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Dyslexia, phonological processing in

Developmental dyslexia is by definition a disorder of written language acquisition, despite adequate intelligence and opportunity, and in the absence of obvious sensory, neurological or psychiatric disorder. It primarily affects the acquisition of reading, and particularly word identification, and secondarily the acquisition of conventional spelling.

Underlying causes of developmental dyslexia

Two main proximal causes have been considered. Historically, the initial hypothesis was that of a visual deficit ("congenital word blindness", coined by William Pringle-Morgan in 1896). In the 1970s, it became evident that what had been interpreted as visual letter confusions were better explained by phonological confusions. Over the last three decades it has been well established that most cases of dyslexia can be attributed to a subtle disorder of oral language (the "phonological deficit"), whose symptoms happen to surface most prominently in reading acquisition. It remains likely that a minority of cases of dyslexia are due to disorders in the visual modality, although the precise nature of the deficit remains unclear. The present entry focuses on cases of dyslexia with a phonological deficit.

Another important theoretical debate is whether the phonological deficit in dyslexia is specific to the linguistic domain, or is caused by an underlying auditory deficit. Although there is considerable evidence that a subset of dyslexic children have difficulties in a variety of auditory tasks, there have been important challenges to the view that this is the underlying cause of their phonological deficit, hence the cause of their reading disability. Again, given that both sides of the debate agree that the phonological deficit is central to understanding dyslexia, this issue will not be further discussed here.

Symptoms of the Phonological Deficit

There is wide agreement on the main symptoms of the phonological deficit in dyslexia: they include poor phonological awareness, poor verbal short-term memory, and slow lexical retrieval. Phonological awareness refers to the realisation that words are made of a combination of smaller units (syllables and phonemes), and to the ability to pay attention to these units and explicitly manipulate them. Typical tasks include counting the number of syllables or phonemes in a word, detecting whether words rhyme, deleting the initial (or final) phoneme, or performing simple spoonerisms (swapping the initial phonemes of two words). Verbal short-term memory typically refers to the ability to retain and immediately repeat verbal material of increasing length: sequences of two to nine digits (digit span), nonwords of two to five syllables (nonword repetition), or even sequences of nonwords (nonword span). Finally, lexical retrieval refers to the ability to quickly retrieve the phonological forms of words from long-term memory. In the context of dyslexia research, this is tested by having participants name series of 50 objects, colors, or digits as fast as possible (rapid automatised naming). Dyslexic children are typically found to have poor phonological awareness (particularly phoneme awareness), reduced short-term memory span, and slow automatised naming, although individual profiles along those three dimensions of course vary, leading to the possibility of subtypes. Thus the most prominent symptoms of developmental dyslexia are diverse, but united by their involvement of phonological representations, hence the consensus hypothesis of a "phonological deficit".

Nature of the Phonological Deficit

The study of the symptoms of dyslexia has led many researchers to hypothesise that dyslexics' phonological representations are somewhat degraded, poorly specified, noisy, lacking either in temporal or in spectral resolution, or are insufficiently attuned to the categories of the native language. An alternative view is that phonological representations in dyslexia are intrinsically normal, but that the observed difficulties in certain (but not all) phonological tasks arise from a deficit in the access to these representations, a process that is particularly recruited for short-term memory, speeded retrieval and conscious manipulations. The precise nature of the phonological deficit therefore remains to be uncovered.

Consequences of the Phonological Deficit

Beyond the observation that most dyslexic children have some form of phonological deficit, the hypothesis is of course that this deficit is the direct cause of the reading disability. In particular, phonological awareness is seen a major cognitive prerequisite for the acquisition of the mappings between graphemes (letters or groups of letters) and phonemes, which themselves provide the foundation of reading acquisition. Verbal short-term memory and efficient lexical retrieval are also thought to play a role in reading acquisition. And indeed, there is ample evidence that these phonological skills are not only defective in dyslexic children, but more generally predict reading ability, both in dyslexic and in normally developing children. However, it has been shown that reading acquisition itself improves phonological skills, so that correlations between the two dimensions do not unambiguously indicate the direction of causation. The differences in phonological skills between dyslexic and control children could similarly be interpreted as resulting from their different levels of reading ability. Indeed illiterate adults who didn't have an opportunity to learn to read have also been found to show poor phonological skills.

More definitive evidence for the causal connection between poor phonological skills (and in particular poor phonological awareness) and dyslexia has come from several additional lines of enquiry. In many studies, dyslexic children have been shown to have poorer phonological skills, not only than normal readers of the same age, but also than younger children who have the same reading level. Furthermore, longitudinal studies beginning before reading acquisition have established that phonological skills predict reading ability several years ahead, and that the phonological deficit is present in would-be dyslexic children even before they learn to read. Finally, a few longitudinal studies starting from birth, using both behavioural methods and event-related potentials, have established that the phonological deficit may have precursors already in the first year of life, in the form of poor categorisation or discrimination of speech sounds.

In summary, there is overwhelming evidence that a phonological deficit is a proximal cause of reading disability in at least a majority of dyslexic children. The precise nature of this deficit remains to be fully understood, and its neural and genetic bases are also under intense scrutiny.

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See also:
Dyslexia, Developmental
Specific language impairment
Reading and eye movement
Language Learning, Genetic Mechanisms

Further Readings:

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