Parafoveal letter identification in primary school children

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During reading, letters in words are identified both foveally and parafoveally [1]. Letters that fall within the foveal area are recognized with the highest acuity from the very beginning of reading instruction, while the role of parafoveal information increases with reading experience. However, adults may still struggle with parafoveal letter identification and may confuse letters due to their visual similarity [2]. The developmental trajectory of these confusions, as well as parafoveal letter identification in children more generally, remain underexplored. The aim of our study was to investigate the mechanisms of parafoveal letter identification in children.

We tested 40 monolingual Russian-speaking second graders (M_{age} = 8.1 years) and 35 third graders (M_{age} = 9.0 years). Participants named aloud all 33 letters of the Russian alphabet, which appeared either in the left or right visual field within the parafoveal area (2.25º of visual angle) in a crowded condition (e.g., *a*) in an eye-tracking gaze-contingent boundary paradigm [3]. Children also completed the Standardized Assessment of Reading Skill [4]. First, we constructed a confusion matrix by comparing the presented letters with the participants' responses. Then, we applied multidimensional scaling [5] and the Louvain modularity method [6] to identify clusters of commonly confused letters. Finally, we built a generalized mixed-effects model with a structure: *identification accuracy ~ grade*(side + oral reading fluency centered + frequency centered)+(1|letter)+(1|participant).*

The confusion matrix is presented in Figure 1. Common confusions involved mirroring (а → е) and the omission (ё → е) or addition of small elements (г → т). Clustering methods identified six clusters of confusions, mostly based on letter roundness and the presence and location of diagonal and horizontal elements. We found that children identified letters more accurately in the right visual field than in the left visual field. We revealed the main effect of oral reading fluency and a significant interaction between oral reading fluency and grade. Other effects were not significant.

In our study, we created the first confusion matrix for Russian-speaking children. We identified clusters of confusions in children that were similar to those observed in adults [2]. We suppose that mechanisms underlying these confusions remain in word reading, where multiple letters are processed in parallel [7]. We confirmed the right visual field advantage in primary school children. Importantly, we found that while slower-reading second and third graders differed in naming accuracy, faster-reading children in both grades showed comparable parafoveal naming accuracy. This suggests that parafoveal letter identification is largely established by Grade 2 and may vary primarily as a function of decoding skill.

References

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Figures and Tables

Figure 1: Confusion Matrix in Russian-Speaking Children