Rapid naming components and its relation to reading comprehension in Spanish

Los componentes de la velocidad de denominación y su relación con la comprensión lectora en español

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Abstract

La velocidad de denominación es uno de los principales predictores de la lectura, especialmente en ortografías transparentes como el español. Si bien ha sido consistente-mente estudiada al nivel de la lectura de palabras, pocos trabajos tratan de explicar su relación con la comprensión lectora. Desde la perspectiva del análisis de los componentes de la velocidad de denominación (pausas entre ítems y tiempos de articulación), esta investigación exploró la relación entre la velocidad de denominación y la comprensión lectora en estudiantes chilenos de primero a cuarto de educación básica. Además, se evaluó si esta relación se puede explicar por las habilidades en la precisión de lectura de palabras y fluidez lectora. Los resultados muestran que ambos componentes comparten una cantidad significativa de varianza con la comprensión. Sin embargo, comparativamente, es mayor la relación de las pausas entre ítems con la comprensión. Además, la precisión en la lectura de palabras y la fluidez son variables que median la relación entre la velocidad de denominación y la comprensión lectora. Los resultados se discuten en el contexto de la velocidad de denominación como una variable relacionada con la fluidez en la lectura y la utilidad de su evaluación en el contexto escolar.

Rapid naming is one of the main reading predictors, especially in transparent orthographies such as Spanish. Although it has been consistently studied at the level of reading words, few works try to explain its relationship with reading comprehension. From the perspective of the analysis of the rapid naming components: pauses between items and articulation times; this research explored the relationship between rapid naming and reading comprehension in Chilean students from first to fourth grade. In addition, we evaluated whether this relationship is explained by accuracy of reading words and fluency. Results show that both components share a significant amount of variance with comprehension. However, the relation between pauses is the greatest with comprehension. In addition, word reading accuracy and fluency are variables that mediate the relationship between rapid naming and reading comprehension. Results are discussed in the context of rapid naming as a variable related to fluency in reading and the usefulness of its evaluation in school context.
Introduction

Naming pace (hereinafter “NP”) is the ability to sequentially name a series of familiar stimuli such as digits, letters, colours or figures as quickly and accurately as possible (Wolf, 1991). It is one of the major reading predictors, both in alphabetical orthographies (Furnes & Samuelsson, 2011; Gómez-Velázquez, González-Garrido, Zarabozo & Amano; 2010; Papadopoulos, Spanoudis & Georgiou, 2016; Powel, Stainthorp, Stuart, Garwood & Quinlan, 2007) and non-alphabetical orthographies such as the Chinese and Japanese orthographies (Kobayashi, Haynes, Macaruso, Hook & Kato, 2005; Shum & Au, 2017). Although most studies approach the link between NP and the fluency and accuracy when reading words (Di-Filippo et al., 2005; Katzir et al., 2006), a link between NP and reading comprehension has also been found (Ho et al., 2017; Weng, Li y Li, 2016). In this sense, it is reported that NP explains between 3.1% and 16% of reading comprehension (Johnston & Kirby, 2006; Joshi & Aaron, 2000). Nevertheless, it is also known that certain variables such as vocabulary and fluency (Poulsen, Juul & Elbro, 2015), working memory and processing speed (Christopher et al., 2012, Weng et al. 2016) have an impact on this link as well.

Attempts have been made to approach the link between NP and reading comprehension (hereinafter, RC) from three different perspectives: according to the first approach, NP has a direct impact on word recognition and fluency, which in turn have a direct impact on RC (Johnston & Kirby, 2006). The second approach proposes a mediation model between NP and RC through reading fluency. In this sense, Kirby, Parrila & Pfeiffer (2003) state that NP is a precursor of fluency and the latter is a key element of RC, which explains why it is necessary to understand what is read (Kim, Wagner & Foster, 2011; Lai, Benjamin, Schwanenflugel & Kuhn, 2014). In last place, the third approach suggests that the processes involved in NP, such as working memory and processing speed could also be linked to RC and hence the link between them (Arnell, Joanisse, Klein, Bussery & Tannock, 2009; Brooks, Berninger & Abbott, 2011).

Furthermore, the NP paradigm used to evaluate the link with RC is significant. Evidence show that alphanumerical paradigms (digits and letters) explain greater reading variance (Manis, Doi & Bhadha, 2000; Savage et al., 2005). Therefore, it can be assumed that the nature of NP with reading of words is partly phonological and orthographical (Georgiou, Parrila & Kirby 2009; Torgessen, Wagner, Rashotte, Burgess & Hecht, 1997). Nevertheless, evidence is not conclusive in the case of the link with RC. It has also been found that non-alphanumerical NP paradigms (colours and figures) are more linked to RC because they involve a greater level of access to semantic information rather than to phonological information (Poulsen et al., 2013). Furthermore, as far as Non-alphanumerical paradigms are free from the influence of reading literacy, they withdraw the effect of this variable when linking it to RC; therefore, they are an indicator of the automation of lexical-semantic retrieval (Johnston & Kirby, 2006; Nation, Marshall & Snowling, 2001; Perfetti, 2007).

According to some authors, the key to understand the link between NP and reading does not lie in the total time assigned to it but in its two main components: pauses between items and the time to articulate them (Georgiou, et al, 2014; Georgiou, Papadopoulos & Kaizer, 2014). Articulation times reflect the level of familiarity with the stimulus that is to be named, whilst pauses represent the information retrieval process through long-term memory (Neuhaus, Foorman, Francis & Carlson, 2001). Research has shown that pauses are the component that is more frequently linked to reading compared to articulation times in the early stages of reading (Georgiou et al., 2014; Georgiou, Parrila & Kirby, 2009). The link between the components of NP and RC is hardly addressed in this field. Li, Kirby & Georgiou (2011) report that
pauses of NP-digits explain around 15% of RC only in year 6 of primary education, but no effect was found among students of year 2 and 4 of primary education. On their part, Neuhaus et al., (2001) report that pauses of NP-letters explain 49% of variance in RC among students of year 1 of primary education and 34% in the case of students of year 2 of primary education. In this same study, articulation times were not linked to RC in any of the school years under study. Likewise, in a study conducted with children aged between 8 and 14, Li et al. (2009) report that pauses of NP-letters and NP-digits explain 12% and 14% of RC, respectively, whilst articulation times are not linked.

Although the results show that pauses are a component of NP that is better linked to RC, there are three limitations regarding these results that should be noted. The first limitation is that only the direct link between the components of NP and RC has been explored and that the mediating effect of fluency and reading accuracy has not been considered. In second place, although it is known that the NP-type paradigm (Alphanumerical, Non-alphanumerical) affects the scale of the impact on RC (Johnston & Kirby, 2006; Poulsen et al., 2013), there is no verification as to whether this happens at the level of components, pauses and articulation levels. The foregoing was only addressed in the study conducted by Li et al. (2009), but only in English. In this sense, the third limitation, i.e. the link between NP and RC, has not been analysed in a transparent orthography such as the Spanish orthography. Given the impact of orthographic depth, this is important to explain reading development (Share, 2008). The depth of orthographic systems is defined by the consistency of the grapheme-phoneme link; for this reason, those orthographic systems where this link is poorly consistent and more than one phoneme corresponds to each grapheme, are defined as opaque, while those systems where this link is more consistent are classified as transparent orthographic systems (Katz & Frost, 1992). In this continuum, English is at the very end of the opacity spectrum, while Finish and Spanish are at the end of orthographic transparency (Bravo-Valdivieso & Escobar, 2014; Katz & Frost, 1992). The depth of orthographic systems is important because it explains the learning speed of reading and the cognitive processes involved in its development (Seymour, Aro & Erskine, 2003; Ziegler et al., 2010). Prior research was also conducted in opaque orthographies such as English orthography (Neuhaus, Foorman, Francis & Carlson, 2001; Li et al., 2011) and non-alphabetical orthographies, such as Chinese orthography (Li et al., 2009). As far as NP is concerned, it is shown that it is a variable that depends on the orthographic system (Araújo, Reis, Petersson & Faísca, 2015; López-Escribano, Sánchez-Hipola, Suro-Sánchez & Leal-Carretero, 2014), which also happens to RC (Florit & Cain, 2011; Tobia & Bonifacci, 2015).

This study explores the link between the components of NP, pauses between items and articulation times, and RC in Chilean students of the first cycle of primary education. Additionally, it aims at determining whether the link between the components of NP and RC varies depending on the type of NP task used: Alphanumerical (letters) or Non-alphanumerical (figures). This study is important as there are no precedents in Spanish that deal with this link, just as there are no previous studies on the impact of fluency and reading accuracy to explain this link.

On the basis of the theoretical background presented, we assume that: a) NP will be correlated to RC, including both the task of letters and figures, NP-letters being the task that reports a higher level of correlation; b) the component that will share a higher level of variance with RC will be the pauses above articulation times; c) pauses in alphanumerical tasks (letters) will better explain the link with RC, and; d) the level of variance that explains the pauses of NP and RC will decrease after controlling the impact of accuracy when reading words and fluency, as these two variables play a mediating role in this link.
Method

Participants

This study has a non-selected sample of 110 children studying the first cycle of primary education: 23 children from year 1 ($N=82.66$, $SD=4.59$), 28 from year 2 ($N=94.24$, $SD=4.21$), 28 from year 3 ($N=106.17$, $SD=3.87$) and 31 from year 3 ($N=117.77$, $SD=5.08$). They all attend working-class schools in the city of Santiago de Chile. The school has a mixed approach to teach reading, in other words, the teachers combine aspects of the synthetic approaches, such as highlighting the phonic components of language, and global methods such as presenting words at the beginning of the reading learning process (Lebrero & Lebrero, 1996). The participants showed an appropriate emotional, sensorial and cognitive development, as reported by the teachers and verified by the evaluator and conducting the tests. All the participants speak Spanish and no one of them repeated any school year. The supervising teachers signed the informed consent and the participants gave their consent to this study.

Instruments

**Naming pace.** It was evaluated by adapting the paradigm of Denckla and Rudel (1974). This task consists in naming stimuli as quickly and accurately as possible from left to right and from top to bottom. The participants were evaluated using the tasks of letters (a,o,s,p,d) and figures (ball, pencil, fish, car, house). The paradigms were presented on a sheet where the 5 stimuli were repeated 10 times randomly, creating a 5x10 grill. Before starting the test, the stimuli were presented to ensure that the participants were familiar with them. The time used to perform the task was quantified in seconds.

**Reading comprehension.** It was evaluated using the Comprehension test of the *Batería III Woodcock-Muñoz*, standardised to the Spanish language (Muñoz, Woodcock, McGrew & Mather, 2005). It is a typically cloze task, where paragraphs with one key word missing marked with a blank are read out loud. The texts become more difficult in terms of length and vocabulary as the test progresses. The score ranges from 0 to 47 points. The authors report an alpha amounting to .83 for the ages under study.

**Reading fluency.** The Fluency test of the *Batería III Woodcock-Muñoz* (Muñoz et al., 2005) was used. The participants had 180 seconds to read definitions out loud and determine whether they were true or false by circling the right answer (example: cows are green). The final score is obtained by deducting the wrong answers from the correct answers. The scores range from 0 to 115 points. An alpha amounting to .90 regarding the participants’ age is reported.

**Reading words.** The Word identification test of the *Batería III Woodcock-Muñoz* (Muñoz et al., 2005) was used. The participants read out loud a list of 76 words; after 6 consecutive errors, the test is suspended. Difficulty is determined by the frequency and the length of the words used. Reading accuracy is awarded points. The authors report an alpha of .94.

**Vocabulary.** The expressive aspect of language was evaluated at the level of single words using the Vocabulary on pictures test of *Batería III Woodcock-Muñoz* (Muñoz et al., 2005). Some pictures are presented in a booklet and are identified by naming the objects shown in the pictures. Difficulty is determined by familiarity with the pictures. The scores range from 0 to 46 points. An alpha amounting to .77 was reported.

**Proceeding and handling of the audio files**

The participants were evaluated individually in a quiet room, lit and free of distraction, located in their own school. The evaluations were performed during the second half of the school year. The tests were administered by a team of 6 evaluators, with a background in psychology, who had been previously trained to
administer the tests in a standardised way. Each participant was evaluated only once in one-hour sessions. The tests were applied in a counterbalanced way to control fatigue as they were being performed.

The audio files of the NP tasks were recorded using Audacity©. Environmental noise was reduced thanks to this software and the audio files were converted to monaural format. The audio files were handled using the PRAAT software (Boersma & Weenink, 2014) to identify articulation times and pauses between items. The audio files underwent four types of clean-ups, described in detail by Georgiou et al. (2008): a) Errors, when an error was made, the pause before it was removed, as well as the stimulus incorrectly named and the pause after it; b) Self-corrections, if the children corrected their error spontaneously, the pauses between the two correct articulations were removed; c) Omitting stimuli, the articulation time between two correct articulations and the following pause were removed; d) Behaviours alien to the task, such as sneezing, talking to the evaluator or cheering up between two articulations were removed.

### Results

**What is the scale of the link between NP and RC?**

Prior to the analysis, both the task NP-Letters and the task NP-Figures and their respective components were positively skewed and transformed using the logarithm with the base of 10, whose proceeding was described by Tabachnik & Fidell (2007). The descriptive statistics of the variables under study are shown in Table 1, as well as the partial correlations between the variables upon being controlled by the vocabulary.

The results show that NP-Letters is moderately and negatively correlated to the measurement of RC and share around 43% of variance. This correlation is negative, as NP is an assigned measured in seconds whereby the less time the better performance. On the other hand, NP-Figures is also moderately correlated to RC, the variables sharing around 15% of variance. These results suggest that NP is correlated to RC, regardless of the type of task used (letters or figures). Nevertheless, the scale of the correlation between the task NP-Letters and RC is greater than the task NP-Figures.

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Table 1.

<table>
<thead>
<tr>
<th></th>
<th>N (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NP-L</td>
<td>41.04 (17.18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PT-L</td>
<td>20.14 (11.36)</td>
<td>.906***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>AT-L</td>
<td>17.42 (3.45)</td>
<td>.586***</td>
<td>.443***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>NP-F</td>
<td>59.18 (14.33)</td>
<td>.634***</td>
<td>.638***</td>
<td>.379***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PT-F</td>
<td>26.56 (9.64)</td>
<td>.548***</td>
<td>.583***</td>
<td>.223*</td>
<td>.864***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>AT-F</td>
<td>28.67 (4.73)</td>
<td>.345**</td>
<td>.322**</td>
<td>.620***</td>
<td>.449***</td>
<td>.203*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Comp</td>
<td>22.61 (6.57)</td>
<td>- .658***</td>
<td>- .625***</td>
<td>- .413***</td>
<td>- .383***</td>
<td>- .311*</td>
<td>- .151</td>
<td>.765***</td>
</tr>
<tr>
<td>9</td>
<td>Fluency</td>
<td>27.81 (12.98)</td>
<td>- .679***</td>
<td>- .666***</td>
<td>- .424***</td>
<td>- .496***</td>
<td>- .396***</td>
<td>- .370***</td>
<td>.659***</td>
</tr>
</tbody>
</table>

**Note.** NP-L= NP-Letters; PT-L= Pauses Letters; AT-L= Articulation Letters; NP-F= NP-Figures; PT-F= Pauses Figures; AT-F= Articulation Figures; Word= word reading accuracy; Comp= Reading comprehension

*a* Measured in seconds

*p < .05; **p < .01, ***p < .001
What is the component of the NP task that is more related to RC?

An analysis of the commonalities was performed to identify which components of the NP tasks explain a greater proportion of RC variance and to determine whether there are any differences regarding the type of task. This analysis identifies the proportion of single and shared variance that an independent variable provides to a dependent variable in the presence of multicollinearity (Nimon, 2010). The total amount of the single and common contributions is $R^2$ of the model. The analysis of the commonalities of the components of the tasks NP-Letters and NP-Figures is shown after controlling the impact of vocabulary to explain RC.

As far as the components of task NP-Letters is concerned, the analysis of the commonalities shows that pauses and articulation times jointly explain 19.4% of RC variance. In the case of the task NP-Figures, pauses and articulation times jointly explain 4.6% of RC. Upon analysing the single contributions of the components of NP-Letters, pauses between items provide a greater proportion of variance to the model -33.96% - while articulation times amount to 3.2%. The analysis of the components of NP-Figures shows that pauses explain 17.1% while articulation times explain 5.7% of RC. In short, while pauses and articulation times of NP-Letters and NP-Figures are linked to RC, pauses explain a greater variance proportion, especially pauses of NP-Letters, around 33% of variance. Therefore, these results suggest that although pauses are the component that is more linked to RC, there is also an impact of the type of task, pauses of NP-Letters being the component that is more linked to RC.

Do fluency and reading accuracy of variable words play a mediating role in the link between NP and RC?

Given that the components of NP-Letters are more linked to RC, the other analysis will focus on this variable in order to present the results sparingly. Commonalities were once again

![Table 2. Analysis of the commonalities components of NP to explain Reading comprehension](image_url)
analysed to determine whether the components of NP-Letters still explain CL variance upon controlling reading of words and reading fluency. The results obtained upon analysis commonalities are shown in Table 3.

Table 3. Analysis of the commonalities components of NP-Letters about comprehension controlling word reading accuracy.

<table>
<thead>
<tr>
<th>Single contributions</th>
<th>β</th>
<th>p</th>
<th>Coefficient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>.236</td>
<td>.000</td>
<td>.0481</td>
<td>6.82%</td>
</tr>
<tr>
<td>Words</td>
<td>.561</td>
<td>.000</td>
<td>.1563</td>
<td>22.16%</td>
</tr>
<tr>
<td>Pauses</td>
<td>-.208</td>
<td>.006</td>
<td>.0218</td>
<td>3.09%</td>
</tr>
<tr>
<td>Articulation</td>
<td>-.023</td>
<td>.720</td>
<td>.0004</td>
<td>0.05%</td>
</tr>
<tr>
<td>Common contributions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common to 1 &amp; 2</td>
<td>.015</td>
<td></td>
<td></td>
<td>2.13%</td>
</tr>
<tr>
<td>Common to 1 &amp; 3</td>
<td>.0109</td>
<td></td>
<td>.0216</td>
<td>1.55%</td>
</tr>
<tr>
<td>Common to 2 &amp; 3</td>
<td>.1647</td>
<td></td>
<td></td>
<td>23.35%</td>
</tr>
<tr>
<td>Common to 1 &amp; 4</td>
<td>.0019</td>
<td></td>
<td>.0027</td>
<td>0.26%</td>
</tr>
<tr>
<td>Common to 1 &amp; 4</td>
<td>.0172</td>
<td></td>
<td></td>
<td>2.44%</td>
</tr>
<tr>
<td>Common to 3 &amp; 4</td>
<td>-.0493</td>
<td></td>
<td>-.0091</td>
<td>-6.99%</td>
</tr>
<tr>
<td>Common to 1, 2 &amp; 3</td>
<td>.0528</td>
<td></td>
<td>.0098</td>
<td>7.49%</td>
</tr>
<tr>
<td>Common to 1, 2 &amp; 4</td>
<td>.0106</td>
<td></td>
<td>.0021</td>
<td>1.51%</td>
</tr>
<tr>
<td>Common to 1, 3 &amp; 4</td>
<td>-.0176</td>
<td></td>
<td>-.0035</td>
<td>-2.49%</td>
</tr>
<tr>
<td>Common to 2, 3 &amp; 4</td>
<td>.1538</td>
<td></td>
<td>.0241</td>
<td>21.81%</td>
</tr>
<tr>
<td>Common to 1, 2, 3 &amp; 4</td>
<td>.1187</td>
<td></td>
<td>.0193</td>
<td>16.82%</td>
</tr>
<tr>
<td>Total</td>
<td>.7054</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results show that the variance proportion of pauses of NP-Letters decreases notably, although they still explain 3.09% of total $R^2$, upon controlling the impact of word reading accuracy. In this model, word reading accuracy makes a greater proportion to the model, amounting to 22.16%. Articulation times are not taken into account as they do not provide any additional variance. The proportion of variance shared between word reading accuracy and pauses jointly explains 23% of RC. Upon replicating the analysis controlled by the impact of fluency (table 4), the proportion of CL variance explained by pauses decreases, but it still explains 4% of variance. Pauses and fluency jointly explain 24% of comprehension. These results suggest that both fluency and word reading accuracy partially play a mediating role between the components of NP and RC, as the proportion of shared variance between the NP component and RC decreases as reading accuracy and fluency are included in the model.

Table 4. Analysis of the commonalities components of NP-Letters about comprehension controlling Reading fluency.

<table>
<thead>
<tr>
<th>Single contributions</th>
<th>β</th>
<th>p</th>
<th>Coefficient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>.198</td>
<td>.002</td>
<td>.0329</td>
<td>5.05%</td>
</tr>
<tr>
<td>Fluency</td>
<td>.474</td>
<td>.000</td>
<td>.1027</td>
<td>15.76%</td>
</tr>
<tr>
<td>Pauses</td>
<td>-.235</td>
<td>.006</td>
<td>.0258</td>
<td>3.96%</td>
</tr>
<tr>
<td>Articulations</td>
<td>-.081</td>
<td>.238</td>
<td>.0047</td>
<td>0.72%</td>
</tr>
<tr>
<td>Common contributions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common to 1 &amp; 2</td>
<td>.0302</td>
<td></td>
<td>.0047</td>
<td>4.64%</td>
</tr>
<tr>
<td>Common to 1 &amp; 3</td>
<td>.0036</td>
<td></td>
<td>.0014</td>
<td>0.54%</td>
</tr>
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<td>Common to 2 &amp; 3</td>
<td>.1606</td>
<td></td>
<td></td>
<td>24.65%</td>
</tr>
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<td>Common to 1 &amp; 4</td>
<td>.0032</td>
<td></td>
<td>.0009</td>
<td>0.49%</td>
</tr>
<tr>
<td>Common to 2 &amp; 4</td>
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<td>.0017</td>
<td>1.98%</td>
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<tr>
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<td>-.0073</td>
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<td>.0100</td>
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<td>Common to 2, 3 &amp; 4</td>
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</tr>
<tr>
<td>Common to 1, 2, 3 &amp; 4</td>
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<td>.0175</td>
<td>16.47%</td>
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<tr>
<td>Total</td>
<td>.6517</td>
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Discussion

This study explored the link between the components of NP, pauses between items and articulation times, and RC in Chilean students of the first cycle of primary education. It also evaluated the mediating role played by reading fluency and accuracy in this link. In first place, it is found that both the task NP-Letters and NP-Figures are correlated to RC. Nevertheless, upon comparing the scale of these links, it was found that the task NP-Letters is more strongly correlated to RC. Therefore, it seems that the
nature of the NP task has an impact on the scale of the link between the variables. This finding is in line with other studies that also report that alphanumerical paradigms such as letters and digits have stronger correlations with reading measurements compared to Non-alphanumerical paradigms (Misra, Katzir, Wolf & Poldrack, 2004; Tannock, Martinussen & Frijters, 2000).

Upon analysing the link between NP and RC at a component level, it was found that pauses between items are more strongly linked to RC, especially pauses of alphanumerical tasks (NP-Letters). The results showed that the pauses of NP-Letters share around 34% of RC variance, whilst the pauses between items of NP-Figures share around 17%. This result is in line with other studies that also report that pauses of alphanumerical tasks share greater variance with RC (Li et al., 2009; Neuhaus, Foorman, Francis & Carlson, 2001). Pauses are the component of NP that is more strongly related to RC because they “lump together” the process related to the retrieval of information from long-term memory, while articulation times only refer to stimulus identification (Cobbold, Passenger & Terrel, 2003; Neuhaus, Foorman, Francis & Carlson, 2001). In this sense, the pauses between items are an indicator of automation in the retrieval of the orthographic and phonological representations required to read (Georgiou et al., 2009; Li et al., 2011); therefore, the faster and more fluent this process is, the more cognitive resources are released to make reading comprehension easier (Logan, 1997; Perfetti, 2007).

The possible link explaining the connection between pauses and reading comprehension can be better explained through the mediating role of reading fluency and word reading. The analysis of the commonalities showed that, on controlling word reading accuracy, the variance shared between pauses and comprehension decreases from 34% to 3%, which suggest that, as a matter of fact, the link partially exists. The link between word reading accuracy and RC has been thoroughly analysed (Perfetti & Stafura, 2014; Kendeou, Van-den-Broek, White & Lynch, 2009). Studies suggest that it would be necessary to automate word decoding, so that it does not entail greater effort and makes comprehension easier as cognitive resources are released (García & Cain, 2014; Gutiérrez-Fresneda, 2017; Perfetti & Hogaboam, 1975). Word reading accuracy and pauses of NP-Letters are linked as both tasks have important phonological components and involve letter recognition. Hence the mediating role of word reading accuracy in the link between NP and RC entails the rapid recognition of letters and longer orthographic units, such as words, and this rapid recognition makes RC easier as this process becomes more fluent (Fumagalli, Barreyro & Jaichenco, 2017; Johnson & Kirby, 2006). Therefore, in the link between NP and RC there is an important component related to access and information recognition speed.

When the analysis is replicated with reading fluency, the significant decrease of the pauses between items to explain RC can be found once again. Therefore, the pauses between items of NP-Letters explain 4% of comprehension, whilst fluency explains 16%. On analysing the common contributions to the model, pauses and fluency share 25% of comprehension variance; in other words, they jointly explain 25% of variance, which means that fluency is a mediating variable in the link between pauses and RC. In this sense, NP is more than a task linked to information processing speed (Vaessen, Gerretsen & Blomert, 2009). Research show that NP still explains reading upon controlling processing speed (Powell et al., 2007). Therefore, NP rather than speed as a general process, is an indicator of processing speed linked to a specific orthography that explains fluency and automation in word recognition (Li et al., 2011, Neuhaus & Post, 2003). Provided that the recognition of lexical and sublexical units is rapid, the reading process is automated and cognitive resources that promote RC are released. In this context, the pauses of NP-Letters are an indicator of the automation when retrieving these
units; therefore, they share this mechanism with word reading accuracy and fluency linked to RC. This link is significant in the orthographic context of Spanish language, where fluency measurements predicts reading performance to a greater extent than accuracy-based measurements (Share, 2008). Therefore, some variables such as naming pace, which entail a significant component of fluency, are important in the case of orthography in Spanish.

It should be noted that there have been some limitations. Subsequent studies should take a larger sample into account from each one of the school grades for a clearer transversal perspective of the role played by the components of NP to explain RC. Likewise, the measurement of fluency used has an important component of comprehension, unlike other measurements that only consider the decoding speed at the level of words, which may also explain the high correlation existing between this variable and RC. Finally, the measurement of word reading used is based on accuracy. Nevertheless, variance was found in the participants’ reading accuracy despite this limitation. Future research should analyse the link between executive functions, the components of NP and RC, because it has been found that executive functions are linked to comprehension and performance in NP tasks (Altani, Protopapas & Georgiou, 2017; Kieffer, Vukovic & Berry, 2013).

In short, pauses of NP-Letters are the component that shares a greater proportion of variance with RC. Upon controlling reading accuracy and fluency, the pauses of the task NP-Letters still provide variance; nevertheless, it decreases, which means that the link between NP and RC can be explained by the mediating role played by word reading accuracy and fluency. In the educational sphere, these results highlight the importance of evaluating both longitudinal and concurrent important precursors of RC. Evaluating naming pace is a quick and easy way of early identification of those students at risk of having reading difficulties, especially those whose skills are compromised in terms of reading accuracy or automation. Therefore, it is important to consider NP measurements in those evaluation batteries aimed at identifying those students at risk of having reading difficulties.

References


Los componentes de la velocidad de denominación y su relación con la comprensión lectora en español

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1. **Introducción**
   - La velocidad de denominación es fundamental para el desarrollo de habilidades lectoras.
   - Su importancia se destaca en diferentes culturas, como en el español.

2. **Componentes de la velocidad de denominación**
   - **Nomenclatura**: velocidad de denominación de palabras.
   - **Fluidez**: velocidad de denominación de sílabas o letras.
   - **Sustitución**: velocidad de denominación de palabras o sílabas.

3. **Relación con la comprensión lectora**
   - Factores como la velocidad de lectura, la velocidad de comprensión lectora, y el vocabulario influyen en el rendimiento de los estudiantes.

4. **Investigaciones previas**

5. **Desarrollo de la lectura**
   - El desarrollo de la lectura se ve influenciado por habilidades visuales y fonológicas.
   - La velocidad de denominación puede ser un predictor temprano del desarrollo lector.

6. **Conclusiones**
   - La velocidad de denominación es un componente crítico para la comprensión lectora.
   - La comprensión lectora, en última instancia, depende del modelado de la lectura.

7. **Recomendaciones para futuras investigaciones**
   - Investigación más profunda en las relaciones específicas entre la velocidad de denominación y la comprensión lectora.
   - Consideración de la diversidad lingüística en las investigaciones.
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Scientific Studies of Reading
Annals of Dyslexia
Journal of Exper.
Language and Cognitive Processing
Reading & Writing Quarterly
95
Journal of Clinical and Developmental Psychology
101
Journal of Educational Psychology
48
Journal of Educational Psychology, 13, 123-146. doi: 10.1080/1057356970130203


imational child psychology, 78(4), 359-373. doi: https://doi.org/10.1006/jecp.2000.2576

Los componentes de la velocidad de denominación y su relación con la comprensión lectora en español

Research Quarterly, 123-141. doi: https://doi.org/10.2307/747978