Executive Functions and Reading: A Neuropsychological Perspective

Presented by

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Source Acknowledgement

Note: This presentation borrows heavily from Brain Literacy for Educators and Psychologists (Berninger & Richards, 2002) and Essential of Executive Functions Assessment (McCloskey & Perkins, 2012). These sources can be consulted for more information on the concepts presented in this overview.
An Integrative Model Specifying Processes, Abilities, Lexicons, Skills, Memory and Achievement in Reading

- General & Specific Knowledge Lexicons
- Semantic Lexicon
  - Word & Phrase Knowledge
- Language
- Reasoning
- Visuospatial

Comprehending Words and Text

- Decoding Unfamiliar and/or Nonsense Words
- Reading Familiar (Sight) Words

Speed
+ Prosody = Reading Rate aka “Fluency”

- Phonological Processing
- Oral Motor Functioning
- Orthographic Processing

Initial Registration (Immediate Memory)
Working Memory
Retrieval from Long Term Storage
Knowledge Stores (Lexicons)

- Vocabulary (Pronunciation, Semantic Lexicons)
- Conventions of Spoken Language (Grammar & Syntax)
- General Information
- Phonologic Awareness
- Morphologic Awareness
- Orthographic Awareness
Abilities (Taught as Skills?)

- Receptive Language
- Expressive Language
- Visuospatial Language
- Reasoning
Processing & Functioning (Taught as Skills?)

- Orthographic Processing
- Phonological Processing
- Morphological Processing
- Oral-motor Functioning
Time Frames of Reference

- Initial Registration/Immediate Memory
- Working Memory
- Retrieval from Long-Term Storage
Reading Skills

- Sight Word Recognition
- Word Decoding
- Reading Speed and Prosody (aka “Fluency”)
- Reading Comprehension
An Integrative Model Specifying Processes, Abilities, Lexicons, Skills, Memory and Achievement in Reading

- General & Specific Knowledge Lexicons
- Semantic Lexicon Word & Phrase Knowledge

Language → Reasoning → Visuospatial

Comprehending Words and Text

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Oral Motor Functioning

Orthographic Processing

Initial Registration (Immediate Memory)

Working Memory

Retrieval from Long Term Storage

indicate Executive Function processing at work

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Executive Functions and Reading

Executive Function Processing

Phonological Processing

Oral Motor Processing

Orthographic Processing
Executive Functions and Reading

① Cueing immediate and sustained attention to orthography for accurate letter/word perception and discrimination

② Cueing and coordinating the use of phonological and orthographic processes for accurate word pronunciation

③ Directing efficient oral motor production, prosody, and rate for reading words and connected text
Executive Functions and Reading

④ Cueing and directing the use of attention and immediate memory resources for reading words and connected text

⑤ Cueing retrieval of information from various Lexicons to read words and connected text

⑥ Cueing and coordinating the use of word recognition, word decoding, and reading comprehension skills
Executive Functions and Reading

7. Cueing and coordinating the use of abilities and the retrieval of knowledge from Lexicons to create meaning for text comprehension

8. Cueing and sustaining the use of working memory resources while reading words and constructing meaning from text

9. Cueing and directing the oral expression of meaning derived from text comprehension

10. Cueing and directing the use of strategies for reading words and deriving meaning from text
Learning vs Producing

Producing difficulties are different from learning difficulties; producing difficulties are more likely to reflect poor use or disuse of executive functions.
Learning Difficulties Only

Learning Difficulties And Producing Difficulties

Producing Difficulties Only

Often NOT recognized as a Learning Disability, even when severe, unless an evaluation involving process assessment is done

Recognized fairly quickly as a Learning Disability

When severe, typically attributed to lack of motivation, character flaws, or behavior/personality problems
Orthographic Processing

- Orthographic Lexicon
- Knowledge Base of Visual Images Representing Letters & Words and Knowledge Base of Orthographic Regularity
- Initial Visual Registration of Letters, Letter Clusters & Words
- Visual Perception and Discrimination of Orthography
- Visual Attention to Orthography
Perception of this image varies depending on whether you are engaging pattern-oriented perceptual processes or detail-oriented perceptual processes. Pattern-oriented processing leads to perceiving the visual image of a young girl. Detail-oriented processing leads to perceiving the visual image of an old woman. Many viewers can consciously or nonconsciously alter the perception process at will, first seeing a young girl, then an old woman or vice versa.
When viewing orthography, detail processing should be the preferred mode for visual processing rather than pattern processing. Although pattern processing can easily distinguish between “rea” and “ear” because the outer contours are different, pattern processing cannot distinguish “bread” from “beard” because the outer contours are the same. Good readers perceive all of the details of every word, thereby avoiding perceptual errors when reading similar words.
Aoccdrnig to a rscheearch at an Elingsh uinervtisy, it deosn’t mtttaer in waht oredr the ltteers in a wrod are, the only iprmoetnt tihng is taht frist and lsat ltteer is at the rghit pclae. The rset can be a toatl mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae we do not raed ervey ltiter by itslef but the wrod as a wlohe.
Reply to something nice:

Subject: too eilsay led atrasy

A mulidutte of cusofend irentent serurfs seem to bilevee taht the oredr of the letetrs in wdros d’esnot mttear wehn you are raindeg as Inog as the frist and lsat leettr are in the crecort pitoison. If so, waht hesiopyeths mghit tehy greanete to epalixn why this citrpyc magesse is etponnexitlty mroe dutifluft to dihecepr by tehm?

I’ll bet it took you more than 11 seconds to read the above passage didn’t it?
Assessing Visual Processing Related to Reading

To maintain the close connection to reading skills and reading achievement, assessment must focus on visual processing of orthography rather than visual processing of nonverbal visual images.
Assessing Visual Processing Related to Reading

• Visual processing must be assessed using orthography (letters, words and numbers) rather than abstract designs or familiar pictures.

• Measures of various aspects of visual perception and discrimination such as the Bender Gestalt, Developmental Test of Visual Perception, NEPSY Design Copying, and WISC-IV Block Design are not appropriate measures for assessing the visual processing used in reading.
Assessing Orthographic Processing Related to Reading

Example of assessment of verbal visual (orthographic) processing directly related to reading:

Process Assessment of the Learner (PAL-II)
Receptive Coding Subtest
PAL Receptive Coding directions:

I will show you two words one at a time.

If the words are exactly the same, say “yes.” If the words are not exactly the same, say “no.”
Assessing Oral Motor Processing Related to Reading

• Oral motor production processing assessment should focus on the fast and accurate integration of phonology and orthography rather than the naming of colors or objects.

• Measures of oral language that focus on verbal expression of connected discourse are not appropriate measures for assessing the specific oral motor production processing used in the fast and accurate reading of words and connected text.
Verbal Visual-Motor Information Processing Neural Networks

OUTPUT

Internal Mental Representation

Oral Motor Production of Language

Seeing Colors & Objects

Seeing Orthography as Letters & Words

INPUT

Seeing Orthography as Numbers

Seeing Orthography as Numbers

Nonverbal Visual Information

Verbal Visual Information (Orthography)

All Visual Information Input
Assessment of Executive Functions does not occur “in a vacuum.” In order to evaluate how EFs cue and direct, they must have something (i.e., specific perceptions, emotions, thoughts, or actions) to cue and direct.
Individually-administered Assessments of EF

- Executive Functions must be assessed in tandem with processes, abilities, skills and/or retrieval form lexicons.
- Specific measures of Executive Functions always involve the assessment, to some degree, of a capacity other than executive functions.
- For the most accurate observation or measurement of EFs, the contributions of other capacities need to be minimized, controlled for, or acknowledged in some way.
Progressive deterioration of performance is observed as executive function demands (+ EF) become greater.
Individually-administered Assessments of EF

- Identify a specific cognitive capacity baseline using a measure that minimizes EF involvement.
- Select and use a measure that adds executive function demands to the baseline capacity and observe the results.
- Continue to add additional EF demands and observe results.
Cascading Production Decrement

PAL-II
Rapid
Automatic
Naming

Progressive deterioration of performance is observed as executive function demands (+ EF) become greater.

PAL-II
Rapid
Automatic
Switching
Progressive deterioration of performance is observed as executive function demands (+ EF) become greater.

Process: D-KEFS Color & Word Naming

Process + EF: D-KEFS CWI Inhibition

Process + + EF: D-KEFS Inhibition/ Switching
EF Involvement in Reading

Essentials of Executive Functions Assessment Rapid Reference 6.6:

- Provides lists of Baseline EF-minimized Tasks and Related EF-saturated (EF+) Tasks for CPD Analyses for reading assessment
The examples provided in this rapid reference illustrate how to identify reading production decrements likely to be resulting from ineffective engagement of executive functions during task performance.
Oral Reading Fluency

Rapid automatic naming tasks can function as good baseline tasks for oral reading fluency, but the multifaceted nature of oral reading fluency requires the use of additional baseline measures in order to assess more specifically the impact of executive functions difficulties. For example, effective performance of RAN tasks can be paired with effective performance of sight word recognition tasks or word decoding tasks to examine the effect of executive functions difficulties on sight word oral reading fluency or nonsense word decoding fluency.

Word level Oral Reading Fluency tasks alter the stimuli of rapid naming tasks to become more challenging by having the child read lists of non-repeating sight words or nonsense words as quickly as possible. This format greatly increases the need for the engagement of the Pace, Retrieve, and Balance cues to coordinate oral motor production with retrieval of sight words or decoding pattern knowledge. This increase in demand for the use of these executive functions to guide the reading process is likely to account for cases where, despite adequate performance on rapid naming tasks and word recognition and/or word decoding tasks, a child demonstrates deficient performance on a sight word fluency and/or decoding fluency tasks such as those found in the Test of Word Reading Efficiency (TOWRE) that require rapid application of sight word recognition (Sight Word Efficiency) or rapid application of decoding skills (Phonemic Decoding Efficiency) as shown below:
Baseline Oral Motor Functioning Measures

- PAL RAN Words Scaled Score 10 (50th percentile)
- PAL RAN Letters Scaled Score 11 (63rd percentile)

Baseline Word Recognition Skill Measure

- KTEA-II Letter & Word Recognition Standard Score 105 (63rd percentile)

Word Recognition Skill EF+ Measure

- TOWRE Sight Word Efficiency Standard Score 84 (14th percentile)

Baseline Oral Motor Functioning Measures

- PAL-II RAN Letters Scaled Score 10 (50th percentile)
- PAL-II RAN Letter Groups Scaled Score 11 (63rd percentile)

Baseline Word Decoding Skill Measure

- KTEA-II Nonsense Word Decoding Standard Score 100 (50th percentile)

Word Decoding Skill EF+ Measure

- TOWRE Phonemic Decoding Efficiency Standard Score 84 (14th percentile)
A process-oriented approach can be effectively used to observe and document difficulties with the use of executive function processes during the performance of reading tasks.
EF Involvement in Reading

Essentials of Executive Functions Assessment Rapid Reference 6.2:

- Description of EF involvement in the act of reading
- Lists the EFs most likely to be involved in various facets of reading
- Describes task behavior likely to be indicating a lack of effective EF use
EF Involvement in Reading

Attention to Orthography

- Cueing/directing/coordinating immediate and sustained attention to orthography for accurate letter/word perception and discrimination
EF Involvement in Reading

EFs Likely to be involved in directing orthographic processing during word reading and decoding:

- Perceive, Focus, Monitor, Correct
EF Involvement in Reading

Behavior indicating EF difficulties:

- Quick but inaccurate offerings for individual words with no recognition of the errors being made; words offered are highly similar in visual configuration to the correct word or start with the same letter or letter combination as the correct word or the nonsense word when performing decoding tests.
EF Involvement in Reading

Fluent Sentence Reading

- Cueing/directing/coordination speeded oral motor production and prosody for fluent sentence and passage reading.
EF Involvement in Reading

EFs Likely to be involved in directing sentence reading rate:

- Execute, Pace, Balance, Monitor, Correct, Sustain
Behavior indicating EF difficulties:

- Sentence or passage reading rate is not consistent with rate demonstrated during fluency instruction or some forms of assessment.
EF Involvement in Reading

Avoiding “zoning out” while reading

- Cueing/directing/coordinating sustained extraction of meaning from passage reading
EF Involvement in Reading

EFs Likely to be involved in avoiding zoning out while reading passages:

- Focus, Sustain, Monitor, Correct
EF Involvement in Reading

Behavior indicating EF difficulties:

- Lack of recollection of any of the content of a passage that was just read despite indications that the words of the passage were being read.
### EF Involvement in Reading

**Essentials of Executive Functions Assessment Rapid Reference 6.12**

**Table Excerpt:**

<table>
<thead>
<tr>
<th>Reading Skill Direct Formal Measures</th>
<th>Most likely Process-oriented observations of reading behavior likely to be indicative of a lack of use of EFs</th>
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<tbody>
<tr>
<td><strong>Sight Word Recognition</strong></td>
<td>1. Quick but inaccurate offerings for individual words with no recognition of the errors being made; words offered are highly similar in visual configuration to the correct word or start with the same letter or letter combination as the correct word or the nonsense word when performing decoding tests.</td>
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<tr>
<td>• KTEA Letter &amp; Word Recognition</td>
<td>2. Mispronunciation of words that previously have been recognized by sight and correctly pronounced.</td>
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<tr>
<td>• WJ-III Letter/Word Identification</td>
<td>3. Lack of application of decoding skills when reading sentences and passages for words that have been decoded correctly during skill drills and/or substitutes similarly configured sight words for nonsense words instead of applying decoding skills.</td>
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<tr>
<td>• WIAT-III Word Reading</td>
<td>4. Word reading rate is not consistent with rate demonstrated during fluency instruction.</td>
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<td><strong>Decoding</strong></td>
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<tr>
<td>• KTEA Nonsense Word Decoding</td>
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<td>• WJ-III Word Attack</td>
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<td><strong>Sight Word Recognition Fluency</strong></td>
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<tr>
<td>• TOWRE Sight Word Efficiency</td>
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**Process-oriented observations by measure:**

- 1, 2, 4**
- 1, 3, 4**
- 1, 2, 4**
EF Involvement in Reading

Essentials of Executive Functions Assessment Rapid Reference 6.15:

- Case study report section describing a process-oriented assessment of executive functions difficulties affecting reading
Alana, an 11 year-old child displays adequate word reading skills when reading word lists and adequate RAN performance with letters and words. However, when asked to read a short two sentence text orally, she experiences extreme difficulties with applying both word reading and rapid naming skills; words are skipped, misread, and reread; highly familiar words are decoded instead of sight read, less familiar words are decoded at an extremely slow pace; word misreadings are left uncorrected despite the disconnect between the orally read word and the meaning of the text (e.g., reading “bornes” for “bones”). Despite superior ability to reason with verbal material, Amanda is unable to offer adequate responses to questions about what she just read, even after taking time to reread sentences silently.
Assessing Executive Functions Related to Reading

Amanda’s case description serves to illustrate an important point:

Executive function processing deficits often manifest as inconsistencies in the use of adequately developed processes, abilities, lexicons, skills and/or strategies resulting in achievement and production below what would be expected.
Many executive functions difficulties related to reading are the result of a lack of adequate maturation of the neural networks involved in the use of these executive functions for reading.
The most effective form of intervention for maturational difficulties with executive functions cues is increased practice of the complete act of reading, i.e., applying the integration of all processes, skills, abilities and lexicons while reading connected text while receiving feedback from an external source.
Interventions for Executive Functions Difficulties Related to Reading

Interventions for executive functions difficulties with word reading miscues (1, 2, 4, 5, 6):

Increase awareness of and use of all of the steps in the word recognition process.
Interventions for Executive Functions Difficulties Related to Reading

Script for increasing awareness and use:

- “Look” (Perceive cue)
- “at each word” (Focus cue)
- “carefully.” (Monitor cue)
Interventions for Executive Functions Difficulties Related to Reading

- “See the letters and words that are on the page, not the letters and words you believe to be on the page.” (Inhibit cue)
- “Quickly” (Pace cue)
- “Figure out if you know the word or don’t know the word.” (Gauge cue)
Interventions for Executive Functions Difficulties Related to Reading

- “Quickly” (Pace cue)
- “say the word if you know it.” (Retrieve cue)
- “Pause if you don’t know it.” (Interrupt cue)
- “Shift to decoding mode” (Shift cue)
Interventions for Executive Functions Difficulties Related to Reading

- “and quickly” (Pace cue)
- “use your decoding skills to sound out the word.” (Retrieve cue)
- “Ask yourself if what you sounded out matches a word you’ve heard before.” (Monitor & Retrieve cues)
Interventions for Executive Functions Difficulties Related to Reading

- “Use your decoding skills again if you don’t recognize what you sounded out or if the word doesn’t make sense in the sentence.” (Correct cue)
For a student who appears to be having a lot of difficulty with substituting visually similar highly familiar words, talk with the student about how words can be illusions in that they can fool us into believing that they look like other words we know.
Follow the discussion with word recognition drills that emphasize the first four cues in the sequence ("Look / at each word / carefully./ See the letters and words that are on the page, not the letters and words you believe to be on the page.")
Interventions for Executive Functions Difficulties Related to Reading

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Interventions for Executive Functions Difficulties Related to Reading

Interventions for executive functions difficulties with reading rate:

Increased oral reading practice with words and passages composed of words that can be recognized by sight.
Interventions for Executive Functions Difficulties Related to Reading

- The goal of fluency instruction is to reduce the executive function demands by making word reading automatic.
- Fluency instruction also helps to improve use of the Pace cue; through repetition, pacing is gradually transferred from being externally guided to internally directed.
Interventions for Executive Functions Difficulties Related to Reading

Interventions for executive functions difficulties with cues involved in reading comprehension:

Strategy instruction that models and teaches the student how to approach the tasks of vocabulary building and reading comprehension.
Comprehension Instruction

The NRP’s conclusions about CI:

- Strategies for active comprehension are normally acquired informally
- Explicit or formal instruction of strategies leads to improvement of comprehension
- When the strategies have been acquired, students can apply the strategies independently
- Students who are not explicitly taught these strategies are unlikely to learn, develop, or use them spontaneously
Comprehension Instruction

“The idea behind explicit instruction of text comprehension was that comprehension could be improved by teaching students to use specific cognitive strategies or to reason strategically when they encountered barriers to comprehension in reading.”  NRP 2000, page 4-5
Comprehension Instruction

The NRP identified 8 kinds of CI that “appear to be most effective and most promising for classroom instruction”:

Comprehension Monitoring – teaching students how to be aware or conscious of the attempt to understand what is being read; procedures for dealing with problems in understanding are learned and applied as needed.
Comprehension Instruction

The NRP’s cited two major approaches to comprehension strategy instruction:

Direct Explanation (DE) – teachers help students view reading as a problem-solving task that requires the use of strategic thinking and help them learn to think strategically about solving reading problems. DE focuses on developing teachers’ capacities for explaining the reasoning and mental processes involved in successful reading comprehension in an explicit manner.
Comprehension Instruction

The NRP’s cited two major approaches to comprehension strategy instruction:

**Transactional Strategy Instruction (TSI)** – also views reading as a problem-solving task, but focuses on teacher’s capacities to facilitate discussion in which students collaborate to form joint interpretations of text and explicitly discuss the mental processes and cognitive strategies involved in comprehension of text.
Comprehension Instruction

Typically, Comprehension Strategy Instruction involves:

- Developing of an awareness and understanding of one’s own cognitive processes that are amenable to instruction and learning
- Guiding and modeling the actions that a reader can take to enhance the comprehension processes used during reading
- Practicing strategies with teacher assistance until students internalize them and use them independently
Use Direct Explanation (DE) or Transactional Strategy Instruction (TSI) to help students interpret this song lyric:

“I’ve got brains like antique floors
I’ve built each one on the one before
I use all three but they don’t agree. One of them wants to love you
Another one wants to club you
I guess my old natures move like glaciers”
- Stuart Davis
Comprehension Strategy Instruction: Does it Work?

The NRP’s review of the research literature led to the following conclusions about CI:

- “The focus on what we know about cognition has led to the development of practical strategies for improving students’ comprehension.” Page 4-41
- “The cumulative result of nearly 3 decades of research is that “there is ample extant research supporting the efficacy of cognitive strategy training during reading as a means to enhance students’ comprehension.” Baumann, 1992.