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PARALLEL SEMANTIC PROCESSING IN EARLY READING ACQUISITION: EVIDENCE FROM THE RAPID PARALLEL VISUAL PRESENTATION PARADIGM

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Abstract

This study investigates whether the "Parafoveal-on-Foveal" (PoF) and "Parafoveal Preview Effect" (PPE), effects observed in adults, also occur in children learning to read. These effects involve faster reading times and improved accuracy when semantic relatedness is present between foveal and parafoveal words. These semantic effects are explored in young readers through the administration of the Rapid Parallel Visual Presentation (RPVP). Forty-six children from 1st to 5th grade were divided into two groups based on the reading acquisition, defined based on literature. The group of beginner readers is composed of 12 children attending 1st and 2nd grade, while children attending from 3rd to 5th grade composed the group of experienced readers. Preliminary results show reduced reading times of the foveal word (PoF) and higher accuracy in reading the parafoveal word (PPE), suggesting that semantic parafoveal processing occurs already in the early stages of development.

Keywords: *Reading, semantic processing, rapid parallel visual presentation paradigm, parafoveal-on-foveal effect, parafoveal preview effect.*

1. Introduction

Reading acquisition in languages with transparent orthographies, such as Italian, generally begins around age six, with high reading accuracy achieved by third grade (Zoccolotti et al., 2009).

Readers typically adopt a serial strategy, moving their gaze word-by-word following a left-to-right direction. Studies on adult readers suggest that when two words are presented simultaneously in the central and peripheral regions, orthographic and lexical information can be processed in parallel (Grainger et al., 2014) and enhance reading fluency. However, whether semantic information can also be accessed remains debated (Schotter et al., 2012; Hohenstein et al., 2014).

The literature recognizes two effects: the "Parafoveal-on-Foveal" (PoF) effect, where reading times for a foveal word are faster when the parafoveal word is semantically related, and the "Parafoveal Preview Effect" (PPE), where accuracy for the parafoveal word improves with semantic relatedness. These effects are semantic markers in reading.

This study examines whether these effects, observed in adults, also appear in children learning to read. Specifically, we investigated the development of PoF and PPE effects in children.

2. Methods

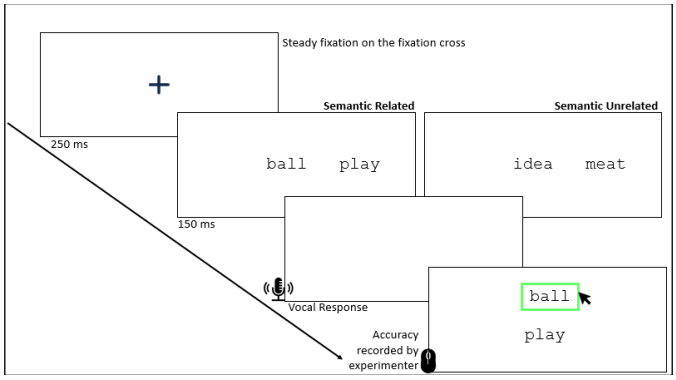
We administered the Rapid Parallel Visual Presentation (RPVP; Rusich et al., 2020) paradigm, presenting pairs of words simultaneously: one in the foveal region (W1), and the other one in the parafoveal region (W2), for 150 ms.

Stimuli included eighty pairs of Italian words, 40 semantically related word pairs (e.g., *PALLA GIOCO*; BALL PLAY) and 40 unrelated pairs (e.g., *IDEA CARNE*; IDEA MEAT), matched for word length and frequency.

Word pairs were presented randomly, and we recorded vocal reaction times (RTs) for the foveal word (W1) and accuracy for both words (W1 and W2).

The experimental procedure is graphically reported in Figure 1.

Figure 1. Procedure of the Rapid Parallel Visual Presentation (RPVP).



53 children from 1st to 5th grade were screened for reading (decoding and comprehension), fluid intelligence, perceptual integration, and metaphonological abilities. The final sample included 46 children with abilities within the normal range, as revealed by screening measures. All children achieved a W1 reading accuracy rate of at least 65 percent (1st grade: 68.9%; 2nd grade: 75.2%; 3rd grade: 81.6%; 4th grade: 86.1%; 5th grade: 87.5%).

Based on stages of reading acquisition, the sample was split into two groups: beginner readers (grades 1-2; N= 12) and experienced readers (grades 3-5; N=34).

3. Analysis

Accuracy on W2 and RTs on W1 were analyzed only for trials where W1 was accurately named, and trials with RTs higher or lower than 2.5 SD from the children's mean RTs were excluded from the analysis.

The PPE and the PoF effects were analyzed using two-way ANOVAs considering respectively the number of words in the parafoveal region correctly named and the mean vocal RTs as dependent variables. The group (e.g., Experienced *vs.* Beginners) and the semantic relationship (e.g., semantically related *vs.* semantically unrelated) between pairs of words were considered the independent variables.

Significant interactions were explored through post-hoc Tukey tests.

All analyses were run using Jamovi 2.6.19.

4. Results

The preview benefit effect (PPE) was analyzed considering the correct naming of parafoveal words (w2). The ANOVA showed a significant main effect of Group (F_{3013}=79.1; p <.001; η^2=.03) and semantic relationship between pairs of words (F_{3013}=69.3; p <.001; η^2=.02). The interaction Group x Semantic Relationship (F_{3013}=7.06; p <.01; η^2=.002) is significant too.

Post-hoc comparison shows that the accuracy of words in the parafovea (W2) is higher in the condition in which the foveal and parafoveal words are semantically related compared to the semantically unrelated pairs, in both beginners (0.29 ±0.02 *vs.* 0.18 ±0.03; p <.01) and experienced children (0.29 ±0.02 *vs.* 0.18 ±0.03; p <.01). Moreover, experienced children were more accurate in semantic related condition compared to beginner ones (0.53 ±0.01 *vs.* 0.29 ±0.02; p <.001).

Regarding the PoF effect, the ANOVA considering vocal RTs showed a significant effect of Group (F_{3013}=232.89; p <.001; η^2=.07). The effect of semantic relationship and its interaction with group is not significant (p >.05 in both cases). The post-hoc comparison shows that experienced readers are more rapid than beginners in naming W1 when the words are semantically related (1194 ±36.3 *vs.* 2109 ±66.1; p <.001).

5. Discussion and conclusions

Accuracy analyses showed that experienced readers more effectively extracted information from parafoveal words than beginners. Both groups showed higher accuracy for semantically related parafoveal words, with an advantage in experienced readers, indicating a PPE.

Vocal RTs for foveal words were faster in experienced readers, especially when words were semantically related, suggesting developmental growth in parallel processing.

For the PoF effect, RTs were faster when the parafoveal word was accurately identified, indicating that accurate parafoveal recognition facilitates foveal word processing.

These findings suggest a developmental trajectory in children's ability for parallel semantic processing, supporting the idea that such effects are fundamental to developing efficient reading strategies during acquisition.

6. Limits and future perspectives

The results of this study seem promising in trying to understand the developmental trajectories of parallel reading processes. However, it seems appropriate to point out some of its limitations. Indeed, the sample still too small to draw strong conclusions.

In addition, semantic processing in a developmental population may be related to the maturation of other cognitive components and correlation analysis should be performed after sample size will be sufficiently large.

For these reasons, the next steps of this *in-progress* work will focus on increasing the sample size and on exploring the role of other cognitive and perceptual mechanisms involved in the parallel semantic processing in children.

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