

Motor Memory

MOTOR MEMORY

Development

Memory plays an important part in learning and performing complex motor skills. When we first learn a new motor skill, we watch our movements carefully and make many decisions and readjustments to get the movements to match our idea of the desired movements. When we repeat the sequence of movements many times, it begins to feel familiar. A pattern becomes more and more firmly established in memory and finally, after much repetition, becomes automatic. We perform automatic skills easily, with little or no conscious attention to the component parts.

Learning to drive a car, to dance, or to write letters and numbers are good examples of this process. At first we must pay attention and make conscious choices to direct each movement. As these skills become automatic, our minds are free to focus on subjects other than the motor activity involved. As we write a letter, our thoughts might be sentences ahead of the words that our fingers are forming for us on paper.

In kindergarten and first grade, children are just beginning to learn to form letters and numbers. They rely heavily on visual information and conscious decisions, they are constantly correcting letters or parts of letters that do not look right, and their performance is slow and hesitant.

The ability to make judgments and guide movement based on internal information from joints and muscles (kinesthetic and proprioceptive awareness) develops with age and experience. By the end of first or beginning of second grade, most children rely more on internal feedback, so their writing speed accelerates and copying becomes easier. When internal information is used for guidance, the child can continue with smooth letter formation when eyes shift to the material being copied rather than stopping during each shift. The child learns how the movements that make a letter feel, and can repeat the sequence using mostly internal cues. Each part of the sequence is cued by the previous movement. Vision is then used for fine corrections and spatial placement (writing between lines, spacing, and so on).

From the fourth through seventh grades, motor patterns for letter and number formations are becoming firmly established and writing becomes automatic. In the classroom, there is increased demand for quick retrieval of automatic movement patterns for writing as the amount of written work increases.

Difficulty with Motor Memory

The term *motor memory* has been used to describe the ability to recall distinct motor patterns, and has been identified as one of the most common causes of handwriting difficulty (Levine 1987). For movement sequences such as letter formations to become automatic, the motor patterns must be firmly established so they can be recalled rapidly and with little thought.

There are many possible reasons for difficulty with motor memory, including more generalized memory or sequencing weakness (not just limited to the motor area); weak kinesthetic memory (difficulty remembering how a sequence of movements feels) so that an accurate pattern is not stored in memory; weak or inconsistent ability to recall movement sequences; inexperience due to lack of practice involving consistent repetition of the pattern; or lack of experience due to attentional problems (the first step in remembering something is attending to it). All of these, or combinations of them, are commonly seen in children with developmental variations or learning disorders. Weak motor memory also can cause handwriting difficulty in children with no other learning problems.

Children with weak motor memory cannot consistently recall the correct sequence of movements needed to form letters or numbers. Most commonly, their memory fluctuates so that sometimes a letter is recalled easily and other times it is not. During writing, they hesitate often as they try to remember how to form certain letters; and they don't keep up a smooth, steady rhythm. They sometimes produce letters which they immediately recognize visually as being incorrect, then cross them out or retrace them in an attempt to correct. Once in a while, they may seem surprised by production of the wrong letter, as though the correct letter was requested but the wrong letter was produced by the hand.

When writing the alphabet or forming numbers, these children often use different movement sequences to produce a letter or number. For example, a child might form a 4 by starting at the bottom going to the top, making the horizontal line, and last, the diagonal connecting the two. In subsequent problems, the 4 might be formed in an entirely different sequence. This child might also make a letter several different ways in the same sentence. This lets us know that the child is unable to retrieve a consistent plan for letter or number formation and must think about formation each time. Weak motor memory cannot be detected by looking at the written product, because these children often use visual analysis skills to guide movement so that the letters look accurate. Only by watching the writing process will we see that the child forms letters in different sequences throughout the sample, hesitates before certain letters, and erases an incorrectly produced letter and replaces it with a correct one.

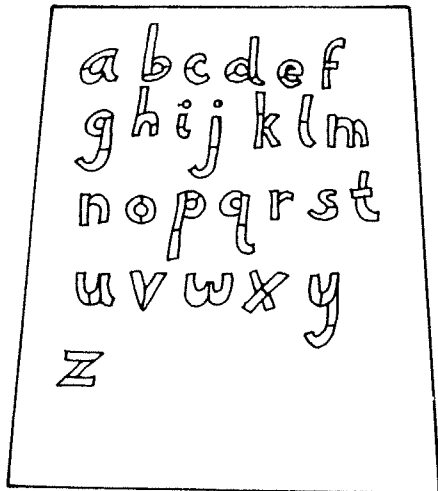
Many of these children have good athletic and fine motor abilities (even drawing), and parents and teachers find themselves puzzled by the difficulty the child has with writing. Drawing, and most other motor skills, do not demand as much recall of precise automatic motor patterns, but rely instead on movements that involve more visual guidance and decision making as they are performed.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

WHICH COMES FIRST?—LETTER AND NUMBER FORMATION



Purpose

To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

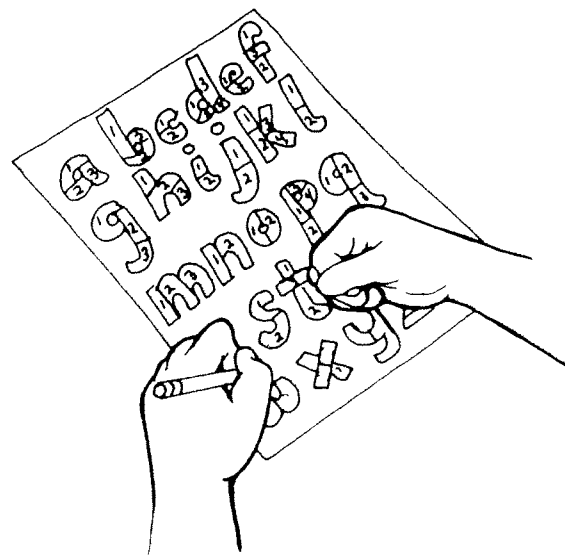
Paper; pencils or markers

Preparation

On sheets of paper, draw letters and numbers in outline form, with lines dividing each outline into parts. Letters and number formations should appear exactly as they are being taught in the child's classroom.

Procedure

1. Child places numbers in sections of the outlined letters and numbers, to show the order of strokes used to form the letter or number.
2. Adult checks each letter or number for accuracy.
3. When all letters are numbered correctly, child traces each with index finger, in the numbered order.
4. When all are traced in correct sequence and directions, child turns the paper over and forms the letters or numbers with the index finger, without looking at the model, while saying their names.



Desired Response

Child accurately numbers all parts of letters and numbers to designate the order in which they are formed. Child traces all letters and numbers and forms them all from memory, using correct sequence and directions of movement.

Variations and Adaptations

Reproduce the papers for use with a group of children or for repeated use.

Have children correct each other's papers by circling outlines that are numbered in the wrong sequence.

If finger control is a problem, increase size of the outlines so child uses larger hand movements.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

WHICH WAY DO THEY GO?—
LETTER AND NUMBER FORMATION

Purpose

To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

Paper; pencils or markers

Preparation

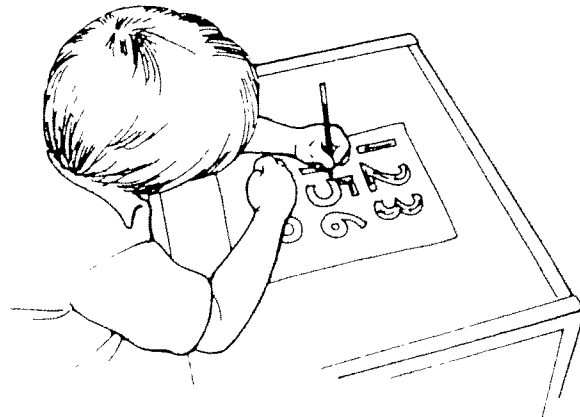
On sheets of paper, draw letters and numbers in outline form. Letters and number formations should appear exactly as they are being taught in the child's classroom.

Procedure

1. Child draws arrows inside outlined letters and numbers, to show the direction of strokes used to form the letter or number.
2. Adult checks each letter or number for accuracy.
3. When all letters are filled with accurate arrows, child traces each with index finger, in the direction indicated by the arrows.
4. When all are traced in correct sequence and directions, child turns the paper over and forms the letters or numbers with the index finger, without looking at the model, while saying their names.

Desired Response

Child accurately draws arrows in all parts of letters and numbers to designate the direction in which they are written. Child traces all letters and numbers and forms them from memory, using correct sequence and directions of movement.



Variations and Adaptations

Reproduce papers for use with a group of children or for repeated use.

Have children correct each other's papers by circling outlines that show inaccurate arrows.

After drawing arrows correctly, children apply white glue in the directions shown, either by squeezing the bottle while moving it along the outline or by applying it with a toothpick or cotton swab. Glue hardens to form raised letters or numbers that can be felt with eyes closed, in the correct movement pattern.

Child applies glue as described above and sprinkles sparkles over the sheet. When glue is dry, child shakes paper to remove excess sparkles, leaving a beautiful page of letters or numbers.

Use sand instead of sparkles.

Adapt this activity for learning and memory of movement sequences used for producing common shapes such as circle, square, and triangle.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

ACETATE TRACINGS—LETTER AND NUMBER FORMATION

Purpose

To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

Cardboard, oaktag, or large index cards; marking pen; acetate cover (clear plastic sheets from photo albums work well); grease pencil; paper towel

Preparation

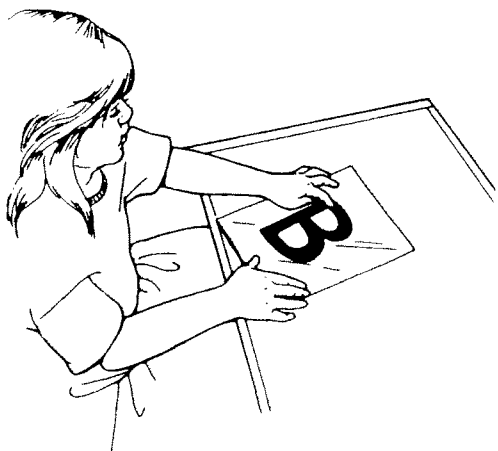
Familiarize yourself with the movement patterns of the letters in use in the child's classroom. Write one letter or number (for all letters and numbers 1-10) on each sheet of cardboard, oaktag, or index card. Write letters and numbers with $\frac{3}{4}$ "-thick lines, exactly as they are being taught in the child's classroom.

Position

Child and adult sit side by side at desk or table.

Procedure

1. Place a sheet with a letter or number on it inside the acetate cover and put it on the table directly in front of child.
2. Child traces the pattern over the acetate using the tip of the index finger.
3. If the sequence of movements is not correct, demonstrate the desired movement sequence by tracing the letter or number over the acetate, using the index finger.
4. Child repeats correct movement sequence using grease pencil.
5. Rub letter off acetate with paper towel; insert a new letter or number.
6. Repeat steps 2-5 with all letters and numbers.



Desired Response

Child produces correct movement sequences for all letters and numbers when presented in alphabetical, numerical, and random order.

Variations and Adaptations

Child says the letter or number names or letter sounds as they are formed.

Adult traces, using correct or incorrect movement sequences; child identifies them as "correct" or "wrong." If incorrect, child demonstrates the correct sequence, then writes it with the grease pencil.

Two children take turns tracing and checking the other's accuracy. Supervise this closely, because incorrect "corrections" can add to the confusion.

Use this technique for teaching movement sequences for common shapes such as circle, square, and triangle.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

COLOR STROKES—LETTER AND NUMBER FORMATION

Purpose

To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

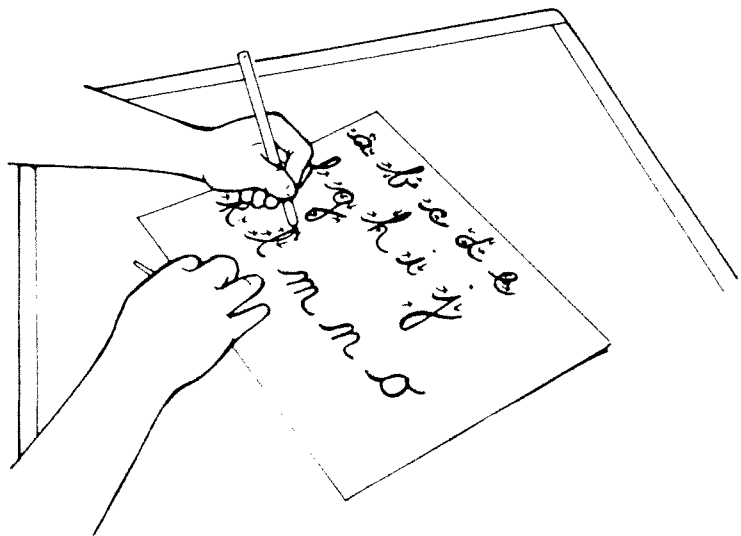
Unlined paper; pencils or markers in four different colors

Preparation

Familiarize yourself with the sequence and directions used for letter formation in the child's classroom. Prepare a strip of paper with desired letters or numbers written on it. Do not include any visual cues about sequence or direction of movements.

Procedure

1. Child looks at models of letters and uses colored pencils to write them, with one color used for each stroke. Child chooses color following these directions:
 - Green used for first stroke
 - Blue for second stroke
 - Yellow for third stroke
 - Red for fourth stroke
2. Adult checks each letter or number for accuracy.
3. When all letters are colored correctly, child adds arrows to indicate the correct direction of strokes.



4. Adult again checks for accuracy.
5. Child traces each with index finger, in the order shown by the colors and directions shown by the arrows.
6. When all are traced in correct sequence and directions, adult removes the visual models (strip with letters and letters just written); child forms the letters or numbers with the index finger, without looking at the models, while saying their names.
7. If letters are formed incorrectly from memory, show the colored letter with arrows; ask child to trace several times with eyes open and again with eyes closed. Encourage child to imagine the colors of the strokes and directions of the arrows.

Desired Response

Child accurately chooses colors and draws arrows for formation of all letters and numbers to designate the order and direction in which they are written. Child traces all letters and numbers and forms them from memory, using correct sequence and directions of movement.

Variations and Adaptations

Have children correct each other's papers, circling letters or numbers that show inaccurate coloring or arrows.

Increase the difficulty of this activity by requiring child to form the letters or numbers using colored pencils without the visual models.

After coloring and drawing arrows correctly, children apply white glue in the directions shown, either by squeezing the bottle while moving it along the outline or by applying it with a toothpick or cotton swab. Glue hardens to form raised letters or numbers that can be felt with eyes closed, in the correct movement pattern.

Child applies glue as described above and sprinkles sparkles over the sheet. When glue is dry, child shakes paper to remove excess sparkles, leaving a beautiful page of letters or numbers.

Use sand instead of sparkles.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY

Classroom and Individual Practice

STROKE SEQUENCE PUZZLES— LETTER AND NUMBER FORMATION

Purpose

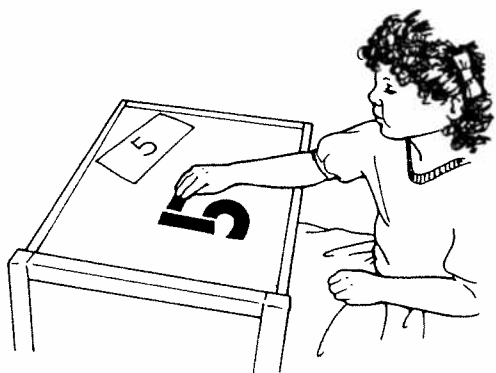
To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

Construction paper or plastic place-mats; glue; scissors; marking pen

Preparation

Familiarize yourself with the sequence and directions used for letter formation in the child's classroom. (See page 432 for a sample of Typical Movement Sequences.) Reproduce the letters on pages 433-434. (Variation: Write large numbers in outline form.) Glue the pages to construction paper or plastic; then cut them out. Cut across letters (or numbers) to divide them into stroke pieces. Put pieces of each letter (or number) into a small envelope and write the letter (or number) clearly on it.



Procedure

1. Adult hands one envelope to child.
2. Child reads the name of the letter (or number) on the envelope and empties the pieces onto the table.
3. Child puts letter (or number) together, placing pieces in the order that strokes are written.
4. If sequence is incorrect, adult asks child to draw the form with finger. If still incorrect, adult demonstrates and child imitates. Child then continues with puzzle.
5. Child traces each completed puzzle with index finger, in the order in which the pieces were placed.
6. Child places each puzzle back in envelope when it is completed successfully. Adult maintains a separate pile of forms which presented difficulty.
7. After replacing envelope in pile, child writes letter (or number) on table top, using index finger.
8. During the next practice session, adult presents only the puzzles which were difficult the previous time.

Desired Response

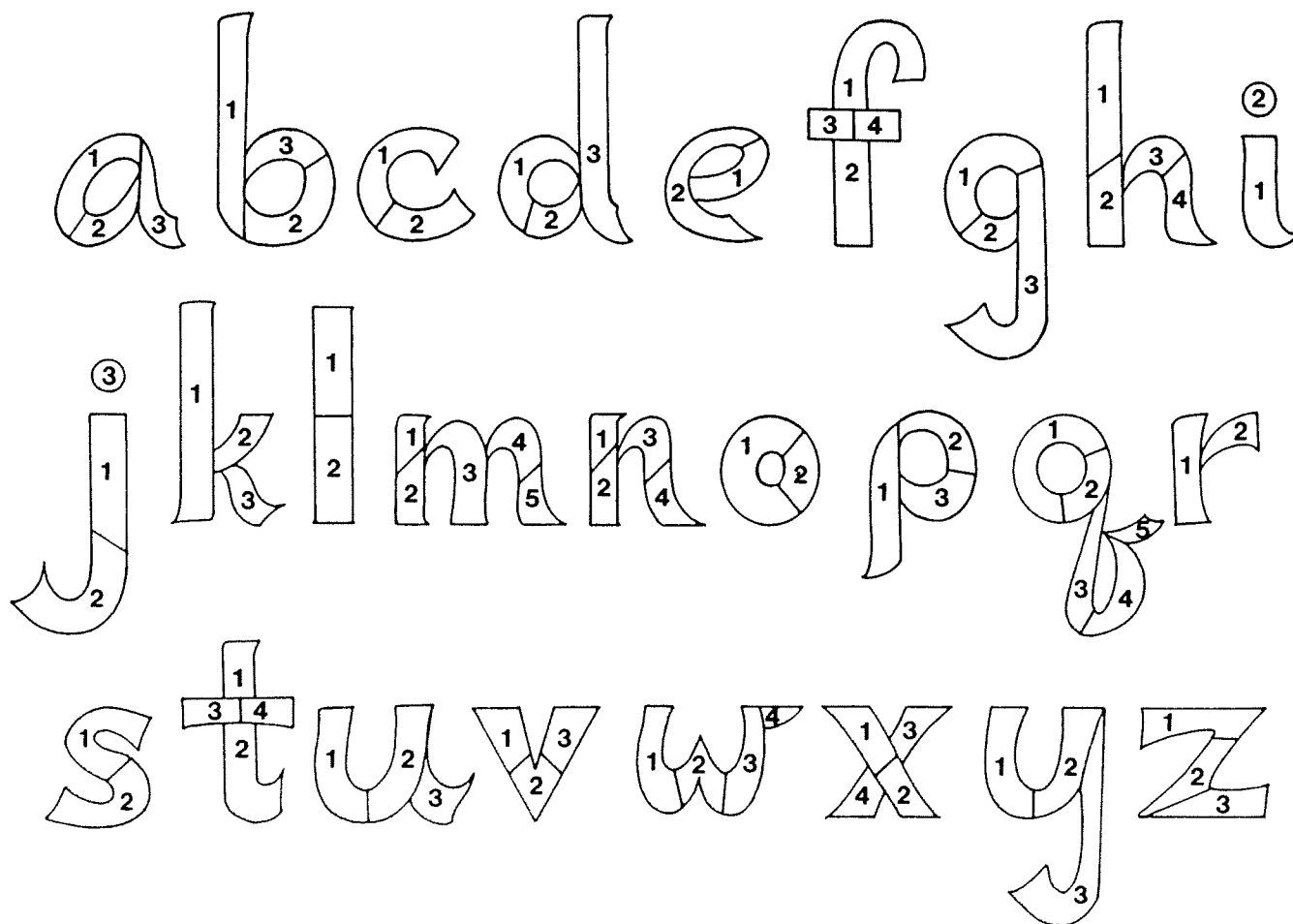
Child accurately places puzzle pieces to designate the order and direction in which the letters (or numbers) are written. Child traces all letters (or numbers) and forms them all from memory, using correct sequence and directions of movement.

Variations and Adaptations

Have child write and cut out letters and numbers. Cutting into stroke pieces is a good activity for analyzing formation sequences.

Children recognize inaccuracies in puzzle placement of other children or intentional inaccuracies made by adult.

If fine motor control is weak, use large puzzles.

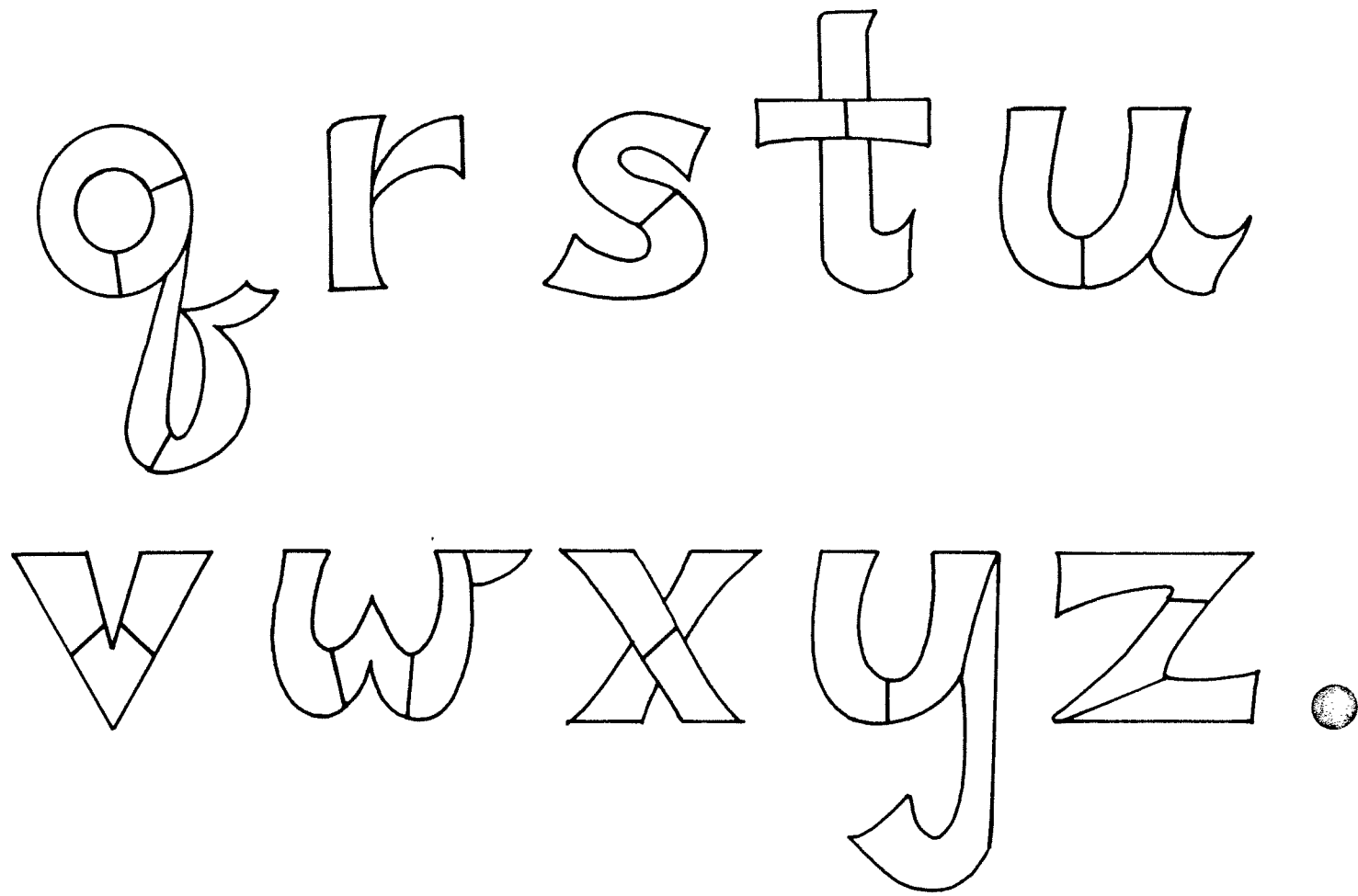
Typical Movement Sequences

Use of these activities should be directed by a qualified therapist.

a b c d e

f g h i j k

l m n o p



Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

RIGHT OR WRONG?—
LETTER AND NUMBER MOVEMENT PATTERN RECOGNITION

Purpose

To improve recall of correct movement sequences of letters and numbers

Materials

Chalkboard and chalk or paper and marker

Preparation

For many children with motor memory difficulty, any writing activity is stressful. Anxiety can increase the difficulty, so encourage the child to "get comfortable, relax, and take a few deep breaths" before beginning. Tell the child that you are going to play a letter game. Familiarize yourself with the movement patterns of the letters in use in the child's classroom.

Position

Child sits in comfortable chair; adult sits next to the child or stands in front of chalkboard, facing the same direction as the child.

Procedure

1. Tell child that you will be forming each letter on the writing surface, and that you will be using correct movement sequences for some and incorrect for others. Child gets one point for each letter identified correctly as the right or wrong sequence, and adult gets one point for each of child's errors.
2. Adult writes each letter slowly, in alphabetical order, using the correct sequence of movements for some and incorrect sequences for others.
3. After each letter, the child identifies the movement pattern as correct or incorrect. Give points as described above.
4. When child accurately describes a sequence as incorrect, ask child to show you the correct sequence with large arm movements in the air or on the desk top (not in writing) while saying the name of the letter.
5. Give additional points for correctly formed letters.



Desired Response

Child recognizes correct movement sequences for all letters when presented in both alphabetical and random order. Correct sequences for formation of numbers are recognized when presented in numerical order or randomly.

Variations and Adaptations

One child forms a letter while the other child tries to get points by identifying correct or incorrect movement sequence.

This can be played as a group activity. Teacher tries to stump the group; the first child to identify and correct the pattern takes teacher's place. Children continue replacing each other until everyone has had a turn.

Repeat for upper-case and lower-case letters and for numbers.

When child can identify correct movement patterns, present letters and numbers in random order. Add a time limit to the child's response to encourage faster recognition.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

DRIVER'S LICENSE GAME—
LETTER AND NUMBER MOVEMENT PATTERNS

Purpose

To improve recall of correct movement sequences of letters and numbers

Materials

Sand on playground or sand table; small toy cars

Preparation

Familiarize yourself with the movement patterns of the letters and numbers in use in the child's classroom. Explain that the child will form ("drive") roads in the sand, in the direction of letters and numbers. Determine how many roads must be driven correctly before the license is obtained.

Procedure

1. Tell the child which road to take ("A," "b," "3," and so on), and to drive the way the letter or number is supposed to be made with a pencil.
2. Child pushes the car in the sand to make the specified letter or number.
3. If the letter or number is made in the wrong sequence, tell child, "The letter looks good but the car was driven in the wrong direction. To get the license, drive it in the right direction."
4. Demonstrate the correct sequence by pushing the car over child's letter in the sand.
5. Child drives over the road again, using the correct sequence.
6. Repeat with all letters and numbers. Provide extra repetition of those which present difficulty.
7. If child has difficulty recalling a movement pattern during classroom writing, ask, "How did you drive the car?"

Desired Response

Child produces correct movement sequences for all letters and numbers when presented in alphabetical, numerical, and random order.



Variations and Adaptations

Have one child drive while another child decides whether the road was driven correctly and, if not, demonstrates the correct direction. This requires adult supervision, because errors in “correcting” the movement pattern can increase confusion.

Have child push car on a sheet of finger-paint paper covered with finger paint, which then is smoothed out after the road is driven correctly.

It helps some children to verbally describe the way they're driving when forming letters and numbers. For example, child says, “The car starts at the top of the road and drives straight to the right (or this way), then down at an angle on road 7.” Other children are confused by this. Try it, and use if it helps.

If sound-symbol association is a problem, encourage child to say the name of each letter or number slowly as it is formed or to make the sound that each letter represents.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

LARGE MOVEMENT SEQUENCES FROM WRITTEN SYMBOLS

Purpose

To improve recall of correct movement sequences for formation of letters and numbers, when visual symbol is present

This skill is important for copying.

Materials

Oaktag or large index cards; marker

Preparation

Prepare large cards or sheets of paper with the alphabet and numbers on them, one letter or number per card. Be sure that the letters or numbers are written in the style that is used in the classroom.

Procedure

1. Stand or sit facing the child. Present a card.
2. Ask child to imagine how it feels to make the letter or number.
3. Child uses large arm movements to form the letter or number in the air, while saying its name.
4. Child repeats formation with eyes closed, paying attention to how the movements feel.
5. If child uses an incorrect movement sequence, demonstrate the correct letter formation, using large arm movements; ask child to try again. Put this card in a separate pile.
6. Repeat with all letters.
7. Repeat cards in the error pile.

Desired Response

Child produces correct movement sequences for all letters and numbers when they are presented visually in alphabetical, numerical, and random order, with increasing speed and accuracy.

Variations and Adaptations

Children enjoy forming letters with fingers in paint or shaving cream on finger-paint paper. Paint or cream can be smoothed over for the next letter.



Child uses a stick to write letters in sand in a sand table, at the beach, or on the playground.

When working on cursive letters, child forms letters connected with one long, flowing, rhythmic movement.

It helps some children to use verbal cues to remember how to form the letter. Most handwriting systems include verbal descriptions that can be recited as the letters or numbers are formed. For example, from the D'Nealian approach, for the letter s, "Curved start, around left, and a snake tail" (Thurber 1986).

This activity can be adapted for classroom use. Teacher stands facing class and shows card. Children use large arm movements to form the letter, while repeating the name in unison. If anyone in the group uses a different movement pattern, teacher demonstrates the correct sequence (turning to face the same direction as the children), then repeats the card until all children form it correctly. Children take turns leading the class.

Children stand in lines, one behind the other, and form letters with arm movement beside their bodies. Form separate lines for right- and left-handed children, with lefties forming their letters to the left of their bodies. Each child can see the patterns of the other children, and immediate feedback is provided if errors are made.

Children with weak visualization skills sometimes find this activity more difficult than remembering the movement pattern when the letter is presented verbally. If so, present the card and say the letter name at the same time. Phase out use of the letter names as skills improve.

Reference

Thurber, D. N. 1986. *D'Nealian home/school activities manuscript practice for grades 1-3*. Glenview, IL: Scott, Foresman and Company.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

LARGE MOVEMENT SEQUENCES FROM LETTER OR NUMBER NAMES

Purpose

To improve recall of correct movement sequences for formation of letters and numbers when they are presented by name

Preparation

Familiarize yourself with the movement patterns of the letters and numbers in use in the child's classroom.

Procedure

1. Stand next to child, facing same direction.
2. Say a letter or number, and ask child to imagine how it feels to make it.
3. Child uses large arm movements to form the letter or number in the air, while saying its name.
4. Child repeats formation with eyes closed, paying attention to how the movements feel.
5. Repeat with the entire alphabet.
6. If child uses an incorrect movement sequence, demonstrate the correct letter formation, using large arm movements; ask child to try again.
7. Record the letters that present difficulty, and return to them throughout the activity.

Desired Response

Child produces correct movement sequences for all letters and numbers when presented in alphabetical, numerical, and random order, with increasing speed and accuracy.

Variations and Adaptations

Children enjoy forming letters with fingers in paint or shaving cream on finger-paint paper. Paint or cream can be smoothed over for next letter.

Child uses a stick to write letters in sand in a sand table, at the beach, or on the playground.



Children use arm movements to form letters on table top, carpet, or other textured surface.

When working on cursive letters, child forms letters connected with one long, flowing, rhythmic movement.

It helps some children to use verbal cues to remember how to form the letter. Most handwriting systems include verbal descriptions that can be recited as the letters or numbers are formed. For example, from the D'Nealian approach, for the letter s, "Curved start, around left, and a snake tail" (Thurber 1986).

This activity can be adapted for classroom use. Teacher stands facing class and names a letter or number. Children use large arm movements to form the letter, while repeating the name in unison. If anyone uses a different movement pattern, teacher demonstrates the correct sequence (turning to face the same direction as the children), then repeats the letter until all children are forming it correctly. Children take turns leading the class.

Children stand in lines, one behind the other, and form letters with arm movement beside their bodies. Form separate lines for right- and left-handed children, with lefties forming their letters to the left of their bodies. Each child can see the patterns of the other children, and immediate feedback is provided if errors are made.

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Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice

BILATERAL ALPHABET AND NUMBERS

Purpose

To improve learning and recall of correct movement sequences for formation of letters and numbers

Materials

Oaktag or large index cards; markers

Preparation

Make cards, clearly writing one letter or number per card, written exactly as they are being taught in the classroom.

For many children with motor memory difficulty, any writing activity is stressful. Anxiety can increase the difficulty, so encourage child to "get comfortable, relax, and take a few deep breaths" before beginning. Familiarize yourself with the movement patterns of the letters in use in the child's classroom.

Position

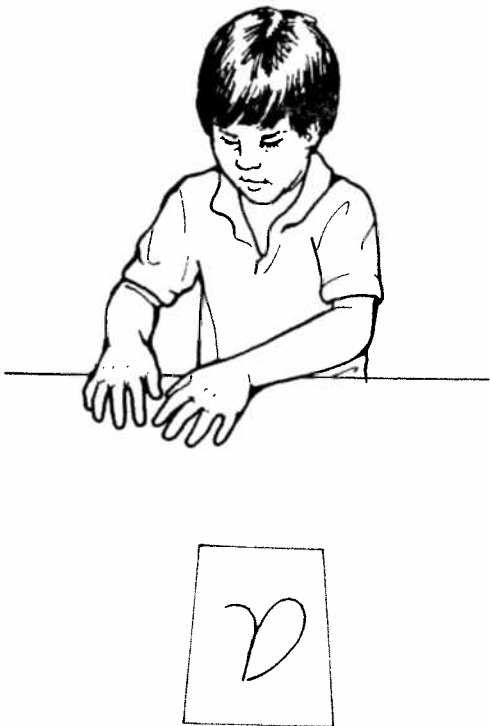
Child sits with both hands, palms down, on table or desk top.

Procedure

1. Adult places the card for the letter "a" or number "1" on the desk immediately in front of child's hands. Adult demonstrates the correct movement sequence, using large hand movements on the table top.
2. Child moves one hand smoothly on the table top to form the letter or number on the card. If the sequence is incorrect, adult again demonstrates the correct sequence until child forms it accurately.
3. Child repeats the formation sequence with the other hand.
4. Child repeats the movement pattern, using both hands at the same time.
5. Adult presents the next card.

Desired Response

Child produces correct movement sequences for all letters and numbers when presented in alphabetical, numerical, and random order, using either or both hands.



Variations and Adaptations

Adult presents letters verbally instead of visually, or presents alternately.

Child says the letter or number names as they are formed.

Child looks at card, not hand, while forming letters or numbers.

This activity can be adapted for learning sequences for common shapes such as circle, square, and triangle.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice
FINGER WRITING

Purpose

To improve recall of correct movement sequences for formation of letters and numbers

Materials

Desk or table top

Preparation

For many children with motor memory difficulty, any writing activity is stressful. Anxiety can increase the difficulty; so encourage the child to "get comfortable, relax, and take a few deep breaths" before beginning. Familiarize yourself with the movement patterns of the letters in use in the classroom.

Procedure

1. Child sits with dominant hand on table or desk top.
2. Child holds hand still and uses small movements of the index finger to form numbers or the alphabet, in order, without looking at hand. Eyes may be closed if this is difficult. Adult encourages rapid, smooth movement.
3. Adult observes how letters or numbers are formed and records those which cause hesitation or are formed incorrectly. The time also is recorded.
4. Adult asks child to imagine how to form each letter that was formed incorrectly, and demonstrates the correct pattern; child repeats several times.
5. Adult says letters or numbers in random order; child forms them as quickly as possible, again using index finger movement. Formations which previously caused hesitation or were incorrect are repeated several times between other letters or numbers, until they are consistently formed accurately.
6. At the end of each session, child repeats Step 2, and adult records performance. Adult and child review progress and letters which still cause difficulty.

Desired Response

Child produces correct movement sequences for all letters and numbers in alphabetical, numerical, and random order, using index finger movements only, with increasing speed and automaticity.



Variations and Adaptations

If child has difficulty remembering the sequence of the letters in the alphabet, adult says letters while child forms them.

For children who have difficulty with control of isolated finger movement, activity is performed with all fingertips on the table top and whole-arm movement.

When working on cursive letters, child forms letters connected with one long, flowing, rhythmic movement.

Children can practice this activity alone at any time, such as on the bus or while waiting at the bus stop. Child moves index finger in the air or against available surfaces and tries to increase speed and fluidity of movement. Before suggesting this, make sure child is forming letters using correct sequences consistently.

This activity can be used for memory of movements required for forming common shapes, such as circle, square, and triangle.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice
MENTAL REHEARSAL

Purpose

To improve recall of correct movement sequences of letters and numbers

This exercise is good for children who can usually produce letters using correct movement patterns, but are slow and hesitant and sometimes forget how to make letters.

Materials

Paper; pencil

Preparation

Familiarize yourself with the movement patterns of the letters and numbers in use in the classroom. Before beginning this activity, take a sample of the child's written alphabet. Record the time and the letters that cause hesitation or are formed incorrectly. Writing activities are often stressful for children with weak motor memory, and anxiety interferes with memory, so take a few minutes to encourage the child to relax before beginning.

Position

Child sits in a comfortable chair with eyes closed; adult sits nearby with pencil and paper.

Procedure

1. Instruct the child to "keep eyes closed and see the letters in your head" (or "on the insides of your eyelids") as they are heard. Say a few letters and ask whether child can imagine them.
2. Ask whether child can see how the letters are formed, as if "tracing them with the eyeballs." Some children can do this better if they imagine their dominant index fingertip tracing the pattern. After a little practice, most children can do this easily. If unable to visualize, child should be encouraged to imagine how the movement sequences feel.
3. Instruct child to imagine how the letters are formed (either how the formation sequences look or how they feel, or both) as you say them, and to say each letter out loud as its formation is imagined.



4. If child hesitates before or during saying the letter out loud, ask if that's a difficult letter. Check by having child form the letter for you on the table top or in the air. If the letter causes hesitation or is formed incorrectly, record it on your paper.
5. Repeat with the entire alphabet, recording letters that present difficulty.
6. End the exercise by repeating the letters which you have recorded.
7. At the end of each session, child writes the letters in alphabetical order on paper and adult records time and letters which presented difficulty. Point out progress.

Desired Response

Child produces movement sequences for all letters and numbers when presented in alphabetical, numerical, and random order, with increasing speed and accuracy.

Variations and Adaptations

Begin by saying letters and numbers in alphabetical or numerical order. Progress to random presentation as skills improve.

Record child's time when imagining the tracing of letters in alphabetical order. Repeat, and have child try to increase speed.

When working on cursive letters, have child imagine letters connected with one long, flowing, rhythmic movement.

Have child mentally rehearse letter and number formations any time and anywhere, such as on the school bus or while relaxing in the bathtub.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

MOTOR MEMORY
Classroom and Individual Practice
WORD MOVEMENT SEQUENCES

Purpose

To improve recall of correct movement sequences for formation of letters when combined to form words

Materials

Index cards; pencil and paper

Preparation

Familiarize yourself with the sequence and directions used for letter formation in the classroom. On index cards, write words with two, three, four, and more letters. Write one word on each card. Choose words that are appropriate for child's reading level. Copy them in manuscript or cursive, whichever form is being practiced.

Position

Child is seated at desk; adult sits at child's side, facing same direction.

Procedure

1. Adult presents card with two-letter word.
2. Child reads the word out loud.
3. Child uses large arm movements to form the word on the table top, saying the name of each letter as it is formed.
4. Child uses movement of only the index finger on the table top to write the word, saying each letter out loud as it is written.
5. Child repeats Step 4 with eyes closed.
6. Child writes the word with pencil.
7. When errors are made, adult demonstrates correct movement sequence; child imitates. Card is placed in separate pile for future repetition.
8. Adult presents next card.
9. When all two-letter words are copied accurately with consistency, present three-letter words. When these are completed accurately, move on to words with four or more letters.

Desired Response

Child copies all words, using correct sequence and directions of movement.

Variations and Adaptations

Children work in pairs, with one helping the other by recognizing errors of formation and demonstrating correct movement sequence. Children reverse roles at regular intervals. Adult observes closely to prevent incorrect "corrections."

Child uses this method for practicing spelling words. Final step is turning card over and writing the word that has been practiced from memory.

When learning cursive, focus on how some letters change form for connection to some other letters. For example, when letters *e*, *r*, or *s* follow letters *b*, *o*, *w*, or *v*, their form must be altered so they will connect. Children often try to start *e*, *r*, and *s* at the baseline, as the letters were originally learned. This makes connection awkward or impossible.

Use of these activities should be directed by a qualified therapist.

Child's Name _____

Date _____

**MOTOR MEMORY
Compensatory Strategies**

CLASSROOM CONSIDERATIONS

Purpose

To improve child's ability to recall specific motor patterns for writing letters or numbers

Strategies

1. When child is learning how to write new letters or numbers, be sure to observe the act of writing for each one, and give immediate feedback when they are formed in the wrong sequence or direction. It is important for the child with weak motor memory to learn and repeat one consistent movement pattern for each letter and number so that it will become more automatic than a pattern that looks right but is formed differently each time.
2. Make sure that use of correct movement patterns for all letters is a goal of the child's early handwriting training. These may not be as important for printing, but they are essential for smooth connections in cursive writing.
3. Demonstrate how to make letters, and stress how the movements feel as much as how the letters look. Tracing and copying tasks can be practiced incorrectly; and because the letters look perfect, the child will be unaware of any error. It is very important to help the child establish correct, consistent movement patterns for forming letters and numbers while they are first being learned. Inaccurate patterns are hard to change in later years and can make cursive handwriting very difficult.
4. Incorporate repetition of movement sequences for letters and numbers into classroom activities. The child with weak memory of movement patterns may need much more repetition than most children before the movements can be recalled accurately.

Many activities can be devised for repeating movement sequences without using a writing implement. Have child write with arms or fingers in the air, with fingers on table top, with a stick in sand, with both hands together, with one hand and then the other. Have child imagine writing letters, write in air while saying letter out loud, and write on desk with eyes closed.

Have child practice spelling words by "writing" them as described above.



Have child (or children) show how to make a letter (or word) correctly as the password for going out to recess. The letter can be made on the palm of the teacher's hand. Change the password letter daily.

5. Teach one letter form, and change as little as possible during the transition to cursive. Because this child has difficulty learning movement patterns, choose a handwriting program that teaches only one letter form, which is later connected for cursive writing. The D'Nealian handwriting program (Thurber 1981) is a good example. This program teaches manuscript letters that are basically the same as cursive, without the connections. This approach minimizes the number of movement sequences that must be learned and remembered.
6. Use a consistent handwriting method throughout the child's educational program. Adoption of one method by the school system (or the district) is ideal, so that as the child progresses through the grades, the movement sequences (and appearance) of the letters taught will be the same. If the child moves to a new school, find out what method of handwriting is being taught there and try to ensure that the child can continue with the original method.
7. It helps some children to recall movement patterns for letters that have been taught in kinesthetically similar groups. This means that letters are grouped according to the kinds of strokes that are used. For example, the kinesthetic writing system described in *Loops and Other Groups* (Benbow 1990) groups cursive letters, *n, m, v, y, x, and z*, and calls them "hills and valleys."
8. Verbal strategies aid learning and recall of movement patterns for letters for some children.

Many writing systems include auditory instructions that are presented as the letter formation is demonstrated, then repeated by the child as the letter is formed. An example from the D'Nealian program (Thurber 1981) is: "Around, down, up, and close" which accompanies formation of the letter *o*. If the program which you are using does not have verbal descriptions, make up your own, but be sure to make them simple and use the same description consistently.

Verbal strategies that describe similarities or differences between unknown and familiar movement patterns often aid recall. For example, to assist recall of formation of cursive letter *k*, teach the child that "*k* is like an *h*, with a kick instead of a hump."

9. When teaching cursive, focus on how some letters change form for connection to some other letters. For example, when letters *e, r, or s* follow letters *b, o, w, or v*, their form must be altered so they will connect. This requires children to use a new movement

Child's Name _____

Date _____

MOTOR MEMORY
Compensatory Strategies

CLASSROOM MODIFICATIONS AND ADAPTATIONS

Purpose

To improve child's ability to express ideas or demonstrate knowledge by minimizing the need for accurate recall of specific motor patterns for writing letters or numbers

Strategies

1. Teach the child to use a keyboard for typing and word processing. These bypass recall of letter formation and enable the child to focus attention on more important features of the activity, such as rules of punctuation and content. Make every effort to ensure that the child has adequate instruction and access to a computer as much as possible.
2. Cursive writing may be more difficult for this child to learn and to use than it is for most children. Cursive words are thought to be recalled as one long, complex movement pattern; while printed words consist of several shorter and more simple patterns (one for each letter), making them easier to recall and produce quickly.

Provide extra time and practice while this child is learning cursive letter formations and connections.

Consider allowing the child to use manuscript writing exclusively if, after considerable exposure to cursive, the child strongly prefers printing.

If the decision is made to continue teaching the child cursive writing, allow manuscript when the child's knowledge is being tested or when attention to the content is the top priority.

3. If learning or recall of letter formations is difficult, consider eliminating upper-case cursive letters. These are rarely used, relative to lower-case cursive letters, and manuscript capitals can be substituted easily. Many adults naturally use a combination of manuscript and cursive writing forms.
4. As with any fine motor problem, if the mechanics of handwriting are interfering with the child's ability to express thoughts or demonstrate knowledge, consider alternate means of expression, such as testing the child verbally, allowing another child to act as a scribe by writing down what the child says, encouraging the child to bring work home for typing or to be typed by a parent, and allowing the child to use a word processor for assignments.

5. Because this child's writing is often slow and laborious, consider reducing writing requirements and allowing more time.
6. Encourage the child to write legibly but not to worry about the appearance of the written product during writing assignments for which the content material is the priority. During classroom time that is devoted to mechanics of handwriting (penmanship), encourage the child to check written work for errors by reading it to see if incorrect letters were substituted, and to erase errors completely.
7. Write model letters on a strip of paper. Tape it across the top of the child's desk. Show the correct letter formation, with numbers to indicate order of strokes, and arrows for direction. This will assist with writing when letters cannot be recalled from memory.

Use of these activities should be directed by a qualified therapist.