

Skill Sequences & Strategies in Training Motor Skills

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General Development of Motor Skills

- Cephalo to caudal
- Mass to specific
- Gross to fine
- Proximal to distal

Developmental Sequence for Early Motor Imitation

- Motor imitation with objects
- Gross imitation of arm or leg movements
- Generalized imitation of “novel” movements
- Imitation of fine motor movements
- Imitation of sequences
- Delayed imitation

Neurologically typical children acquire new fine/gross movements continually and simultaneously

Why teach imitation?

- Research suggests that early motor imitation skills are an indicator of optimal outcomes in children with ASD (Sutera et al, 2007) including language development (Stone et al, 1997)
- Children with autism have more difficulty acquiring motor im than peers with DD of similar mental ages (Stone et al, 1997)

Why teach imitation?

- Imitation can be used to establish a mand repertoire (Ross & Greer, 2003)
- Fluent fine motor & oral motor imitation are correlated with fluent speech (Gernsbacher et al, 2007)
- Strong imitation with objects is correlated with spontaneous play skills (Stone et al, 1997)

Why teach imitation?

- Motor imitation is also extremely important for non-vocal learners who rely on sign language as their primary form of communication

Problems with Motor Imitation

- Learner's motor skills are generally delayed
- Learner's motor skills and imitation skills do not match
- Learner lacks precision in imitation
- Inappropriate source of stimulus control
- Generalized imitation has not been established
- Abnormal tone / strength

Motor Skills: Strength

- All motor skills require some amount of strength
- Examples of tasks that require greater amounts of muscle force include:
 - Sit-ups (gross)
 - Push-ups (gross)
 - Writing with pencil using adequate pressure (fine)
 - Opening a jar (fine)
- Muscle strength and muscle tone are not the same

Strength vs. Tone

- Strength – amount of force exerted by a muscle
- Tone – amount of tension in a muscle
- Normal tone = passive partial contraction of the muscle when at rest
- Hypotonia = muscle is extended at rest, latent response to quick stretch (“floppy”)
- Hypertonia = muscle is contracted at rest, fast and excessive contraction in response to quick stretch (“stiff”)

General Tips for Building Strength in Children

- Evoke several consecutive responses (mass trials) rather than interspersing a variety of skills, in order to fatigue the target muscle group
- In most cases, moving against gravity provides a challenge
- Incorporate objects to provide resistance
- Focus on form, not speed, of exercise
- Practice daily

Selecting Targets for Imitation

- Choose AT LEAST 2 targets to teach simultaneously
- Consider:
 - Chronological age
 - Developmental norms
 - Functionality / social validity of skill

Basic Intervention Strategies

- Physical prompting
- Shaping
- Intensive teaching & natural environment teaching
- Continue teaching until generalization occurs

Imitating Simple Actions with Obj.

- This is likely the first objective you will teach to a learner who lacks a motor imitation repertoire
- Teach “meaningful” actions before non-meaningful actions (Stone et al, 1997)
- Use objects that provide visual or auditory feedback (Ingersoll et al, 2003)
- As soon as possible, begin teaching conditional discrimination:
 - Vary the verbal Sd
 - Selecting object from field
 - Multiple actions with one object

Imitating Gross Motor Movements

- Simple, socially significant arm/hand movements are the easiest to prompt (wave, clap, etc.)
- Leg/foot actions may be difficult to prompt, especially if the learner has a motor delay, and are often less functional than arm/hand movements

Walking Up Stairs

- Critical components:
 - Hold on to rail
 - One or both feet placed on bottom step
 - Then, one/both foot per step, maintaining balance over the foot and holding/releasing the rail (24 months)
 - Eventually, child should place only 1 foot per step (28-36 months)
 - Children typically lead with their stronger leg

Walking Up Stairs

- Forward chain
- Prompt child to hold rail
- If you have difficulty evoking alternating leg motions, consider within-stimulus prompt
 - Color code shoes/steps

Walking Down Stairs

- Walks down, placing 2 feet on each step and holding rail, by 26 months
- Children typically lead with their weaker leg
 - May need to practice leading with weak leg in isolation prior to alternating
- Walks down, 1 foot per step, without rail, by 44 months
- Backward chain to teach this skill

Standing on 1 Foot

- Standing on 1 foot for 3 or more seconds usually proceeds hopping on one foot
- We stand on 1 foot to put on/remove pants, shorts, or shoes, step into/out of bathtub, and play playground games
- Critical components:
 - Head & trunk are aligned over standing foot, body remains upright with minimal sway

Standing on 1 Foot

- Emerges at approximately 30 months (3s)
- By 42 months, child can balance for 5s, but may sway
- By 46 months, child can balance for 5s, swaying 20 degree or less
- By 53 months, child stands on 1 foot, then the other, for 6s each foot, without moving feet or swaying more than 20 degrees
- By 60 months, child stands on 1 foot, then the other for 10 s each

Standing on Tiptoes

- Emerges around 43 months (3s)
- By 52 months, stands on tiptoes for 8 sec without swaying more than 20 degrees or moving feet
- Many children with autism acquire this skill and exhibit high frequencies/durations (idiopathic toe walking)

Jumping Up

- Child should be able to jump 2 inches off the ground by 26 months
- Teach on a springy surface first
 - Hold on, bounce with bent knees
 - Hold on and jump on springy surface
- Hold on & jump off floor
- Jump off floor without holding on

Jumping Forward

- By 32 months, child hops forward 24 inches, with 2-footed take off and landing
- Critical components:
 - Knees bent at 90 degrees, arms extended back
 - Trunk should be bent forward 45 degrees
 - To jump, arms extend forward & upward as legs push to straighten
 - Knees bend to absorb shock upon landing, as arms straighten
 - Feet are slightly in front of body

Jumping Forward

- Hand held prompts initially
- Use visual cues:
 - Hoops, Hullybaloo, hopscotch, etc.
 - Jump over a jump rope

Jumping Down

- By 30 months, a child should be able to jump down from a step or stool 16-21" high
 - 1 foot may lead
- By 32 months, child jumps down from 24" high object, with 2-footed take off/landing

Jumping Down

- Critical components:
 - Knees slight bent, arms bent & extended back
 - Feet together to start jump
 - Knees are slightly bent upon landing
 - Arms move forward
 - Both feet hit the ground at the same time
- Practice jumping down from low objects, gradually increase height

Hopping on 1 Foot

- By 44 months, child hops forward 6" on 1 foot
- By 54 months, child hops forward 3 feet, switches feet, and hops back
- By 64 months, child hops 20 ft in 6 seconds or less without losing balance or letting free foot touch floor

Hopping on 1 Foot

- Pre-requisites:
 - Standing on 1 foot
 - Jumping up/down/forward on 2 feet
- Critical components:
 - Arms bent at elbows
 - Leg bent back almost 90 degrees
- Use visual cues
- Use timer to increase fluency

Galloping

- By 52 months, child gallops 10 feet forward
- Limited functionality & window of age appropriateness
- Critical components:
 - Lead leg moves forward, rear foot moves up to lead foot
 - Arms lift slightly as lead leg moves forward
 - Equal cadence throughout movement

Skipping

- By 62 months, child skips forward 10 feet
- Limited functionality & window of age-appropriateness
- Critical components:
 - Hop
 - Step
 - Change feet
- Forwards chain, teach slowly, then build speed

Ball Skills

- Imitating arm/leg movements with balls are often taught after basic imitation with objects has been established

Rolling Ball on Floor

- By 12 months, child catches ball rolled on floor
- By 13 months, child rolls ball forward on floor
- Use large, light-weight ball
- Physically prompt, helpful to have 2 adults present

Throwing Ball Overhand

- By 20 months, child throws tennis ball 3 ft forward
- By 28 months, throws ball 7 ft forward, using up & back arm motion
- By 40 months, throws ball 10 ft forward, with arm/leg opposition & trunk rotation

Throwing Ball Underhand

- By 24 months, child throws tennis ball 3 ft
- By 40 months, hits target, 2/3x
- By 46 months, throws ball 10 ft forward, with upper trunk rotation & step forward
- Teach using targets
- Emphasize pulling arm backward, and later, stepping forward with opposite foot

Trapping Ball to Chest

- By 26 months, child catches ball by trapping to chest, by bending arms upward
- Large, slow moving objects are easiest to catch

Catching Ball

- By 34 months, child catches with arms extended
- Teaching strategy: “clap” the ball
- Initially, use balloons or light-weight textured balls

Kicking Ball

- Start with large, light-weight ball (beach ball)
- Progress to smaller, heavier balls
- Provide a “goal” (soccer net, bowling pins, etc)

Kicking Ball

- By 20 months, a child kicks a ball forward 3 feet, deviating no more than 45 degrees from midline
- By 24 months, child deviates no more than 20 degrees
- By 30 months, kicks ball forward 6 feet, using opposing arm /leg movements & bent knee
- By 72 months, child kicks a ball forcefully enough so that it travels 12 feet in air

Imitating Arm/Hand Movements Without Objects

- Teach at least 2 targets at a time
- Teach “meaningful” actions before non-meaningful actions (Stone et al, 1997)
- The location of the movement is easiest for individuals with ASD to discriminate & imitate (Seal & Bonvillian, 1997)
- Bidirectional movements are acquired before unidirectional movements (Bonvillian & Siedlecki, 1998)

Imitating Arm/Hand Movements

- Research on the acquisition of sign language in young children offers helpful information (Bonvillian & Siedlecki, 1998, 2000)
- Acquiring aspects of sign language:
 1. Location (easiest)
 2. Movement
 3. Hand shape (hard)

Movement Aspects First Acquired

- Level 1
 - Contact
- Level 2
 - Close
 - Downward

Difficulty of Movement Aspect

- Level 3
 - Twist
 - Nod/bend
 - Side-to-side
 - To-and-fro
 - Up-and-down

Most Difficult Movements

- Level 4
 - Wiggle
 - Link
 - Away
 - Toward
 - Cross
 - Upward
 - Right / left
 - Circular
 - Interchange
 - Converge
 - Open
 - Pronate
 - Supinate
 - Diverge

Hand Shapes Acquired by Young Signers

- Level 1
 - 5
 - G (index finger pointing)
- Level 2
 - B
 - A

Hand Shapes Acquired by Young Signers

- Level 3
 - “Baby O”
 - O
 - C
 - L
- Level 4
 - V
 - K
 - X
 - 3
 - H
 - E

Imitating Sequences & Delayed Imitation

- Imitating sequences and delayed imitation may require the use of a mediating response

Teaching Self-Rehearsal to Evoke Joint Control

- Teach self rehearsal to evoke joint control
 - Advanced visual perception skills require the development of a strong tact repertoire in order for their development to occur.
- Joint control is the effect of 2 Sds (rehearsal and tact) acting jointly to exert stimulus control over a response.

(Lowenkron,1984)

Joint Control

- Joint control occurs when the learner’s self rehearsal (covert echoic) is matched by another stimulus (seeing purple bead). The two jointly control the response (selecting the bead).
- Teaching the self-rehearsal must occur prior to joint control occurring (Gutierrez,2006). Without the self-rehearsal there is no second source of stimulus control.

Self-Rehearsal

1. Tact
2. Self echoic
3. Motor response

Grasping Objects

Power

- Fingers and thumb act against the palm to transmit force to an object
- Spherical
- Cylindrical
- Hook

Precision

- Forces are directed between the thumb and fingers, not against the palm
- Pad-to-pad
- Tip-to-tip
- Pad-to-side

Three Jaw Chuck Grip

- Typically seen between 9-11 months
- Hand separation
- Prepares for pincer / tripod
- Activities:

Inferior Pincer Grip

- Seen by 10-11 months
- Pad-to-pad
- Hold back other fingers
- Do not allow middle-finger substitution
- Activities

Superior Pincer Grip

- Seen in children 11-12 months old
- Tip-to-tip
- Use same strategies as inferior grip

Lateral Pinch Grasp

- Holding a key
- Sometimes used inappropriately by children with weak pincer grip

Effect of Pencil Grasp on the Speed and Legibility of Handwriting in Children

Heidi Schwellnus, Heather Carnahan, Azadeh Kushi,
Helene Polatajko, Cheryl Missiuna, Tom Chau

KEY WORDS

- child
- hand strength
- handwriting

OBJECTIVE. Pencil grasps other than the dynamic tripod may be functional for handwriting. This study examined the impact of grasp on handwriting speed and legibility.

METHOD. We videotaped 150 typically developing kindergarten students while they performed a writing task. We categorized the grasps they used and evaluated their writing for speed and legibility using a handwriting assessment. Using linear regression analysis, we examined the relationship between grasp and handwriting.

RESULTS. We documented six categories of pencil grasp: four mature grasp patterns, one immature grasp pattern, and one alternative grasp pattern. **NUMBER** linear regression results revealed no significant effect for mature grasp on either **speed** or **legibility**.

CONCLUSION. Pencil grasp patterns did not influence handwriting speed or legibility in this sample of typically developing children. This finding adds to the mounting body of evidence that alternative grasps may be acceptable for fast and legible handwriting.

Schwellnus, H., Carnahan, H., Kushi, A., Polatajko, H., Missiuna, C., & Chau, T. (2010). Effect of pencil grasp on the speed and legibility of handwriting in children. *American Journal of Occupational Therapy, 68*, 714-720. <http://ajot.aota.org/2010/06/01/ajot/68/714>

Writing Grasp Research

- The *American Journal of Occupational Therapy* published research on the writing forces associated with four pencil grasp patterns in 74 children in grade 4.
- The students completed a handwriting assessment before and after a copy task and grip and axial forces were measured.

Writing Grasp Research

- Grip forces were generally similar across the different grasps, although adducted thumb grasps exhibited higher mean grip and axial forces.
- Grasp did not have a significant impact on legibility or speed
- Conclusion: focus more on speed and letter formation than on grasp patterns

Significance of Drawing

- Children are often required to draw as part of reading, writing, or art projects
- Drawing may also be used as a strategy for solving math problems
- Later in life, drawing may function as an instrumental ADL (drawing a map, making a diagram, etc)

Developmental Sequence of Drawing Skills

- Vertical line
- Horizontal line
- Circle
- Cross +
- Square
- Triangle
- Complex representational drawing

Teaching Drawing Skills

- Teach the following “types” of drawing
 - Imitation
 - Copying
 - Dictation
- Use a “clean slate” every time
- Most learners will require physical prompting, at least at first

Teaching Drawing Skills

- If physical prompts alone are ineffective, consider the use of within-stimulus prompts
 - Tracing
 - “Dot” prompts
 - Color-coded prompts
 - Verbal prompts

Copying a Circle

- Mastered around 36-40 months
- End points must overlap, 1" or less
- Consider use of "dot prompt" during teaching
- Some children may need to be taught circular scribble as a pre-step

Copying Cross

- Teach after vertical line & horizontal line are mastered
- Intersperse vertical & horizontal line
- Can prompt DOR
- Can use color-coded within-stimulus prompts

Copying Square

- Emphasize stopping at the corners
 - May need to pick pencil up at first
- Dot prompts
- Verbal prompts
- Backwards chaining

Copying Triangle

- Teach imitation of diagonal lines first
- Emphasize stopping at corners
 - May need to pick pencil up at first
- Dot prompts
- Verbal prompts
- Backwards chaining

Representational Drawing

- Teach learner to tact shapes / components
- Utilize a differential observing response

Differential Observing Response

- When learners are taught to first touch or tact a critical aspect of a stimulus, stimulus control can be expanded (Constantine & Sidman, 1975, Geren et al., 1997). This is referred to as a differential observing response (DOR).
- Teaching a differential observing response may be useful to help learners whose behavior is not yet controlled by all critical aspects of a non-verbal stimulus.

Developmental Sequence of Cutting

- Snipping with scissors
- Cutting a piece of paper in half
- Cutting a straight line
- Cutting a circle
- Cutting a square
- Cutting irregular shapes

Teaching Snipping

- Teach “open & shut” motion prior to actual cutting (tongs, castnets, etc)
 - Most children gain independence with the squeezing the scissors closed before they learn to open them
- Teach child how to pick up & put on scissors
 - Desired finger placement

Cutting

- Prompt from behind the child
- Disposable drinking straws or cardstock require less hand coordination than thin paper
- Develop fluency with snipping before moving to cutting across a piece of paper
 - Gradually increase the length of the paper

Cutting

- To teach cutting on a line, start with a thick line (which requires less control)
 - Stickers can be added to increase visual attending
 - Gradually thin the line
- Once the learner can cut straight lines independently, move to cutting angles
 - Focus on “stop & turn”

Cutting

- When the learner can cut angles independently, introduce cutting a square
- After the learner masters cutting a square, probe cutting a circle, followed by irregular shapes (heart, star, peanut, hat, etc)

Developmental Sequence of Coloring

- Irregular scribble, using shoulder
- Wide scribble, using forearm
- Coloring in 1 direction, using wrist
- Precise coloring, using distal finger movements

Coloring Between Lines

- By 60 months, a child should be able to color between 2" wide shape, filling 75% of the shape, and crossing the line no more than twice
- Most children progress from gross to fine coloring
- Within stimulus prompts, coupled with physical prompts, often work well

Handwriting

- Handwriting is a complex skill
- Children who have deficits in sensory perception, strength, coordination, or cognition are likely to also have difficulty learning to write neatly and efficiently

Pre-Requisites for Writing

- Hand dominance
- Crossing midline
- Bilateral hand use
- Functional grasp
- Pushing hard enough on a writing utensil to produce a mark
- Imitation with objects
- Imitation of drawing lines & simple figures
- Visually discriminating between similar figures

Stages of Writing

- Imitation
 - Do what I do
- Copying
 - Write what I show you
- Transcription / dictation
 - Write what I tell you

Grasp & Writing

- A functional grasp allows the necessary fine movements needed to write
- An atypical grip does **not** necessarily mean that a child will have handwriting problems
- Consider:
 - Signs of fatigue / poor endurance
 - Too much pressure
 - Too little pressure
 - Dexterity

Posture & Writing

- The body must be stable to support distal mobility
- Investigate the height of the chair & writing surface
- Hips, knees, ankles should be at 90-120 degrees
- Forearm should be stabilized on writing surface
- Wrist should be extended

Handwriting Curricula

- Most children require a systematic curriculum in order to learn writing skills
- A variety of curricula are commercially available, including
 - The Sensible Pencil
 - Handwriting Without Tears
 - Zaner-Bloser
 - D'Nealian

Handwriting Without Tears

- Developed by Jan Olsen, an occupational therapist
- Emphasis on following developmental sequences for learning letters (diagonals come last)
- Modified teaching strategies are likely warranted for our learners with developmental disabilities such as autism
- Direct instruction has been shown to be effective (Park, Weber & McLaughlin, 2011)

Teaching Sequence

- Generally teach capital letters before lowercase letters
- HWT groups letters by formation patterns
 - Frog jump: F E D P B R N M
 - Starting corner: H K L U V W X Y Z
 - Center starters: C O Q G S A I T J

Adapted Sequence

- Straight line: F L E H T I
- Curved: D P B C O G U J S
- Diagonal: R N M Q A K V W X Y Z

General Steps to Mastery

- Imitate on slate
- Copy on slate
- Copy in blocks
 - For children who struggle with this step, consider adding more steps between slate/blocks
- Copy between lines
 - Pros / Cons of HWT paper
- Writing dictated letters between lines
- Copy between smaller lines

Writing Name

- Developmentally, most neurotypical children write their names in all capitals before using appropriate capitalization
 - Pros
 - Cons
- It is usually beneficial to teach learners with special needs to print their first name with appropriate capitalization from the start

Lowercase Letters

- HWT teaches in this order:
 - Look-a-likes: c o s v w t
 - Adaptation = teach x and z before t
 - Magic c: a d g
 - Remaining vowels: u i e
 - Transitions: l k y j
 - Dive down: p r n m h b
 - Final letters: f q x z