Orthographic Processing:
A Subcomponent or Subtype of Dyslexia?

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Cullowhee Conference

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At the end of this activity, participants will be able to…..

- **describe why dyslexia assessment and intervention is best understood using the phonological processing model,**
- **understand that individuals with dyslexia also have varying degrees of impairment in orthographic processing that need to be addressed during evaluation and instruction,**
- **know how to use measures of reading and spelling to identify deficits in phonologic and orthographic processing, and**
- **discuss how intervention can be adjusted to address weaknesses in orthographic processing.**

C.D.

- **Family history of reading difficulties**
- **Kindergarten entry delayed due to problems with the alphabet**
- **Tutored after school in first grade when benchmarks showed reading delays**
- **Numerous errors trying to spell phonetically**
- **Strong math qualified her for GT program**

C.D.

- **End of first grade FIE did not qualify her for additional services: word reading, nonsense word decoding (NWD), spelling below 25th percentile**
- **IEE (7y-10m; Gr 1.9) recommended accommodations and intervention to improve accuracy/efficiency of word/passage reading: word reading, reading rate, comprehension below 25th percentile (PA and NWD above 50th percentile)**
- **Reading expert encourages the family to request school intervention for orthographic dyslexia**

IDA and TEA Definition

Dyslexia is a specific learning disability that is neuro-biological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the **phonological component** of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge.

Annals of Dyslexia, Volume 53, 2003
Texas Education Agency, The Dyslexia Handbook, 2014

DSM-5 Definition

SPECIFIC LEARNING DISORDER WITH IMPAIRMENT IN READING:

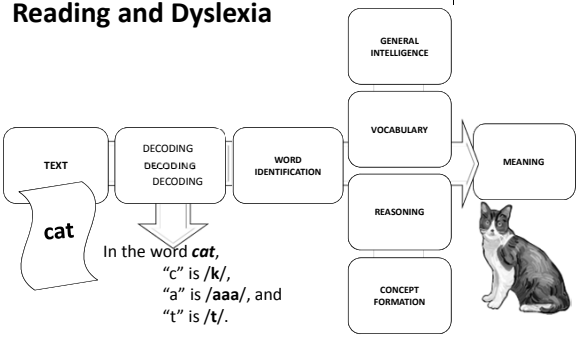
word reading accuracy
reading rate or fluency
reading comprehension

dyslexia is an alternative term for problems with accurate or fluent word recognition, poor decoding and poor spelling.

assessment of cognitive processing not recommended or required for diagnosis

APA, 2013

Phonological Processing Model of Reading and Dyslexia



From Shaywitz (1996). *Scientific American*, *275*, 98-104.

Origins of the Phonological Processing Model of Reading and Dyslexia

Segmented units of speech (phonemes) are also represented in print at the phonemic level through the alphabet.

Liberman, Shankweiler and Liberman, 1989

ALPHABETIC PRINCIPLE

Phonemic segments of spoken words map to orthographic units (letters and letter strings).

Learning to read requires the child establish mappings (connections) between letters in printed words and phonemes of spoken words.

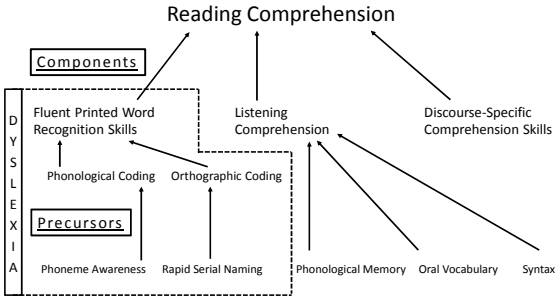
Liberman, Shankweiler and Liberman, 1989

EVIDENCE FOR A PHONOLOGICAL PROCESSING CORE DEFICIT IN DEVELOPMENTAL DYSLEXIA

- Word identification depends heavily on the ability to learn and apply letter-sound associations to decode.
- Compared with normal readers, those who struggle to read have difficulties with phonological awareness and problems with phonological analysis that persist into adulthood.
- Phonological awareness and decoding training have beneficial effect on word identification, spelling and overall reading ability.

Vellutino et al, 2004

Cognitive Components of Reading Comprehension and Their Precursors

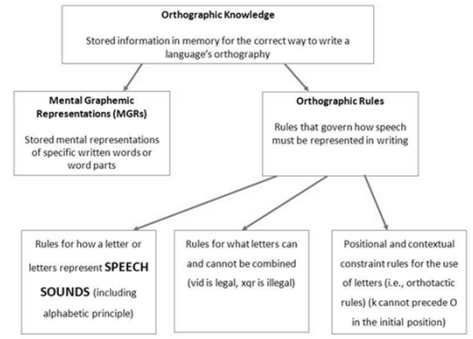


Pennington, 2009

TWO RECIPROCALLY RELATED COMPONENTS OF PRINTED WORD RECOGNITION

Phonological Coding	• Using letter-sound knowledge to pronounce unfamiliar words (measured by pseudoword reading, e.g. ik, lirst, smaut))
Orthographic Coding	• Using memory for letter, letter cluster or whole word to identify a familiar word measured by irregular/exception words (e.g. pint), or homophones (e.g. rose vs. rows)

What is Orthography?



Apel (2011). *Language, Speech, and Hearing Services in Schools, 42,* 592-603.

EVIDENCE THAT ORTHOGRAPHIC PROCESSING HAS A ROLE IN DYSLEXIA

- Orthographic awareness (sensitivity to the constraints on how letters in written words are organized) contributes to learning letter-sound associations.
- Phonological and orthographic awareness interact to produce (sight) word recognition memory.
- Individuals with poor phonological awareness will have poor orthographic awareness as children and adults with dyslexia.

Vellutino et al, 2004

REASONS FOR SPECULATION CONCERNING AN ORTHOGRAPHIC SUBTYPE OF DEVELOPMENTAL DYSLEXIA

- Cases of adult acquired phonological/deep (problems decoding/spelling using phonics) and orthographic/surface (problems reading/spelling irregular words) dyslexia.
- Hypothetical dual route reading system with potential deficits in phonological and/or orthographic coding.
- Cases of children with adequate decoding but poor real word reading:
  - dyseidetic dyslexia (Boder, 1973)
  - developmental surface dyslexia (Coltheart et al, 1983)
  - orthographic dyslexia (Roberts & Mather, 1997)

Origins of Dyslexia Subtyping Models

www.prospectjournal.org/2012/01/12/remembering-the-great-war

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Origins of Dyslexia Subtypes

G.R. (Deep Dyslexia)

- 46yo male. Missile wound in left temporo-parietal area at age 18
- Mild dysarthria
- Severe deficits in verbal short-term memory (digit-and-word-spans)
- Comprehension and object naming less affected
- Reading and spelling 'disturbed'
  - Significant concreteness effect (50%C concrete nouns v 10%C abstract nouns and function words)
  - Errors tend to be nouns, usually semantic substitutions (speak → '*talk*', sick → '*ill*', large → '*big'*, employ → *'factory')*
  - Derivation errors (truth → '*true*', depth → '*deep*')

Marshall & Newcombe (1973). *Journal of Psycholinguistic Research, 2*, 175-199.

Origins of Dyslexia Subtypes

J.C. (Surface Dyslexia)

- 45yo male. Missile wound in left temporo-parietal area at age 20
- No articulation problems
- Significant impairment in reading and spelling
  - Word frequency correlated with performance
  - No semantic errors
  - Tendency to pronounce all graphemes (e.g., *reign→ 'region'*)
  - Grapheme-phoneme conversion variable, with vowel digraphs, consonant clusters, Cve especially difficult
  - Stress-shift errors (begin → *'begging')*
  - Gives phonetic value to silent consonants (e.g. island → izland)

Marshall & Newcombe (1973). *Journal of Psycholinguistic Research, 2*, 175-199.

Summary of Surface Dyslexia Symptoms

- Accuracy is better for regular (*care*) versus irregular (*choir*) words
- Errors on <u>*common*</u> irregular words are often regularizations (*bear* → /bēr/)
- Some multisyllabic words may be read with wrong stress
- Homophone matching more accurate with regular words (*bale/bail* vs *air/heir*)
- When words are read incorrectly, they are frequently misunderstood as the error response
- Homophone confusions occur in silent reading comprehension
- Spelling is poor, majority of errors phonologically correct

Coltheart et al. (1983). *Quarterly Journal of Experimental Psychology, 35A*, 469-95.

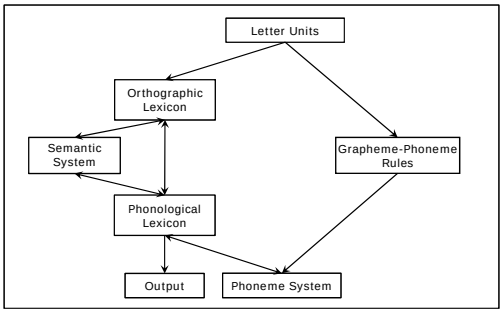
Diagnostic Criterion

	Surface				Deep		
	R.O.G	E.M.	K.M.	E.E.	D.E.	B.B.	P.W.
Regular	92	72	74	59	69	72	59
Irregular	64	13	51	33	69	79	74

<u>Note</u>: Tabled values indicate percent correct

Shallice (1988). *From neuropsychology to mental structure.* p. 83

Dual Route Model



Coltheart et al. (2001). *Psychological Review, 108*, 204-256.

DEEP ROUTE
Sub-lexical Representation

Feature Detectors

Letter Units

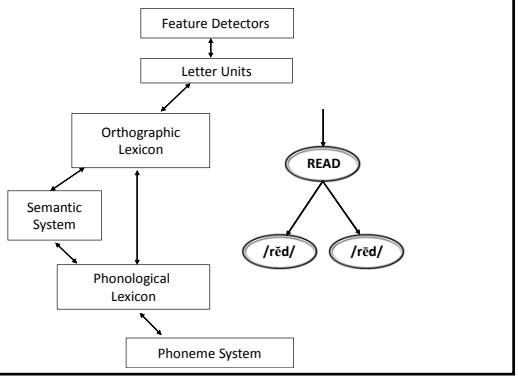
Production Rules

IF
input = **CVCE**
THEN
M(V) = $\overline{V}$
AND
F(V) = ∉

Grapheme Phoneme Rules

Phoneme System

SURFACE ROUTE
Lexical Representation



Neurological Model of Reading

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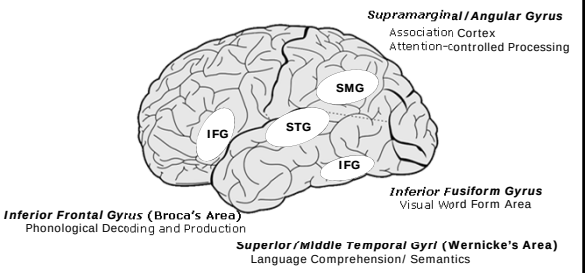
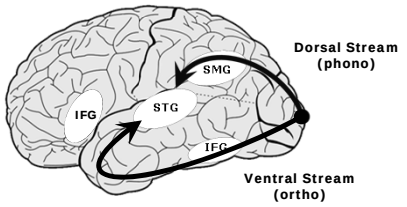


Sandak et al. (2004). *Scientific Studies of Reading*, *8*, 273-292.

Neurological Model of Reading

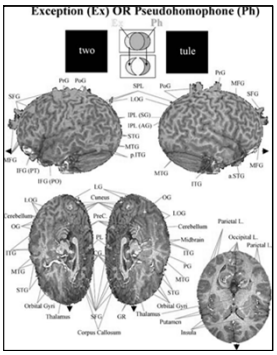


Sandak et al. (2004). *Scientific Studies of Reading*, *8*, 273-292.

Neurological Model of Reading

Reading Exception Words activates ventral-lexical stream

SURFACE ROUTE (ortho)

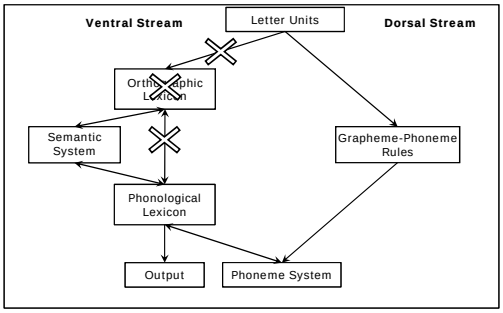


Reading Pseudohomophones activates dorsal-sublexical stream

DEEP ROUTE (phono)

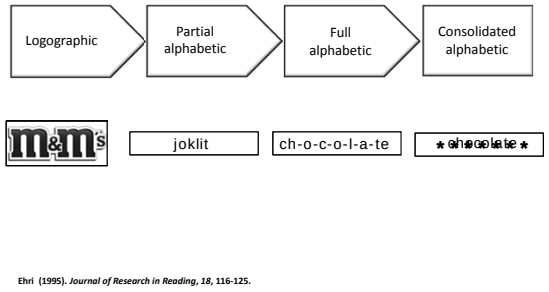
Borowsky et al. (2006). *Brain Topography*, *18*, 233-239.

Surface Dyslexia According to Dual Route Model



Coltheart et al. (2001). *Psychological Review*, *108*, 204-256.

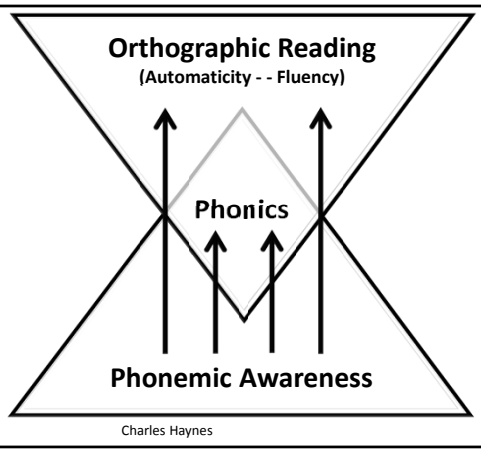
Phases of Reading Development



Ehri (1995). *Journal of Research in Reading*, *18*, 116-125.

Mappings between orthography and phonology allow novel words to be decoded and provide a foundation for acquisition of more automatic reading skills.

Ehri, 2005

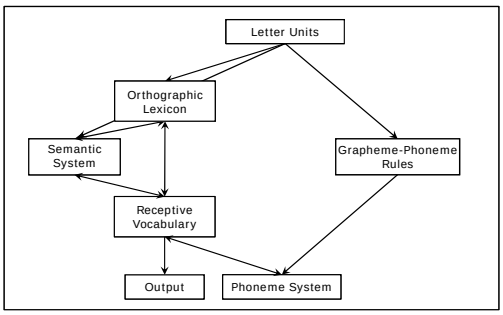


Charles Haynes

Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in what oredr the ltteers in a word are, the olny iprmoetnt tihng is that the frist and lsat ltteer be at the rghit pclae. The rset can be a total mses and yoou can still raed it wouthit porbelm. This is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the word as a wlohe.

Amzanig, huh

Dual Route Developmental Model



Developmental Dyslexia Subtypes

Construct	Phonologic	Orthographic
Early speech/language	• Articulation errors • Mispronunciations of words	Slow retrieval on RAN tasks
Symbol recognition and recall	• Poor recall of sound-symbol relationships • Confusion of similar phonemes (p/b)	• Poor recall of letter appearance • Confusion of similar graphemes (p/q)
Word identification	• Poor recall of letter sounds • Poor decoding • Overuse of context	• Poor recall of letter sequence • Difficulty with rapid recognition of high frequency words • Difficulty recognizing syllables • Overuse of decoding strategy
Spelling	• Poor sequence of sounds • Errors based on similar sounding phonemes • Addition and omission of sounds • Poor knowledge of rules • Overuse of visual features (becuaes/because)	• Reversals based on similar appearing graphemes • Transposition of letters (tow/two) • Overgeneralization of spelling rules (rede/read) • Use of impossible patterns (eggzit/exit) • Overuse of auditory features (becaws/because)

Roberts & Mather. (1997). *Learning Disabilities and Practice*, *12*, 236-250.

MEASURING ORTHOGRAPHIC ABILITY

ERROR ANALYSIS

- reading and spelling of acquired cases (Marshall and Newcombe, 1973)
- spelling error analysis for intervention (Moats, 2010)
- developmental spelling inventories
- prescriptive assessment software
  SPELL-2 (Masterson, Apel and Wasowicz, 2006)

CF CA 14-5 GR 8.8

PC: problems with reading fast enough and spelling

HX: good at spoken language, higher thinking and math
attended public school K-4; then home school
family had difficulty learning to read

spelling errors	error type
carless/careless	orthography (VCE or misuse dropping rule)
could'nt/couldn't	orthography (contraction)
rouph/rough	orthography (MGR)
ridding/riding	morphology (rules for adding suffix)
desighn/design	orthography (MGR)
climb/climbed	morphology (suffix omission)
whisel/whistle	orthography (Cle)
strangth/strength	phoneme confusion (? dialect)

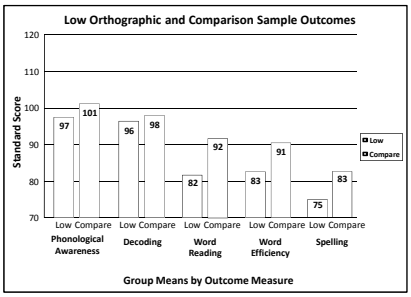
C.F.

CA 14-5 GR 8.8
CTOPP pa SS 109
CTOPP rn SS 112
WRMT watt SS 94
WRMT wid SS 83
GORT-4 rate SS 6
WRMT pc SS 84
WIAT-II spell SS 75

C.F.
School dyslexia services grades 3-4
TSRHC Dyslexia Lab grades 7-8

	CLINIC CA 9-9 GR 4.1	PRE-TEST CA 12-8 GR 7.0	POST-TEST CA 14-5 GR 8.8
IQ	WISC-III FSIQ 92		
PA	TAAS inadeq.	CTOPP SS 70	CTOPP SS 109
RN		CTOPP SS 79	CTOPP SS 112
Decoding	DST 0.52 MS 0.39 PS	WRMT watt SS 82	WRMT watt SS 94
SWR	WIAT br SS 85	WRMT wid SS 82	WRMT wid SS 83
RR	DST av gr 3.3	GORT-4 rate SS 4	GORT-4 rate SS 6
RC	WIAT SS 87	WRMT pc SS 83	WRMT pc SS 84
Spelling	WIAT SS 91	WIAT-II SS 78	WIAT-II SS 75

ORTHOGRAPHIC DEFICITS
FOLLOWING TSRHC DYSLEXIA LAB INTERVENTION
(2003 - 2014)



N=170 Low N=29 Compare N=141
Low = Words Id ≤ 85 SS, Word Att > 90 SS
Baseline: Sig. Gp. Diff. ($p < .05$) Read + Spell Gains: NS

"FIVE BLOCK" SPELLING ERROR ANALYSIS OF WORDS
WIAT PRE/POST FOR N=29 (Ortho Gp.)

LESS % PHONO ERRORS AT POST-TEST

MEAN % NON-PA AT PRE-TEST .57	MEAN % NON-PA AT POST-TEST .70

$$\frac{OA + MA + MGR + SA}{PA + OA + MA + MGR + SA} = \%\ NON\text{-}PA\ ERRORS$$

14/29 had at least .10 increase in % NON-PA errors pre to post
Significant difference pre-posttest, $t(29) = 3.1$, $p < .01$

MEASURING ORTHOGRAPHIC ABILITY

DIAGNOSTIC READING TASKS (Castles and Coltheart, 1993)

Detect difference in reading:

regular (e.g., check)

irregular (e.g., break)

nonword (e.g., drick)

MEASURING ORTHOGRAPHIC ABILITY

HOMOPHONE CHOICE (Stanovich et al., 1991)

"Which is a flower?" rose - rows

ORTHOGRAPHIC AWARENESS (Siegel et al., 1995)

"Which is legal in English?" folk – filv

ORTHOGRAPHIC CHOICE (Olson et al., 1994)

"Which is a real word?" bloo - blue

MEASURING ORTHOGRAPHIC ABILITY

EMBEDDED WORDS (Hultquist, 1997)

"Where's the word?" xKlhbindfq

TEST OF SILENT WORD READING FLUENCY (Mather et al., 2014)

"Draw a line between as many words as you can." (3 min.)

e.g. Seeheinmygogetdoupgreentwodress

TEST OF IRREGULAR WORD READING EFFICIENCY (Reynolds and Kamphaus, 2007)

Reading irregular words in a list format while being timed. (2 min.)

Process Assessment of the Learner

wall

Berninger (2001). *Psychological Corporation.*

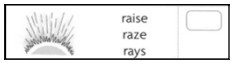
Process Assessment of the Learner

them	then
quieter	quieter
from	form
because	became
them	them
good	oo
because	aw
different	an
them	em
fender	o
travels	e
servant	a

Berninger (2001). *Psychological Corporation.*

Test of Orthographic Competence

- Punctuation (e.g., tom was born on june 25 1986)
- Abbreviations (e.g., Tues.; etc.)
- Letter choice (pdbq) (e.g., re_ ; _uaint)
- Word Scramble (ti; kckon)
- Sight Spell (tw__; __rcle)
- Homophone Choice



Mather et al. (2008). *Pro-Ed, Inc.*

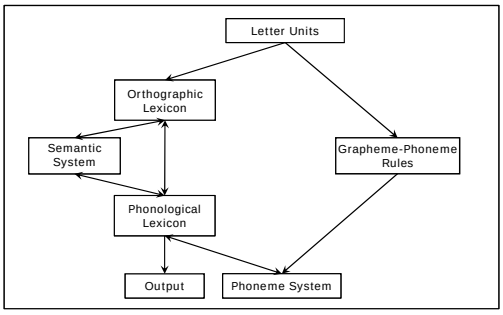
'Pure' Subtype Prevalence

	Castles & Coltheart	Manis et al.	Stanovich et al.	Peterson et al.
Phonological	15%	10%	9%	16%
Surface	17%	10%	12%	2%
Mixed	60%	76%	75%	82%

Percentage below age level on one or both dimensions (nonword or exception word reading)

Castles & Coltheart (1993). *Cognition*, *47*, 149-180.
Manis et al. (1996). *Cognition*, *58*, 157-195.
Stanovich et al. (1997). *Journal of Educational Psychology*, *89*, 114-127.
Peterson et al. (2013). *Cognition*, *126*, 20-38

What is the Core Deficit?



Coltheart et al. (2001). *Psychological Review*, *108*, 204-256.

Surface Dyslexia Core Deficit

- Sample with dyslexia (n=51), same-age controls (n=51) and reading-level matched younger controls (n=27)
- Instruments

  Nonword oral reading (*baich*, *sleesh*)

  Exception word list (e.g., *sword, bouquet*)
- Relative deficits determined by using 95% CI band from regression of exception word reading and nonword reading performance

Manis et al. (1996). *Cognition*, *58*, 157-195.

Surface Dyslexia Core Deficit

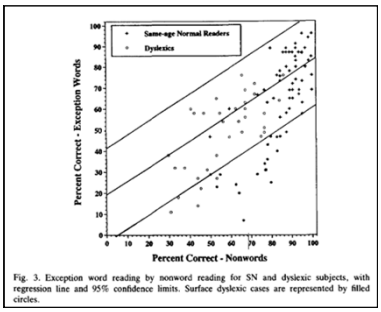


Fig. 3. Exception word reading by nonword reading for SN and dyslexic subjects, with regression line and 95% confidence limits. Surface dyslexic cases are represented by filled circles.

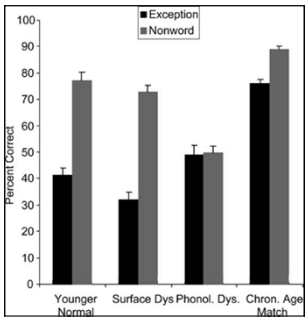
20/51 below 95% CI band for exception relative to nonwords

15/51 surface dyslexics (worse on exception words)

5/51 mixed (exception = nonwords)

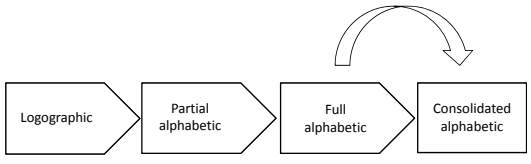
Manis et al. (1996). *Cognition*, *58*, 157-195.

Surface Dyslexia Core Deficit

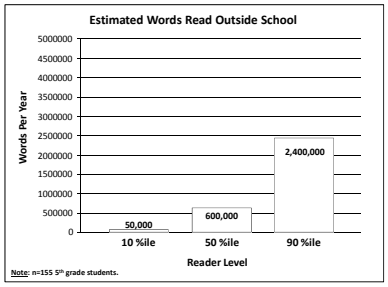


Manis et al. (1996) data reported in Bailey et al. (2004). *Journal of Experimental Child Psychology, 87*, 125-154.

Treatment of Orthographic Deficits



Print Exposure



Anderson, Wilson, & Fielding (1988). *Reading Research Quarterly*, *23*, 285-303. Table 3.

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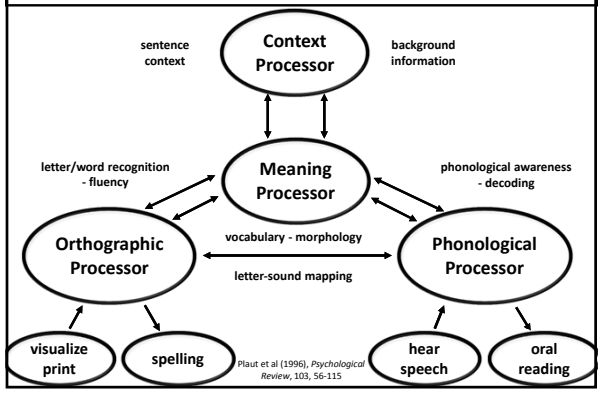
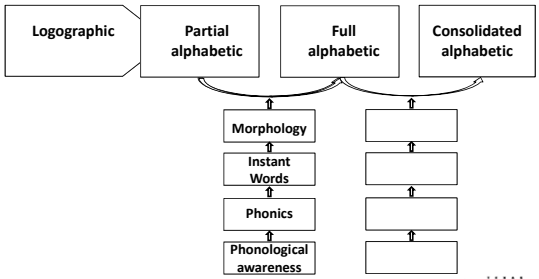
FOUR PROCESSING SYSTEMS IN WORD READING



Plaut et al (1996), *Psychological Review*, 103, 56-115

Comprehensive Reading Instruction



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TREATMENT OF ORTHOGRAPHIC DEFICITS

- Identify PWD>WR, reduced reading rate, relative absence of single grapheme-phoneme spelling errors.
- Research on effective methods for remediating orthographic processing problems is limited.
- Direct instruction should address problems related to reduced exposure to text and underdeveloped knowledge of conventional spellings.
- Reduce orthographic deficits by encouraging more accurate word and connected text reading at each level of instruction (role for supportive reading technology).

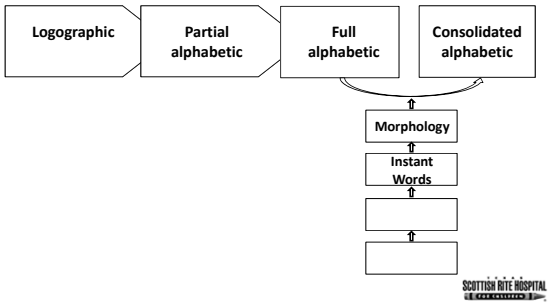
TREATMENT OF ORTHOGRAPHIC DEFICITS

- Use multi-sensory (Fernald) technique where the child looks at the word, says the word, pronounces it while tracing it several times, then writes it from memory (Mather and Wendling, 2012).
- Provide extra practice reading/spelling high frequency irregular words (e.g. once, said) from word lists and student's errors, emphasizing irregular elements (e.g. color or enlarge letters) using a flow list procedure.
- Promote speed in word recognition using Rapid Word Recognition Chart with irregular words (Birsh, 2005).

TREATMENT OF ORTHOGRAPHIC DEFICITS

- Build reading fluency with repeated reading of texts at the independent reading level (Meyer and Felton, 1999).
- Provide instruction in common letter sequences, syllable patterns, orthographic rules, rules for adding prefixes and suffixes, contractions, possessives, plurals and abbreviations (Moats, 2010; SPELL LINKS Masterson, Apel and Wasowicz, 2006)

Orthographic Processing Deficits



CONCLUSIONS

- Word reading development typically progresses from a primitive, visually based logographic strategy, via an alphabetic-phonological stage, to an advanced, automatic visual-orthographic strategy.
- Processing of phonology, orthography and semantics/context all contribute to word reading ability and dysfunction (dyslexia).
- Relative contributions of phonological and orthographic processing to word reading deficits (dyslexia) can be inferred by analysis of reading /spelling errors and measures of phonological processing/coding and orthographic processing/coding.

CONCLUSIONS

- Significant difficulty reading irregular/exception words relative to regular words is the most basic distinguishing feature of surface/orthographic deficits.
- Pure developmental dyslexia subtypes (i.e. only phonological, only orthographic) are rare, so most need multi-component intervention that includes direct, explicit instruction in:
  - Phonological processing/phonics/decoding
  - "Sight word" high frequency word practice
  - Fluency development with repeated reading
  - Vocabulary-word meaning in varied contexts
  - Use of literal and inferential comprehension strategies
  - Logic of English spelling, emphasizing patterns, word origin and morphology

CONCLUSIONS

- Empirical support for phonological training in dyslexia is greater than it is for orthographic training but both are typically necessary.
- The pattern of orthographic deficits is often the result of insufficient exposure to written language, sometimes is evident following intensive phonological training and less commonly is produced by a biologically based neuro-cognitive difference.
- The orthographic subtype label overstates the prevalence of dyslexia largely due to orthographic deficits and ignores co-existing phonological deficits.
- Clinicians should be prepared to flexibly evaluate and remediate all factors contributing to the reading impairments of children with dyslexia according to a student's needs rather than rigidly following approaches dictated by labels.

Why is Dyslexia Assessment and Intervention Best Understood Using the Phonological Processing Model?

- Deficits in phonological processing are the most important neurocognitive contributor to the word reading problems of individuals with dyslexia.
- Measures of phonological processing are the best predictors of word recognition development.
- Systematic instruction in phonological awareness and phonics produce the greatest gains in the word reading skills of children with dyslexia.
- Phonologic deficits almost always accompany problems with orthographic processing in developmental dyslexia (i.e. orthographic dyslexia subtype "neglects" this).

Why is it Important to Evaluate and Treat the Problems with Orthographic Processing of Individuals with Dyslexia?

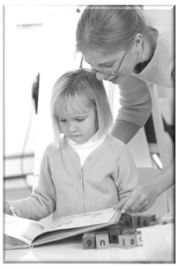
- Most individuals with dyslexia have problems with orthographic processing.
- Phonological and orthographic processing are reciprocal and interact with semantics (and context) to support word reading.
- Orthographic processing is necessary for skilled reading.

How Can Deficits in Phonologic and Orthographic Processing be Distinguished Using Measures of Reading and Spelling?

- Phonologic processing problems cause: difficulty decoding nonsense words (e.g. zut); addition, omission or confusion of sounds (e.g. flat/fat, dank/drank, bop/pup); over reliance on visual features (e.g. becuaes/because)
- Orthographic processing problems cause: difficulty with rapid word recognition, esp. low frequency or phonologically irregular words (e.g. yacht); use of impossible orthographic patterns (e.g. eggzit/exit); over reliance on auditory features (e.g. becuz/because)

What are the Most Effective Methods for Remediating Orthographic Processing Problems?

- Instruction that uses repeated reading to develop automatic recognition of sub-word patterns (e.g. syllables), words and continuous text.
- Teaching word study with an emphasis on morphological awareness, syllable structure and spelling rules.



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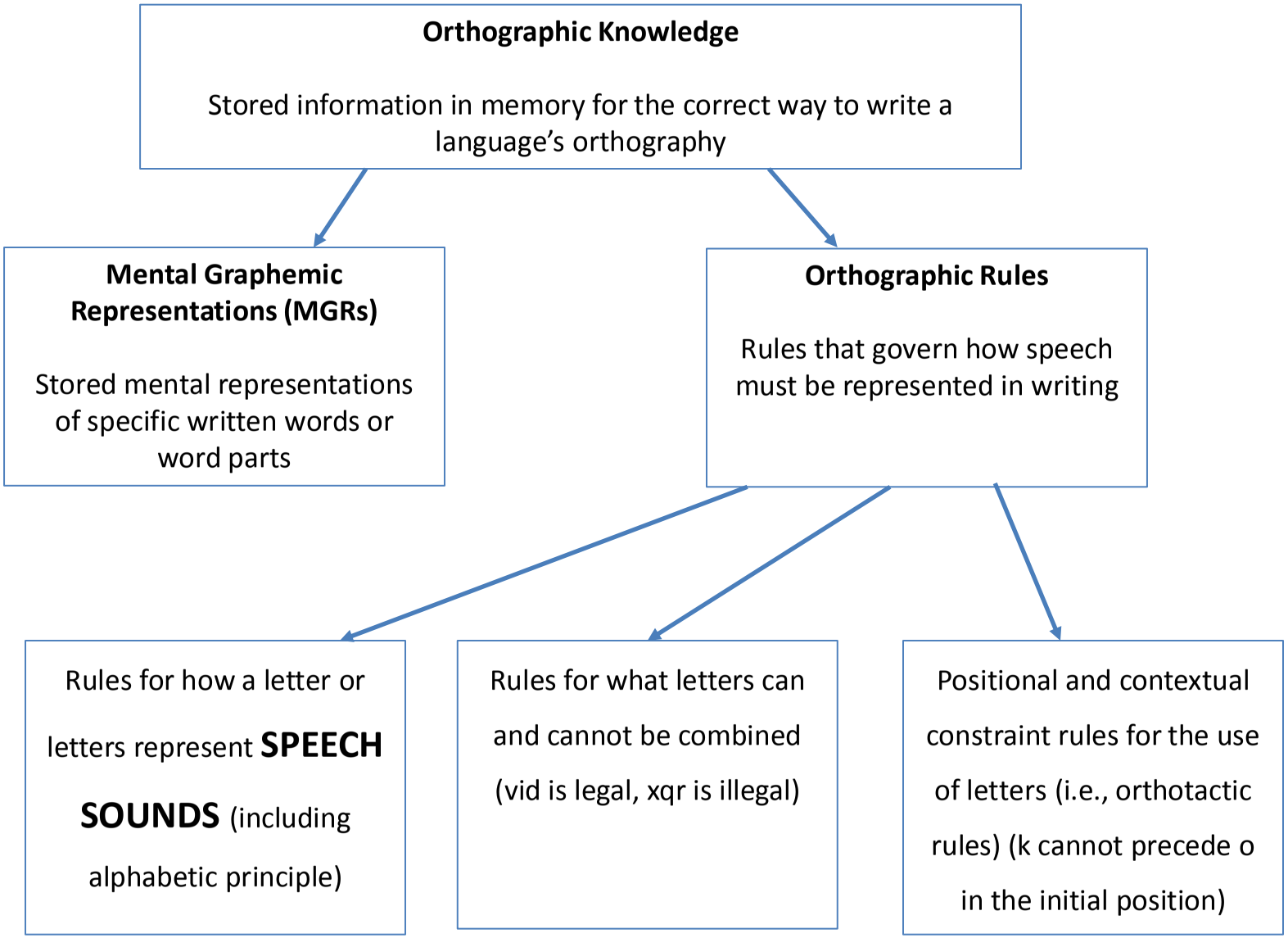
What is Orthography?



Apel (2011). *Language, Speech, and Hearing Services in Schools, 42,* 592-603.

Phases of Reading Development

TABLE 1
Summary of Word Reading and Spelling Abilities That Characterize Ehri's (2005) Four Phases of Development

Prealphabetic	*Partial Alphabetic*	*Full Alphabetic*	*Consolidated Alphabetic*
May or may not know letters	Most letter shapes and names known; incom- plete knowledge of GPs	Major GPs of writing system known	Grapho-syllabic spelling units known
Lack of phoneme awareness	Limited phonemic awareness; benefit of articulatory awareness instruction.	Full phonemic awareness: segmentation and blending	
No GP connections between spellings and pronunciations	Partial GP connections formed	Complete GP connections formed	Grapho-syllabic connections predominate
Sight words learned by remembering salient visual or context cues	Sight words learned by remembering partial GP connections	Sight words learned by remembering complete GP connections	Sight words learned primarily by grapho-syllabic connections
Sight word memory: unreliable, semantic errors, reading the environment	Sight word memory: Confusion of similarly spelled words	Sight word memory: accurate, automatic, unitized, growing, limited mainly to shorter words	Sight word memory: accurate, automatic, unitized, expanding rapidly; multisyllabic words easier to learn
No non-word decoding ability	Little or no non-word decoding ability	Growing ability to decode unfamiliar words and nonwords	Can decode unfamiliar words and nonwords proficiently
Cannot analogize	Analogizing precluded by partial memory for word spellings	Some use of analogizing but limited by smaller sight vocabulary	Greater use of analogizing as sight words accumulate
Unfamiliar words predicted from context	Unfamiliar words predicted using initial letters and context	Unfamiliar words in context read by decoding; context used to confirm or disconfirm words read	Unfamiliar words in context read by decoding or analogy; context used to confirm or disconfirm words read
Words spelled nonphonetically	Partial phonetic spellings invented; weak memory for correct spellings	Phonetically accurate GP spellings invented; growing memory for correct spellings	Grapho-syllabic and GP units to invent spellings; proficient memory for correct spellings

Note. Grapho-syllabic spelling units include subsyllabic units such as rime spellings, spellings of syllables, and spellings of morphemes including root words and affixes. GP = grapheme-phoneme connections.

Ehri (2014). *Scientific Studies of Reading*, 18, 5-21.

Developmental Dyslexia Subtypes

Construct	Phonologic	Orthographic
Early speech/language	• Articulation errors • Mispronunciations of words	Slow retrieval on RAN tasks
Symbol recognition and recall	• Poor recall of sound-symbol relationships • Confusion of similar phonemes (p/b)	• Poor recall of letter appearance • Confusion of similar graphemes (p/q)
Word identification	• Poor recall of letter sounds • Poor decoding • Overuse of context	• Poor recall of letter sequence • Difficulty with rapid recognition of high frequency words • Difficulty recognizing syllables • Overuse of decoding strategy
Spelling	• Poor sequence of sounds • Errors based on similar sounding phonemes • Addition and omission of sounds • Poor knowledge of rules • Overuse of visual features (becuaes/because)	• Reversals based on similar appearing graphemes • Transposition of letters (tow/two) • Overgeneralization of spelling rules (rede/read) • Use of impossible patterns (eggzit/exit) • Overuse of auditory features (becaws/because)

Roberts & Mather. (1997). *Learning Disabilities and Practice*, *12*, 236-250.

SPELLING ERROR ANALYSIS

Word Errors	Phonemic Awareness	Orthographic Awareness	Morphological Awareness	Mental Graphemic Representation	Semantic Awareness	Letter Production
	a consonant or vowel representing a sound/phoneme is omitted, added, confused or out of place Vowel (V) Consonant (C) Omission-O Addition-A Transposition-T Confusion-C	Illegal substitutions & situational spelling rules: (phonetically plausible) vowel digraphs/diphthongs, VCe, vowel-r, consonant digraphs/trigraphs, /k/ (c,k,ck,ch,x,qu), consonant doubling, Cle	affix is missing, spelled incorrectly or its addition to base word not appropriately modified; base word not used to spell derived form; misspelling of modifications Ex: -ed=/t/, -y=/e/ tion=shun, Photo=foto, busy for bizness, calfes for calves	word is phonetically accurate and does not break a rule concerning an orthographic pattern or morphology (flote)	word is misspelled based on meaning (homophone confusion: there/their, be/bee, one/won)	(reversals/ inversions)

Based on Kenn Apel's model of "The Five Blocks of Word Study"

Orthographic Dyslexia Seminar

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