

Reading Patterns in Bilingual and Monolingual Speakers: Scanpath Analysis

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Introduction

- The majority of research in bilingual reading focuses on local quantitative differences between bilingual and monolingual reading as measured by conventional word-by-word eye-movement measures (Cop, Drieghe & Duyck; 2015; Parshina, Laurinavichyute & Sekerina, in press).
- The aim of the current study is to investigate differences in reading from another, yet unexplored perspective. We ask: Are there global qualitative differences in reading behavior among bilinguals and monolinguals?
- To answer this question, we adopt a novel to bilingual research scanpath approach that gives us an analytical handle on global stimulus-level gaze trajectories or reading strategies as assessed through sequences of eye fixations that extend beyond the word-level (von der Malsburg & Vasishth, 2011).

Participants:

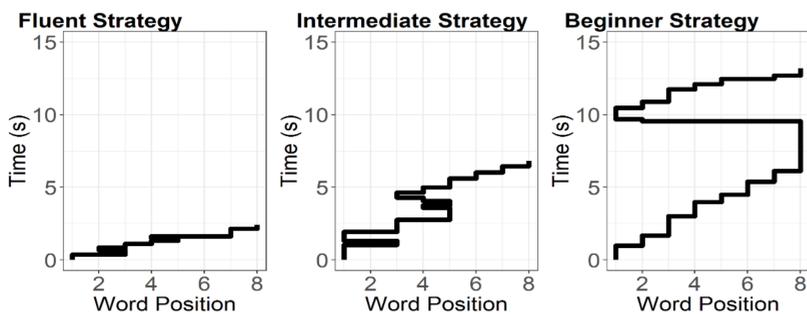
30 Monolingual Russian-speaking adults
30 monolingual Russian-speaking 8-year-old children
30 Heritage Speakers of Russian
30 L2 learners of Russian

Method:

Participants read 30 sentences from the *Russian Sentence Corpus child version* (Korneev et al., 2017) with eye-movements recorded

Results

- We identified 3 prototypical reading strategies based on the scanpaths closest to cluster centroids:
 - fluent** reading characterized by straight left-to-right reading, short fixations, frequent word skipping and few regressions;
 - intermediate** reading with longer fixations, less skipping and higher regression probability than the fluent strategy;
 - beginner** reading where readers fixated words longer, skipped words even less than in the intermediate strategy, and were likely to re-read large portions of the sentence multiple times.



Example of prototypical reading strategies for the sentence "Nedaleko byl slozhen stog sena, ryadom stojali grabli" (A haystack was stacked nearby, a rake was next to it) as identified by scanpaths closest to the centroids of the clusters.

Descriptive characteristics of reading strategies

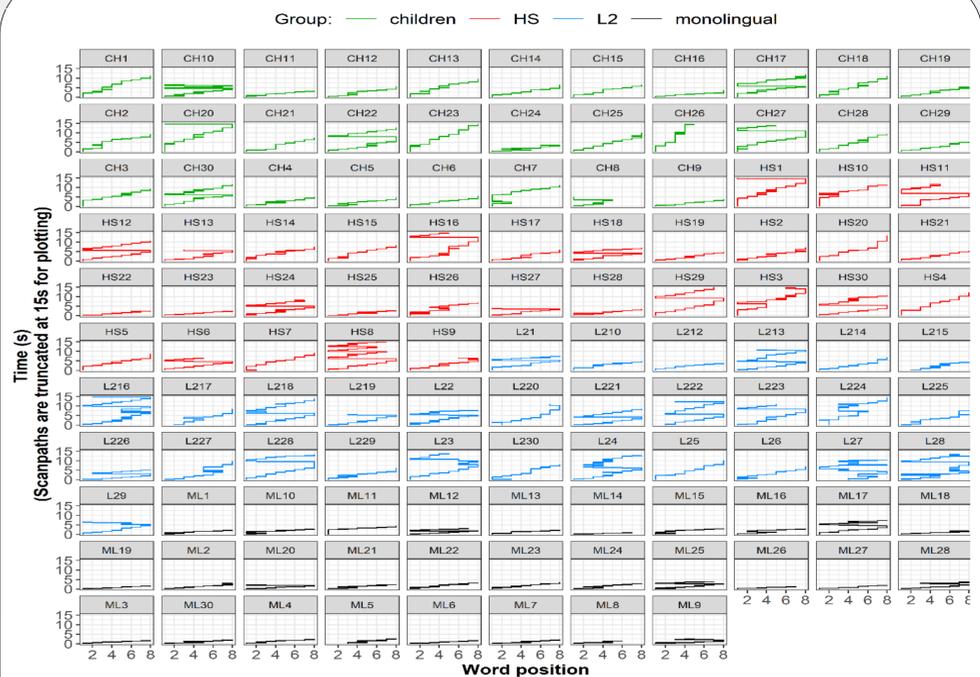
	Fluent		Reading strategy Intermediate		Beginner	
	Mean	SD	Mean	SD	Mean	SD
Gaze duration	289.3	81.8	689.9	338.2	1053.5	544.4
Skipping probability	17.1	13.7	8.7	11.9	5.8	10.9
Fixation count/word	1.3	.390	2.8	1.1	5.1	2.1
Regression probability	12.9	14.7	25.4	18.7	38.2	22.7
Count of word readings	1.0	.270	1.4	.492	2.2	.923
Total time reading/sentence (s)	2.1	.761	6.4	2.9	13.8	5.9

Research Questions:

- What are the most common reading strategies that readers use for comprehension of the simple sentences in Russian?
- Do groups of speakers differ in their preference for reading strategies?
- What variables among individual differences influence the choice of reading strategies for bilingual readers?

Measures and analyses:

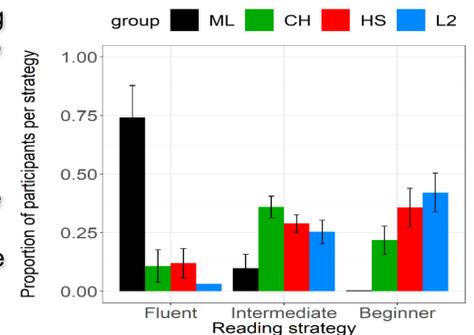
- To get the general idea of how participants read the sentences, we created a plot of scanpaths for every participant and sentence by using duration and coordinates for all fixations within the sentence
- To estimate the variability of scanpaths among participants we calculated the pair-wise dissimilarities of all scanpaths for each sentence.
- By applying mixture of Gaussians modeling, we conducted a cluster analysis on the dissimilarity matrix to identify categories of scanpaths that present qualitatively different reading strategies.



Scanpaths for Sentence that elicited the most diverse scanpaths. 'ML' - monolingual, 'CH' - child, 'HS' - heritage speaker, 'L2' - L2 learner.

We fit separate GLMMs for each reading strategy (strategy as an outcome and group and individual differences as predictors):

- Monolinguals consistently adopted the fluent reading strategy, while children showed a preference for the intermediate strategy.
- HSs and L2 learners: proficiency and age of arrival to the USA (for HSs) were the strongest predictors for intermediate strategy.
- Lower proficiency and later age of arrival (for HSs) predicted beginner reading strategy for bilinguals



Proportions of participants using the three reading strategies. ML - monolingual, CH - child, HS - Heritage Speaker, L2 - L2 learner

Conclusions

- We established through scanpath analyses that different groups of readers employ qualitatively different reading strategies to cope with the difficulties of written language processing.
- These strategies are not evident at a word-level analysis.
- The intermediate strategy indicates local processing delays in reading by children and HSs (word re-readings and longer fixations).
- The beginner strategy may additionally indicate global difficulties in semantic and morphosyntactic information integration (multiple sentence re-readings) for low-proficient bilinguals.

References

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