Between the Lines of Handwriting

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Learning Objectives

Participants will describe the importance of handwriting in primary education as the basis for literacy

Participants will explain the 8 hallmarks of handwriting instruction

Participants will identify the underlying components of handwriting

Participants will be able to explain how deficits in tactile perception, praxis and visual motor integration impact students in the classroom

Participants will summarize how to assess components of handwriting including use of classroom and clinical observations and standardized measures

Participants will give examples for how to collaborate with teachers to implement Tier 1 MTSS strategies

Top 3 Common OT Referrals

Handwriting	Sensory Processing	Fine Motor Skills
88.5%	81.97%	74.75%

Smiles et al, 2025

Handwriting by the Numbers



18 to 37%

of the school day that requires handwriting as the dominant task



30%

estimated prevalence of handwriting difficulties among school-aged children



83%

the number of students referred for handwriting difficulties found to have praxis issues

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Importance of Handwriting

With technology advances, we often think that handwriting has lost its importance, however, handwriting is a basic building block and forms the foundation for future learning (Marano et al, 2025 and Bonneton-Botte et al, 2023):

- Handwriting is a complex neurophysiological process integrating motor, cognitive, and emotional components.
- Handwriting is a determining factor for academic success
- It is required for academic success reading, spelling, math and increased risk of lower academic progress
- Serves as a foundation for literacy

Why do students struggle?

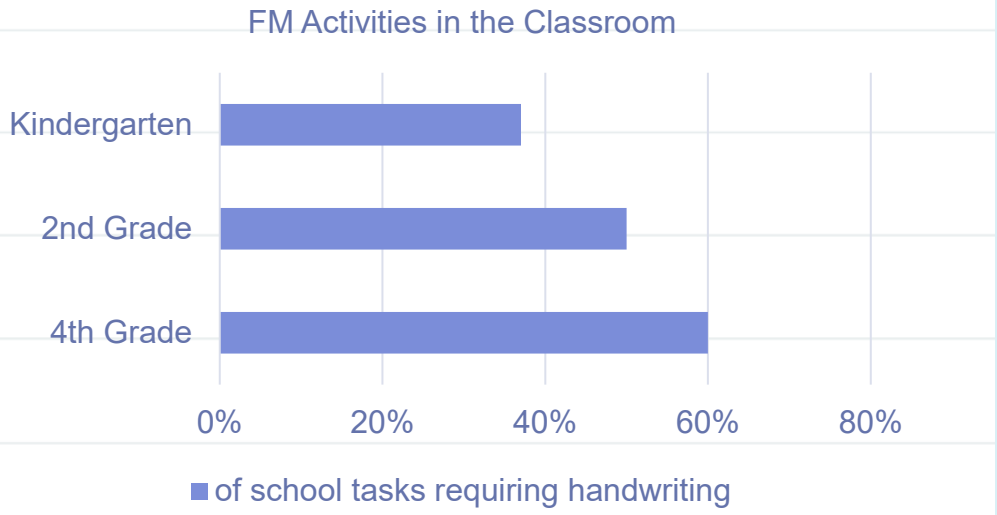
- A survey of elementary school teachers revealed that handwriting instruction is inconsistent and unstructured. (Asher, 2006)
- There's a huge gap in the sensory-motor skills in struggling versus proficient writers (Donica, et al 2025)
- There's not enough quality practice (Lopez-Escribano et al, 2022; Case-Smith 2002)



Demands increase in primary grades

The demand for handwriting ability increases significantly as students progress through elementary school

In 2020, Caramia et al replicated a 1992 study by McHale and Cermak. They found that kindergarten students spent 37% of the school day in fine motor tasks while second graders spent 50% and fourth graders 60%.



Lack of handwriting instruction

In a review by Engel, et al in 2018, they looked at 13 different handwriting curriculums and found that there is no superiority of one program over the other.

- No program was found to be better than the other
- Consistency of using the same program from one grade to another was the key
- Any adaptations to the curriculum for struggling students had to be done with fidelity to the curriculum and consistently from one teacher to another.



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Hallmarks of Handwriting Instruction

Vander Hart, et al (2010) and Swinth (2025)

Frequent/Daily Lessons



50-100 minutes per wk, with daily practice

Direct & Explicit Instruction



Letters are taught in a specific, logical order

Modeling



Proper pencil grip, paper position, and letter formation

Guided Practice



Trace, copy, and use visual cues before writing from memory

Use of Feedback



Correct poorly formed letters and praise correctly formed ones

Independent Practice



Provide lots of opportunity for practice and review

Self-Evaluation



Encourage students to evaluate their own writing

Integrated Lessons



Within the context of meaningful writing assignments

Ultimately, what all this means is that handwriting must be systematically taught and students need daily practice.

Task Analysis

Occupational Therapy

Fine Motor
- In-hand manipulation
- Range of motion (wrist, fingers, shoulders)
- Strength
- Tactile discrimination
- Pencil grip
- Hand dominance
- Joint integrity
- Fluidity of movement

Visual Motor

Neuromuscular

Sensory Processing
- Tactile
- Proprioception
- Vestibular

Praxis

Executive Functions*
- Memory (*Updating*)
- Attention (*Inhibition*)

Instruction

Orthographic Factors
- Phonology
- Letter knowledge
- Coding
- Fluency
- Sub-lexical processing
- Syllable structure
- Letter formation

Fine Motor Skills

Fine motor skills involve the coordination of small muscle movements in the hands and fingers to perform tasks like grasping, drawing, and writing





Functional Observations

Pencil grasp
In-hand manipulation
dexterity

Assessment Tools

BOT-3
MFUN
PDMS-3
Clinical and classroom observations

What the research says...

Unimanual dexterity is the only predictor of handwriting quality for typical developing children (Volman, 2006).

Sequential finger touching was a strong predictor of handwriting legibility (Berninger & Rutberg, 1992).

Pencil grip is *not* related to handwriting legibility and speed (Rosenblum, et al, 2006; Dennis and Swinth, 2001).

Visual Motor Integration

Visual motor integration is the coordination between visual perception and hand movements that allows a writer to translate external stimuli into a fluid, coordinated trace.





Functional Observations

Spatial irregularities (alignment, sizing, spacing)
Temporal issues (speed)
Letter formation and accuracy

Assessment Tools

BOT-3
MFUN
PDMS-3
THS-R
DTVP:3
MVPT
TVPS-4
Beery-VMI*

What the research says...

When children are learning how to write, they rely on visual skills as proprioception doesn't mature until age 10. At that time, feedback and feedforward mechanisms mature leading to increases in writing fluidity and automaticity. Children with poor visual motor integration continue to struggle with the automaticity (Bonneton-Botte, 2023).

Neuromuscular

The neuromuscular components of handwriting involve a complex interaction between the brain network, internal motor representations, and foundational biomechanical structures.



Functional Observations

Fatigue
Hand pain
Slumping in chair or leaning over
Difficulty with neatness of work
Difficulty holding a pencil
Awkwardness of movement

What to look at:

- Muscle Tone
- Proximal joint stablity (shoulder, elbow, wrist)
- Hand arches
- Separation of the sides of the hand
- Open web space & thumb movements
- Joint integrity/laxity
- Retained primitive reflexes

What to know:

Diagnosis/Medical conditions
Developmental history

What the research says...

When matched for developmental age, adults with Down Syndrome were able to write with the same speed, legibility and formation (Tsao et al, 2017). This indicates that children with DS may not be ready to learn to write until they are older.

In a study by Visser and Franzsen (2010), children who did not crawl as infants are more likely to have difficulty with pencil grasp and development of visual perceptual skills (spatial relations)

Tactile

Tactile perception involves the body's ability to interpret information from touch, which is essential for developing the manual dexterity required for writing.





Functional Observations

Pencil grasp
Difficulty manipulating writing tools, dropping items
Pressure grading issues
Alignment and spacing

Assessment:

In hand manipulation
Manual dexterity
Touch localization
BOT-3

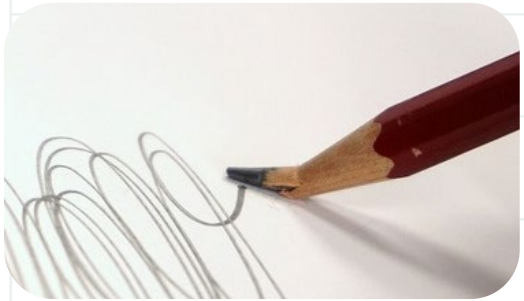
What the research says...

In a study by Donica et al (2025b), 67% of participants with handwriting difficulties demonstrated tactile perception deficits, compared to only 25% of their typically developing peers

Children with tactile deficits may have more difficulty using electronic tablets with fingers or stylus due to decreased haptic feedback (Bonneton-Botte et al, 2023)

Proprioception

The body's ability to perceive its own position, movement, and spatial orientation without using vision and relying on internal sensors in muscles, joints, and skin to provide feedback





Functional Observations

- Grasp is too hard or too light
- Cannot see pencil marks
- Breaks pencils
- Visually monitoring all movements

Assessment Tools

- BOT-3
- SOSI-M
- COP-R
- SPM-2

What the research says...

As mentioned previously, proprioception together with vision allows for automaticity of writing. This then frees up cognitive resources for language processing such as spelling and composition (Bonneton-Botte, 2023).

Vestibular

Vestibular contributions to handwriting are through balance and postural control which provide the foundation for fine motor execution.





Functional Observations

Poor postural control
Balance
Difficulty with distal movements of the hand
Poor bilateral coordination
Decreased ability to attend and focus
Fatigue

Assessment:

SOSI-M
BOT-3
SPM-2

What the research says...

Bilateral coordination, the ability to use both sides of the body in a coordinated way, has been found to have the greatest impact on academic performance (Donica et al, 2025b).

Some students may benefit from increased vestibular input using Ayres-SI not only to increase attention, but the foundational components of balance and bilateral coordination (Case-Smith, 2002)

Praxis

Praxis directly influences a child's ability to plan, sequence, and execute letter forms and arrange the letters into words. Praxis relies on neuro feedback and feedforward mechanisms. When praxis stems from sensory deficits, it is called *Somatodyspraxia*.





Functional Observations

Poor legibility
Poor ability to imitate
Pencil grasp
Poor grading of force
Alignment of letters
Inconsistency in patterns
Poor fluency of writing

Assessment:

SOSI-M
BOT-3
SPM-2
MABC-2 (and MABC-3)
Here's How I Write (HHIW)
THS-R

What the research says...

83% of students with handwriting difficulties have measurable praxis deficits (Donica et al, 2025a)

Early instruction relies heavily on a child's ability to replicate and imitate teacher demonstration. Praxis is required to replicate and assume static starting positions required for handwriting while also planning and sequencing movements to execute letter and word formations (Donica et al, 2025a).

Executive Functions

EFs are higher-order cognitive processes that serve as a critical bridge between the physical act of forming letters and the higher-level goals of written expression. EFs involve **coordinating motor execution with cognitive planning, managing mental resources, and regulating behavior** to produce a coherent written product.

- **Initiation**: getting started
- **Inhibition:** being able to stop
- **Cognitive Flexibility:** the ability to shift between physical or mental tasks
- **Emotional control**
- **Working Memory (updating):** remembering one or two-step instructions
- **Organization**
- **Planning**
- **Self-Monitoring**

What the research says...

Inhibition, emotional control, working memory, and monitoring correlate with handwriting dimensions of stroke height and writing pressure (Rosemblum, 2018).

For kids with EF challenges, repeated practice is the key (Otero et al, 2014)

While OTs are not the main supporter of "Executive Functions," our intervention can address aspects of EF such as planning and organization, self-regulation, self-monitoring strategies and accommodations.

A Word About Dysgraphia

Per Chung and Patel (2015), *dysgraphia* is a learning disorder in which the individual's writing skills are below the level expected for his or her age and cognitive ability. Experts think there are different types of dysgraphia depending on the underlying mechanism and cause.

Linguistic dysgraphia or *dysorthography* results from inefficiency in the verbal working memory from phonologic (sounds) to orthographic (written letters) memory (graphomotor loop)

Motor dysgraphia or *peripheral dysgraphia* refers to difficulties coordinating movements to write letters. Fine motor control, visual motor/perception, kinesthesia, grasp patterns, force and endurance are deficits in this type of dysgraphia.

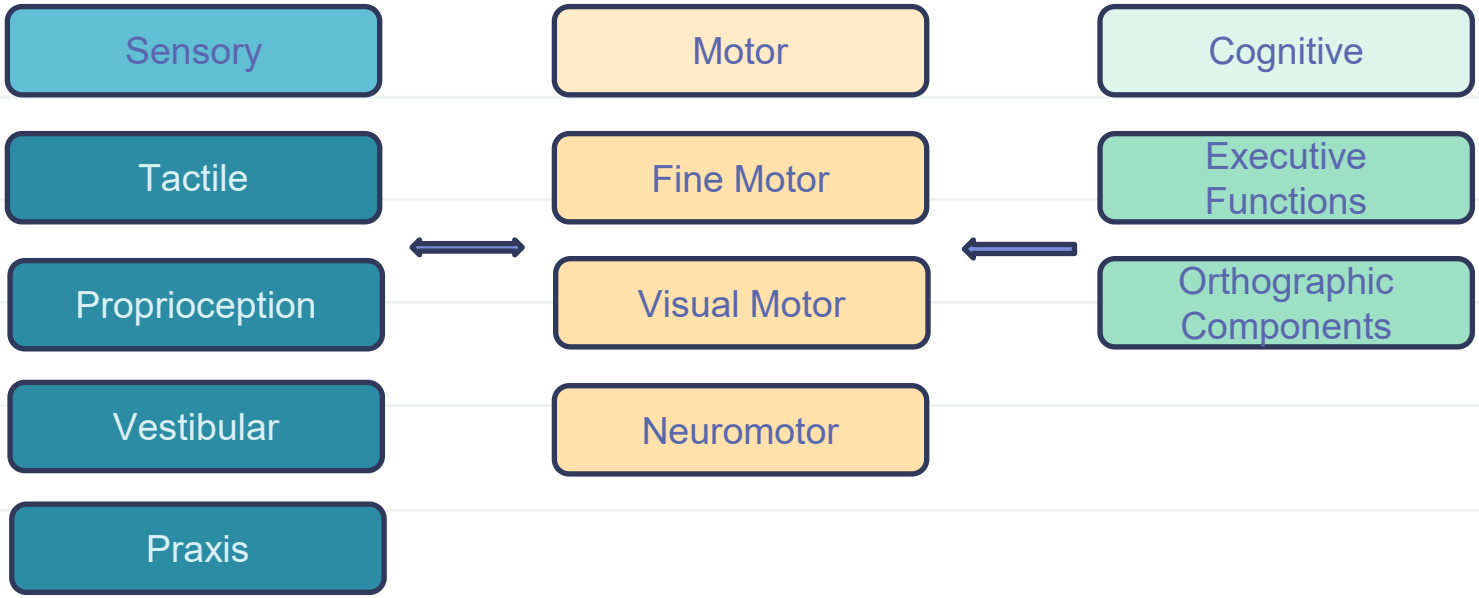


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Developmentally Speaking

- Children first need to acquire knowledge about the written language system before they can learn to write basic strokes such as lines (Bonneton-Botte et al, 2023). This occurs between ages **3 and 5**.
- Generally, **before 6 years of age**, children do not integrate visual and proprioceptive information resulting in segmented lines, inaccurate strokes, and visually monitoring movements. (Palmis et al, 2017; Bonneton-Botte et al, 2023).
- Proprioception matures around **age 7** resulting in more automaticity of movements due to feedback and feedforward mechanisms (Bonneton-Botte et al, 2023).
- Around **age 10**, letter formation is automatic and is stored in long-term memory, resulting in more cognitive resources being available for spelling and composition (Bonneton-Botte et al, 2023; Marano et al, 2025).
- Between ages **10 and 14**, a balance is reached between feedback and feedforward control resulting in automatic, fast and fluid writing ability, however, this is sometimes at the expense of legibility (Bonneton-Botte et al, 2023).

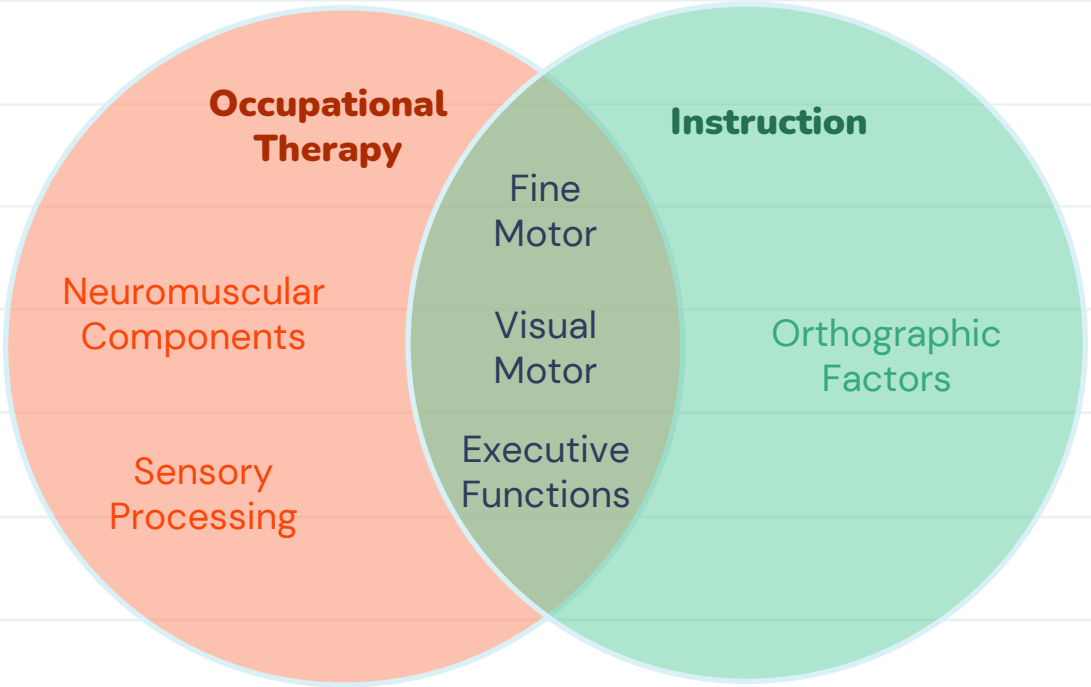
Handwriting Components



“It is important to realize that as related service providers, occupational therapy practitioners should not be the primary individuals in educational settings providing handwriting instruction.”

Yvonne Swinth, 2025

Overlap of Components



Adapted from Lee et al, 2022

OT collaborative role

- OTs are professionals that support academic success and **should not be the primary individuals in educational settings providing handwriting instruction** (Swinth, 2025).
- **Consultation Focus:** OT time may be better spent providing consultation, coaching, or education to ensure that instruction includes **daily repetition and practice** (Cole, 2023).
- **Consistency and Fidelity:** OTs should advocate for the district to use **one consistent handwriting curriculum** across all grade levels to ensure continuity and prevent conflicting instruction (Engel, 2018; Cole, 2023).
- **Individualized Remediation:** Rehabilitation is based on **individualized assessment and remediation** to address specific deficits (Bonneton-Botté, 2023).

Curriculum-based interventions that have an embedded motor learning practice component, with either direct or indirect involvement from occupational therapy, may have a positive impact on a student's handwriting ability (Cole, 2023).

Practice, practice, practice

- **Actual handwriting practice is the most critical component** for improving legibility and speed (Hoy et al, 2011)
- Sensory or motor activities performed in isolation are generally ineffective (Hoy et al, 2011).
- **Activity-based interventions provides the biggest gains** (Novak & Honan, 2019).
- Fewer than 20 practice sessions (including homework) are ineffective (Hoy et al, 2011; Cole, 2023).
- Parent collaboration is highly effective and worthwhile (Novak & Honan, 2019).

According to Hoy, et al (2011), OTs may be most effective when advocating for **more handwriting instruction and practice for all children** within the general school curriculum



In the Digital Age

- Individuals who physically hand-write, exhibit superior letter recognition during reading tests compared to those who rely on typewriting (Wang & Wang, 2024).
- Students with decreased tactile discrimination skills may have a harder time using digital media such as touch screens and stylus pens due to decreased haptic feedback.
- While voice-to-text or keyboards are useful, they **do not directly address or remediate** underlying higher-order impairments such as planning and organization (Chung & Patel, 2015).
- Digital learning environments should be seen as a **means to personalize learning** rather than a total replacement for the foundational experience of writing by hand (Bonneton-Botte et al, 2023)
- iPads and apps should not be used as a primary mean for improving handwriting (Cole, 2023)
- For technology to be effective, it must be integrated with **task-specific practice** (actual writing) and used consistently across all settings (home, school, and therapy) to ensure fidelity (Cole, 2023).

MTSS Tier 1

High-quality, explicit handwriting instruction for **all students** in the classroom. This is led by classroom teachers, but supported by OTs.

Core Instruction: program using consistent terminology, modeling, direct instruction and daily dedicated practice

Collaboration: Occupational therapists (OTs) often play a **consultative or advisory role** assisting in the selection of effective methods and supports

Goal: The primary objective is prevention and ensuring that every child receives the foundational instruction necessary to develop automaticity in letter formation



Case Study

Observations during the initial assessment (5 years, 9 months) included:

- Poor in-hand manipulation skills
- Primitive pencil grasp (4 fingers extended with thumb opposed)
- Difficulty with bilateral tasks
- Spinning, bumping into peers
- Frequently leaning and sliding out of his chair
- Difficulty with finger to nose movements
- Difficulty with jumping jacks
- Not able to maintain balance on 1 foot
- Could not imitate novel body positions

School based OT for 30 minutes per week through kindergarten and 1st grade with a fine motor goal. Student still struggled in all academic areas, had difficulty with fine motor tasks, completing class work, difficulty learning new tasks during school performance (Holiday Program), and difficulty paying attention.

In 2nd grade, student re-evaluated and found to have difficulty with **praxis**. Student recommended for therapy room services 1x60/week in addition to 30 min/week school based OT.

In Summary

- **Practice is Paramount:** Intervention **must include adequate handwriting practice**.
- **Required Dose:** Practice should occur at least **twice weekly for 10 weeks**, achieving a total of **at least 20 practice sessions** (Hoy et al, 2011; Cole, 2023).
- **Task Specificity:** Instruction should be **explicit and task-specific** to handwriting; interventions focusing only on isolated component skills without handwriting practice are **ineffective** (Hoy et al 2011, Novak & Honan, 2019).
- **Instructional Strategies:** Effective instruction includes **modeling**, **guided practice**, and ensuring the **use of feedback** (rich, precise, and immediate)
- OT should consider a move to more **consultative** services instead of weekly services.

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