

# Abnormal visual crowding and developmental dyslexia: Cause or effect?

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Journal of Vision September 2018, Vol.18, 545. doi:<https://doi.org/10.1167/18.10.545>

## Abstract

For about 10% of people reading acquisition is extremely difficult, they are affected by a heritable neurodevelopmental disorder called dyslexia. Differences in perceiving the written word might be one of the causes of reading disabilities. Visual crowding is a universal phenomenon that impairs the recognition of stimuli in clutter, and there are some evidence that visual crowding is more severe in individuals with developmental dyslexia (DD) than in typical readers. The direct consequence of stronger crowding on reading is the inability to recognize letters when they are surrounded by other letters. However, the causal link between abnormal crowding and reading disorder is not yet clearly established. Here, we show multiple causal links between the visual crowding and learning to read. The results of four experiments in 128 participants reveal that: i) an abnormal visual crowding characterizes an unselected group of children with DD; ii) two action video game trainings that reduce visual crowding are able to improve reading skills in two unselected and independent children with DD, and; iii) pre-reading visual crowding longitudinally predicts future poor readers. Challenging the uni-causal phonological explanation of DD, our results demonstrate that learning to read

depends also on an efficient visual neural network employed for the object recognition in clutter. These results provide new insights for early identification and possible prevention for DD.

Meeting abstract presented at VSS 2018

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