As Savage et al. (2003) have proposed, English speakers can use the syllabic pattern based on nucleus variation in the reading acquisition process. According to Strange, Bohn, Trent, and Nishi (2004) the standard American English inventory includes nine so-called monophthongs and two diphthongised nonrhotic vowels: a front-unrounded series [iː, ɪ, eɪ, ɛ, æː] a back-rounded series [uː, ʊ, oʊ, ɔː], and the low and mid-low back vowels [ɑː, ʌ]. So it would be very important to study English speaking children's ability to read different words based on nucleus variations. For instance, after learning how to read the word *bat* children should be able to read words such as *bet*, *bit*, *but*, *bait*, *beat*, *beet*, *boat*, *boot*, or *bout*.

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Appendix

Syllabic Patterns Test

How do you read this?	*re*	*fe*	*gra*	*vas*	*vas*
Which letter is this?	*r,e*	*f,e*	*g,r,a*	*v,a,s*	*v,a,s*
How does this letter sound?	*r,e*	*f,e*	*g,r,a*	*v,a,s*	*v,a,s*
What does this word mean?	*re*	*fe*	*gra*	*vas*	*vas*
If you read this as ____ this one is read as ____	*re/* *ra*	*fe/* *fa*	*grapa/* *gripa*	*vas/* *ves*	*vas/* *gas*
What does this word mean?	*ra*	*fa*	*grapa*	*ves*	*gas*
If you read this as ____ this one is read as ____	*ra/* *rama*	*fa/* *fama*	*gripa/* *graso*	*ves/* *vis*	*gas/* *has*
What does this word mean?	*rama*	*fama*	*graso*	*vis*	*has*
If you read this as ____ this one is read as ____	*rama/* *roma*	*fama/* *fuma*	*graso/* *groso*	*vis/* *vos*	*has/* *zas*