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, Dribe & Duyck; 2015; Parshina, Laurinavichyte & 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 & Vasilysh, 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

1. 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 proportion 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 stol sena, rymdom 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

<table>
<thead>
<tr>
<th>Reading strategy</th>
<th>Fluent</th>
<th>Intermediate</th>
<th>Beginner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaze duration</td>
<td>289.3</td>
<td>689.9</td>
<td>1053.5</td>
</tr>
<tr>
<td>Skipping probability</td>
<td>17.1</td>
<td>8.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Fixation count/word</td>
<td>1.3</td>
<td>2.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Regression probability</td>
<td>12.9</td>
<td>25.4</td>
<td>38.2</td>
</tr>
<tr>
<td>Count of word readings</td>
<td>1.0</td>
<td>1.4</td>
<td>2.2</td>
</tr>
</tbody>
</table>
| Total time reading/sentence(s) | 2.1   | 6.4          | 13.8     | 5.9

We fit separate GLMMs for each reading 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

Conclusions

We established through scanpath analyses that different groups of readers employ qualitatively different reading strategies to copy 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.

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References


Notes

1. Fluent
2. Intermediate
3. Beginner

Fluent Strategy
Intermediate Strategy
Beginner Strategy

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

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