



The Procedural Deficit Hypothesis of Dyslexia

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Objective

- To offer an explanatory hypothesis of dyslexia that can account for many of the seemingly unrelated deficits that co-occur in dyslexia, as well as some of the preserved functions in the disorder.

Hypothesis (Procedural Deficit Hypothesis)

- a substantial portion of the deficits in dyslexia are linked to abnormalities in the brain structures that underlie a single brain system: the procedural memory system.

Predictions

- Dyslexics should be impaired at procedural memory functions: the various visuo-motor and cognitive skills, rules and habits that are learned and processed in this system, across domains, including in language (across syntax, morphology and phonology).
- Other functions that depend on the brain structures that constitute the procedural memory system, such as working memory, dynamic mental imagery, and lexical retrieval, are also predicted to be impaired, even though their relationship with procedural memory functions may be unclear.
- Functions of the declarative memory system, a brain system that is rooted in temporal lobe structures, and interacts with, but has been dissociated from, procedural memory, are expected to be spared in dyslexia, or even enhanced due to compensation effects. These functions include the learning and long-term storage of knowledge of facts, events and words (lexical memory).

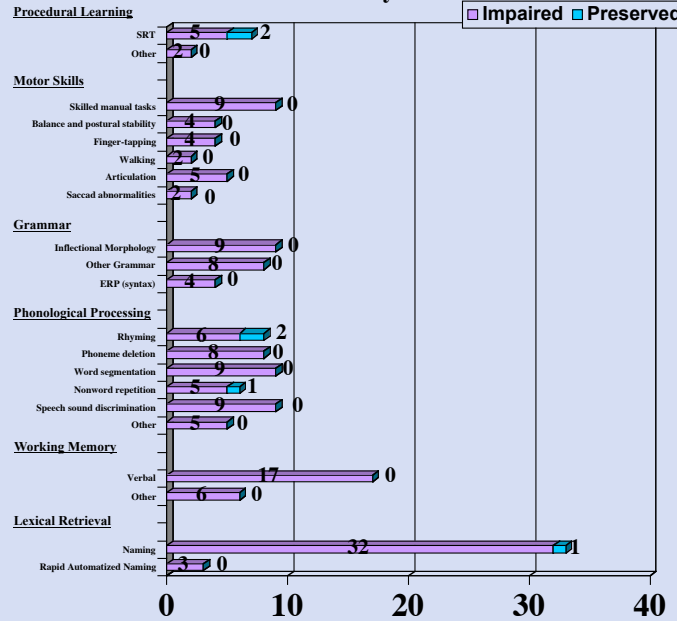
Approach

- As a first step to test the Procedural Deficit Hypothesis, or PDH, we compiled a list of functions that depend on the brain structures of the procedural memory system, as well as functions that depend on the declarative memory system.
- We then carried out a literature examination of the status of all these abilities in dyslexia. In this poster we report our literature examination to date.

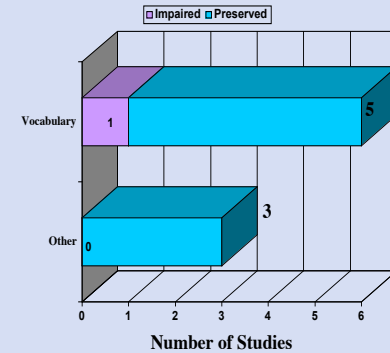
The Procedural Memory System: Overview

- subverses the learning of new, and the execution of established, sensory-motor and cognitive skills, habits and rules [1-6]
- may be specialized for sequences and rules, across domains (including motor and language) [1, 7-11]
- the brain structures which constitute this system are rooted in frontal/basal-ganglia circuits, but additionally include portions of parietal cortex, superior temporal cortex and the cerebellum [1, 12-15]

Procedural Memory and Related Functions



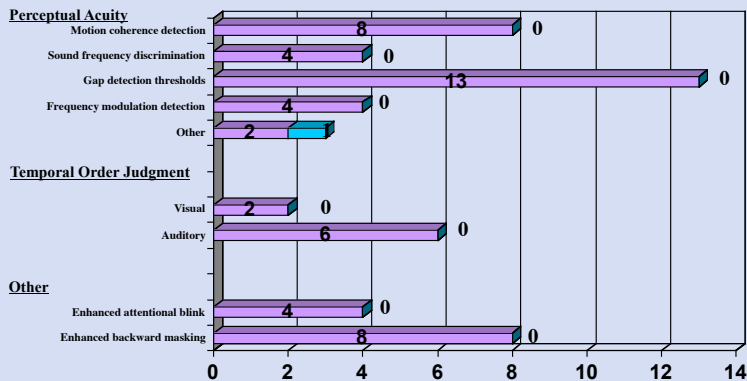
Declarative Memory



Noteworthy Test Cases

- One study found impaired repetition of low-frequency words but spared repetition of high-frequency words (as predicted).
- Two studies found preserved matching of sound to orthography relative to reading-age controls. One found an impairment.
- Two studies found preserved matching of sound to non-word orthography relative to reading-age controls.
- Two studies reported impaired letter fluency (frontal lobe-based), while two studies reported superior semantic fluency (temporal lobe-based).

Other Phenomena with Unclear Relationship to Procedural Memory



Conclusions

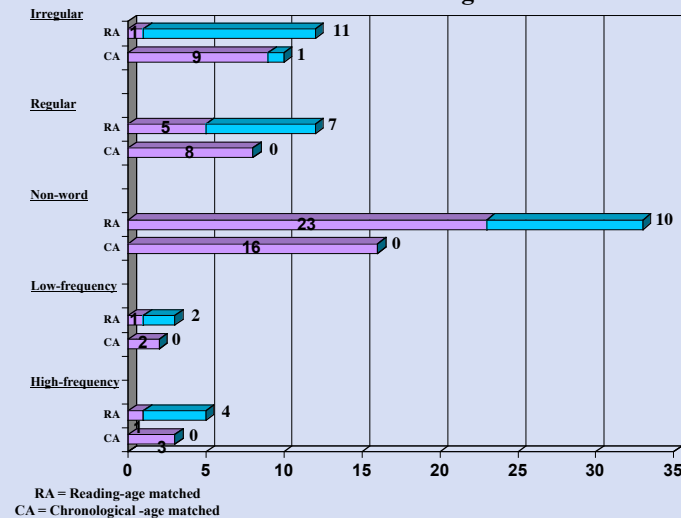
- Persuasive evidence of impairments to functions linked to procedural memory and its underlying brain systems.
- Some evidence of preservations for declarative memory.

Future Directions

- Further testing of procedural memory functions, particularly procedural learning.
- Further testing of declarative memory, particularly with regards to potential enhancements.
- Further explore interactions of procedural and declarative memory (see "Noteworthy Test Cases").
- Further explore the relationship between procedural memory and deficits in Dyslexia not previously linked to procedural memory or its underlying brain systems.

Number of Studies

Reading



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