



Developmental Dyslexia

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Lecture 6, 29.10.2020

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Roadmap for today's lecture

- What is developmental dyslexia
 - History
 - Symptomatology
 - Definitions
 - Underlying causes of dyslexia
 - Causal theories
 - Interventions for remediation
 - A miracle cure for dyslexia?

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Learning outcomes

1. Name and critically discuss two causal theories of developmental dyslexia
 2. Evaluate theories of developmental dyslexia in terms of their ability to account for a range of behavioural difficulties experienced by dyslexic individuals

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<ul style="list-style-type: none"> ■ Poor reading & spelling ■ Impaired phonological processing <ul style="list-style-type: none"> ■ Poor phonological awareness ■ Rapid naming ■ Impaired verbal short-term memory ■ Slow verbal processing speed ■ Directional confusion ■ Messy handwriting ■ Finger differentiation problems ■ Visual difficulties (e.g., tracking text) ■ Difficulties with mental arithmetic, remembering sequences etc. ■ Motor dysfunction (e.g., poor balance) 	<p>Literacy or literacy related</p> <p>Non-literacy related</p>	<hr/>
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How can we explain this multitude of difficulties?

- Two possibilities
 - We try to account for them all (**critical features**)
 - Some of these symptoms are secondary or irrelevant (**associated features**), thus, do not need to be explained in the context of our theory

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From lecture 5

1. The procedural deficit theory

- What is in common, across these seemingly unrelated symptoms (reading, calculating, walking) is that they all involve skill automatization (implicit or 'unconscious' learning) reflecting procedural learning skills
- Network that includes prefrontal language systems and basal ganglia, parietal and cerebellar structures
- Impaired procedure vs. intact declarative system (explicit learning system underlying factual/event knowledge) has been posited as a cause of DLD

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1. The procedural deficit theory

- Similar underlying assumption in Nicolson & Fawcett's (2005; 2007; 2011) cerebellar-deficit framework of dyslexia
- Key prediction: any skill that requires automatization (e.g., cognitive, motor, **reading aloud**, ...) will be impaired
- E.g. theory can explain why phonology is impaired in dyslexia but also explain heterogeneity of dyslexic symptoms
- Linked with evidence of cerebellar anomalies in dyslexic individuals, including metabolic anomalies, decrease in gray matter and other structural differences

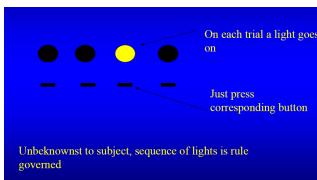
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From lecture 5

The Serial Reaction Time Task

Some evidence for deficits among dyslexic individuals



Nissen & Bullemer (1987)

- Learning blocks: Repeating sequence: fixed (e.g., 4231324321) or probabilistic (e.g., 4r2r1r3r)
- Test blocks: 'predictable' vs randomly generated sequences

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A statistical learning task – last week's seminar

Familiarisation Phase

Blue T-like symbol	Blue X-like symbol	Blue dot with a vertical line
Blue spiral symbol	Blue double arrow symbol	Blue circle with a vertical line
Blue wavy symbol	Blue circle with a horizontal line	Blue I-like symbol
Blue three-dot symbol	Blue downward-pointing triangle	Blue house-like symbol

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A statistical learning task – last week's seminar

Test Phase

Blue T-like symbol	Blue X-like symbol	Blue dot with a vertical line
Blue spiral symbol (circled)	Blue double arrow symbol (circled)	Blue circle with a vertical line (circled)
Blue wavy symbol	Blue circle with a horizontal line (circled)	Blue I-like symbol
Blue three-dot symbol	Blue downward-pointing triangle	Blue house-like symbol (circled)

Some evidence for deficits among dyslexic individuals

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The Procedural theory: Criticisms

1. The theory cannot account well for cases where these generalized learning difficulties do not occur
2. Deficits are not always found (at least in well compensated dyslexic adults; Samara & Caravolas, 2016)
3. Little evidence that verbal/ non-verbal procedural learning ability correlates with performance on measures of language and literacy (West et al. 2019)
 - Poor reliability of procedural/implicit measures such as the serial reaction time (discussed in Lecture 4) in 7 to 8-year-olds and no evidence of correlation with measures of literacy, language or numeracy

I will come back to this during the seminar

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2. The phonological deficit theory

- A cognitive deficit in the representation, storage and/or retrieval of speech sounds (**phonological deficit**) causes reading/spelling difficulties
- Marked impairments in dyslexic individuals' phoneme awareness and other measures that draw heavily on phonological processing
 - including verbal short-term memory; nonword repetition; rapid automatized naming tasks

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Evidence supporting the PD theory

- Lecture 5: Three foundation skills that account for unique variance in subsequent reading/spelling accuracy
- Training studies
 - Treatment that helps overcome poor performance in these skills will be effective for children at risk of or diagnosed with dyslexia
 - Prevention studies (children at risk of dyslexia)
 - Remediation studies (children diagnosed with dyslexia)

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Training studies supporting the PD theory

- Evidence that early intervention programmes that train phonemes and letters in context of reading can facilitate reading development (decoding) in at-risk children
 - Bradley & Bryant (1985)
 - Hatcher, Hulme, & Ellis (1994). "Sound linkage" study
 - Hindson et al. (2005). "Sounds foundations"
 - Bowyer-Crane et al. (2008). RCT "Reading+Phonology (vs. oral language) intervention

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Bradley & Bryant (1985)

- Tested causal influence of PA on literacy via a **training study**
 - Theoretically irrelevant (though otherwise beneficial) treatment group (semantic training)
 - Untrained control group
 - 40 x 10 min. Individual sessions over 2 years

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Bradley & Bryant (1985)

- **Design**
 - PA training – 'Odd-one-out alliteration' activities
 - PA + letter/phonics training
 - Conceptual/semantic training controls
 - Untrained controls (baseline)
- **Post training effects on reading and spelling**
 - **PA Group:** 3 & 6 months n.s. gains vs group C (8 & 10 month gains respectively vs. group D)
 - **PA + Phonics Group:** Best results: 8 & 17 months sig. gains vs. group C (14 & 24 month gains vs group D)
 - **Conceptual Group:** Marginal effects on literacy progress
 - **Untrained Control Group:** n.s. effect on gains in literacy

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So what about the remaining symptoms?

Criticism: Phonological-deficit models of reading disability cannot account for all dyslexic symptoms

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So what about the remaining symptoms?

- A consequence of poorly developed literacy skills?
 - e.g. dyslexic children have auditory difficulties in how they perceive rapidly changing speech but this may reflect a phonological deficit (Hulme & Snowling, 2009)
- Another view: If these are not critical features, we do not need an explanation for them
 - E.g., Dyslexia in an individual is often **comorbid** (accompanied more often than expected by chance) with DLD, DCD, Dyscalculia , AD(H)D (Kain, Landerl, & Kaufmann, 2008; Pennington, 2006; Sharma, Purdy, & Kelly, 2009)

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Bringing it all together

- Highly prevalent disorder and long persistent disorder with a heterogeneous profile
- Its **phenotype** changes within and across individuals
 - Implications for intervention programmes
- Occurs at all levels of intelligence: average, below, high and high above average
 - No consistent evidence for meaningful differences (e.g., prognosis, intervention response) in high&low IQ readers

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Bringing it all together

- Several theories proposed to account for dyslexia at the cognitive and brain level
 - Most acknowledge core phonological deficit
- Evidence-based treatments BUT
 - Treatment resisters or non-responders: approximately 20-30% of children treated in well-established interventions remain poor readers (Carroll et al. 2011)
 - Gaps in reading fluency persist, despite significant improvements in accuracy. Even when the intervention invests on reading connected text (Torgesen et al., 2001; 2003)

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Core & recommended reading

- Bowyer-Crane, C., Snowling, M. J., Duff, F. J., Fieldsend, E., Carroll, J. M., Miles, J., ... & Hulme, C. (2008). Improving early language and literacy skills: Differential effects of an oral language versus a phonology with reading intervention. *Journal of Child Psychology and Psychiatry*, 49(4), 422-432.
- Hatcher, P. J., Hulme, C., & Ellis, A. W. (1994). Ameliorating early reading failure by integrating the teaching of reading and phonological skills: The phonological linkage hypothesis. *Child development*, 65(1), 41-57.
- Hindson, B., Byrne, B., Fielding-Barnsley, R., Newman, C., Hine, D. W., & Shankweiler, D. (2005). Assessment and Early Instruction of Preschool Children at Risk for Reading Disability. *Journal of Educational Psychology*, 97(4), 687.
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- Hulme, C., Bowyer-Crane, C., Carroll, J. M., Duff, F. J., & Snowling, M. J. (2012). The causal role of phoneme awareness and letter-sound knowledge in learning to read: Combining intervention studies with mediation analyses. *Psychological Science*, 23, 572-577.

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Core & recommended reading

- Hulme, C., Snowling, M. J., West, G., Lervåg, A., & Melby-Lervåg, M. (2020). Children's language skills can be improved: lessons from psychological science for educational policy. *Current Directions in Psychological Science*, 29(4), 372-377.
- Nicolson & Fawcett (2007). Procedural learning difficulties: reuniting the developmental disorders? *Trends in Neurosciences*, 30, 135-141
- Snowling, M. J., & Hulme, C. (2020). Annual Research Review: Reading disorders revisited—the critical importance of oral language. *Journal of Child Psychology and Psychiatry*.
- West et al. (2019). Procedural and declarative learning in dyslexia. *Dyslexia*, 25, 246-255.
- West, G., Vadillo, M. A., Shanks, D. R., & Hulme, C. (2017). The procedural learning deficit hypothesis of language learning disorders: We see some problems. *Developmental Science*, e12552

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