

The processing of morphology in children with and without reading disabilities

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Resumen

En este trabajo presentamos los resultados de un experimento diseñado para estudiar la influencia del procesamiento morfológico en el reconocimiento léxico de palabras complejas por parte de niños con y sin patología lectora. ¿Utilizan los niños los constituyentes morfológicos de las palabras para comprenderlas?, ¿cómo se ve influido este proceso por las capacidades lectoras de los niños? Para llevar a cabo el estudio se manipula la variable de Frecuencia de Base y se realiza una tarea de definición de pseudopalabras. Los resultados muestran que los niños con dificultades lectoras, incluso en una tarea en la que no existe límite de tiempo para su realización, tienen menor rendimiento que sus compañeros sin dificultades. Estos resultados parecen indicar que las dificultades que diferencian a jóvenes lectores con y sin dificultades no se ciñen exclusivamente a la etapa de acceso al léxico, sino que también el procesamiento léxico y semántico podrían verse alterados.

Palabras clave: Acceso al léxico; Dislexia; Habilidad lectora; Morfología.

Abstract

This paper presents the results of an experiment carried out to study the morphological processing of children with, and without, reading disorders. Is it the case that children use the morphological constituents of a word to understand it, and how is this usage influenced by reading ability? We have studied this issue by presenting novel complex words in a semantic definition task with eight years old children. Our results show that, even in a no time pressure task, proficient readers were better at constructing the meaning of novel complex words than children with a reading impairment. These results suggest that differences between proficient and reading disabled children could be not only related to the lexical access, but also to the lexical and semantic processing.

Key words: Dyslexia; Lexical access; Literacy; Morphology.

Introduction

During the development of reading, children acquire and refine various skills to make reading more easy. Most words in any speaker's lexicon, young or adult, are composed of two or more morphemes (e.g., Booig, 2002; Rey-Debove, 1984 for Dutch and French respectively) and most novel words are morphologically complex. So it is clear that it is important to be able to construct the meaning of a complex word by using its constituent

morphemes (see also Ehri, 1998). Processing novel words using morphemes is especially useful when one has to deal often with novel complex words as happens with children. In fact, it has been shown that children are increasingly aware of morphological relationships between constituents of complex words (e.g., Carlisle, 2000, Carlisle and Stone, 2005; García and González, 2006) and that the increase of morphological awareness has a direct impact on reading comprehension (Kieffer and Lesaux, 2008). The better the morphological awareness, the better the comprehension and the larger the vocabulary size, the better the comprehension (Lee, 2011; Stanovich, 1986). Morphological awareness and vocabulary size are related variables that lead both to a better reading comprehension.

Many studies have already shown that adults make use of morphological information to perform various language tasks (e.g., Caramazza, Laudanna and Romani, 1988; Domínguez, de Vega and Barber, 2004; Greber and Frauenfelder, 1999; Koester and Schiller, 2008; Longtin, Segui and Hallé, 2003; Meunier and Longtin, 2007, Verhoeven and Perfetti, 2003). Evidence of morphological processing in children has also been observed, for instance by manipulating the Family Size variable (FS hereafter). This variable, firstly mentioned by Schreuder and Baayen (1997), counts the number of complex words in which a given stem appears. Bertram, Laine and Virkkala (2000) studied Finnish children from 3rd and 6th grade. Bertram *et al.* (2000) showed in a semantic definition task that words with higher FS were better defined than words with low FS. This result was more clear for children from 6th. than from 3rd. grade. Bertram *et al.* (2000) concluded that most children made use of morphological knowledge to define words. These authors also suggest that the use of morphological information becomes more efficient as children grow up. Similar results were observed by Nicoladis and Krott with Canadian children with French as a first language (2007). They observed, in a semantic definition task with low frequency compounds, that compounds with high FS modifiers received better definitions than compounds with low FS modifiers. Nicoladis and Krott (2007) concluded that children are sensitive to, and make use of morphological information in order to perform the task.

Evidence concerning morphological processing not only involves FS, but also Base Frequency (BF hereafter). The BF variable is defined as the frequency of the stem's word target. For instance, according to the LEXESP database (Sebastián, Cuetos, Martí and Carreiras, 2000) the Spanish word "flautista" (flutist) has a frequency of 2 per million, but a BF of 6, because "flauta"(flute) has frequency 6, and it is the stem of

“flautista”. Derived words usually have lower surface frequencies than their stems. A facilitatory effect has been associated with BF. This effect has been observed in different investigations with adult readers (e.g., Carlisle and Katz, 2006; Lavric, Clapp and Rastle, 2007; Taft, 1979, 2004) and with children (Marcolini, Burani and Colombo, 2009). Marcolini *et al.* (2009) observed that non-words composed by using high BF were rejected more slowly than those that had been composed by low BF in a lexical decision task. Nonwords with a high BF generate more activation than nonwords with a low BF in the mental lexicon and therefore may be more difficult to reject these high BF nonwords. The study of Marcolini *et al.* (2009) did not include a reading disabled children group, and the lexical decision task carried out in their study introduces time limit. Barca, Burani, Di Filippo and Zoccolotti (2006), Davis, Cuetos and González (2007) or De Luca, Borrelli, Spinelli and Zoccolotti (2002), suggested that the main difference concerning proficient and reading disabled children is the slowness with which reading disabled children read. Therefore these authors considered that differences between proficient and reading disabled children should not be explained in qualitative terms, but in quantitative ones. Taking into account the reading slowness of the reading disabled children, it would be possible that an effect of BF appeared on the group of proficient readers but not on the group of reading disabled children when performing a time pressure task as in Marcolini’s *et al.* (2009) study, but what we may expect when the task does not include time limit? If we postulate that differences between proficient and reading disabled children are at the level of lexical access, then we may not find differences between proficient and reading disabled children performing a task without time pressure. However, if differences are not restricted to lexical access, but also to lexical and semantic processing, then proficient readers may show better performing than reading disabled children.

Experiment

In order to investigate whether reading disabled children have difficulties only at the lexical access level, or also at the lexical processing level, we carry out a semantic definition task without time pressure. In this semantic definition task children have to define novel complex words in which low BF and high BF are manipulated. This variable has been shown to have a facilitatory effect both in adults and in proficient children, and it is argued as evidence of morphological awareness and processing. In the case that proficient and reading disabled children show same results in our task, we

could suggest that differences between both groups are located at the lexical access and that proficient and reading disabled children make use of morphological knowledge in order to define novel complex words. In this case a main effect of “Reading ability” would not reach significance. On the contrary, if proficient readers show better scores than reading disabled children, we could conclude that differences between groups are not only located at the lexical access level, but also at the lexical processing level. In this case a main effect of “Reading ability” would reach significance. Regarding the BF variable, in line with Marcolini *et al.* (2009), we expect to find a significant effect for proficient children. However, for reading disabled children we may be more cautious. We believe that if reading disabled children show same results than proficient children on the “Reading ability” variable, then an effect of BF may appear as a main effect. However, if reading disabled children do not show same results than proficient children on the “Reading ability” variable, then the main effect of BF could not reach significance.

Method

Participants

A total of 26 native Spanish-speaking children from two different public schools in Toledo performed the experiment. Half of them showed reading disabilities and half not. In order to select the children in the reading disorder group we initially considered all the children who were formally diagnosed as reading disabled by the psychoeducational team of their schools. As far as we could only get the formal approval for one day session with the children, it was impossible to make a full screening of them in order to select the children according to the results of our own exam. However, we were allowed to assess the results of the psychoeducational evaluation of each reading disabled child. We decided to use the results of the Prolec-R test (Cuetos, Rodríguez, Ruano and Arribas, 2007) as a critical criterion. Children selected showed a profile consistent with reading disabilities in this test¹. Their average age was 8.69 (1.31). The children in the group of skilled readers were chosen randomly from the other school mates with the simple caution not to choose any child that had previously received any treatment for language disorders. The average age was 8.07

¹ The Prolec-R is a reading test for Spanish speaking children between 6 and 12 years that consists on nine different exams, each of them is evaluated as a normal, slightly below normal or well below normal.

(0.27)². No child had a psychiatric history or was medicated in any way at the moment of this study.

Materials

Twenty six complex novel words were created, thirteen with high BF and thirteen with low BF. Novel complex nonwords were generated by concatenating legal stems and affixes whose concatenation did not create existing words. No morpho-phonological changes were made in the stems while concatenating derivative morphemes because of the importance of such changes (Bertram, *et al.* 2000, Carlisle, 2000; Carlisle and Stone, 2005). Cumulative Frequency refers to the frequency of all the members of the FS without counting the base frequency itself. Other variables taken into account and controlled are displayed in Table 1.

Table 1. Descriptive statistics of the variables

	BF	CF	NS	LL	AFS	SFS	LO
High	114.1	13.3	0	7.1	935	6.7	4.8
BF	(76.9)	(12)		(1.5)	(285)	(1.7)	(1.2)
Low	13	8.4	0.3	8.1	863	6.4	4.9
BF	(7.4)	(11.8)	(0.7)	(1.1)	(316)	(1.3)	(1.1)

Standard deviations in parentheses. BF Base Frequency, CF Cumulative Frequency, NS Neighbourhood Size, LL Letter Length, AFS Affix Family Size, SFS Stem Family Size, LO Letter Overlap

Procedure

Following Bertram *et al.* 2000; Burani, Bimonte, Barca and Vicari, 2006; or Nicoladis and Krott, 2007; we used a semantic definition task. Children were asked to provide a definition of the target stimuli. Each novel word was written in a plastic card. Children could take and manage them as they wanted. They were said that they probably did not know the word, but they had to try to provide a definition. In the case they did not provide a definition we asked them only one more time to try it. If no response was provided, the next item was presented. Three training trials was presented, none of

² The design of the experiment does not make use of a reading level matched control group. This is because the present study is a first approach to establish whether the difficulties of the reading disabled children are restricted to the lexical access level or whether the lexical and semantic levels could also be compromised.

which were subsequently used. Responses were recorded and transcribed later. Stimuli were randomly presented. As in Burani *et al.* (2006) the score of the responses was rated on a 0-2 scale. When the response clearly showed understanding of the stem, response was assessed with a 2, for example, explicitly saying the stem. If the answer was fairly satisfactory, suggesting certain knowledge of the novel word, the response was assessed with a 1. If no answer or an answer was in no way related to the target, the response scored a 0.

Results

Two external reviewers evaluated the transcriptions. They did not know the hypotheses of the experiment nor any other relevant information that could affect their evaluations. They just were asked to evaluate the definitions in accordance with the criteria mentioned above. Results comparing the two reviewers' data show that there are no differences between them ($P < .8$). The data analysis was carried out on the basis of one of the reviewer's data. However, analyses were also conducted with the other reviewer's data. The results were almost identical and showed the same effects.

Results were analyzed in two separate repeated measures ANOVAs by participants (F1) and by items (F2). A main effect of the –between subjects- “Reading ability” showed significance both in the analyses by subjects ($F(1,24)=9.12$ $MSe=0.177$, $p < .006$) and in the analysis by items ($F(1,24)=10.522$ $MSe=0.153$, $p < .003$). Proficient readers defined novel words better than reading disabled children (1.361 vs. 1.713 respectively, see Table 2). A main effect of BF was not significant in the analysis by subjects ($F(1,24)=1.75$ $MSe=0.23$, $p < .19$) and in the analysis by items ($F < 1$). The interaction of Reading ability \times BF was not significant both in the analysis by participants ($F(1,24)=1.09$ $MSe=0.23$ $p > .3$) and in the analysis by items ($F < 1$). A planned comparison analysis was carried out on the effect of BF. This analyses show that nor the group of proficient readers, neither the group of reading disable children show a significant effect, although a trend is observed by which proficient readers are more sensitive to the BF than reading disabled children ($P > .1$ vs. $P > .85$ respectively).

Table 2. Main scores of children

	Reading disabled children	Proficient readers
High	1.37	1.76
BF	(0.33)	(0.21)
Low	1.35	1.66
BF	(0.41)	(0.26)

Standard deviations in parentheses

Discussion

The results show that proficient readers perform better than reading disabled children a semantic definition task without time limit. It has been suggested that differences between proficient and reading disabled children are related with the slowness with which reading disabled children read (Barca, *et al.* 2006; Davis, *et al.* 2007; or De Luca, *et al.* 2002). If reading disabled children had problems restricted to the slowness in reading, they may perform the tasks equally well than proficient readers in tasks without time pressure. However our results show that reading disabled children scored significant lower than proficient readers. This means that reading problems in these children are not restricted to lexical access, but also to the lexical processing. Reading disabled children show less degree of efficiency in the use of morphological information once it has been accessed. These results are consistent with the data of McGregor, Rost, Guo and Sheng (2010). McGregor *et al.* (2010) observed that specific language impairment children (SLI) were significantly poorer than their age match peers at explaining compounds in a definition task, but both groups of children were equally good in parsing compounds into morphological constituents. McGregor *et al.* (2010) suggested that their results show evidence of morphological awareness in SLI children although these children have a poorer ability to use it compared to skilled children.

Concerning the role of the BF variable we have hypothesised a significant effect, at least for proficient readers. However no such an effect has been found. Marcolini *et al.* (2009) have found an effect of BF in proficient children in a lexical decision task. We believe that different tasks employed may explain the different results observed. Semantic definition is a metalinguistic task that allows us to explore the morphological awareness of children (Lewis and Windsor, 1996) but it does not assure an automatic

process (Levy, 1987). Apparently our metalinguistic task is less sensitive to BF than a lexical decision one.

Conclusions

Our results show that reading disabled children have not only difficulties at the lexical access level, but also at the lexical processing level. Problems at this level could be explained in terms of morphological knowledge or in terms of semantic processing. Do reading disabled children have correct representation of morphemes? Do reading disabled children process correctly the morphemes' meanings? Our study can not answer this question, and therefore new studies must be conducted in order to assess such an important point. On the other hand, our results support the educational projects devoted to train the morphological processing in reading impairment children (e.g., Arnbak and Elbro, 2000; Lázaro, 2010).

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