

Global reading behavior in a second language: A scanpath analysis

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Background. Traditionally, eye-tracking studies of reading in a second language (L2) have relied on word-level measures (e.g., fixation durations, regressions, skipping), which capture moment-to-moment lexical and syntactic processing but collapse the temporal order of fixations. Scanpaths (Fig. 1), on the other hand, preserve this structure by depicting global stimulus-level gaze trajectories, or *reading strategies* [1] that prior studies have found to differ between L1 and L2 readers at the sentence level [2], between children and adults [2], as a function of task demands [3] and stimulus complexity [4]. The current study expands scanpath research in bilingualism by applying scanpath analysis of global reading behavior to the largest cross-linguistic L2 reading dataset to date, the Multilingual Eye Movement Corpus (MECO; [5]). Utilizing data from 443 bilingual participants from 11 diverse L1 backgrounds (Fig. 2 for the list) reading the same 12 English (L2) texts, we investigated: (RQ1) the stability of individual reading strategies across L2 texts, (RQ2) cross-linguistic influences of the first language (L1 background), (RQ3) correspondences between L1 and L2 scanpaths, and (RQ4) the relationship between global reading strategies, L2 comprehension, and proficiency.

Method. For RQ1 – RQ4, scanpath (dis)similarity was calculated using the *scasim* function [1], which quantifies the similarity of scanpaths within and between participants and across languages. Additionally, to address RQ2, we applied model-based clustering with 12 clusters (to reflect the number of L1 backgrounds) to pairwise dissimilarities. To address RQ4, we derived two additional scanpath measures: distance from the central scanpath (i.e., the extent to which an individual scanpath differs from the most common scanpath for a given text) and within-cluster density (i.e., how typical a scanpath is within a cluster of scanpaths reflecting a shared reading strategy).

Results and Discussion. RQ1: Individual L2 readers displayed consistent global reading behavior in L2 both when comparing scanpaths across language samples ($|d| = 1.27$) and within language samples ($|d| = 0.97$; Fig. 2). RQ2: L1 background left a detectable but weak imprint on L2 scanpaths (cluster purity = .35), and RQ3: L1 scanpaths did not reliably predict L2 scanpaths once laboratory differences were controlled for ($|d| = 0.12$; cf. word-level findings in [5]). RQ4: Finally, scanpath similarity measures (distance and density) were associated with both greater comprehension and L2 proficiency. Together, these findings emphasize the complementary value of scanpath-based measures alongside traditional word-level eye-tracking measures for assessing global reading behavior across languages.

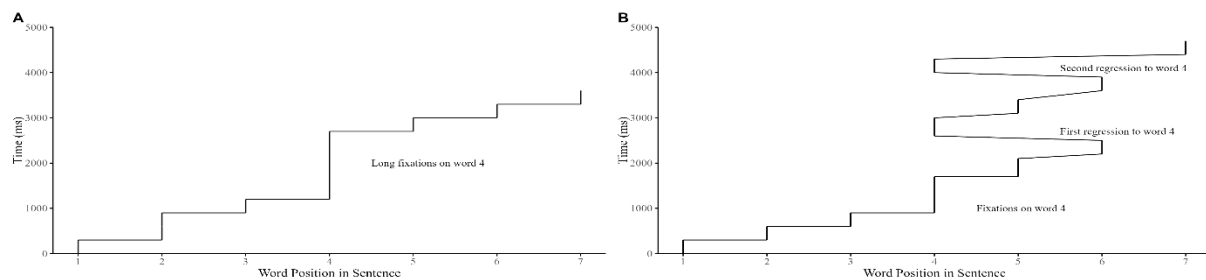


Figure 1: Example scanpaths in sentence reading. (A) The reader progresses from left to right with a prolonged fixation(s) on word 4. (B) After the first-pass reading of later words, the reader makes two regressions to the word 4.

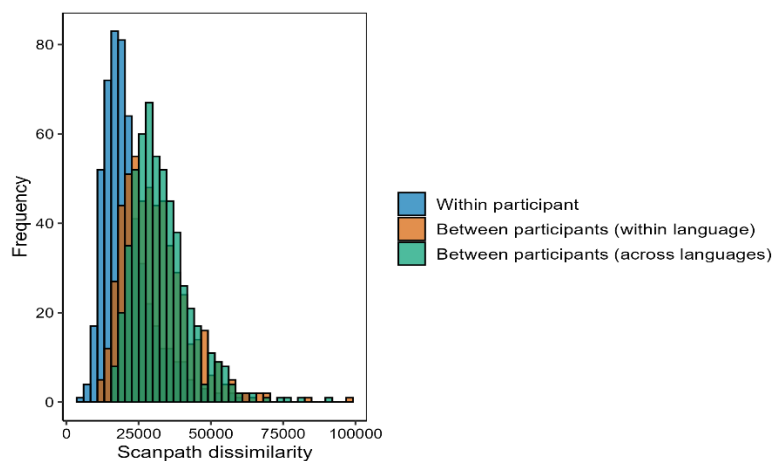


Figure 2: Distribution of scanpath dissimilarity scores within participants, between participants within the same language sample, and between participants across languages. Lower values indicate greater scanpath similarity. L1 backgrounds: Dutch, Estonian, Finnish, German, Greek, Hebrew, Italian, Norwegian, Russian, Spanish, Turkish, plus L1 English from Canadian sample.

References

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