

Phonological recovery in Spanish developmental dyslexics through the tip-of-the-tongue paradigm

Paz Suárez-Coalla, Aida Collazo Alonso and María González-Nosti
Universidad de Oviedo

Abstract

Background: Developmental dyslexics have difficulties accessing and retrieving the phonological form of words, in the absence of a deficit at the semantic level. The aim of this work was to study, through the Tip-of-the-tongue (TOT) paradigm, the problems of lexical access in Spanish-speaking developmental dyslexics and the relationship with their phonological awareness. **Method:** A group of developmental dyslexics (14) and other children without reading difficulties (14), aged 7 to 12, performed a picture naming task of medium and low frequency and a task of phonological awareness. **Results:** The results indicated that dyslexic children generally show a greater number of TOT phenomena than the control group. Despite being able to provide semantic information of the drawing, they had difficulties retrieving partial phonological information. **Conclusions:** These results indicate that developmental dyslexic children have particular difficulty in accessing the phonological form of words, which may be interesting for the development of intervention programs for these children.

Keywords: Developmental dyslexia, phonological recovery, TOT paradigm.

Resumen

Recuperación fonológica en disléxicos evolutivos españoles mediante el paradigma de la punta de la lengua. Antecedentes: los disléxicos evolutivos tienen dificultades para acceder y recuperar la forma fonológica de las palabras, sin presentar un déficit a nivel semántico. El propósito de este trabajo era estudiar, a través del paradigma del fenómeno de la punta de la lengua, los problemas de acceso léxico en niños con dislexia evolutiva y su posible relación con la conciencia fonológica. **Método:** un grupo de niños disléxicos (14) y otro grupo sin dificultades lectoras (14), con edades comprendidas entre 7 y 12 años, realizaron una tarea de denominación de dibujos de frecuencia media - baja y una tarea de conciencia fonológica. **Resultados:** los resultados indicaron que los niños disléxicos generalmente presentan mayor número de fenómenos de punta de la lengua que el grupo control. A pesar de ser capaces de dar información semántica acerca del dibujo, los disléxicos presentan dificultades para recuperar la información parcial fonológica. **Conclusiones:** los resultados indican que los disléxicos evolutivos tienen particular dificultad para acceder a la forma fonológica de las palabras. Esto puede ser interesante para desarrollar programas de intervención para estos niños.

Palabras clave: dislexia evolutiva, recuperación fonológica, paradigma TOT.

The difficulty in learning to read is the fundamental and most visible feature of developmental dyslexia (Shaywitz, 2003; Snowling, 2000). There have been diverse causal explanations of developmental dyslexia throughout years of research. It was long thought that the main problems of dyslexics were visual (Stein, 2001). However, the current theory with more empirical support is the phonological deficit theory. According to this theory, poor phonological skills would be the main problem for people with dyslexia, although other difficulties (auditory, visual, motor) could occur simultaneously (Ramus et al., 2003).

In Spanish, there is a considerable amount of research addressing developmental dyslexia characteristics (Davies, Cuetos, & González-Seijas, 2007; Jiménez & Ramírez, 2002; Suárez-Coalla

& Cuetos, 2012), and several studies have also shown a significant relationship between phonological skills and reading acquisition (Défior, 2002; Défior & Herrera, 2003; García-Miranda, 2005; Jiménez & Ramírez, 2002; Suárez-Coalla, García-de-Castro, & Cuetos, 2013). Furthermore, it has been described that dyslexics have difficulty accessing the phonological lexicon in naming tasks (Bowers & Wolf, 2000; Denckla & Rudel, 1976; Fowler & Swainson, 2004; Hennessey & Truman, 2002; Nation, Marshall, & Snowling, 2001; Messer, Dockrell, & Murphy, 2004; Raman, 2011; Rubin, Bernstein, & Katz, 1989; Truman & Hennessey, 2006). Moreover, they are less accurate than their peers in the recovery of long, unusual and unfamiliar words and make more semantic substitutions and circumlocutions in oral narrations and spontaneous speech (Dietrich & Brady, 2001; German & Simon, 1991; Swan & Goswami, 1997).

Naming difficulties have been demonstrated in languages with different degrees of transparency, including Spanish (e.g., German: Wimmer, 1993; Dutch: Yap & van der Leij, 1993; Spanish: Guzmán, et al., 2004; Novoa & Wolf, 1984; Suárez-Coalla, González-Nosti, & Cuetos, 2012), but this fact has been interpreted in different

ways. On the one hand, it is considered a problem of automating cognitive processes responsible for reading fluency (double-deficit Hypothesis, Wolf & Obregon, 1997), whereas, on the other hand it could be due to a difficulty retrieving phonological representations stored in the long-term memory, which would be a phonological processing problem, caused by inaccurate or weak phonological representations (Torgesen, Wagner, & Rashotte, 1994).

In the same vein, the paradigm of the Tip of the Tongue (TOT) phenomenon (Schwartz, 1999; Schwartz & Metcalfe, 2010) has been used to tackle problems of naming or access to the phonological lexicon. In situations of the TOT phenomenon, there are difficulties in accessing and retrieving the phonological form of the word one wants to say. The person is certain he or she knows the word, but at the same time is unable to access and emit it, although the concept is clear and it is possible to access semantically or phonologically related words (Brown & McNeill, 1966). It is a universal phenomenon, which does not depend on contexts, cultures or languages (Brennen, Vikan, & Dybdahl, 2007; Hanly & Vandenberg, 2010). Most studies on this topic have focused on Anglo-speaking literates, although one study about oral language in Guatemala showed that this phenomenon seems to have no direct relation to literacy, supporting the idea of universality of the phenomenon (Brennen et al., 2007).

Given that, in such situations, we are able to access semantic and partially phonological information, this phenomenon has been interpreted as the result of insufficient phonological activation of the target. This phenomenon has been explained on the basis of the *oral production model* by Levelt (Levelt, 2001), who suggests that the first step, in which the activation of the concept or semantic representation in the lexicon of the speaker takes place, does not present any problems, but the second step, in which the phonological segments of the target word are activated, does present problems.

Regarding the possible presence of more TOT phenomena in people with dyslexia, some studies have been carried out in Hebrew or English (Faust, Dimitrovsky, & Shacht, 2003; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010). These studies describe the presence of greater difficulty in dyslexics to recover the phonological form of the words, in accordance with the model of Levelt and the presence of phonological deficiency in these persons. Specifically Faust et al. (2003) studied the phonological recovery problems using a naming task in a group of Hebrew-speaking dyslexic children (3rd and 4th) and found that they experienced more TOT phenomena than those without dyslexia. Both groups did not differ in terms of semantic information, but they did in phonological information, that is, access to the phonological form of words and the number of spontaneous recoveries. Similar results were obtained with dyslexic adolescents (Faust & Sharfstein-Friedman, 2003), although in this study there were no differences between dyslexic and nondyslexic adolescents in the amount of phonological information available during a TOT situation. In English (an opaque language, unlike Hebrew), more TOT phenomena were found in dyslexics than in children without dyslexia, with more failures in phonological information retrieval in the absence of receptive vocabulary problems (Hanly & Vandenberg, 2010). These studies support the hypothesis of a deficit in phonological processing in dyslexic children, regardless of the written text. However, more studies are needed in different languages in order to confirm the universality of this deficit.

Thus, in this work, we aimed to study the recovery in the phonological lexicon by evolutive dyslexics in Spanish, a

transparent language like Hebrew. We have used the paradigm of the TOT phenomenon, which will establish the facility to recover the phonological code from a concept. Moreover, taking into account these children's difficulties of phonological processing (phonological awareness), we will try to discover the possible relationship between the phonological awareness (PA) tasks and access to the phonological form of the words. To do this, we will take as reference studies in other languages (Faust et al., 2003; Faust & Sharfstein-Friedman, 2003; Hanly & Vandenberg, 2010), expecting to find more TOT phenomena in children with dyslexia than in the children of the control group. The main goal of this study is to check whether dyslexic children show greater difficulty than controls in accessing the phonological form of words, in the absence of semantic differences between the two groups. We also intend to check whether or not dyslexics are able to provide the same amount of partial phonological information in TOT situations as normally achieving readers. The final aim of this study is to test whether there is a relationship between phonological processing skills and the number of TOT phenomena.

Method

Participants

The study was conducted with 28 children (between 7 and 12 years), 14 diagnosed with dyslexia and 14 normally achieving readers. Both groups were matched in sex and no significant differences were found in age ($t = .408, p = .687$) (see Table 1). All the participants spoke Spanish as their first language, and belonged to a middle sociocultural environment. Furthermore, none of the children had cognitive or behavioral problems, school delays, or social or family conflicts.

Children with developmental dyslexia were selected in a speech therapy center from Asturias and were 2.5 standard deviations below the mean (in accuracy and speed) on the word and pseudoword reading subtests of PROLEC-R (Cuetos et al., 2007). The control children were randomly selected from a public school from Asturias.

As seen in Table 2, before starting the study, several batteries were applied to all the participants to rule out cognitive or vocabulary problems. These tests were the Wechsler Intelligence Scale and the PEABODY test of receptive vocabulary (Dunn, Padilla, Lugo, & Dunn, 1986). This test consists of 125 multiple-choice sheets, with four black and white illustrations on each page. The examiner says a word and the child has to point to the corresponding picture. No significant differences were found between controls and dyslexics groups in terms of IQ ($t = .978, p = .084$) or receptive vocabulary ($t = .196, p = .860$).

The reading level of all the children was assessed using the PROLEC-R battery of evaluation of reading processes (Cuetos

Table 1
Distribution of participants

	GENDER		LEVEL				AGE (Mean)	
	Male	Female	2°	3°	4°	5°		6°
<i>Dyslexics</i>	9	5	5	1	3	1	4	8.9 (SD=1.7)
<i>Controls</i>	9	5	5	1	3	1	4	9.2 (SD=1.9)
<i>Total</i>	18	10	10	2	6	2	8	

et al., 2007). As expected, the control group was superior to the dyslexic group, both in accuracy for reading words ($t = 8.715, p = .001$) and pseudowords ($t = 4.448, p = .002$) and in reading speed for both types of stimuli ($t = 6.970, p = .000; t = 7.331, p = .001$, respectively).

Instruments

The tasks used in this study were: a *picture naming task* (under the TOT paradigm) and a *phonological awareness task* (PECO, Ramos & Gordillo, 2006).

The picture-naming task. This consisted of 66 black-and-white line drawings, taken from Snodgrass and Vanderwart (1980). All of them had a middle or low frequency according to the Pérez, Alameda and Cuetos database (2003). Initially we started with 100 stimuli but, after a pilot study with four children, 44 drawings were removed, as they were not recognizable or did not reach the 100% name agreement. A recognition task was designed to be presented when the child was not able to retrieve the target word. This task included four written words in each sheet: a nonword phonologically similar to the target, a semantically related word, a phonologically similar word and the target word. The children were asked to name the pictures from a PowerPoint presentation on a laptop, and it was explained that if they did not know what it was or they knew the name but they were unable to recall it, they should say so. If the children did not know the name of the drawing, their response was classified as Don't Know (DK) and they were referred to the corresponding item of the recognition task. If there was a TOT phenomenon, the experimenter questioned the children about the semantics (meaning), morphology (gender) and phonology (phonemes and number of syllables) of the target word. The responses, as well as the possible spontaneous recoveries of the words, were recorded on a single sheet. If the children were not able to recover the word, they were referred to the recognition task.

In short, the following data were collected from the naming task:

- Know. Correct name of the drawing.
- Do not Know (DK). Manifestation of ignorance of the drawing.
- TOT. Tip of the tongue phenomenon.
- Partial semantic information. The child provides information about the meaning of the word or its utility, which would indicate that he has conceptual information about the target word, which can be retrieved.

- Partial morphological information. The child provides information on the gender of the target word, which indicates that he knows morphological information about it.
- Partial phonological information. The child provides information about the length or any of the phonemes of the target word, indicating a partial access to the phonology of the word.
- Spontaneous recovery. Spontaneous access of the target word, before going to the recognition task.
- Identification of the target word in the recognition task. The child is able to identify the target word when presented in a sheet, along with other terms (semantically related, phonologically similar pseudoword, phonologically similar word).

The test for the evaluation of phonological awareness: *PECO* (Ramos & Gordillo, 2007) assesses the phonological processing skills at the syllable and phoneme levels, that is, the ability to be aware and mentally manipulate the syllabic and phonemic structure of words. The test consists of six tasks:

1. *Syllable identification.* In this task, the child has to identify among others, a drawing whose name contains one syllable given by the evaluator.
2. *Phoneme identification.* Like the previous task, the child has to point to a picture whose name has a phoneme given by the evaluator.
3. *Syllable addition.* The child is presented with some cards that represent syllables and the child must combine them to make a word.
4. *Phoneme addition.* Similar to the previous task, the only difference being that one of the cards represents a single phoneme that the child should add to produce the correct word.
5. *Omission of syllable.* The child should say the name of some drawings omitting a syllable given by the evaluator.
6. *Failure phoneme.* Same as above, but in this case, the child must skip a given phoneme.

Procedure

The tasks were carried out in two sessions of approximately 30 minutes, during the months of February and March 2012. Each child was individually tested in a room without noise or visual distractions in the speech therapy center for dyslexic children, and at the school in the case of children without dyslexia.

The naming task was carried out in the first session and the test of phonological awareness in the second.

The application of PECO was directed by the manual itself. The trial items were applied to verify that the child understood what was asked in each type of task (identification, addition and omission). It was also found that children knew all the drawings in the test.

Data analysis

The analysis of the collected data was performed using the statistical program SPSS.19. Two types of analysis were conducted on the data: quantitative and qualitative.

The quantitative analysis included bivariate Pearson correlation tests, a stepwise regression analysis and multiple intergroup

	PROLEC-R				WISC	PEA-BODY
	Words		Pseudowords			
	Hits	Speed	Hits	Speed		
<i>Dyslexics</i>	32.2 (5.6)	96.8 (41.5)	26.7 (6.7)	126 (56.8)	104 (9.1)	96.5 (13.5)
<i>Controls</i>	38.1 (1.8)	34.3 (15.6)	33.8 (3.4)	62.1 (21.6)	111.5 (12.3)	95.6 (14)

Standard deviations are indicated in parentheses

comparisons using the Student *t*-test. In the qualitative analysis, on the other hand, intergroup comparisons were made in terms of contrasts of proportions.

Results

Quantitative analysis

The means of the two groups in Know, DK and TOT responses were compared using the Student *t*-test.

We found no significant differences between groups in the conditions Know (Average dyslexics = 49, *SD* = 8.08; controls = 53.57, *SD* = 4.98) and DK (Average dyslexics = 2.00, *SD* = 2.07; controls = 1.57, *SD* = 1.65), which makes sense if you consider that these data refer to the semantic level. Therefore, if children have a similar level in PEABODY, they will have similar results in DK and Know.

However, we did find a significant difference between the two groups in TOT, producing more events of this type in the dyslexic group (Average dyslexics = 5.43, *SD* = 3.85; controls = 2.71, *SD* = 2.5) ($t = 2.20, p = .037$) (See Figure 1).

Subsequently, a *bivariate Pearson correlation test* between the participants' punctuations in PECO test and their amount of TOT phenomena was conducted. A significant correlation ($r = -.448, p = .008$) was found between both tasks. Data suggest that the higher the score of the children in phonological awareness, the lower the number of the TOT phenomena.

A correlation was also carried out between the TOT and the different tasks of PECO (identification, addition and omission), and the results indicate that only the omission significantly correlated with TOT (default $r = -.393, p = .039$) (see Table 3).

Finally, an analysis of stepwise regression was conducted, in which the different tasks of PECO were included. The results show that the omission task explains 12% (adjusted $R^2 = 0.122$) of the variance of the TOT phenomena.

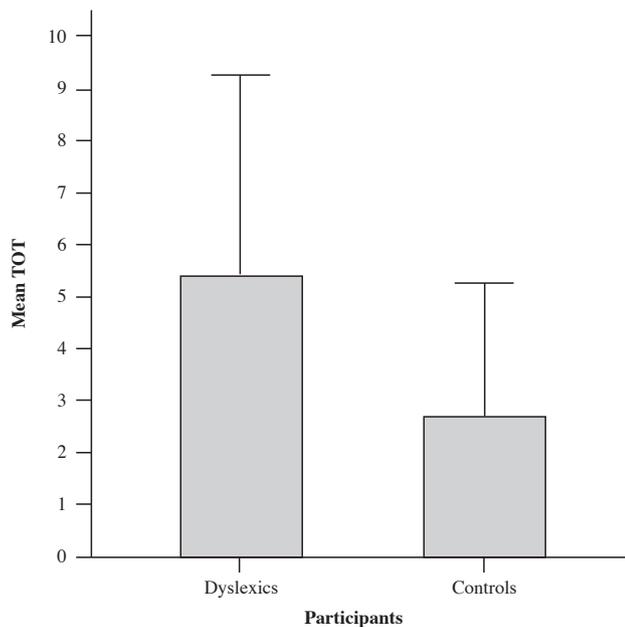


Figure 1. Mean and Standard deviation of TOT phenomena in dyslexic and control groups

Table 3
Correlations between participants' scores in PECO test and number of TOT phenomena

	Identification	Omission	Addition	Total
TOT	-.287 .138	-.393* .039	-.355 .064	-.448* .008

* The correlation is significant at level .05

Qualitative analysis

The information provided by the children about the stimuli of the naming task was classified as partial information (semantic, phonological and morphological), spontaneous recovery and recognition.

Once the information was classified according to this criterion, we calculated the percentage by group and category. From this analysis, we found that, from the total number of TOT phenomena in each of the groups, dyslexics are able to retrieve partial semantic information in 77.6% of cases, compared with 73.7% in controls; partial morphological information in 21%, compared with 18.4% controls; whereas partial phonological information could be retrieved only in 6.5% of the items, compared with 15.8% of controls. In terms of percentage of spontaneous recovery of the target word, we obtained 52.6% in the control group, compared with 31.5% in the dyslexic group. Finally, the percentage of recognition in the control group was 84% compared to 88% in dyslexics. However, a test for the contrast in proportions indicated that there is only significant difference between groups in the case of spontaneous recovery ($p = .05$), that is, the controls spontaneously recover a significantly higher percentage of words than dyslexics.

Table 4
Stepwise regression analysis between the tasks of the PECO test and the number of TOT phenomena

	R ²	BETA	SE	t value	p value
Omission	.154	-.393	.437	-2.177	.039

Discussion

The aim of this study was to study the recovery of the phonological form of words by developmental dyslexics in Spanish language using the TOT paradigm, as well as to address its possible relationship to phonological processing skills. This paradigm allows assessing on-line access to the phonological lexicon, and permits one to know the phonological difficulties of dyslexics, not taking into account the reading problems. (Hanly & Vandenberg, 2010).

The results indicated that developmental dyslexics produce more TOT phenomena than children without dyslexia, but they are not due to problems at the semantic level, as dyslexic children do not differ from the control group in terms of receptive vocabulary (PEABODY scores, Know and DK responses). This was corroborated by the absence of differences in the semantic information retrieval when the children were in a TOT situation, and in the recognition of the target word in the recognition task.

The phenomena, therefore, are not due to poor vocabulary or to a difficulty accessing the concept. Nor were there significant differences in the recovery of morphological and phonological information and in the recognition of the target word. The difference in the phonological retrieval percentage, although not significant, showed that dyslexics were able to retrieve less phonological information when they were in a TOT situation (6.5% versus 15.8%). The difference in the percentage of spontaneous recovery was significant, which means that children without dyslexia were able to spontaneously access the word before going to the recognition task; in addition to which, they did not fail to select the correct word in the recognition task in the few cases in which they were not able to recover the target word. The same results were found in the study of Hanly and Vandenberg (2010), indicating that the recognition task is less demanding than the naming task, since it only requires identifying the target word, whereas naming implies recovering a phonological form, which sometimes is not accessible.

These data confirm that dyslexic children can access semantic information the same as children without dyslexia, but have more difficulty accessing the phonology of the target word (phonological information and spontaneous recovery), as described in other studies (Faust & Sharfstein-Friedman, 2003; Faust et al., 2003; Hanly & Vandenberg, 2010). These data support the universality of phonological retrieval difficulties in dyslexic children and the

explanations from the models of oral language production (Levelt, 2001).

Moreover, dyslexic children showed a yield below the control group on tasks of phonological awareness, confirming phonological processing difficulties in this population (Elbro, 1998). The correlation between the TOT phenomena and the phonological awareness tasks shows that there is a common denominator between TOT phenomena and reading. These findings are in perfect consonance with the most underpinned theories about the causes of dyslexia: the phonological deficit and the double-deficit theories. They uphold that dyslexics show specific difficulties in performing phonological processing, that is, manipulation and retrieval of phonological information stored in long term memory, which manifests in both oral and reading levels (Raman, 2011; Ramus et al., 2003; Nation et al., 2001; Suárez-Coalla et al., 2012; Swan & Goswami, 1997). The speed of access to phonological information is also compromised (Bowers & Wolf, 2000; Novoa & Wolf, 1984; Wimmer, 1993; Wolf & Obregón, 1997).

In summary, this study corroborates that recovery problems of the phonological form of words are present in dyslexic children to a greater extent than in children without dyslexia, and that it is not a vocabulary problem, but a difficulty accessing the phonological form. This has important practical repercussions, as it could be put into practice when carrying out the rehabilitation of these children by implementing intervention programs that promote phonological retrieval of words.

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