Eye-tracking as a proxy for coherence and complexity of texts

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Reading is a complex cognitive process that involves primary oculomotor function and high-level activities like attention focus and language processing. When we read, our eyes move by primary physiological functions while responding to language-processing demands. In the 19th century, founders of visual behavior research examined eye movement in elementary reading experiments and described how the eyes capture visual information for brain processing. It was noticed that the eyes do not register information through smooth continuous movements, instead, they make successive jerks (saccades) between events in which the gaze is briefly maintained to "scan" small locations (fixations), where the information is effectively captured. Thereby, we move our eyes in a way that they can efficiently capture pieces of visual data that our brain then puts together in order to create a complete neat image. Moreover, the mental demands in processing the image also influence where we continually direct the gaze. With the development of eye-tracking devices, scientists were able to observe precisely the gaze trajectories, revealing their strong dependence on the attention focus and examination strategies of the subjects.

Since individuals can express similar as well as entirely different opinions about a given text, it is therefore expected that the form, content and style of a text could induce different eye-movement patterns among people. A question that naturally arises is whether these individuals' opinions and patterns can somehow be correlated, so that eye-tracking can be used as a proxy for text subjective properties, such as coherence and complexity. It is in this framework that models from Statistical Physics combined with methods developed using Information Theory can be useful to characterize the behavior of complex systems. For instance, the Pairwise Maximum-Entropy technique represents a powerful tool for studying a complex system from which experimental data can be obtained, but no knowledge about the underlying function that describes its states is given. Precisely, by measuring quantities such as expectation and cross-covariance values among the components of a complex system, it is possible to use the principle of Maximum Entropy in order to solve an inverse problem and infer the parameters of a corresponding "Hamiltonian" model.

Here, we performed a set of eye-tracking experiments with a group of 20 individuals reading different types of texts, including children stories, random word generated texts and excerpts from literature work. Simultaneously, an extensive internet survey has been conducted for categorizing these texts in terms of their "complexity" and "coherence", considering 400 individuals selected according to different ages, levels of education and social classes. The computational analysis of the fixation maps obtained from the gaze trajectories of the subjects for a given text reveals that **(*i*)** the average "magnetizations" of the texts correlate perfectly with their corresponding average "complexities" observed in the survey, and **(*ii*)** the "coherent" texts are closer to their corresponding critical points than "non-coherent" ones, as computed from the Pairwise Maximum-Entropy method, suggesting that different texts may induce distinct "cohesive" reading activities.