

# Reading and Dyslexia: A Complex System's Approach

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Although dyslexia has received widespread acknowledgement as a learning disorder, its cause(s) is still much debated after decades of intensive research. Dyslexic readers have been found to score below average on, amongst others, perceptual, motor and cognitive skills pertaining to speech and language, working memory, attention, ordering and sequencing, temporal processing, balance and motor control, auditory and tactile processing, mental calculations, etc.

The prevailing perspective on psychological phenomena is governed by the assumption of component-dominant dynamics, that is, a single component may be held responsible for the malfunction of a process. Reading research attempts to reveal the workings of independent components and subcomponents of sensation, perception, reading, and articulation, each representing independent cognitive functions. Although the merits of this approach are well-acknowledged, this approach cannot account for time-dependent structure present in reading data, such as, response times, EEG, eye-movements, etc.

We would like to propose an alternative approach, called interaction-dominant dynamics, which acknowledges the importance of relationships among components rather than the causal properties of the components themselves. Such a system is highly interconnected and each of the components may alter the dynamics of other components and thus the entire system in a more fundamental way than the intrinsic dynamics of the components. We will present three different, relatively new approaches to the analyses of reading data, that reveal interesting characteristics of reading behavior based on the assumption that reading (actually almost all behavior) is fundamentally time-dependent.

The first analysis pertains to response time distributions of children with and without dyslexia who performed a reading task and three non-reading tasks. The nature of the distributions of each task was assessed using 560 stimuli. Results indicated that children with dyslexia yield slower, broader, and more variable pronunciation time distributions than their age-matched counterparts. Moreover, children with dyslexia produced similar, but less prominent trends toward slower and more variable performance across the three non-reading tasks. The outcomes support a continuum based, rather than localized-deficit account of dyslexia and suggests that reading is best seen as an interaction-dominant system.

The second and third analysis takes into consideration the variability of the response times. We discuss two complexity measures ( $1/f$  scaling and Recurrence Quantification Analysis) that employ background noise as metrics of reading fluency. Background noise is often overlooked in scientific inquiries of cognitive performances. However, it is becoming widely acknowledged in psychology, medicine, physiology, physics, and beyond that temporal patterns of variability constitute a rich source of information. These measures assess the extent of interdependence across, rather than within cognitive components. The outcome suggests that developmental dyslexia resides from dynamical instabilities in the coordination among the many components necessary to read, which could explain why dyslexic readers score below average on so many distinct tasks and modalities.

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Prof. dr. Anna Bosman received her PhD from the University of Amsterdam in 1994. In 1995 she went to the USA and spent a year as a post-doc with prof. Guy Van Orden. Upon her return to the Netherlands in 1996, she was appointed at Radboud University Nijmegen. She studies 'Reading', 'Spelling', 'Dyslexia', 'Effective spelling instruction methods', 'relational therapy for people with intellectual disabilities'. Her view on science is inspired by complex systems theory. For a full list of publications, please consult [www.annabosman.eu](http://www.annabosman.eu)

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