Understanding Orthography: Reading and Spelling do Involve the Eyes!

Decoding Dyslexia Utah
Wasatch Reading Summit
Improving Literacy Using the Science of Reading
Nancy Mather, Ph.D.
October 3, 2024

Conflict of Interest/Test Disclosures

I am a co-author of four tests I will briefly mention:

- Tests of Orthographic Competence-2 (PRO-ED, 2022)
- Test of Silent Word Reading Fluency-2 (PRO-ED, 2014)
- WJ IV (Riverside Insights, 2014)
- Tests of Dyslexia (WPS, 2024)

Topics

- What is orthography?
- How does poor orthographic processing affect reading and spelling development?
- What are some standardized tests and some informal ways to assess orthographic knowledge?
- What are examples of accommodations and interventions for students who struggle with orthographic processing?

Definitions Related to Orthography

- Orthography: the writing system of a language (includes spelling, punctuation, capitalization)
- Orthographic Processing: the brain's ability to recall letter orientation, spelling patterns, and words with both accuracy and speed
- Orthographic Knowledge: acquired information stored in memory regarding how spoken language is represented in written language
- Orthographic Retrieval: recall of the images of individual letters, word parts, and words

Source: Mather, N., & Jaffe, L. (2021). Orthographic knowledge is essential for reading and spelling. *Reading League Journal, 2*(3), 15-25.

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Orthographic Knowledge Is Essential for Reading and Spelling

by Nancy Mather and Lynne Jaffe

A colleague recently assessed Samantha, a young girl (age 9 years, 11 months), and was puzzled by her test results. She described them in the following way: "On the GORT-4 (Gray Oral Reading Test-4, scaled scores, mean = 10, standard deviation = 3), she scored 10 on Reading Rate, 13 on Accuracy, and 14 on Reading Comprehension. Her performance on an untimed phonological awareness task was good, and her Full Scale IQ score of 130 places her in the gifted range. She had no difficulty reading nonsense words on an untimed task (85th percentile) and was in the average range (46th percentile) when reading a list of irregular words, although she had no difficulty with those same words in context. In fact, she seems to be a beautiful reader. Her only problem is spelling. She makes numerous spelling mistakes, even on simple words, such as spelling *very* as *vry*, *only* as *onle*, and *they* as *thay*. Within a paragraph, she often spells the same word three different ways." Our colleague's question to us was, "Why is this happening? Could this be dyslexia? Her written stories are absolutely amazing, but her spelling is truly awful."

Learning Disabilities Practice 1997

Learning Disabilities Research & Practice, *12*(4), 236–250
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Orthographic Dyslexia: The Neglected Subtype

Rhia Roberts
Chapman University
Nancy Mather
University of Arizona

Phonologic deficits have recently received much attention in the study of reading disabilities. In this article, Rhia Roberts and Nancy Mather examine in detail the role of orthographic deficits as another important factor in research and treatment of reading disabilities. They argue persuasively that "orthographic dyslexia" must not be ignored.

TEXAS SCOTTISH RITE HOSPITAL FOR CHILDREN
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ORTHOGRAPHIC PROCESSING: A SUBCOMPONENT, NOT A SUBTYPE, OF DEVELOPMENTAL DYSLEXIA

WHAT IS ORTHOGRAPHY, ORTHOGRAPHIC KNOWLEDGE AND ORTHOGRAPHIC PROCESSING?

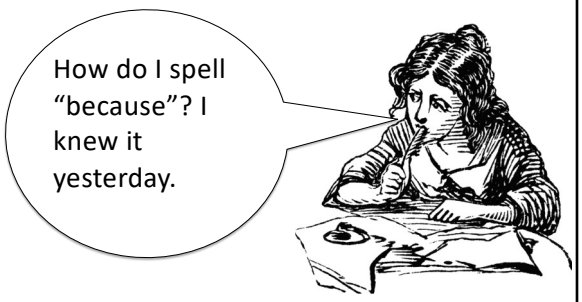
Orthography is the methodology of writing a language, which primarily consists of spelling, but includes, contractions, punctuation and capitalization. Knowledge of orthography is stored in memory in the form of rules and representations of words or parts of words.[1] Orthographic processing, or coding, is the skill or facility to use orthographic knowledge to read and spell words.

Source: Scottish Rite Hospital for Children (2014, November). *What is orthography, orthographic knowledge and orthographic processing*? Dallas, TX: Luke Waites Center for Dyslexia and Learning Disorders.

Subtype vs. Subcomponent

- Make separable contributions to word recognition and spelling
- contribute differently to reading and spelling difficulties
- require different types of intervention

Unstable Visual Orthographic Images



Orthographic Processing

- quality of orthographic codes
- the speed of accessing those codes
- knowledge of both whole word and subword units

Source: Hultquist, A. M. (1996). Orthographic processing in reading disabled students and reading age controls: Whole word and subword units. (Doctoral dissertation, American International College, 1996). *Dissertation Abstracts International*, 57:1485A.

Orthographic Processing and Retrieval

Orthographic processing is the ability to accurately and rapidly form images of individual letters, spelling patterns, and words. This includes letter form, letter orientation, and common letter combinations. When typical young readers sound out a word a few times, they then remember the word as a whole. As skill increases, they notice and store images of frequently seen words and letter combinations and patterns (e.g., con, er, tion).

Subsequently, when the reader encounters one of these words again, the word is recognized and its sound and meaning are activated. A person who has a weakness in orthographic processing is less likely to recall the patterns; thus, no image is created or only a partial image is created. Subsequently, when they see a word or word part (even one seen many times before), it does not register as familiar or activate both sound and meaning. Consequently, these readers depend more on sounding words out for recognition, acquire sight words more slowly, and read less fluently.

Orthographic retrieval is the ability to retrieve those images from memory, as in spelling. Once writers have retrieved and written a word where they are unsure of the correct spelling, they may use orthographic recognition to see if the word "looks right." For example, *smoke* and *smoak* are both phonically accurate but only one is the correct spelling. Knowing which one is correct depends on orthographic knowledge.

Similar constellations of symptoms have been referred to as:

- word blindness (Kussmaul, Hinshelwood, Morgan, Orton –early 1900s)
- visual dyslexia (Johnson & Myklebust,1968)
- dyseidetic (Boder, 1973)
- surface dyslexia (Castles & Coltheart,1973; Marshall & Newcombe, 1978).

Pringle Morgan (1896)describing an intelligent 14-year old boy:
"He seems to have no power of preserving and storing up the visual impression produced by words - hence the words, though seen, have no significance for him. His visual memory for words is defective or absent; which is equivalent to saying that he is what Kussmaul has termed "word blind." I may add that the boy is bright and of average intelligence in conversation...The schoolmaster who has taught him for some years says that he would be the smartest lad in the school if the instruction were entirely oral."
Source: Morgan, W. P. (Nov. 7, 1896). Word blindness. *British Medical Journal,* p. 1378.

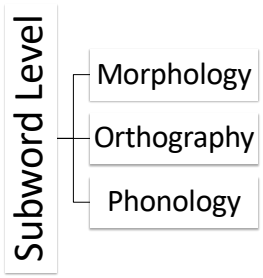
Morphology, Orthography, and Phonology

Morphology: the meaningful units of language and how they are combined to form words

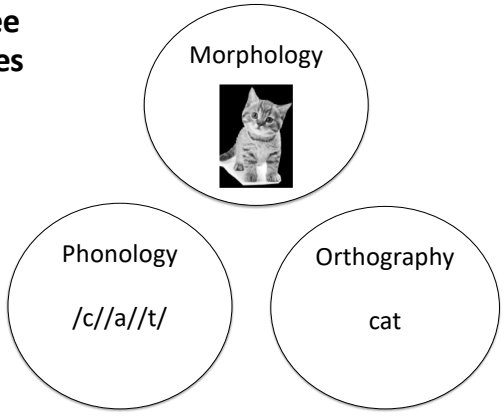
Orthography: the marks of a writing system, including punctuation and spelling patterns

Phonology: the sounds of a language

Dyslexia: a disorder at the sublexical (subword) level



Three Codes



Ehri's Theory

- The pronunciations of words are the anchors for written words in memory
- Mapping occurs when words are both decoded (read) and encoded (spelled)
- Sight words are learned by forming connections between the letters seen in the spellings of words and the sounds already stored in memory
- The two most important phonological awareness abilities for mapping are blending and segmenting

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading, 9,* 167–188.

Orthographic mapping:
"…the process readers use to store written words for immediate, effortless retrieval. It is the means by which readers turn unfamiliar written words into familiar, instantaneously accessible sight words" (p. 81).

Source: Kilpatrick, D. A. (2015). *Essentials of assessing, preventing, and overcoming reading difficulties.* Hoboken, NJ: John Wiley & Sons.

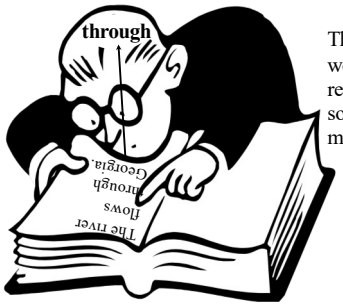
Orthographic Mapping

Starting point: forming the connections between the graphemes and the phonemes.

Graphemes:	man
Phonemes:	/m/ /a/ /n/
Graphemes:	m a n man

Sight words

Typically developing readers only need to see a word 1 to 4 times to retain it.



The sight of the word triggers recognition, sound, and meaning.

When a reader who has a limited sight word vocabulary is asked which word looks right, the response is likely to be, "Words never *look right* to me" (Willows & Terepocki, 1993, p. 35).

Source: Willows, D. M., & Terepocki, M. (1993). The relation of reversal errors to reading disabilities. In D. M. Willows, R. S. Kruk, & E. Corcos (Eds.), *Visual processes in reading and reading disabilities* (pp. 31-56). Lawrence Erlbaum.

Poor Orthographic Processing and Reading

- Has trouble remembering sight words
- Continues to sound out words after many exposures
- Confuses low-image words (e.g., of and for)
- Confuses similar-looking letters and words (e.g., on and no)
- Has a slow word perception and reading rate

Spelling

- Sequencing the sounds in order requires phonological processing, particularly phonemic segmentation
- Recalling the visual elements of words requires orthographic processing. This is critical for the retrieval of predictable letter sequences that cannot be sounded out (e.g., -ght, -tion), as well as the irregular parts of words (e.g., the ai in said).

Poor Orthographic Processing and Spelling

Has difficulty learning how to form letters

Reverses letter and numbers past the age of 7

Has trouble copying from a board or book

Spells words the way they sound, not the way they look

Spells the same word inconsistently

Violates rules of English spelling

Has poor spelling into adulthood

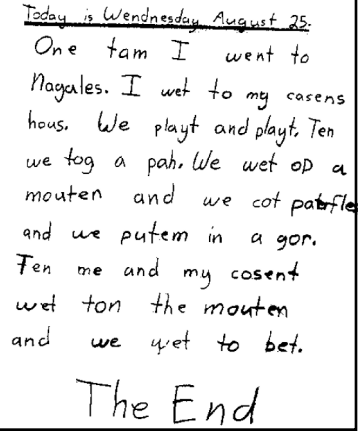
Consider the age of the student and the amount of exposure to print.

Problems in Phonology and Orthography that Affect Spelling

Phonology	Orthography
• does not put sounds in order • adds or omits sounds • represents phonemes with incorrect graphemes • confuses similarly sounding speech sounds (e.g., /b/ and /p/ -voiced and unvoiced consonant pairs) • confuses vowel sounds	• puts all sounds in the correct sequence but uses incorrect graphemes • reverses letters (e.g., b and d) and transposes words (e.g., saw and was) • spells common high frequency words like they sound, not how they look • regularizes the irregular element of words (e.g., "thay" for *they*, and "sed" for *said*)

Amanda, Grade 3
Weaknesses in phonological processing

1. Leaves out nasal sounds (e.g., wet for went, mouten for mountain).
2. Confuses voiced and unvoiced consonants, e.g., d-t (bet for bed, ton for down), b-p (e.g., paterfles for butterflies).
3. Omits the digraph *th*, (e.g., pah for path, ten for then).
4. Confuses medial vowel sounds.
5. Makes errors on the spelling of past tense (e.g., playt for played).


Today is Wendnesday August 25.
One tam I went to Magales. I wet to my casens hous. We playt and playt. Ten we tog a pah. We wet od a mouten and we cot paterfle and we putem in a gor. Ten me and my cosent wet ton the mouten and we wet to bet.
The End

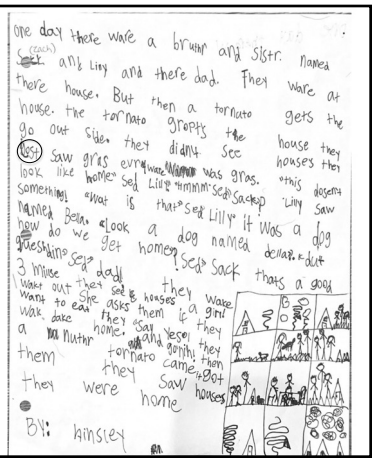
Ainsley, Grade 3

Weaknesses in orthographic processing

Spells words the way they sound (e.g., sed, a nuther, bruthr, giril).

b-d reversals (*dake* for back, *dut* for but, della for Bella), a backward J

Misspells high frequency words (e.g., were, said, does).

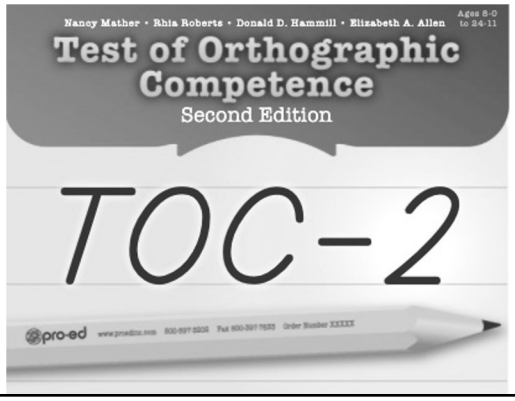


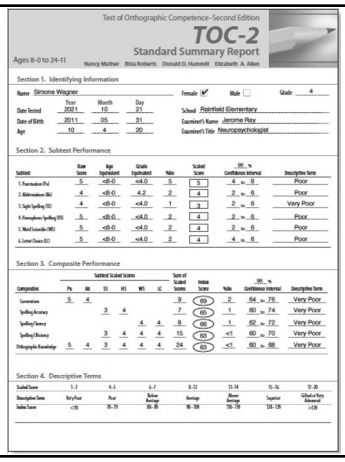
Questions to Ask

- Has the student had adequate print exposure?
- Are sounds sequenced correctly in most spellings?
- Are spellings more accurate when a phoneme is represented by a single letter grapheme (f) than a multiple letter grapheme (gh or ph)?
- Are spellings more accurate of regular words (nonsense words and real words) than of irregular or exception words?

Standardized Assessments of Orthography

2023





Six Subtests

- **Punctuation**: a list of printed sentences that contain no punctuation and the student must supply the missing punctuation.
- **Abbreviations**: a list of abbreviations and the student writes what each means.
- **Sight Spelling**: the student is asked to fill in the missing letters of a word that has a silent or irregular element (e.g., __ow) know

- **Homophone Spelling**: The examiner says a word as the student looks at a picture of word that has a homophone (e.g., oar with a picture of a boat oar).
- **Word Scramble**: The student is shown a set of scrambled letters that can be rearranged to form a real words (e.g., rna). Timed for 3 minutes.
- **Letter Choice**: The student is shown rows of words where one of four letters is missing from the word (p, d, b or q). The student has two minutes to write in the missing letters.

Five Composites

- **Orthographic Knowledge**: All six subtests
- **Conventions**: Punctuation and Abbreviations subtests
- **Spelling Accuracy**: Sight Spelling and Homophone Spelling
- **Spelling Fluency**: Word Scramble and Letter Choice (both timed)
- **Spelling Efficiency**: All four spelling tests

Test of Silent Word Reading Fluency-2

(TOSWRF-2) PRO-ED

itbagredsunfell

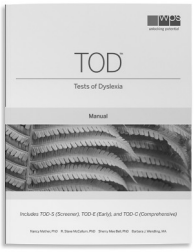
chaosempathysurrendercostume

it/bag/red/sun/fell/

Correlations with the TOC		
Spelling Accuracy	.87	Very Large
Orthographic Ability	.92	Nearly Perfect

Tests of Dyslexia (TOD, 2024)

- TOD–Screener
- TOD–Early (K-2)
- TOD–Comprehensive (Grade 1 to Adult)
- Co-normed rating scales (parent, teacher, self)
- Intervention guide



Authors: Nancy Mather, PhD, R. Steve McCallum, PhD, Sherry Mee Bell, PhD, and Barbara Wendling, MA
Publisher: WPS

TOD Measures of Orthography

Orthographic Processing Composite (two tests)

- Letter and Word Choice: Examiner reads a letter or word aloud and the examinee selects the correct letter or correctly spelled word from a choice of four (e.g., prak, park, karp, kpra)
- Word Pattern Choice (timed): Examinee selects from a row of four letter strings the one that looks most like a real English word (e.g., ffeb, fefb, beff, bffe)

TOD Measures of Orthography

Additional measures:

- Irregular Word Spelling: Examinee spells words that have an irregular element
- Irregular Word Reading: Examinee reads words with an irregular element
- Rapid Irregular Word Reading (timed): Examinee reads words with an irregular element as quickly as possible

Informal Measures of Orthographic Processing

- Exception word reading and spelling
- Homophone choice
- Letter-string choice
- Analysis of classroom writing samples and spelling tests

Examples of Exception Words

again	people
answer	said
because	their
come	though
could	two
does	was
eyes	water
great	were
once	whose

Homophone choice tasks
(Olson, Kleigl, Davidson, & Foltz, 1985; Stanovich & West, 1989)
Which is the correct spelling for the flower?
rows or rose
Which is related? (rose: flour or flower)

Letter-string choice tasks (Treiman)
Circle the one that looks more like a real English word (e.g., bist, bsti)

Possible Discrepancies

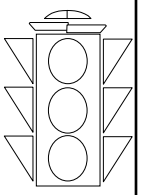
- Between oral language and written language
- Between reading and spelling
- Between spelling and ideation

Reading Accommodations

- Extended time
- Shorter assignments
- Read for a specific amount of time, not a certain number of pages
- Partner reading

English Words and a Traffic Light

Green: Phonically regular words: (e.g., cat, swim)
Yellow: Irregular but frequent patterns (e.g., ight, ould)
Red: Irregular (e.g., once)

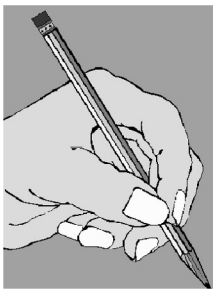


Tips for Spelling Tests

- Phonically regular words
- Words with a common spelling pattern
- Shorter word lists
- Daily testing instead of weekly testing
- Give partial credit for good spelling attempts on spelling tests (e.g., rane for rain).

Tracing

- Attention
- Memory (Orthography)
- Sound-Symbol Associations
- Handwriting



Why Tracing is Effective

1. Requires student to pay attention and look at each letter.
2. Reinforces the connections between the phonemes and graphemes.
3. Student has to write the word from memory, not copy it.

Write-Say Method (based on Fernald)

- **Select word and write it on a card.**
- **Pronounce the word and have the student look at and say the word.**
- **Have the student pronounce the word while tracing it as many times as needed until he or she can write the word from memory.**
- **Have the student write the word correctly 3 times from memory and then file in a word bank.**
- **Review the word periodically to ensure the student can read and spell the word with ease.**

Talk-to-Yourself Chart

(Adapted from Benchmark School, Gaskins)

1. **The word is _____.**
2. **When I stretch the word, I hear _____ sounds.**
3. **There are _____ letters because _____.**
4. **The spelling pattern is _____.**
5. **This is what I know about the vowel:_____.**
6. **Another word I know with the same vowel sound is:_____.**
7. **Other words that share this same spelling pattern are:_____.**

1. The word is *right.*
2. When I stretch the word, I hear *3* sounds.
3. There are *5* letters because it takes *i-g-h* to represent the *i* sound.
4. The spelling pattern is *ight.*
5. This is what I know about the vowel: the vowel is a spelling pattern that makes the long i sound.
6. Another word that I know with the same vowel sound is: *ride.*
7. Other words that share this same spelling pattern are: *light, fight, flight, right, night, might, tight, sight, fright, plight*

Example of an Orthographic Mapping Intervention

Provide the student with daily practice in phoneme–grapheme mapping (Grace, 2022). Using enlarged graph paper and tokens, the student will first represent an orally presented word with tokens and then with letters underneath. The two questions posed are: *What do you hear? What do you write?* One token represents one sound. Follow this progression:

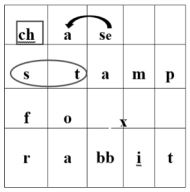
- Begin with regular words where the number of phonemes equals the number of graphemes
- Introduce words with consonant blends
- Introduce words with digraphs (written in one box)
- Introduce words with silent letters (e.g., *v-c-e*, *mb*)
- Introduce words with vowel digraphs (e.g., *oa*, *ee*)

Source: Grace, K. (2022). *Phonics and spelling through phoneme-grapheme mapping*. Really Great Reading.

Orthographic Mapping Example

Specific rules for mapping:

- Vowel and consonant digraphs go in one box with a box drawn around the digraph.
- Consonant blends go in separate boxes with a circle drawn around each blend.
- The letter *x* goes in the middle of two boxes because it makes two sounds.
- CVCe words: the last consonant and small *e* go in one box with an arrow pointing to the long vowel.
- Double consonants go in one box.



SPELL-Links™ | Learning By Design™ Inc. Making A Difference in K-12 Education

Effective orthographic mapping and foundational skills instruction requires combining sounds + letters + meanings/morphology. SPELL-Links does it!

Spelling Patterns and Exception Words

- Introduce only a few words at a time.
- Provide frequent review.
- Provide a personal list for a student or have the words posted on a word wall.
- Teach related spelling patterns in families when possible (e.g., would, could, should).

Use Mnemonics for Frequent Spelling Patterns and Words

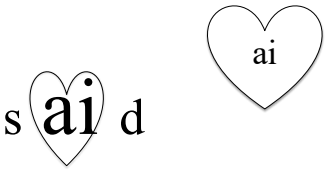
-ould "oh you little dog"

Because

Big
Elephants
Can
Always
Understand
Small
Elephants

Principles of Irregular Word Instruction

1. **Introduce one exception (red flag, trickster) word every several lessons. Highlight or color code the irregular element (e.g., s**ai**d).**
2. **Have the student spell the word letter by letter and then say the word.**
3. **Gradually increase the rate to several new words each day.**
4. **File in a word box and provide systematic review of the words.**

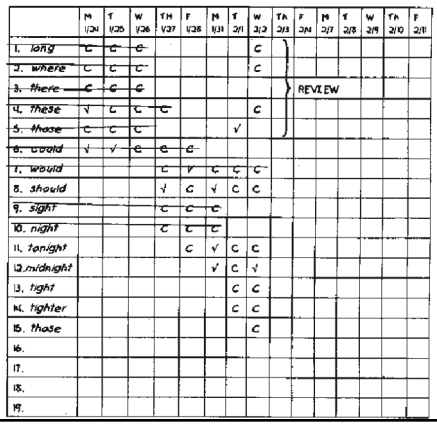


Draw a heart around the irregular part. Say the sounds of the regular letters and the letter names of the irregular part.

/s/ A- I- /d/

Spelling Flow List

- **Daily testing of a few words**
- **Keep on list until word is spelled correctly 3 days in a row**
- **Review weekly. If incorrect, add back to flow list.**
- **Select words from student's writing or a high frequency list.**


Spelling List: 6 words Name: Marcos

	M 1/24	T 1/25	W 1/26	TH 1/27	F 1/28	M 1/31	T 2/1	W 2/2	TH 2/3	F 2/4	M 2/7	T 2/8	W 2/9	TH 2/10	F 2/11
1. long	C	C	C					C							
2. where	C	C	C					C							
3. there	C	C	C							REVIEW					
4. these	√	C	C	C				C							
5. those	C	C	C				√								
6. could	√	√	C	C	C										
7. would				C	√	C	C	C							
8. should				√	C	√	C	C							
9. sight				C	C	C									
10. night				C	C	C									
11. tonight					C	√	C	C							
12. midnight						√	C	√							
13. tight							C	C							
14. tighter							C	C							
15. those								C							
16.															
17.															
18.															
19.															

Principles of Spelling Instruction

- Don't count off for spelling if it's not a spelling test.
- Don't ask students to edit their own work.
- Select words at the instructional level.
- Don't ask students to write their words 5 times.
- Focus on high-frequency words.
- Mark the number right, not wrong.
- Don't assign words they can't read.
- Change the difficulty level if they are missing too many.
- Encourage neat handwriting.

Rapid Word Recognition Chart

Chart composed of five rows of 6 irregular words

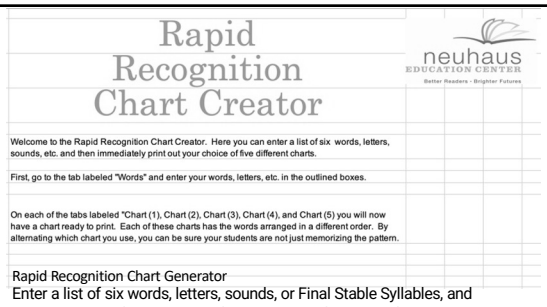
Time how quickly the student reads the chart.

Count and record number of words read successfully

Source: Carreker, S. (1999). Teaching reading: Accurate decoding and fluency. In J. R. Birsh (Ed.). Multisensory teaching of basic language skills. Paul Brookes.

Rapid Word Recognition Chart

pretty	said	who	there	they	what
said	pretty	there	who	what	they
there	who	they	said	pretty	what
who	what	said	they	there	pretty
they	there	pretty	what	who	said


Rapid Recognition Chart Creator

neuhaus EDUCATION CENTER
Better Readers - Brighter Futures

Welcome to the Rapid Recognition Chart Creator. Here you can enter a list of six words, letters, sounds, etc. and then immediately print out your choice of five different charts.

First, go to the tab labeled "Words" and enter your words, letters, etc. in the outlined boxes.

On each of the tabs labeled "Chart (1), Chart (2), Chart (3), Chart (4), and Chart (5) you will now have a chart ready to print. Each of these charts has the words arranged in a different order. By alternating which chart you use, you can be sure your students are not just memorizing the pattern.

Rapid Recognition Chart Generator

Enter a list of six words, letters, sounds, or Final Stable Syllables, and generate 5 Rapid Recognition charts to use with your students. To use the Rapid Recognition Chart as an assessment, time the number of student readings of the chart within one minute.

Open/Download Rapid Recognition Chart Generator (Excel)

https://www.neuhaus.org/resources/consumables-and-tools/#rapid-recognition-chart-generator

Look Alike Words to Promote Mapping

- Use "look alike" words on rapid word recognition charts to practice orthographic mapping.
- This forces students to look at every letter in a word and to map and not guess at the word.
- Reading similar words helps build the mental habit of attending to every letter-sound correspondence within words.

black	**block**	**blink**	**brick**	**brink**
brisk	**blunt**	**brand**	**bland**	**bleed**
blaze	**bride**	**bring**	**brake**	**bled**

Adapted from: Redding, N. (2022). Orthographic mapping: Defining and developing. Presentation at the International Dyslexia Association Conference.

Common Points of Fluency Methods

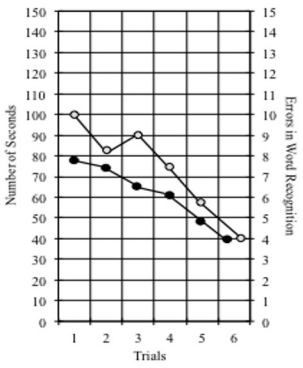
- **Read while listening to the same material**
- **Track print with finger or marker**
- **Use high-interest material**
- **Can use material at the instructional level**

Repeated Readings

- Designed for children who read slowly despite adequate word recognition (Samuels, 1979).
- Select a passage from 50 to 100 words long from a book that is slightly above the student's reading level.
- Have student read the same passage several times.
- Time the reading and count the number of errors.
- Record the reading time and the number of words pronounced incorrectly.
- Use two different color pencils for recording time and errors, or you make the points for time, a circle, and the line for errors an "X" or square.

Adapted from: Samuels, S.J. (1979). The method of repeated readings. Reading Teacher, 32, 403-408.

Repeated Readings Chart



- Repeated reading remains the most effective intervention for improving fluency in students with learning disabilities.
- Provide a model of fluent reading prior to repeated reading practice.
- Set a performance criterion (how fast the student should read).
- Use of easier level text produced greater gains in accuracy, fluency, and comprehension for most students.
- Correction and feedback can also enhance fluency performance.

Source: Stevens, E. A., Walker, M. A., & Vaughn, S. (2017). The effects of reading fluency interventions on the reading fluency and comprehension performance of elementary students with learning disabilities: A synthesis of the research from 2001 to 2014. *Journal of Learning Disabilities, 50,* 576-590.