Why children struggle in reading: within-child related factors

In a nutshell

- Within-child factors affecting reading skills can be genetic, brain-based, or psychological.
- It is recognised that reading disabilities run in families. A gene is the basic unit of heredity passed from parent to child. We also know that there is no single gene for reading disabilities. The genetic background is quite complicated, and genetic factors affect brain development during pregnancy already.
- Proficient reading requires the concerted participation of several brain regions. Different brain systems

activate during different reading-related tasks (e.g. combining letters to sounds or reading whole words) during learning to read and when the child is a fluent reader. So, there is no single “reading center or area” in the brain.

- Children with reading disabilities seem to have problems in activating those areas or we could say neuronal networks used in learning to read or fluent reading.
- Important cognitive skills for learning to read are letter knowledge and phonological skills needed for combining letters and sounds. The ability to automatically retrieve (e.g. names of the letters from long-term memory) is an important skill for fluent reading. Also, memory processes are important in reading.
- High interest in reading promotes improvement in reading skills. When the child is interested and desired to learn to read and is an active reader, we say that the child is motivated to practise reading.
- There is a bidirectional relationship between reading and motivation. Interest in reading contributes to reading activity, and in turn, the amount of reading enhances the child’s reading performance.

Genetic factors

The genetics of dyslexia is an important but complicated issue. Experienced teachers and clinicians in different countries have noticed that reading difficulties seem to run in families and are heritable. However, since families share genes and also environments, it is not so easy to determine whether the causes of dyslexia are genetic[1]Elliot, J.G. & Grigorenko, E.L. (2014). The Dyslexia Debate. Cambridge

University press.[2]Fletcher, J.M., Lyon, G.R., Fuchs, L.S. & Barnes, M.A. (2019). Learning disabilities. From identification to intervention. Second edition. New York: The Guilford Press.[3]Olson, R.K., Keenan, J.M., Byrne, B. & Samuelsson, S. (2013). Why Do Children Differ in Their Development of Reading and Related Skills? Scientific Studies of Reading, 38–54..

One strategy to solve the heritability problem has been to conduct *twin studies* to compare identical (monozygotic, MZ) twins who share 100% of their genes with fraternal (dizygotic, DZ) twins, who on average share 50% of their genes. Because MZ and DZ twins usually share the same environment (meaning that they usually grow up in the same family), it is assumed that if MZ twins are more similar than DZ twins, this must principally reflect a greater genetic similarity between MZ twins. Research has demonstrated that the probability both twins have dyslexia is higher for MZ twins (approximately 90%) than for DZ twins (approximately 40%).

Twin studies have also shown that the environment has a greater influence before reading instruction begins, reflecting differences in home literacy environment and parental attitudes to literacy (how important literacy is to the parents). It should also be kept in mind that heritability for a factor such as educational attainment is higher in more equal environments and societies. In more unequal societies, heritability is higher among high socioeconomic classes, whereas the environment has wider effects among individuals in low socioeconomic contexts[4]Olson, R.K., Keenan, J.M., Byrne, B. & Samuelsson, S. (2013). Why Do Children Differ in Their Development of Reading and Related Skills? Scientific Studies of Reading, 38–54.[5]Selita, F., & Kovas, Y. (2019). Genes and gini: what inequality means for heritability. Journal of Biosocial Science, 51, 18-47..

Looking for dyslexia genes. We now know that there is no single gene for dyslexia; rather, genetic influences on dyslexia are likely due to many genes with small effects operating together. This likely involves thousands of genes, and research is just beginning to understand this complicated issue. Furthermore, it is important to remember that the environment experienced by children at risk of reading disability can have a considerable effect on their literacy development[6]Van Bergen, E., van der Leij, A., de Jong, P.F. (2014). The intergenerational multiple deficit model and the case of dyslexia. Frontiers in Human Neuroscience, 02 June 2014.. The way it is managed can have an important effect on attainment, academic self-esteem, and well-being in adulthood.

Brain based factors

We know that genetic factors affect brain development during pregnancy, and how neural networks that are involved in learning to read develop in the brain. Neuroimaging studies tell us what happens in our brain when we read, and what kind of differences there are within the brain when comparing children with and without reading disabilities. The main finding is that the functional system needed for proficient reading requires the concerted participation of several brain regions. Different brain systems activate during different reading-related tasks. While single regions of the cortex are necessary, by themselves they are not sufficient for the overall process of skilled reading[7]Elliot, J.G. & Grigorenko, E.L. (2014). The Dyslexia Debate. Cambridge University press.[8]Kearns, D., M, Hancock R., Hoeft, F., Pugh, K.R., Frost, S.J. (2019). The Neurobiology of Dyslexia. TEACHING Exceptional Children, 51(3):175-188.[9]Shaywitz, S.E., & Shaywitz, B.A. (2001). The neurobiology of reading and dyslexia. Focus on Basics. Aug 2001, 11-15.[10]Snowling, M.J.

(2019) Dyslexia. A very short introduction. New York: Oxford University Press..

The three most important areas in the left hemisphere are described in Figure 2.

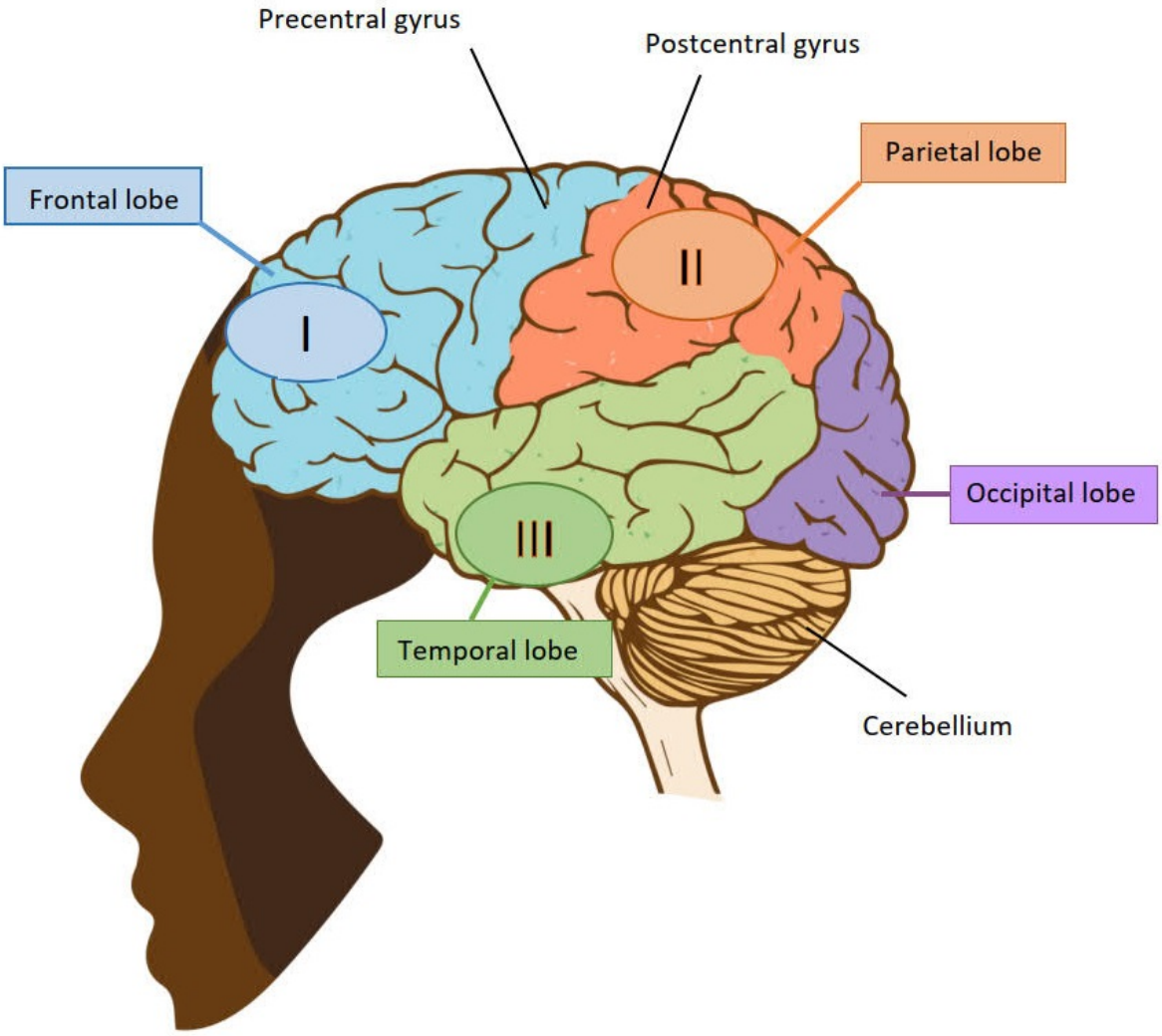

Figure 2. Neural systems for reading. (I) Anterior system in the left inferior frontal lobe. (II) Dorsal parietotemporal system and (III) Ventral occipitotemporal system.

The first area in Figure 2 is Broca's area in the frontal lobe (I). This is related to articulation and word analysis. This area is responsible for speech production and is active during aloud and silent reading. The second area (II) is important for creating letter–sound connections and is most important for assembling the phonological codes of words in the first stage of reading development. The third area (III) is needed

for whole-word recognition. This visual and fast system is needed for fluent reading[11]Kearns, D., M, Hancock R., Hoeft, F., Pugh, K.R., Frost, S.J. (2019). The Neurobiology of Dyslexia. TEACHING Exceptional Children, 51(3):175-188.[12]Snowling, M.J. (2019) Dyslexia. A very short introduction. New York: Oxford University Press..

To read, the beginning reader must break the code; that is, transform the visual features (letters) of the word into the linguistic sounds (phonemes) they represent; then, they can access the meaning of the word. For this, the second system is critical.

This process is often difficult for children with reading disabilities, and they may try to compensate for these problems by shifting to other systems. They may use the first anterior system (I), which is critical for articulation. Forming the word with their lips, tongue, and vocal apparatus may help dyslexic readers develop awareness of the sound structure of the word. Alternatively, they may use the third system (III) to facilitate visual pattern recognition to compensate for the impaired word analysis system (II).

Children with reading disabilities may also use the occipitotemporal area in the right hemisphere to facilitate visual pattern recognition, compensating for the impaired word analysis systems in the left posterior regions. This shift to ancillary neural systems may support accurate (but not fluent) and automatic word reading. However, the reading systems do not work as smoothly and integrally as observed in non-impaired readers[13]Kearns, D., M, Hancock R., Hoeft, F., Pugh, K.R., Frost, S.J. (2019). The Neurobiology of Dyslexia. TEACHING Exceptional Children, 51(3):175-188.[14]Snowling, M.J. (2019) Dyslexia. A very short introduction. New York: Oxford University Press..

Interestingly, although the task of reading varies depending

on the orthographic system of the language, brain activation during reading seems to be quite similar. There may be 'biological unity' of dyslexia across languages, although some language-specific aspects of the so-called 'neural signature' of dyslexia have been reported. Reduced activation of brain regions of the left hemisphere (including the word form area) is a universal feature of dyslexia. However, there are some differences between English and regular orthographies in the spatial extent and location of clusters of over- and under-activation related to the demands on decoding[15]Elliot, J.G. & Grigorenko, E.L. (2014). The Dyslexia Debate. Cambridge University press.[16]Kearns, D., M, Hancock R., Hoeft, F., Pugh, K.R., Frost, S.J. (2019). The Neurobiology of Dyslexia. TEACHING Exceptional Children, 51(3):175-188..

From the perspective of adult illiteracy and learning to read in adulthood, it is interesting that learning to read also changes the brain. Comparing adults who have learned to read in adulthood with illiterate adults, some studies have reported increased grey matter in the brain. Increased white matter indicating a stronger connection in areas of the corpus callosum that connects left and right hemispheres has also been reported. Similar changes were observed previously in the brains of children as they learn to read.

Cognitive skills

The development of reading skills depends on a range of cognitive abilities. A key challenge in the field of dyslexia is to understand its cognitive or 'proximal' causes. Understanding of these cognitive level causes can also provide a rationale for the design of interventions. To understand the difficulties of decoding we need to understand the most important cognitive functions in reading, as follows[17]Elliot, J.G. & Grigorenko, E.L. (2014). The Dyslexia Debate. Cambridge

University press.[18]Fletcher, J.M., Lyon, G.R., Fuchs, L.S. & Barnes, M.A. (2019). Learning disabilities. From identification to intervention. Second edition. New York: The Guilford Press.[19]Snowling, M.J. (2019) Dyslexia. A very short introduction. New York: Oxford University Press.[20]Lyytinen, H., Erskine, J., Hämäläinen, J., Torppa, M., & Ronimus, M. (2015). Dyslexia–Early Identification and Prevention: Highlights from the Jyväskylä Longitudinal Study of Dyslexia. Current Developmental Disorders Report. 2, 330-338.:

- Phonological awareness,
- Letter knowledge,
- Rapid automatised naming (rapid and automatic retrieval of verbal material from the long-term memory, RAN), and
- Short-term and working memory.

Phonological awareness

We all have a phonological processing system, which is used to process the sounds in words. Phonemic awareness is the awareness of sounds (phonemes) that make up spoken words. This is important to learn the correspondences between letters and sounds when learning to read. The main role of the phonological processing system is to analyse and manipulate sound structures of words. This means it is possible to hear the sounds and syllables of the words and convert them into letters (spelling). It is also possible to see letters on a page and convert them into something you can hear (reading). Many children with reading difficulties struggle to either split words they hear into separate sounds or combine sounds to syllables and words. Accordingly, they are more likely to struggle with reading and spelling.

Letter knowledge

Letters are a form of written communication.Letter knowledge helps the child to operate with the phonemes of the oral language and leads the child towards greater sensitivity to the phonemic structure of words. Children need to learn letter–sound correspondences to be able to read and spell. In regular languages (such as Bantu languages and Finnish), letter knowledge has been a particularly strong predictor of decoding.

Rapid automatised naming

Many children with reading difficulties are slower than their classmates in quickly naming serially presented visual stimuli that are already well known to them. This process is called rapid automatised naming (RAN). The child’s ability to retrieve names of letters, numbers, objects, and colours from long-term memory can easily be assessed using simple RAN tasks. Naming speed seems to be related to almost all aspects of reading, but most strongly to reading speed and fluency.

Working memory

It is unsurprising that memory deficits are considered to have a causal effect on reading difficulties. Key processes in learning to read involve coding, storage, and retrieval of stable associations between speech and written language. Of great importance is the lexical retrieval process that requires recognition of an array of letters that form a particular word and subsequent retrieval of its name and meaning from memory. Although both verbal and visual long-term memory capacities tend to be weaker in poor readers, most studies of memory processes have focused on short-term or working memory. The concept of working memory evolved from the concept short-term memory. These concepts are sometimes used synonymously in the literature.

Motivation

Although the development of reading skills is affected by different cognitive antecedents, evidence also suggests that a high interest in readingpromotes improvement in reading skills. Thus, there appears to be a bidirectional relationship between reading and motivation. Interest in reading contributes to reading activity, and in turn the amount of reading enhances the student's reading performance at school. Children are more motivated to read and engage more when they are good at it. Therefore, the question of how to best motivate children to read should not be divorced from the question of how best to teach them. It is well observed that teaching practices play a role in the development of various aspects of motivation. Subsequently, one clear and achievable means of maximising motivation is to ensure that children have solid basic skills and consider themselves a reader as a key part of their identity. Skilled alphabetic decoding and fluent word reading are fundamental to achieving this outcome. Children with reading difficulties are often less motivated to read. However, a positive finding is that engagement in reading-related activities can serve as a protective factor for young children at risk of future reading disability[21]Snowling, M.J. (2019) Dyslexia. A very short introduction. New York: Oxford University Press..

References

[mfn_list_execute_after_content_processed]

Research briefs

Why Do Children Differ in Their Development of Reading and Related Skills?

Read more

Rapid Automised Naming

Genes and Neurobiological Factors and How Environment affect learning to read

Letter Knowledge

Phonological Awareness

Working Memory

Motivation

Additional reading

Genes and Neurobiological Factors and How Environment affect learning to read

Genetical factors and dyslexia