

## Evidence for Top-Down Processing in Reading Comprehension of Children

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### ABSTRACT

The current research discusses the problem of the different reading processing models that prevail nowadays in Psychology. Here we find a duality between the bottom-up approach, which has been extensively studied, and the top-down approach, which has been scarcely investigated. We attempt to identify the moment in a child's development when top-down processing in reading comprehension starts working. The level of difficulty of the texts used to assess comprehension was experimentally manipulated by breaking up the structure of the words in order to prevent the use of bottom-up processing. The school year of the participating children was the second independent variable. The effects of both variables on reading comprehension were shown, besides the existence of top-down processing in children. The results suggest that top-down processing is present from very early ages, that it starts to develop around the second year of primary school and that its effectiveness is comparable to that of bottom-up processing in later school years.

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### Evidencia del procesamiento arriba-abajo en la comprensión lectora en niños

#### RESUMEN

El presente estudio aborda la problemática de los modelos de procesamiento de la lectura actualmente vigentes en la Psicología, donde existe un dualismo entre los modelos de procesamiento de abajo-arriba, ampliamente estudiados, y los modelos de procesamiento de arriba-abajo, investigados limitadamente. Buscamos conocer en qué momento del desarrollo evolutivo comienza a funcionar el procesamiento de arriba-abajo en la comprensión de la lectura. Se manipuló experimentalmente el nivel de dificultad de los textos utilizados para evaluar la comprensión, rompiendo la estructura de las palabras con el fin de imposibilitar el uso del procesamiento de abajo-arriba, y también se utilizó como segunda variable independiente el curso escolar de los participantes. Se comprobaron los efectos de ambas variables sobre la comprensión lectora y se probó la existencia del procesamiento desde arriba en niños. Los resultados mostraron que el procesamiento de arriba-abajo está presente desde edades muy tempranas, comenzando a desarrollarse desde segundo de primaria y alcanzando en los cursos superiores una efectividad equiparable al desarrollo del procesamiento desde abajo.

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Reading comprehension is one of the linguistic skills, specifically the one that refers to the interpretation of written discourse. This skill constitutes a "complex activity which simultaneously mobilises different representational levels and procedures" (Fayol, 2004, p. 191), since it is made up of linguistic components as well as cognitive, perceptual, attitudinal and sociological factors. In consequence, we can say that this ability goes beyond the strictly linguistic plane and takes in the complete process of text interpretation, from decoding

and linguistic comprehension to interpretation and evaluation. Thus, readers do not merely draw on information from the text but, for its interpretation, they also contribute their own experience and prior knowledge, etc. Clearly, then, reading goes far beyond word decoding. However, as Oakhill & Cain (2007, p. 63) note, "... reading comprehension does not necessarily develop automatically once word reading is proficient, but [...] is dependent on different skills and may need specific teaching" The important fact is to teach children something more than grapheme-phoneme connections.

We can find multiple studies in the literature that have approached the analysis of reading comprehension in its different aspects. From them, diverse theories about how this process is produced have been shaped. We will start by explaining the different points of view

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concerning comprehension processes, and which constitute the theoretical basis of this research.

On one hand, we find the traditional standpoint that has been used to understand the reading comprehension process; **bottom-up processing**, which is based mainly on the smallest linguistic units of a text from which particular knowledge schemas are activated. In this view, the comprehension process starts with words (their pronunciation, semantic value, morphology, etc.), which later give access to more extensive units (syntagmas, sentences, paragraphs) and finally to interpreting the whole text. Thus, the global message of the text is considered the sum of the information in each paragraph. The interpretation of each paragraph is determined by the previous interpretation of each sentence which is the result of interpreting each word, and so on.

**Top-down processing** is the opposite approach. This standpoint holds that comprehension begins with more global aspects, (the title, the basic idea of each paragraph, etc.) and subsequently, goes into smaller linguistic units. In this way, this type of processing is principally based on the prior knowledge the speaker has and in the communicative situation. To understand a message, we first start from the meaning of a paragraph (or chunk of text), and later turn to the sentences and words that make up the message. Top-down processing, therefore, allows the understanding of an ambiguous text because it activates high level schemas that guide the reading process. In this way, prior knowledge and reader expectations become essential elements in the comprehension process. Thus, when we confront a text, our previous experience guides our comprehension process. In addition, as some authors point out, we can assume that the comprehension ability in itself is developed at an early age (Kendeou, van den Broek, White, & Lynch, 2007). That is to say, children are already able to understand causal relationships and events that happen around them before facing texts. Both this ability and their growing knowledge of the world is precisely what allows them to understand what they read.

The two approaches outlined above in their extreme forms seem diametrically opposed. However, nowadays most researchers into text comprehension take the view that reading is an interactive process including both bottom-up and top-down components. As Kintsch (2005, p. 126) notes: "both top-down and bottom-up processes are integral parts of perception, problem solving, and comprehension. Without sensory input (bottom-up) we could neither perceive, nor comprehend, nor think. However, perception, comprehension, and thought would be equally impossible without a memory or knowledge component (top-down). It makes no sense to ask whether one is more important than the other: nothing happens without both. So the question for the theorist is not top-down or bottom-up, but how do these processes interact to produce fluent comprehension."

Starting from what has been previously presented, supporters of the bottom-up model state that good readers are better at analyzing words; whereas supporters of the top-down model maintain that good readers, above all, are capable of taking advantage of the context to a greater extent than less skilled readers. This point of view is held by authors like Garton & Pratt (2004). They believe children resort to context in order to understand the meaning of words. This conclusion is also based on studies of comprehension of pseudowords, where recognition seems to improve when children can resort to context in order to identify meaning (Tunmer & Chapman, 2004). These results lead authors such as Goodman and Smith (quoted in Tunmer & Chapman, 2004) to defend the view that teaching reading must be focused on showing beginners to use the context as a word recognition strategy. That is, "context influences text comprehension by facilitating the integration of new information into the reader's knowledge base" (Tunmer & Chapman, 2004, p. 200). In addition, from Kintsch' perspective of the CI model as mentioned above, text comprehension is highly interactive.

"Processes at many different levels interact – the perceptual processes involved in reading or listening, syntactic and semantic analysis, knowledge integration, as well as reasoning processes whenever they are necessary. All of these are both top-down and bottom-up. What we see is in part determined by what we expect to see" (Kintsch, 2005, p. 127). Therefore, prior knowledge plays a crucial role in the interpretation of texts.

Both top-down and bottom-up perspectives now form the basis of every study related to reading comprehension. However, several authors have developed different theories in order to explain reading comprehension in relation to memory. We will make a quick review of the theoretical accounts that try to explain how information is activated (or reactivated) from background knowledge during reading.

There are two main perspectives. First, a mechanism based in a memory-based process, which has a clear bottom-up emphasis. From this memory-based perspective, each word, phrase, or concept that a reader processes triggers an automatic spread of activation to other, related words and concepts in memory (for the text read so far and in background knowledge). In this account, the reader has little or no control over the information that is activated at any point during reading (Gerrig & McKoon, 1998; O'Brien, Rizzella, Albrecht, & Halleran, 1998). In other words, "to understand a discourse, readers have to relate the language input to background knowledge" (Sanford & Garrod, 2005, p. 205).

A key component of this memory-based process is resonance. The resonance model assumes that "incoming text information – as well as information already residing in working memory – serves as a signal to all long-term memory, including both the inactive portion of the discourse representation as well as general world knowledge" (Gerrig & O'Brien, 2005, p. 229). Within the memory-based perspective, the activation of background information takes place only through this passive resonance process, which is also a dumb and unrestricted process. As a result, the reactivation of information is not goal-directed and, therefore, any information related to the current contents of working memory has the potential to be activated (Gueraud, Harmon & Peracchi, 2005).

Another aspect emphasized by memory-based approaches is readiness, which is defined as having the appropriate information ready in the memory to use as a text unfolds. As Sanford & Garrod (2005) explain: "much of the evidence in favor of the memory-based approach relies on the demonstration that information is activated in memory regardless of whether it is relevant to interpreting the text" (Sanford & Garrod, 2005, p. 215).

In contrast with the previous perspective, constructionist models emphasize the top-down elements of the comprehension process (Myers & O'Brien, 1998). From this constructionist perspective, readers' goals and strategies play a central role in the activation of information from memory. Readers are described as actively striving to achieve understanding of the text, strategically activating information to satisfy their search for meaning (Graesser, Singer, & Trabasso, 1994). Readers are also reflected as problem solvers, actively searching for linking actions and events to their causes (e.g., Black & Bower, 1980; Graesser et al., 1994; Trabasso, Secco, & van den Broek, 1984; van den Broek, 1990, quoted in Myers & O'Brien, 1998). Moreover, a fundamental assumption is that "readers make every effort to establish local and global coherence" (Graesser et al., 1994, p. 379, quoted in Myers & O'Brien, 1998).

An example of a constructionist model is the explanation-based view. In contrast with the memory-based view, as Gueraud et al. (2005) explain, within the explanation-based process, "the reactivation of background information, whether passive or active, is goal-directed; that is, the reader will only seek information that is relevant and in most instances, this information will facilitate the integration process (Gueraud et al., 2005, p. 244).

Although both types of processes intuitively seem necessary during comprehension, because they are often studied separately

they have traditionally been presented as competing accounts of underlying reading mechanisms. Indeed, the competition between these accounts has, at times, led to acrimonious exchanges between researchers. Only recently have memory-based and constructionist processes been explicitly considered as complementary and perhaps mutually supportive, as happened with bottom-up and top-down processes. Another example of this new perspective is the contribution-integration model (Kintsch, 2005), which we have already mentioned above. This model describes “the interplay between top-down and bottom-up processes in comprehension: how top-down processes guide comprehension and how bottom-up processes constrain it. At every level of analysis – from basic linguistic processing to knowledge integration – both top-down and bottom-up processes jointly determine the nature of the mental representations formed in comprehension” (Kintsch, 2005, p.125).

Theoretical accounts now suggest that a failure to incorporate both mechanisms results in impoverished theories (e.g., Kintsch, 1998; van den Broek, Rapp, & Kendeou, 2005). For example, leaving out more automatic mechanisms fails to explain how multiple, at times even irrelevant meanings, are quickly activated during reading (Kintsch, 1998; O’Brien, et al., 1998). Additionally, ignoring strategic components such as the reader’s specific goals or particular demands of the task (e.g., Linderholm & van den Broek, 2002) fails to account for how those irrelevant meanings may “fall away” during comprehension.

As we have already explained, there are different standpoints about how the comprehension process is produced. The majority of studies maintain, in general, the bottom-up processing model. Therefore, very little research into top-down processing has been carried out. Our research does not deny the existence and importance of bottom-up processing, however it goes further than most studies in its search for evidence for the functioning of top-down processing in order to know how good readers use context when reading. The aim of comprehension “involves the construction of a clear, complete, and integrated representation of a text’s meaning” (Oakhill & Cain, 2007, p. 64); and, for this to be possible, we cannot set aside any of the important elements of this process, as for example, the reader’s prior knowledge and the context of the text.

For the reasons explained above, a focus on top-down processing is the principal object of study of this research. Knowledge of how this type of processing develops and an understanding of how text comprehension abilities develop as children are learning to read are key elements to understand the development of reading competence. And this is the main reason for carrying out this research. Its importance lies in the fact that knowing how children use both their prior knowledge and the context to approach reading, will perhaps lead to the development of effective teaching strategies that contribute to comprehension.

## Objectives

The overall objective of this research is to study at which moment of children’s development top-down processing starts working in reading comprehension.

More specific objectives focus on the following aspects:

First of all, we will try to determine if there are differences in reading comprehension performance between students of different ages when reading texts that require the use of top-down processing. Therefore, our first hypothesis is:

*H1:* There will be signs of top-down processing in children of 4th and 6th grade of Primary Education due to the development of their reading ability. However, this will not occur in children of 2nd grade, who are still learning to read.

Finally, we also attempt to determine if there are differences in reading comprehension performance when reading texts that require

the use of top-down processing, depending on the different difficulty levels of the texts, in each school year. Assuming this, we consider:

*H2:* The difficulty levels of the texts will not reduce the reading comprehension if top-down processing already exists.

## Method

### Participants

The initial sample for this study was composed by 141 participants from the Colegio Parque Conde de Orgaz (International Montessori School), placed in Madrid. It is a private school, mixed and secular, that offers a bilingual education in English.

After the assessment of the participants’ answers to the questionnaires, finally the data analysis were made on a final sample of 130 pupils, specifically by the groups of 2<sup>nd</sup> grade of Primary (42 students, 17 male and 25 female), 4<sup>th</sup> grade of Primary (48 students, 22 male and 26 female) and 6<sup>th</sup> grade of Primary (40 students, 16 male 24 female). To sum up, the final sample was composed of 130 participants aged 6 to 11, from which 55 were boys and 75 were girls. All the participants were rewarded for their participation in three occasions. This reward consisted of three candies or stickers that participants could choose.

### Materials

We used three short stories for children from a book oriented to the improvement of reading and comprehension for children of the first course of Primary education (Alzu y López-Sáez, 2003). The three short stories were *La niña que era amiga de la Luna* (Gesualdi, 2003), *El mago Gaspar* (Díaz, 2003), and *La túnica de Alim* (Alguacil, 2003).

The short stories’ length was reduced in order to limit their psychical area to a DIN-A4 paper in Times New Roman font size 14, using also an image extracted from the original children’s short stories. For this transformation some of the non-essential phrases and paragraphs were removed and some non-frequent words to children were exchanged for more frequent words that, even without being synonyms, kept the coherence of the text. For example, the word *tracking* (glasses) was replaced for *magic* (glasses), keeping the rest of the text identical to the original.

The adaptations of the area extension were needed to adjust the texts to the youngest children’s reading ability and for the maintenance of the task motivation. However, the word adaptations were done in order to assist the recognition of words once the texts were submitted to the necessary changes to create the experimental conditions. Those modifications consisted in messing up the order of the letters in each word of the text, forming pseudowords this way.

Three different versions of each short story were created with different difficulty levels: neutral version (normal text, without pseudowords), easily messed up words and difficult messed up words. There were finally nine morphologically different short stories. Below, in table 1, show an example of the different difficulty levels of one of the short stories.

In order to establish the different difficulty levels, the variation of the words was effectuated by a series of specific rules, in view of replicability of the research. All these rules are summed up in the Table 2 and described below: every written accent was removed as they are not necessary to the comprehension of pseudowords; both the titles and the pictures of the short stories were kept in order to facilitate comprehension through contextual clues. Regarding the formation of pseudowords, it was taken as general rule the variation of the sequence of letters that compose the word, maintaining the first and the last letter of each word in the correct place. Obeying this rule, words composed by two or three letters did not undergo any variation. However, two exceptions were established: proper names

**Table 1**  
Three versions of the same paragraph used in this study

Neutral version: "El niño vio que el animal corría tras su amigo Salam. Alim echó a correr a toda velocidad detrás del tigre. Cuando lo alcanzó, se quedó parado, muy quieto, sin respirar, delante del animal."
Easily messed up version: "El niño vio que el animal corria tras su aimgo Salam. Alim echo a correr a toda velocidad detras del tigre. Cuando lo alcanzo, se quedo parado, muy quieto, sin respirar, delante del animal."
Difficult messed up version: "El niño vio que el animal corria tras su agimo Salam. Alim echo a correr a toda velocidad detras del tigre. Cuando lo alcanzo, se quedo parado, muy quieto, sin respirar, delante del animal."

will not be modified; and the letters "ch" and "ll" will be considered as one single letter and will always appear together.

In the easily messed up version we made a variation of the general rule with the intention of facilitating the identification of the messed up words. The first and the last two letters of each word were unchanged, instead of just the first and the last letter. In this way, four letters words were not modified. And five letters words were the exception, as they were modified, following the general rule of the neutral version. Furthermore, if one word was doubled in the same text, its respective pseudoword will be always the same. To sum up, this is the easy difficulty version because fewer pseudowords appear in the texts. In addition, there is a higher morphological similarity between words and pseudowords, as the appearance of more than three consecutive consonants was avoided, and the original order of vowels was maintained. As a result, pseudowords in this version were more intuitive.

Regarding the difficult messed up version, the general rule of keeping the first and the last letter of each word unchanged was maintained. Letter combinations were not made in an intuitive way, and different letter combinations were used for doubled words in the texts, with the exception of four letters words, as there is only one possible combination. This represents an increase in difficulty due to the lack of familiarity with the words previously read in the text, and the larger number of pseudowords.

In order to assess the reading comprehension, we used a questionnaire for each short story. The same questionnaire was always used independently of the short story version used. In this way, if we find differences in reading comprehension we can say that the different versions of the short stories are the ones that are causing those differences, not the questions. Each questionnaire was composed of ten multiple-choice questions with three answer options, from which only one was correct.

With the intention of keeping the participants' motivation, the questionnaires were presented with five questions per DIN-A4 from which. One question was always presented by image format, similar to the questions showed in the book from where the short stories were taken (Alzu y López-Sáez, 2003). All questions were designed to assess comprehension; they were presented in chronological order according to the short stories. Finally, we included a more difficult question based on inferences that asked about the story's moral.

With the three versions designed from each short story and the comprehension questionnaires, six booklets were created. Each one of them contained the three short stories, in the three different versions, with their related comprehension questionnaires. This way, every participant passed through the three experimental conditions: neutral, easily messed up and difficult messed up, always in this order. The stories and their different versions were balanced with the intention of guaranteeing that the obtained results were caused by

**Table 2**  
Specific rules established to create the different difficulty levels

	Easily messed up words	Difficult messed up words
Type of general combination	The first and the last two letters of each word were unchanged. Intuitive combination (few consecutive consonants and the original order of vowels was maintained)	The first and the last letter of each word were unchanged. Not so intuitive combination
4 letters words	Unchanged	Changed (only one possible combination)
5 letters word	Modified	Modified
Repeated word in the text	Always the same pseudoword	The same word presented different sequence each time

the experimental condition and not by a concrete version of the short stories.

Finally, we used three candies or stickers per participant in order to maintain the motivation during the execution of the task.

#### Procedure

It was used a 3x3 quasi-experimental design. The dependent variable was reading comprehension, operationalized by the results obtained with the ten multiple-choice questionnaire related to the previously read short story. The first independent variable is the school year, with three levels (second grade, fourth grade and sixth grade) and the second independent variable is the difficulty level, with three levels (neutral, easily messed up and difficult messed up). The school year is a quasi-experimental variable and because of this it is an inter-subject distributed variable. The difficulty level was administrated intra-subject.

The instructions given to the participants were imparted by two researchers that stayed in the class during all the experimental process. Both researchers introduced themselves as university students that needed the pupils' help for a work, which consisted of reading three short stories and answering to some questions. They were told that the second and the third story were mysterious (without saying that the letters of the words were messed up). It was also mentioned that they would be rewarded every time they finished the questionnaire of each short story (they could choose between a candy or a sticker). Finally, the researchers wrote an easy difficult example sentence on the blackboard, taken from another short story different to the ones used in the task (Castro, 2003): *Me entancan los viajes espaciales. Cuando sea mayor, viajaré al espacio.* (Me encantan los viajes espaciales. Cuando sea mayor, viajaré al espacio). A volunteer was asked to read the example sentence aloud. Afterwards, they were informed that they had no time limit to solve the task, and that the short stories were different, so they should work individually on them.

After the instructions, the first story was randomly administrated to the participants, taking care of keeping a similar number of subjects for each experimental condition. For that we previously obtained a list with the number of subjects from each primary class. Each model was numbered in order to avoid mistakes in the distribution of the booklets and ensuring the identity of the participants.

The first short story given to participants was always the neutral version, in order to assess the base comprehension level of the subject. It was always followed by the easy messed up version, and lastly the difficult messed up version was given.

If the participants had any doubt about a particular pseudoword, they were told not to worry and to continue reading even if they did not know a specific word. If the participants asked about any of the questions of the questionnaire, they were told to check the story

again; if they could not find the answer, they should leave the question blank.

Once all the participants had finished the task and handed over the third short story, researchers asked three last questions aloud in order to collect some qualitative information about the task. They asked the children if they have had any difficulty reading the stories, if they knew what happened to the stories and if they have had problems with any specific question of the questionnaire.

## Results

The main objective of the quantitative analysis is to determine if there is an effect from the independent variables, school year and difficulty level, on the independent variable, reading comprehension. We also want to determine if an interaction effect between the effects of the independent variables exists.

Before explaining these analyses, it is also important to stand out some other analyses, made with the objective of excluding possible masked variables.

The first analysis concludes with the exclusion of 11 subjects from the experimental sample. This decision was motivated because the participants omitted one page from the questionnaire, having five consecutive questions without an answer. Those subjects were excluded in order to avoid the distortion of the analysis.

Then we proved that none of the used models caused a significant different performance from the other models. All the models have a very similar number of participants, this way, all models represent a similar percentage of the sample, concretely; 17.7, 17.7, 16.2, 16.2, 16.2 y 16.2, according with the order in which the models were mentioned before. In order to prove that there were not significant differences between the frequencies of the different models we used a Chi-square test (with a statistical  $\chi^2 = .246$  with five degrees of freedom, associated with a  $p = .999$ ) that allowed us to say that the proportion from each model was equivalent. We also proved that none of the models worked differently from the rest with respect to the reading comprehension, we used a one factor completed randomized ANOVA's procedure in order to analyze the obtained global scores from each model. With this test we can say (with a statistical  $F = .800$  associated with  $p = .776$ ) that there are no significant differences between the averages of comprehension for any of the used models.

Afterwards, we analyzed the independent variables' effects. We used a repeated measures two factors ANOVA's. The repeated measures factor was the difficulty level, with three levels (neutral/easily messed up words/ difficult messed up words), and the school year was a completed randomized factor, also with three levels (second grade/ fourth grade/ sixth grade).

As Figure 1 shows, the two factors' main effects were supported by the analysis, concluding a main effect from the independent variables on the dependent variable, reading comprehension. For the difficulty level we found a statistical  $F = 14.67$  associated with  $p = .000$  and a statistical  $F = 41.74$  associated with  $p = .000$  for the school year. The interaction effect between difficulty level and school year was also revealed as significant (with a statistical  $F = 11.26$  associated with  $p = .00$ ).

In a more exhaustive analysis of these effects, significant differences were shown for the effect of the school year over the reading comprehension in all the difficulty levels; excepting the condition of easily messed up words and difficult messed up words between fourth and sixth grade of primary. This suggests a tendency for the increase of the reading comprehension while the school year increases too. However, for the difficulty level, we only found significant differences for the three difficulty levels with the second grade participants, reducing the comprehension score while the difficulty level increases, opposite from the fourth and sixth grade participants that did not show differences.

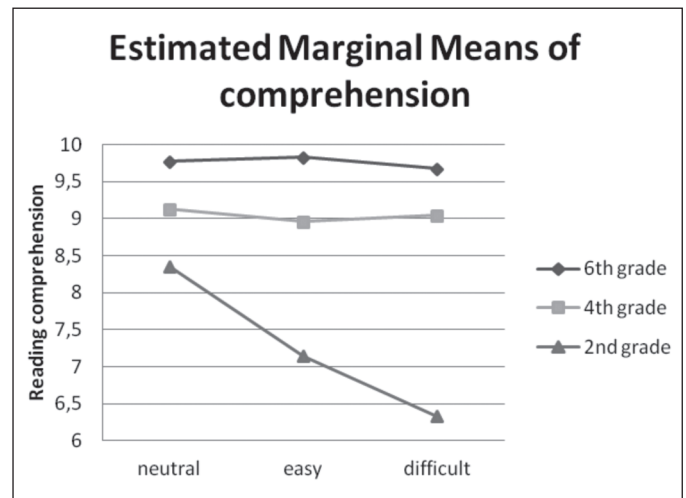


Figure 1. Estimated Marginal Means of Comprehension

Regarding the qualitative information collected, differences for the independent variable school year were found between second grade of primary and the superior grades (fourth and sixth grade). In relation to the task execution, the superior grades' participants said they found the task easy, without the least difficulty with the questions. On the other hand, without the least difficulty with the questions. Some of them declared that the task had been easy, but others, that it had been a bit difficult. In relation with the questionnaire, we recorded some declarations like "some of the questions were difficult because the story was hard to understand", "I did not find some answers in the stories". In relation with the questions about what was happening to the stories, in second grade we recorded explanations like these: "the words are strange", "the letters are disorganized". The youngest participants had also some doubts: "In which language is this?" or "I do not understand this word".

Besides, researchers observed differences in the duration of the task depending on the school year. Sixth graders completed the task in a shorter time than the youngest participants. Approximately, 50 minutes for sixth graders, 50 minutes for fourth graders and about 90 minutes for second graders. This is only an estimation, as time was not controlled objectively. Furthermore, second graders showed big intra-group differences, which did not appear in fourth and sixth grade of primary education.

## Discussion

The present research was carried out in order to find evidence for top-down process in the reading comprehension of young children. An assumption was that both bottom-up and top-down processes are complementary and both are needed for effective comprehension (Gueraud & O'Brien, 2005). Our objective was to test if this process works in children that have already learned to read and in children that are still learning. The aim was to investigate the origin and development of this processing.

In accordance with our hypotheses, the results show the presence of top-down processing in children of 4<sup>th</sup> and 6<sup>th</sup> grade of Primary Education, since they maintain a steady performance in comprehension, just as happens with normal readers (Myers & O'Brien, 1998; Graesser, Singer, & Trabasso, 1994) even when the difficulty level is manipulated (by breaking up word structure), and thereby complicating the use of bottom-up processing. Blocking, in an experimental way, the use of the said type of processing, we can assume that the only possible option to explain such good results in the participants' reading comprehension is the use of another type of processing, in this case top-down processing, which plays an active

role in the process of comprehension by allowing readers to make use of the context and their prior knowledge in order to understand the information in the texts and give them coherence (Trabasso, Secco, & van den Broek, 1984; van den Broek, 1990; Graesser et al., 1994) quoted in Myers & O'Brien (1998).

Surprisingly, the results show an unexpectedly good performance in the youngest children, as it had been hypothesized they would not be users of top-down processing. These participants obtained quite high scores in the comprehension questions, which leads us to think that this type of processing is already working at that age. However, their performance in comprehension worsens as difficulty increases and the use of bottom-up processing is prevented. This shows us that top-down processing is still in development and it is not yet on a level with bottom-up processing. This can be due to the short period of time these children have been reading.

Any way, we can say that top-down processing appears in very young children, almost since they come into contact with reading. It develops in a quick and autonomous way, and in parallel to bottom-up processing, supporting theories about the complementarity of both processes (Kintsch, 2005). Once it begins to develop, its use is consistent; increasing the performance of this type of processing as reading improves. So, thanks to this processing, as children grow up, their reading comprehension improves considerably, and they obtain better access to the texts' meaning (Myers & O'Brien, 1998).

In addition, top-down processing involves very intuitive learning. It is not taught at school, but children seem to acquire it without problems, in relation with Kintsch's idea; both, top-down and bottom-up processes are integral parts of comprehension, nothing happens without both (Kintsch, 2005). However, due to the importance of the context to guide children's inferences while reading, assisting its role while learning to read could produce positive effects resulting in more rapid and more efficient acquisition, providing in turn greater understanding and speed.

As we have already mentioned, children approach reading with prior knowledge which they actively use in the comprehension of the texts they read (Graesser, Singer & Trabasso, 1994), and the results of this research support the importance of the activation of this prior knowledge. Therefore, in the development of reading competence, it is not so important that children understand every word of the text, but it is necessary to strengthen the facilitating role of the context in the integration process (Gueraud, et al., 2005).

This research has tried to shed light on, in our view somewhat overlooked, top-down processing, with the intention of increasing the psychological knowledge of reading in order to open future areas for future research. We consider it important to continue this research and develop new studies with different populations, in particular with not bilingual children, because we think that this variable could produce an effect on comprehension levels due to the procedure with which children are taught to read in English.

A further possibility is to change the contextual information provided. In the present study, participants had access to titles and drawings that provided them with contextual information. By omitting the drawings or the titles we can change the contextual information available and assess whether this influences top-down processes and comprehension. This is not an issue in the present research due to the fact that all the experimental conditions used the same contextual clues, so this variable could not have produced an effect on our results.

Another option would be to establish new assessment questions to measure reading comprehension supported by a group of

pedagogues and professionals with greater experience in education.

### Conflict of interest

The authors of this article declare no conflicts of interest.

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