Reading assessment of children with reading disabilities using scanpaths

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In Denmark, children with reading difficulties are provided special reading training in small groups or individually. A new reading application records the eye movements of the child as they read aloud to assist the teacher in monitoring their reading strategy. Analysing scanpaths of these readings, we try to detect passages of fluent reading. The predictiveness of the scanpath measure is validated against common text difficulty measures. The teachers' markings of misread words are used as a gold standard in our setup. Automatically discriminating fluent from non-fluent reading can be used e.g. as automatic reading assistance and evaluation.

The use of scanpaths in readers with reading disabilities is an underexposed area of research. Contemporary eye-tracking research mostly only focus on different fixation measures. By looking at the whole scanpath, in which the total of tracked x- and y-coordinates are included, we get a richer representation of individual readings. Scanpaths have been used in reading research, but before von der Malsburg, Kliegl & Vasishth (2015), they have not been employed as a sentence-based measure to distinguish between different readings. The goal of the present work is to check whether we can employ scanpaths as discriminator to differentiate easy and difficult readings.

Data is gathered in a classroom setting and consists of over 9000 sentences read by 71 Danish children with a reading difficulty. We adopt Malsburg et al.'s scanpath similarity measure to compare similar sentences read by these children. This enables us to look at the variance between different readings of similar sentences, some read correctly and some with words marked as misread by the teachers. We also analyse scanpath regularity through Recurrence Quantification Analysis.

The misread markings are then contrasted to different sentence difficulty measures, including surprisal cost and phonetic ambiguity, by using correlation measures. This comparison enables us to give an indication of the quality of a new reading, controlling for the difficulty of the sentence.
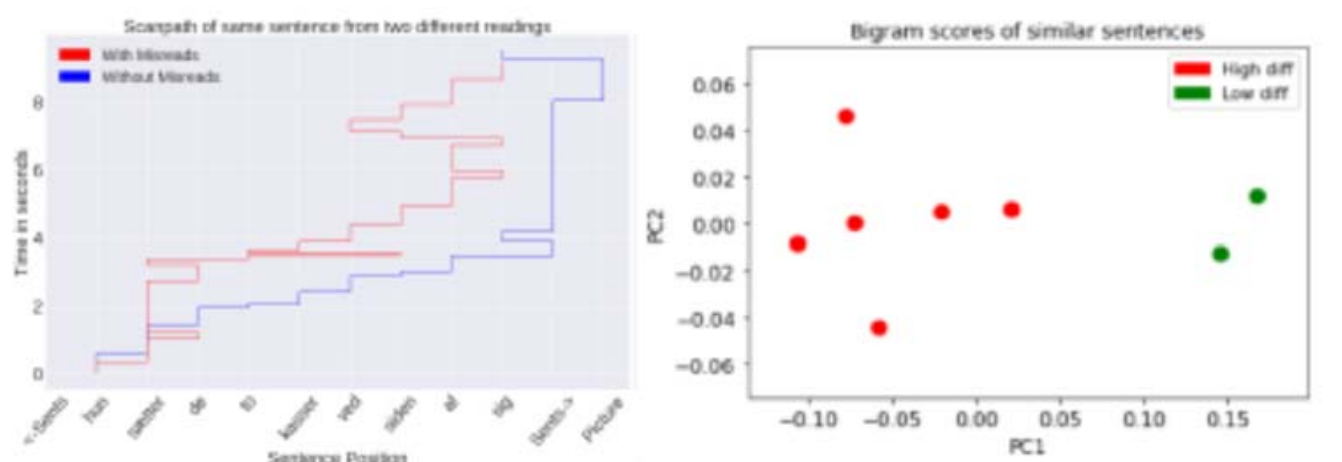

Figure 1a) 2 scan path plots of the same sentence, one with at least one misread word (red) and without any misreads (blue). '<- Sents' means fixation on a previous sentence on the same page, 'Sents ->' refers to looking at a sentence ahead on the same page. 'Picture' means the reader looked at the image on the same page. Figure 1b) shows the similarity between different readings of similar sentences, meaning they have the same sentence length and similar word lengths. One point is one reading. The clusters are based on the surprisal (bigram) score of each read sentence. PC1 and PC2 are the principal components.

References

- Malsburg, T., Kliegl, R., & Vasishth, S. (2015). Determinants of scanpath regularity in reading. *Cognitive Science*, 39(7), 1675-1703.