Genetic factors

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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 know whether the causes of dyslexia are genetic?

Twin studies comparing identical (monozygotic, MZ) twins who share 100 % of their segregating genes, with fraternal (dizygotic, DZ) twins, who on average share 50% of their genes, has been one strategy to solve the heritability problem. Because MZ and DZ twins usually share the same environment, it is assumed that if MZ twins are more similar to each other than DZ twins this must principally reflect the greater genetic similarity of MZ twins. Research has shown that the probability that both twins have dyslexia is higher for MZ twins (about 90%) than for DZ twins (about 40%).

Twin studies using statistical modeling show that heritability estimates for reading fluency are high (0.7) meaning that 70% of the variability in reading between people is attributable to genetic factors. These studies have also shown that the environment has greater influence before reading instruction begins reflecting differences in home literacy environment and parental attitudes to literacy. It is also important that genetic correlation between phonological awareness and reading is high, suggesting common genetic influences and hence likely common causation of the underlying mechanism. It should also be kept in mind that heritability of eg. educational attainment is higher in equal environments and societies. In more unequal societies, heritability is higher among high socioeconomic classes, whereas among low socioeconomic individuals, the environment has wider effects[1]Selita, F., &

Kovas, Y. (2019). Genes and gini: what inequality means for heritability. Journal of Biosocial Science, 51, 18-47..

It is important to remember that these twin study findings do not speak to the genetic and environmental causes of poor reading at the individual child – they relate to group patterns.

Looking for dyslexia genes. We know now from molecular genetics, that there is no single gene for dyslexia, rather, genetic influences on dyslexia are likely to be due to many genes with small effects operating together. During the last twenty years the development has been very rapid, and so-called candidate genes have been identified (the first ones based also on the Jyväskylä Longitudinal Study of Dyslexia sample). It is expected that there will be thousands of genes involved and research is just taking the first steps to understand this complicated issue.

There are different methods in molecular genetics to study dyslexia. The so-called linkage studies helped in identifying of the broad sections of chromosomes for dyslexia on chromosomes 1,2,3,6,15, and 18. These studies allowed, by using different methods, the specification of gene variants and 'candidate genes' in these regions. However, the association between a candidate gene and aspects of the dyslexic profile is relatively weak in most cases. Genome-wide association studies (GWAS) look for correlation between millions of DNA variations and behavioral measures and need very large sample sizes. We may conclude that we know that dyslexia is a heritable condition but we still have a long way to go before understanding its genetic basis. And it is very important to remember that the environment that children at risk of dyslexia experience can have a considerable effect on their literacy development. The way it is managed can have an important effect not only on attainment but also on academic self-esteem and adult well-being.

One important aspect to understand is gene-environment correlation in dyslexia[2]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.. Gene-environment correlation refers to the influence of genes working through the environment. Parents and children share about 50% of their genes and environment. This is called *passive gene-environment correlation*. *Evocative gene-environment correlation* evokes in interpersonal interactions between the parent and the child. This means that the child who has inherited the genetic risk of dyslexia, is perhaps not so eager to participate in common book reading situations with the parent because of poor language skills, and this may lead to that the parent is less motivated to spend time reading with the child, and thus the child is exposed less to reading. The *active gene-environment correlation* means that the child with genetic risk for reading difficulties will select environments where there is little exposure to print e.g. playing with toy cars or pursuits instead of book reading situations (that is difficult for the child). In a way, children are selecting the activities and environments where they experience success and positive emotion. It means that the print exposure, that is important for learning to read, will be smaller to these children than in children without the genetic risk.

References

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