# Eye-movement Comparison in Reading in Deaf and Hearing Russian Sign Language Speakers

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Deaf individuals constitute a unique group of readers, as they cannot rely on phonological codes while reading. Phonological deficit (Bélanger, 2015) is associated with the difficulty of correlating letters with sounds and complicates word recognition. Until 2012, phonological deficit was believed to be the main cause of lower reading skills in deaf individuals, but Bélanger et al. (2012) demonstrated that phonological codes are not used by both the skilled and less-skilled deaf readers. It is still likely that hard-of-hearing people that use sign language on a daily basis might read better than deaf signers, as language development of hard-of-hearing signers is, presumably, more similar to that of hearing people, as they have earlier exposure to spoken language.

At the same time, deaf individuals have an enhanced visual perception field (Bavelier, 2006). They perceive 18 characters to the right of the current fixation while reading, while hearing people who do not know sign language perceive only 14 characters (Bélanger, Slattery, 2012). It remains unclear whether hearing sign language users also have an enhanced peripheral vision. The highly developed peripheral vision may result from the structural reorganization of the brain caused by deafness or from extensive exposure to and the use of sign language.

To test whether hearing Russian Sign Language (RSL) users can read better than deaf signers and whether enhanced peripheral vision helps them to read, we studied eye movements while reading in hearing RSL signers using both RSL and speech (N=13, M age= 25 years) and RSL signers with complete hearing loss using only RSL to communicate (N=13 people, M age = 29 years). Even though Russian is in most cases the second language for deaf individuals and the first for hearing RSL signers, we assume that both groups read Russian fluently since all the participants are studying/studied at higher educational institutions.

Eye movements were recorded using an Eyelink 1000+ at 1000 Hz. Participants read 144 sentences (Example 1) from the Russian Sentence Corpus (Laurinavichyute, 2019). All sentences were no longer than 13 words. After 58% of the sentences, participants were asked to answer comprehension questions by choosing one of three answer options.

Mixed-effects linear models were used for data analysis. We found that deaf and hearing RSL signers have comparable reading skills: similar fixation durations, skipping rates, numbers of fixations per word, saccade landing positions, as well as word and sentence processing speeds.

However, some patterns of poorer reading skills were found in deaf individuals. Comprehension question responses showed that the deaf understand or/and remember what they read worse than the hearing do (70% vs. 80%, p-value = .013). Moreover, deaf individuals slowed down on longer words more than the hearing.

We found that both deaf and hearing signers benefit from peripheral vision while reading. Deaf individuals are more effective than the hearing at processing long words using a single fixation (Graph 1). For hearing participants, the increasing frequency of the next word accelerates both reading (Graph 2) and rereading speed of the current word and reduces the number of fixations on it.

To sum up, we found that both deaf and hearing signers can effectively extract information on the periphery while reading. That means that both groups use peripheral vision to a similar degree, however, comparison with native Russian speakers that do not use RSL is needed to assess whether peripheral vision is at all enhanced in RSL speakers.

Example 1.
Sentence:
Дорога ведет в глухой лес, петляя по склонам (The road leads into the deep forest, winding along the slopes.)
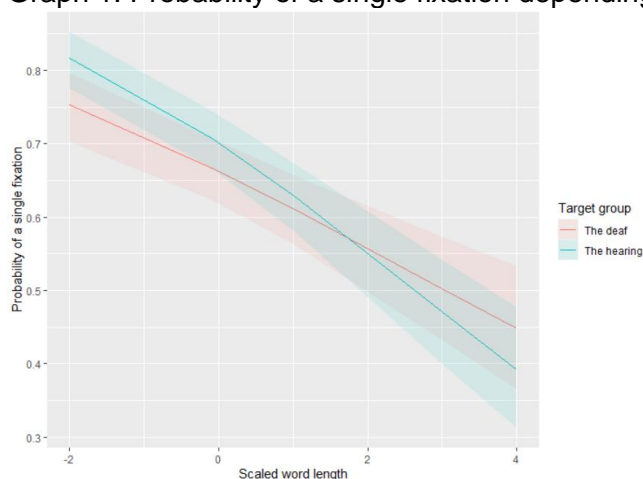Question and suggested answers:
Куда ведет дорога? (Where does the road lead?)
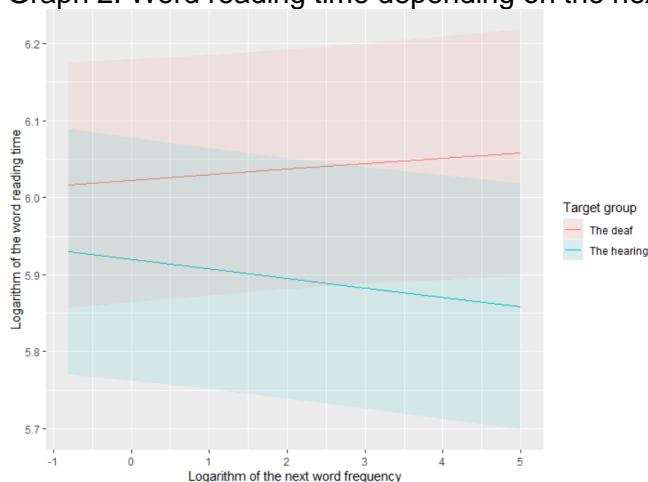В лес (Into the forest)
В огород (Into the garden)
В деревню (Into the village)

Graph 1. Probability of a single fixation depending on the word length.



Graph 2. Word reading time depending on the next word frequency.

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