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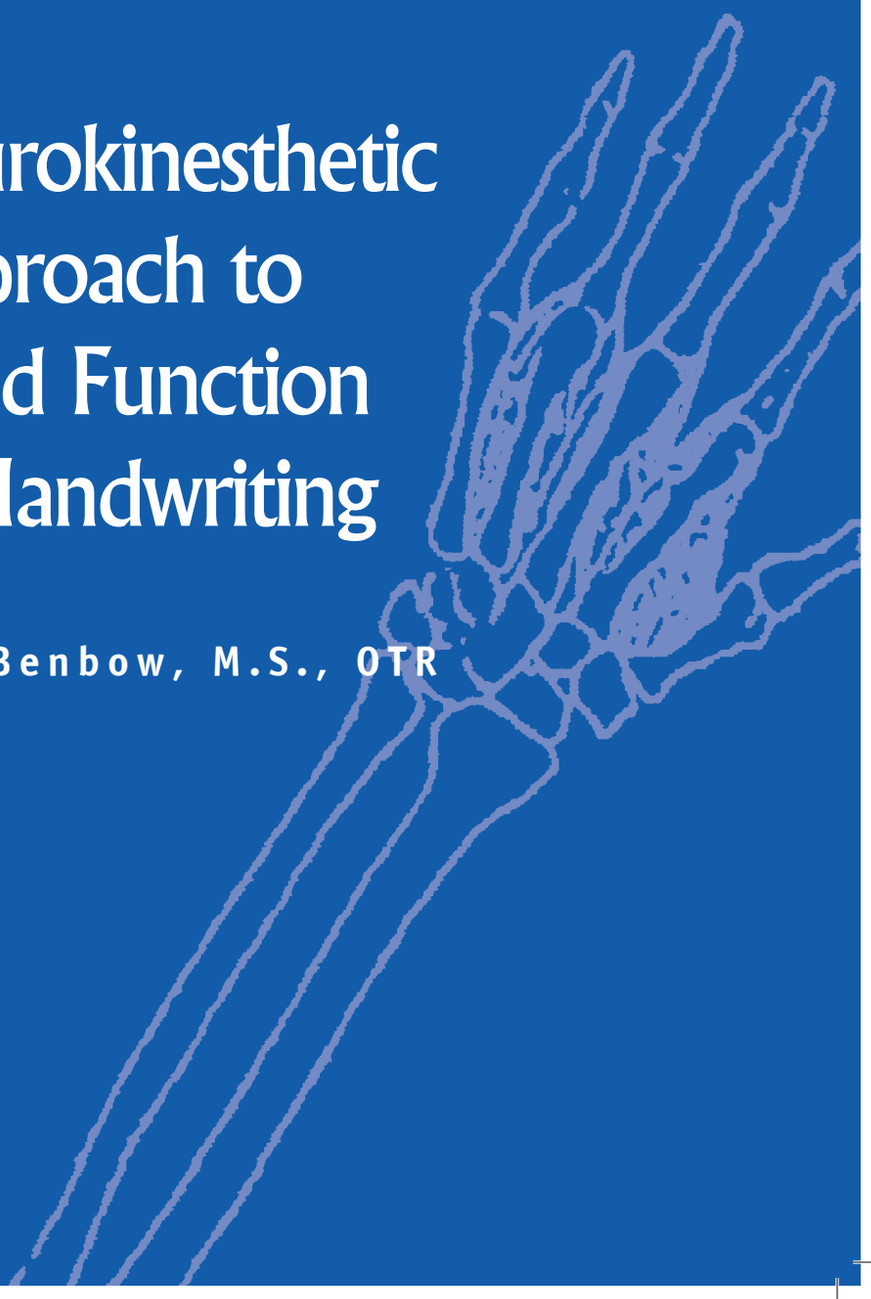
Neurokinesthetic Approach to Hand Function & Handwriting

Mary Benbow, M.S., OTR



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Understanding the Hand from the Inside-Out
Developmental Activities Based on Hand Anatomy

Mary Benbow, MS, OTR

RELEVANT ANATOMY

Normal use and function of the hand are dependent upon the synergy of many muscles; those acting on the wrist, as well as the digits. The muscles of the wrist are important because they stabilize and prevent unwanted wrist movements, which allow the finger muscles to maintain an adequate length that is favorable for producing tension and prehension. The muscles of the hand and wrist are so closely linked that it is virtually impossible to voluntarily omit a muscle from the synergy of which it belongs. Understanding the anatomy of the hand and wrist is important for appreciation of the intricate and synergistic function of the muscles and joints, which work so intricately to provide functional grasp, release and skilled manipulation.

WRIST EXTENSORS AND FLEXORS

Finger movements should work in reciprocal synchrony with movements of the wrist. Grasp is weaker with wrist flexion than with wrist extension. Wrist extension is critical to stabilizing the structure and allowing finger movements at the best mechanical advantage for freedom of range and control.

Children with fine motor and writing problems often lack good wrist stability in extension and therefore cannot activate the most functional finger movements required for skilled manipulation.

To maintain good stability of the wrist in extension for distal finger function, it is necessary for the wrist flexors to work antagonistically with the wrist extensors to provide stable co-contraction and maintain the proper control of the wrist in its best functional position.

EXTRINSIC MUSCLES

The extrinsic finger muscles have their bellies in the forearm. These muscles narrow to pass through the carpal tunnel and into the tendon sheath. They insert on the IP joints of the digits. The extensor extrinsics are responsible for extending the MP joints of digits 2 through 5 and extend the wrist by continued action. The flexor extrinsics flex the PIP joints and the MP joints and the wrist by continued action.

MUSCLES OF THE PALM

The palmar aponeurosis is a fibrous tissue within the palm that is pulled by the palmaris longus, which gathers the fascia as a unit to arch the palm. The brevis draws the skin over the hypothenar eminence to the middle of the palm and also assists in palmar arching.

Intrinsic muscles of the palm function primarily to move the fingers in abduction or adduction in relation to the midline axis of the hand. The palmar interossei, dorsal interossei and lumbricals function to provide delicate coordination of the digits in abduction, adduction, flexion of the MP joints while extending the PIP joints, shape the fingers to fit objects, control tension between the finger flexors and control precise balance between the thumb and index fingers.

INTRINSICS OF THE FIFTH DIGIT

The little finger and the thumb have a special relationship and add to the grasp and balance of the hand. The flexor digiti minimi, abductor digiti minimi and opponens pollicis & digiti minimi are referred to as the hypothenar muscles. They work in synergy to flex the MP joint of the 5th digit, abduct the fifth digit and rotate the fifth MC joint at the CMC joint for opposition to the thumb.

EXTRINSIC MUSCLES OF THE THUMB

The extrinsic muscles of the thumb all have their origin in the forearm. The extensor poillicis brevis and longus extend the MP joint of the thumb and radial deviates the wrist. The abductor pollicis longus abducts the CMC joint, radially deviates the wrist and assists in slight flexion of the wrist. The flexor pollicis longus flexes the IP joint of the thumb and the MP and CMC joints by continued action.

INTRINSIC MUSCLES OF THE THUMB

The intrinsic muscles of the thumb are the abductor pollicis brevis, flexor pollicis brevis and opponens pollicis. These three muscles make up the skill triad and provide rotation of the thumb at the CMC necessary for active opposition, manipulation and delicate touch. The adductor pollicis is a power muscle and adds strength to opposition.

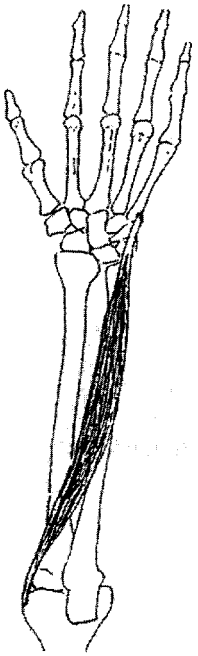
HAND MOVEMENTS

The structure and function of the anatomy of the hand and wrist are responsible for an almost infinite combination of skilled movements of the digits, supported by stability of the wrist and elbow, arches of the hand and the joints of the upper extremity. If one considers the intricate movements of the hand and its skills, the many problems, which can arise in writing and manipulation, can be appreciated.

Children with dysfunctional hands show typical symptoms of a lack of neuromuscular maturity. The arches of the hand are often flat and incompletely developed. There is also a lack of motoric separation between the radial and ulnar sides of the hand. The internal stability of the hand is often in the low normal or low tone range. A related problem is in establishing good wrist stability. The digits often lack controlled flexion/extension and rotation, which are critical for manipulation. Each child must be carefully assessed for the specific degree and area of dysfunction, so that appropriate developmental hand activities can be used to prepare, strengthen and develop the components of functional hand, wrist and finger movements.

WRIST EXTENSORS AND FLEXORS

EXTENSOR CARPI ULNARIS

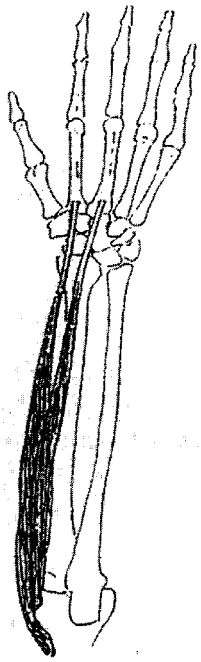


Function:

- Extend wrist
- Ulnar deviation of wrist
- Work synergistically with the thumb triad.
- Stabilize wrist for skill.

EXTENSOR CARPI RADIALIS LONGUS

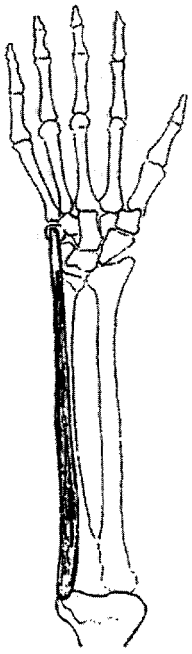
EXTENSOR CARPI RADIALIS BREVIS



Function

- Extend wrist
- Radial deviation of wrist (L)
- Stabilize wrist for power (B)

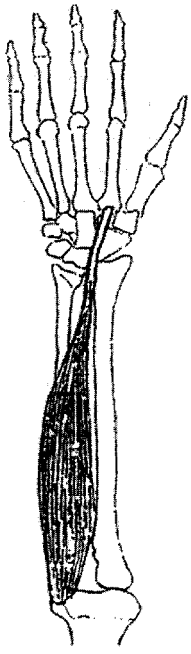
FLEXOR CARPI ULNARIS



Function:

- Flex the wrist.
- Ulnar deviation of wrist.

FLEXOR CARPI RADIALIS

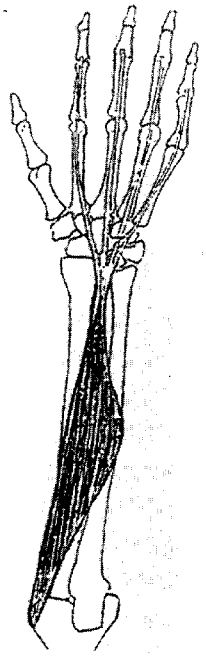


Function:

- Flex the wrist.
- Radial deviation of wrist

EXTRINSIC EXTENSORS OF DIGITS

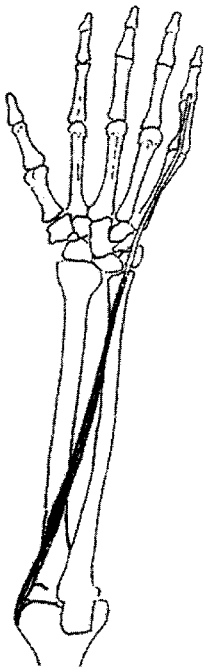
EXTENSOR DIGITORUM COMMUNIS



Function:

- Extend MP of joints of digits 2, 3, 4, 5.
- Extend the wrist by continued action

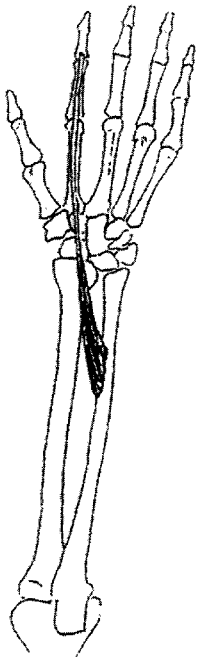
EXTENSOR DIGITI MINIMI PROPRIUS



Function:

- Extend MP joint of digit 5.
- Extend wrist by continued action.

EXTENSOR INDICIS PROPRIUS



Function:

- Extend MP joint of digit 2.
- Extend wrist by continued action.

Altering an Inefficient Grip

In development of motor skills, there is evidence of transfer between different forms of action. The precision grip once mastered and reliably used with a spoon begins to be used in drawing with a pencil. Therefore the instructor or therapist should evaluate the child's skills in use of a spoon or fork before attempting to alter the more complex skill with a writing tool. Silverware requires only stabilization with the skilled digits. A writing tool requires stabilization with mobilizing. If the child uses an immature power grip on a spoon, the instructor should develop this sub-skill before advancing to writing tools.

Hand structures required for tool stabilization with distal manipulating are:

a) Active metacarpal phalangeal arch with three degrees of freedom (flexion/extension, adduction/abduction, and rotation) at the metacarpal phalangeal joint of the index finger.

b) Full range of motion at the carpal metacarpal joint of the thumb is required to stabilize the open web space. Conditions a & b may require therapeutic intervention with specific developmental activities to achieve the desired results.

c) Joint stability; a most prevalent finding is ligament instability within the joints of the hands. Shifting the pencil into a more stable web space between the index and ring fingers is often a convenient intervention. In severe cases the use of a neoprene splint, as an outside stabilizer may be required.

Before intervening with a student with an inefficient grip, it is critical for him to understand why it is worth his effort to change it. Pencil grips that are not held within the pulps of the digits do not lead to economy, variety and convenience for proximal-distal axis in the simple flexor or extensor synergy to produce fast enough writing needed once the output demands increase about third grade.

An adducted grip (which diminishes the proprioceptive input from the lumbricales from the skilled digits) does not allow the luxury of the unconscious regulation of the gripping pressure on the shaft of the pencil or the downward pressure of the pencil point against the writing surface. This is the reason many students frequently need to stop, release their grip on the pencil and shake the pain out of the fingers. He should be made aware that power grips might result in painful joint dysfunctions later in life due to the stress they cause to the support structures of the joints.

The following sequence can make the transition to the functional grip less stressful and more successful.

1.The instructor demonstrates how to position a pencil between index and long finger to make large random patterns on the paper using only shoulder and elbow movements.

2. The child imitates the instructor by positioning the between the same two digits to make large free flowing movements (no finger movements, letter or number symbols are allowed).

3. After the child adjusts to the feel of the pencil in the index/middle finger web space, she should be encouraged to draw anything she pleases.

DEVELOPMENTAL HAND PROGRAM

The developmental hand program consists of over 65 activities designed to improve hand function, dexterity and control. The activities are divided into 9 sections, including proximal control of the shoulders, the elbow and the wrist, distal finger movements, precision translation, precision rotation, motoric separation of the two sides of the hand, thumb activities and joint stability within the hand. Activities are easily chosen based on the observation of hand skills assessment previously described. Each of these activities is clearly explained and demonstrated in the video "Developmental Hand Program," by Mary Benbow, and available from Clinician's View®.

The human hand is dependent on multiple factors for sensibility of adjustment, economy of execution and accuracy of skill. This hand program has been developed to guide professionals in systematic assessment and inclusive activities to enhance the varied components of fine motor skills of children.

OVERALL DEVELOPMENT

Developmental therapists, trained to look at the whole body and its interrelationships, must address ergonomic factors (postural, tonal, and stabilizing) for fine motor intervention to be most effective. Fine motor difficulties listed in this handout will focus on incomplete utilization of the proximal joints of the upper extremity, immature hand development and lack of joint stability. Commonly related developmental issues such as bilateral integration and visual-motor in coordination will not be addressed in this handout.

PROXIMAL JOINT CONTROL

The development of dexterous hand skills depends on the interaction of all joints of the upper extremity: scapulothoracic, glenohumeral, elbow and wrist. Every joint must move freely into its mature pattern (s). Therefore, each joint should be assessed for functional mobility as it is incorporated in mature upper extremity patterns. In children who experience fine motor delays, it is common to find the shoulder slightly biased in internal rotation, adduction and/or flexion; the elbow in pronation and/or flexion; and the wrist toward flexion and ulnar deviation.

In addition to adequate range of motion, every proximal joint must provide a stable base of support for the joint(s) distal to it to enable maximal control. Proximal joint instability is best treated in an adapted physical education setting with weight bearing, traction and compression type activities.

SCAPULA/SHOULDER ACTIVITIES

1. BALL TAPPING: The child uses a 12" to 14" stick braced between the palms of the hands to gently tap a suspended 8-10 inch ball. The ball should be hung at a level that will require as full elevation of the arms as the child is capable of controlling. Gentle tapping will demand more mid-range control while developing more stable scapula and shoulder joints.

2. MIRROR ARM PATTERNS: Pair off. The instructor initiates a slow symmetrical movement sequence with her arms for the child to follow as if looking in a mirror. Reverse the

"leader/follower" roles. Grade by working at a higher level and/or at a slower pace. An advanced goal would be for observers to detect which person is the leader of the sequence.

3. PRECISE POURING: (Pouring from a pitcher or a watering can requires controlled distal mobility¸ or proximal stability). Fill the container to the level that challenges the strength limitations of the child. Pour colored water into several small containers without spilling between them or overflowing their rims. Work for accuracy with more fluid (weight) in the container and/or reduced quantity containers.

4. SPHERE ON SPOON CARRYING: Carry a round ball, marble, or stone at arm's length on a long handled wooden spoon. Grade by positioning the grip more distal from the bowl of the spoon, increasing the weight of the sphere or distance to be traveled. A final goal could be to carry a heavy sphere to a target with the eyes closed.

5. ROPE TURNING: Turn one end of a jump rope with a partner. The child should first use his dominant hand to develop external rotation of the dominant side shoulder. Then he should turn to use the non-dominant hand to develop the other shoulder.

6. ROPE JUMPING: Self-swing a jump rope. (The handles of the jump rope should touch his armpits -when the child stands with feet together with the middle of the rope passing under the arches). Swing the rope backwards over the head. Reverse swinging requires movement of all upper extremity joints into their mature patterns. Initially, the child should concentrate only on swinging the rope. When he hears the rope strike the floor behind himself, he should step backwards over it.

7. **PLAY BOY:** The elliptical form is forced to opposite ends of the strings when the child abducts at the shoulders. The handles can be positioned from shoulder elevation to shoulder depression. Lying supine is most beneficial for the child with low tone who has scapula instability, poor balance, or isolated control of his upper extremities.

8. BLACKBOARD SHOULDER LOOPS: Produce external rotation loop (overhand) patterns with chalk on a blackboard. Start at eye level and midline and move as high and wide as the reach will allow. Work for pattern smoothness and uniformity. Close eyes and continue patterns kinesthetically.

ELBOW ACTIVITIES

1. SLINKY: The metal slinky should be shifted back and forth while being maintained in a full palm up position.

2. MAGNET STICK FOR VISUAL TRACKING: The child horizontally holds the tracking card with his non-dominant hand to guide a metal object along a printed track. He guides the metal object by sliding a magnet (glued to one end of a stick) from beneath the card track. The magnet stick should be held in a tripod posture with the dominant hand. Start by guiding a flat metal object (paper clip or safety pin), which requires less exact supination. Advance to guiding a tiny metal ball, whose tangential contact demands maintaining the magnet stick in precise supination.

Dysgraphia Subtypes

Ruthmary Deuel -- 1995

Washington U. St. Louis, MO.

Dyslexic dysgraphia

1. Spontaneously written text poorly legible, with textural complexity influencing legibility
2. Oral spelling severely abnormal
3. Copying of written text relatively preserved
4. Drawing relatively preserved
5. Finger-tapping speed normal

Dysgraphia due to motor clumsiness

1. Spontaneously written text is poorly legible
2. Oral spelling relatively preserved
3. Copying of written text poor legible
4. Drawing usually compromised
5. Finger-tapping speed abnormal ***

Dysgraphia due to defect in understanding space

1. Spontaneously written text poorly legible
2. Oral spelling relatively preserved
3. Copying or written text poorly legible
1. Drawing severely abnormal
5. Finger-Tapping speed normal

MEMORY AND HANDWRITING

It is the category of "procedural memory" that is most relevant to handwriting.

PROCEDURAL MEMORY

Implicit: This memory is for automatic recall of a series of movements such as riding a bike, typing, swimming, tying shoelaces, driving, or writing cursive script. When handwriting is taught to the automatic kinesthetic level, the student is using implicit memory. This allows him to free up working memory and focus his full attention on the thought he wishes to record or the words he must spell. As long as a student has to shift his attention between remembering how to produce letter configurations and formulating an idea he wants to express, he will be at risk for "output failure." In taking class notes or copying from the blackboard, he will not be able to function at the level of his true potential. Students who develop the skills of cursive writing to the automatic kinesthetic level will be able to function more effectively at academic and life tasks. There is minimal erosion of this type of memory over the life span. Though physical changes of aging may make handwriting difficult, an older person typically continues to have procedural memory for cursive writing such as **a** legal signature.

Working: Working memory is used when the brain's "conductor" tells it where to shift focused attention moment by moment while performing a task. Working memory is needed to keep several things in mind simultaneously with one or more components "shifted to the back burner." An example is remembering the subject of a sentence while writing the predicate. In written schoolwork, problems arise when a student must also have to recall how to spell a word and configure the letters. The student will be overwhelmed and discouraged by these multiple demands when speed in note taking is required or an increased amount of written material is expected.

ATTENTIVELY STORED MEMORY

Semantic: The memory of words, symbols and trademarks. One tends to add words to semantic memory throughout life. This type of memory is highly resilient throughout the life span.

Remote: The memory needed to win big on "Jeopardy". This includes the rapid recall of facts collected from reading, movies, school courses and everyday exposure to the world. Decline of remote memory may simply be a retrieval problem.

Episodic: This is the memory of recent events-the name of the video you viewed last week or what you ate for dinner last night. You may well remember how to drive (implicit memory) but forget where you parked your car. Loss of episodic memory troubles many people. Reduction of episodic memory will make learning a new task slower than when the person was younger.

Handwriting Observations
Assessment of Cursive Writing Skills
Developed by Mary Benbow MS, OTR

EQUIPMENT REQUIRED

Appropriate sized desk and chair	Small piece of soft putty or clay
Stop watch	Round fine tip marker
Pencil	2 identical wooden stem tops
Prism scope	Distal Finger Control Sheet
2 Production Consistency Sheets	Visual Motor Orientation Sheet

PHYSICAL OBSERVATIONS & NOTES	Yes	No
1. ELBOW SUPINATION: {Child standing} Evaluator flexes the child's elbows to 90 degrees and passively rotates each forearm to full palm up position. NOTE if movement at either elbow seems resistant at end range. From this flexed elbow position, instruct the child to actively turn each of his forearms to its full upright position. NOTE any shoulder(s) compensation. *Camera slightly off to side but wide enough to observe elbow and shoulder movements.*		
2. WRIST STABILITY IN EXTENSION: {Child seated at appropriate sized desk} Have the child stabilize his flexed elbow on the desk top at eye level. The child is instructed to roll out a pea sized ball of clay or putty between his thumb and index finger pads. *Camera should be facing the child's hand* NOTE a) position of the wrist and b) stabilizing technique the hand assumes to isolate control at the metacarpophalangeal arch .		
3. ABDUCTION OF THE THUMB IN THE PLANE OF THE PALM: The child holds his hands up in front of his face with his fingers pointing straight up. From this position, he should separate his thumbs from the sides of his hands as far as is comfortable. NOTE the degree of separation of the thumbs from the sides of his hands. The thumb angles should approximate 90 degree "L" and reverse "L" shapes. *Camera angle should be straight on.*		

PHYSICAL OBSERVATIONS & NOTES	Yes	No
4. DEPTH OF ARCHES OF THE DOMINANT HAND: Instruct the child to bring his thumb pad into approximation to his little finger pad but not quite touch them together. He will need to see into his own palm to monitor this task. NOTE the depth of the "hole" at the base of the long finger and the movement of the hypothenar eminence. *Camera should aim directly into palm to observe the "hole" at the base of the long finger and little finger side of the palm.*		
5. SNAPPING FINGERS: Instruct the child to snap his fingers while stabilizing his flexed elbow on the desk top at eye level. *Camera aimed into palm.* If he is able to snap, have him repeat it slowly a few more times. NOTE: a) separation of the ulnar digits from the radial digits, b) pad to pad positioning, c) extension of index finger in isolation from the long finger and d) thumb CMC abduction.		
6. FINGER SUCCESSION TASK (TIMED TASK): Teach thumb touching in succession to each finger tip starting with little finger "5" and moving across to 4, 3, and 2 back to 5 to continue. Practice until the child gets the idea of continuing the pattern as quickly as possible. Instruct the child to stabilize his bent elbows and position his hands forward outside his peripheral visual field. During timed trials, the child is asked to "Keep touching each finger in succession until I tell you to 'stop'". Record the number of seconds after "go" to complete 5 sequences (20 touches) (dominant hand and then non-dominant hand). *Camera is aimed directly opposite the child's raised hands to record s unilateral smoothness and synkinesis .*	R	L
DOMINANCE	R	L
7. SKILLED HAND: Instruct the child to spin a simple wooden stem top 5 times in order to observe refinement of his spinning patterns. NOTE a) hand spontaneously used and b) if he spins toward the body midline in a pronated pattern or away from the body in a supinate pattern and which fingers are placed on the stem of the top . Encourage him to practice with his other hand (non dominant) a few times. Now give him two identical tops to spin simultaneously. *Camera should be focused to the desk top for spinning activity.*		
8. SIGHTING EYE: Instruct the child to hold a prism scope with both hands to view. NOTE the initial eye spontaneously used. Now ask the child to look with his other eye to observe: a) if the recessive eyes sees about the same as the dominant eye, b) if the child shifts his head and eye to a lateral position in order to sight, or c) child reports that he cannot see with his recessive eye. *Camera should focus of the child's eye and neck posture.*		

HANDWRITING FOR ALL STUDENTS

Functional handwriting must be taught more efficiently, thoroughly and permanently to all school children. This includes the great number of subtly delayed students who have trouble mastering a functional level of graphic skill to function comfortably in school and life. Developmental delays such as incomplete bilateral integration, organizational, memory, analytical and or perceptual motor output should be accommodated for with specific compensatory teaching techniques. With compensatory tips, all students should be expected to learn to write legibly in an integrated classroom setting.

Manuscript before cursive may have a number of negative factors that hinder developing speed and kinesthesia for effective cursive handwriting.

I) The paper is typically positioned square to the desk edge (except for D'Nealian) rather than on a slant to utilize the efficient diagonal draw of the wrist flexors for down stroking.

2) Manuscript techniques require mentally separating letters into their many line units and then joining the line units into letters. This demand is beyond the ability of children with part-to-whole perceptual motor or spacing problems. Cursive writing requires learning letters as whole motor units.

3) Many manuscript letters (including 12 capitals) have diagonal line(s). This is the hardest line orientation to produce and prevents mastery for many youngsters at the age when manuscript is customarily taught in our schools. Cursive writing avoids the most difficult diagonal where the line unit moves into (L) downward space

4) Spatial confusion is compensated for in cursive letters where all lower case letters lead-in from the writing line and move up into right space. With manuscript, spacing is required between each letter and each word. In cursive, spacing is reduced to between words.

5) There are no mirror image letters in lower case cursive formations. "b and d" and "p and q" output confusion is eliminated.

6) Children with right hemisphere spatial difficulties, known to be more rigid in their learning style, have a perplexing task in shifting to a new writing system. Most of these children will have struggled with but never really mastered manuscript in the first two to three years of school. Making such a shift is often beyond their tolerance. Frequently these students will revert to less efficient manuscript when task demands are high. Mixing the two letter systems is also a common finding.

Educators would be sensible to wait for developmental readiness for graphic skills to develop before formal instruction for paper work is expected. Curricula that use instructional techniques to accommodate for perceptual and motor delays and deficits should enable nearly all students to advance to cursive writing at an earlier age. Second grade is the optimal time for most children to learn cursive handwriting. Student interest is high, and typically students have not yet acquired faulty habits of inventive cursive before formal instruction begins. Training activities of combining letters into simple two- and three-letter words to practice letter formations and connector units are at a more appropriate level for second graders. Initiating cursive/instruction in the fall of second grade allows a full year for students to stabilize this motor learning and be prepared for the higher volume of written work expected at the third grade. At this age, if cursive is enthusiastically taught, it can be enthusiastically learned. Dysfunctional writing with its misery and frustration should become obsolete.

PENCIL GRIPS

The pencil must be held in a manner that provides both stability and mobility. Speed, axial force and control, pausing and endurance while writing can be influenced by the way the writer grips his pencil. Early and extended amounts of time "writing" before that have developed adequate stability in their hands, established a dominant hand, or learned the names of letters they are trying to copy. Through trial or error experiences with markers, crayons, and pencils some grips will become very efficient, others will become very inefficient. Benbow (1987) and Schneck (1991) found more inefficient grips among typically developing girls, than boys in schools in the Boston area.

OPTIMAL TIME TO TEACH CURSIVE HANDWRITING

At the beginning of second grade seems ideal in that:

1. Student interest and motivation is high.

2. Students will not have acquired the faulty habits of "inventive cursive" before formal instruction.

3. Training activities of combining letters into simple two and three letter words to practice letter formations and connector units are at a more appropriate cognitive level.

4. Timing will allow a full school year for students to stabilize this motor learning and be prepared for higher volume and cognitive level of written work expected in third grade.

CURSIVE WRITING BENEFITS

1. Movement patterns lend themselves to more automatic or kinesthetic motor learning.

2. Reversals and transpositions are less likely to occur. 3. Connected line enables learning words as units.

4. Production is faster because the multiple stops and starts and re-orientation of line segments are eliminated for each letter.

5. The motor patterns for letters and frequently used words will be established in his kinesthetic memory with extended practice.

COMMON HANDWRITING PROBLEMS

CAUSES AND SOLUTIONS

I. Difficulties with the loops that drop below the writing line.
Evaluate tracking into downward space using the "Observation of Visual Motor Orientation and Efficiency" sheet.
Pause at middle marker below the writing line.
Move the writing paper higher on the desk.
Develop kinesthetic sense for down stroke distance.

II. Failure to close round letters.
Evaluate all rotary joints - 1) supination at the elbow, 2) thumb carpometacarpal abduction with medial rotation and 3) metacarpal arching with index metacarpal phalangeal rotation.

a) Increase range of motor in supination.
b) Increase range of motion and stabilization at file CMC joint of the thumb.
c) Develop arches in the hand and rotation at the MP joint of the index finger.

III. Incomplete retrace before the release stroke
Emphasize the rule that all letters lead-in from the writing line. Therefore one must retrace all letters except (b, o, w, and v) to the writing line to properly initiate the lead-in for the succeeding letter.

BEAUTIFUL BUT NON-FUNCTIONAL HANDWRITING

OBSERVATION: Well formed letters that are meticulously written. Writing speed 2-5 times slower than classmates.

PARENT REPORT: "My bright child's hand cannot keep pace with his thinking. It is the only difficulty he has with school work."

TEACHER COMPLAINT: "Child has good ideas but he can't get them down on paper." When asked to hurry up, the writing becomes totally illegible. "He cannot <u>even</u> read his own class notes".

LEARNING PROBLEM: Writing has not been mastered to the automatic kinesthetic level. The writer became stuck using the visual / motor strategies initially taught, Visual guidance of the writing fingers is far too slow when output volume increases during mid-third or fourth grade. The student falls behind in his work when paragraphs or pages of written work are required.

Dx: Based on evaluation of the following writing samples:

A) The child should write a lower case connected cursive alphabet with eyes open.
B) The child should write a lower case connected cursive alphabet with eyes closed.
   a) Identify the "Think Breaks" in both samples. {These are darker line interruptions seen in the connector(s) preceding the letter(s) the child has to pause to motor plan}.
   b) With vision diverted, can the child visualize the letters and write them using his kinesthetic sense?

THE WAY TO GO!
KINESTHETIC APPROACH TO HANDWRITING

Functional handwriting must be taught more efficiently, thoroughly and permanently to all school children. This includes the great number of subtly delayed students who have trouble mastering a functional level of graphic skill to function in school and life. Developmental delays such as incomplete bilateral integration, organizational, memory, analytical and or perceptual motor output skills should be accommodated for with specific compensatory teaching techniques. Employing compensatory procedures, all students should be expected to learn to write legibly in an integrated classroom.

It is *evident* today that many students fail to naturally advance from visual motor learning visual motor programs. Techniques taught in traditional writing curricula, to the automatic! kinesthetic level of motor competence required for cursive script. They become "stuck" in drawing letters taught in

When writing output demands increase about mid-third grade, the written work of these students will deteriorate. The visual system will no longer be efficient enough to monitor the fingers as they manipulate the pencil to form sentences and paragraphs. The typical solution to 'slow down' will improve legibility but functional speed will be compromised.

Cursive handwriting is a kinesthetic skill. Therefore the ideal way to teach handwriting is with kinesthetic teaching strategies. Direct kinesthetic steps to teaching handwriting leaves nothing to chance in developing writing skill to its highest level. From the first teaching session, kinesthetic skills are practiced, integrated and evaluated as each letter is mastered. Kinesthesia, the sensibility of body position, movement, and weight is enhanced when a movement is repeated to the automatic level with vision averted.

The 26 lower case letters in our alphabet can be reduced to four movement groups determined by their lead-in stroke. The four lead-in strokes can be visually associated with common objects in the child's world. Kinesthetic reinforcement focuses on the "feel of the motion" from the skin, joints and tendon receptors, and muscles to position, direct or correct letter progression. Teaching steps require the student to simultaneously visualize and verbalize the line progression for entire letter as he writes it in the air with eyes open and later closed. When able to visualize, verbalize and move his pointed fingers through the letter sequence in the air, he repeats the same progression on practice paper. The verbalization for each letter is the "motor plan'. The initial letter of each group must be over learned to the automatic/kinesthetic level so it can be modified for the remaining letters in the group. Practice of any letter within a group will reinforce mastery of the entire group. This makes kinesthetic motor learning very efficient.

Essentially all second graders can master the lower case alphabet in six weeks if they practice thirty minutes each school day. Permanent integration of the lower case is usually achieved in 2-3 months. During the interim period before capitals taught, manuscript capitals should be used in combination with the lower case cursive letters for all classroom work. In this way, novice writers will be less likely to mix upper and lower case letters. When a student has achieved kinesthetic mastery of the lower case alphabet, he should undertake learning the capitals grouped for kinesthetic efficiency as well.

Essentially all children learn to write more expeditiously using kinesthetic techniques. However these techniques are an added blessing to students with inadequate memory for configuration and perceptual motor problems; including integration of the diagonal, part-to-whole integration, crossing the midline confusion, and spacing problems. Kinesthetic techniques limit visual demands to the initial analysis of the line progression for each letter. Visual monitoring of writing should be limited to the placement of words on the writing line, accurate retraces and spacing of words. Motor learning at the automatic/kinesthetic level will gradually become more proficient without reduction in quality because it "feels' right and the writer secure. Kinesthetic motor learning is most permanent as it effortlessly moves to the level of implicit memory.

Kinesthetic learning techniques are intriguing to practice. Averting vision reduces stress while increasing enjoyment. Youngsters are enlivened to become skilled at penmanship. Kinesthesia eliminates the drudgery of learning this much needed but neglected skill.