

A close-up photograph of a hand holding a compass, drawing a circle on a piece of paper with a grid. The hand is positioned in the center-right of the frame, and the compass is held in a way that it is actively drawing a line. The background is a light-colored surface with a grid pattern, and the overall lighting is bright and even.

# Fine Motor Development

## Chapter 11

*“Typically, fine movement involves the coordination of the use of the eyes and hands together” . . . But what about the child who cannot see, or the soccer player requiring fine motor control of the foot?*

# Fine Motor Movement

- Movements that are predominantly produced by the small muscles or muscle groups in the body
- Does fine motor movement involve hands and eyes only?
- Non-hand fine motor movement can be developed

# Assessing Fine Movement

- Tools for assessment of fine motor development have many problems
  - Some lack clear performance criteria
  - Some contain incomplete and/or “old” norms

# Assessing Fine Movement

- Noller and Ingrisano (1984) conducted a study to determine the attainment of various fine motor skills
  - Emergence times are similar to the established norms
  - Achievement times varied considerably to the established norms

# Assessing Fine Movement

- Conclusion: All the data available are fine for rough indications of fine motor emergence and attainment
- However, there are still many discrepancies

# Categorizing Manipulation

- *Manipulation* is the use of the hands
  - Involves intrinsic and extrinsic movements
  - *Intrinsic movements* are coordinated movements of the individual digits used to manage an object in the hand
    - Handwriting—writer manages the pen to write a letter
  - *Extrinsic movements* displace the hand and the in-hand object via upper limb movement
    - Handing the written message to a coworker

# Example of Intrinsic Movement ~ Handwriting





# Categorizing Manipulation

- *Simple synergies* involves all hand movements in which the action of all the digits is similar
  - Squeezing a rubber ball
  - Pinching
  - Dynamic tripod

# Categorizing Manipulation

- *Reciprocal synergies* are combinations of movements involving the thumb and other involved digits reciprocally and simultaneously interacting to produce relatively dissimilar movements
  - Flexion of the fingers as the thumb extends
  - Twiddling of the thumbs
  - Rolling a pencil between thumb and forefinger

# Categorizing Manipulation

- *Sequential patterns* involve a specific sequence of hand movements toward a goal
  - These patterns are not simultaneous
  - Tying a knot
  - Unscrewing a lid
  - Squeezing a tube of toothpaste

# Development of Prehension

- *Prehension* applies specifically to the act of grasping
  - Approaching, grasping, releasing
- This is a critical hand movement for later movement development
- Classic study: Halverson (1931) described the early reaching and grasping of 4- to 13-month old infants

# Development of Prehension

- Halverson chronicled the process of prehension
  - The object is visually located
  - The object is approached
  - The object is grasped
  - The child disposes of the object by releasing it

# Development of Prehension

- Halverson recorded 3 basic methods of reaching
  - Sweeping the hand and arm in a backhand manner toward the object
  - Indirect or circuitous method which involves approaches from various angles
  - Direct reach, evident in motorically mature children

# Development of Prehension

- Halverson noted a proximodistal pattern of development
  - Movement ability progressed in a direction away from the body
- Halverson observed a gradual increase in the movement's speed and efficiency with age (16-52 weeks)

# Development of Prehension

4 months	Incapable of making contact with an object
5 months	Ability to contact crudely; inability to acquire the object
5 months	“primitive squeeze”
6 months	“squeeze grasp” – clumsy and unsuccessful
7 months	“hand grasp”
7 months	Thumb opposition
8 months	“superior palm grasp”
9 months	“inferior forefinger grasp”
13 months	“forefinger grasp”
13 months	“superior forefinger grasp”

Halverson's 10 stages of grasping

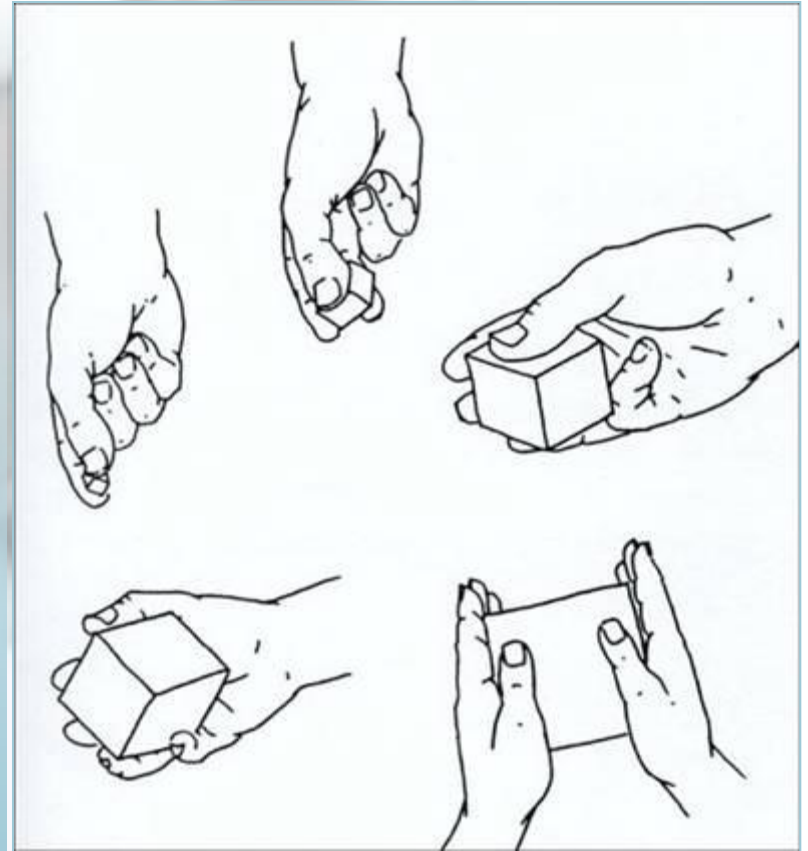


# Alternate View of the Development of Prehension

- Newell, Scully, Tenenbaum, and Hardiman (1989)
  - Adult and child reaching and grasping were examined
  - Explained some concerns for methods used in Halverson study

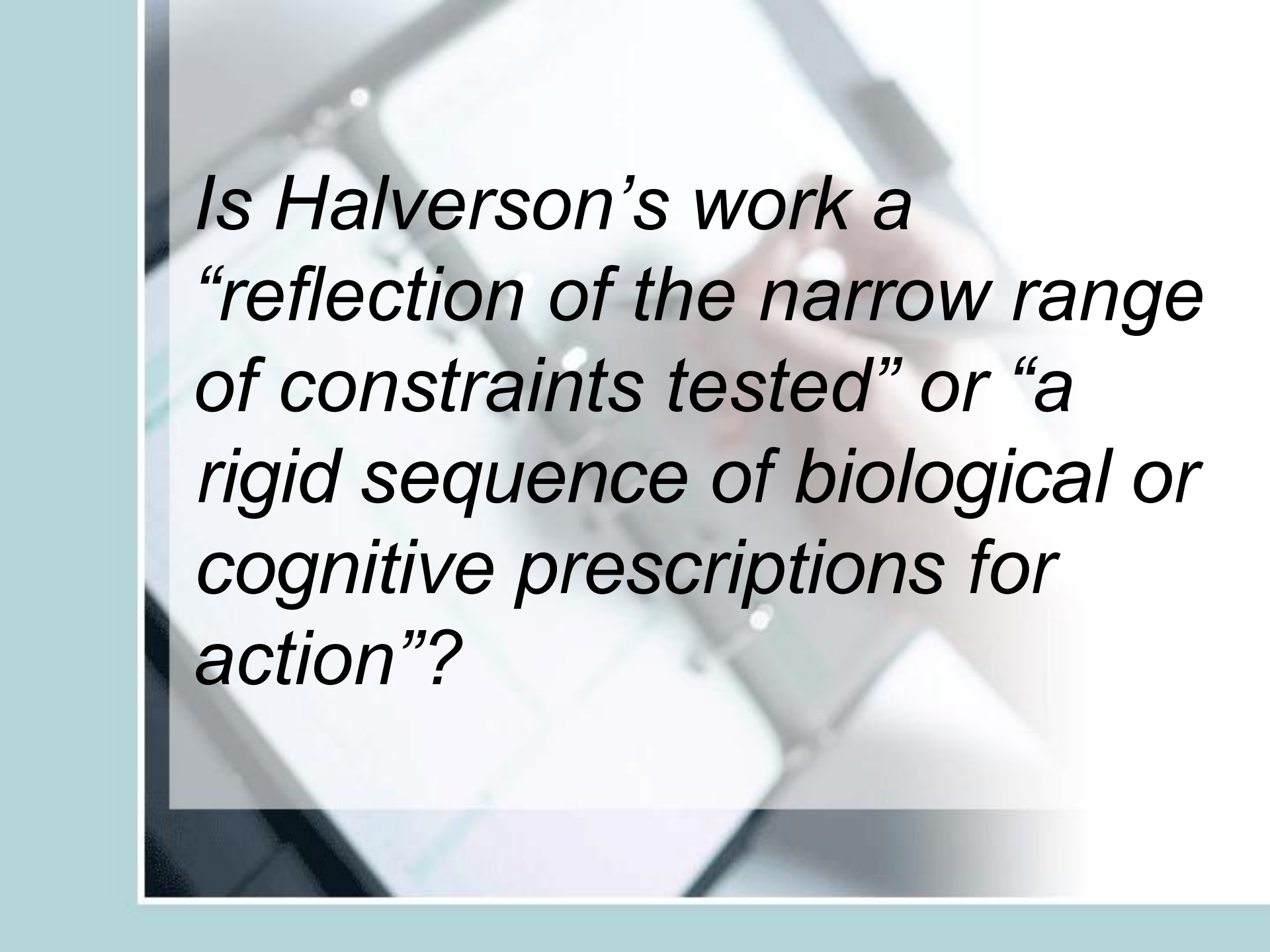
# Alternate View of the Development of Prehension

- Object size plays a role in grip patterns
- In contrast to Halverson, developmental progression may be more flexible than previously noted



# Alternate View of the Development of Prehension

- Other researchers have observed
  - Children open their hands wider than adult reachers
  - Children are more variable in their reach-to-grasp
  - Grip formation is not mature by 6-7 yr
  - Children rely on vision in reaching



*Is Halverson's work a  
"reflection of the narrow range  
of constraints tested" or "a  
rigid sequence of biological or  
cognitive prescriptions for  
action"?*

# Exploratory Procedures and Haptic Perception

- *Haptic perception* is the ability to glean information from objects by manipulation
  - Temperature
  - Size
  - Texture
  - Weight
  - Shape

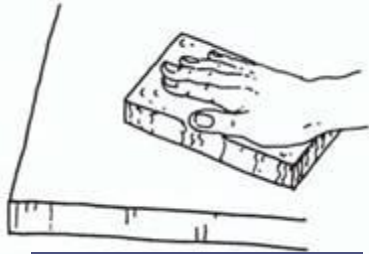
# Exploratory Procedures and Haptic Perception

- The emergence of haptic perception appears to be closely linked to one's ability to perform certain hand movements
  - Exploratory procedures ~ lateral, alternate rubbing motions to determine texture, unsupported holding to determine weight

# Exploratory Procedures and Haptic Perception

- Manipulation is integral to the emergence of haptic ability
- Haptic sensitivity occurs in a predictable sequence

# Exploratory Procedures and Haptic Perception



Static Contact

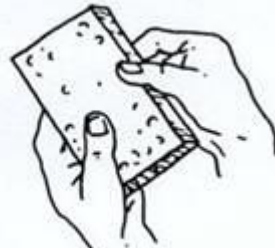
Enclosure



Unsupported Holding



Contour Following



Optimal hand movement patterns for acquiring object properties



Lateral Motion

Pressure





# Exploratory Procedures and Haptic Perception

Birth – 3 months	4 months	9-10 months
<ul style="list-style-type: none"><li>•Babies clutch object with fist</li><li>•Palmar grasp</li><li>•Sufficient to detect haptic qualities of an object</li></ul>	<ul style="list-style-type: none"><li>•Wider variety of hand movements</li><li>•Visual control of manipulation</li><li>•Exchange object from hand to hand</li></ul>	<ul style="list-style-type: none"><li>•Two-handed manipulation easy (baby can sit)</li><li>•One hand can position while the other hand explores</li></ul>

Bushnell & Boudreau (1993) ~ 3 phases of object manipulation

# Writing

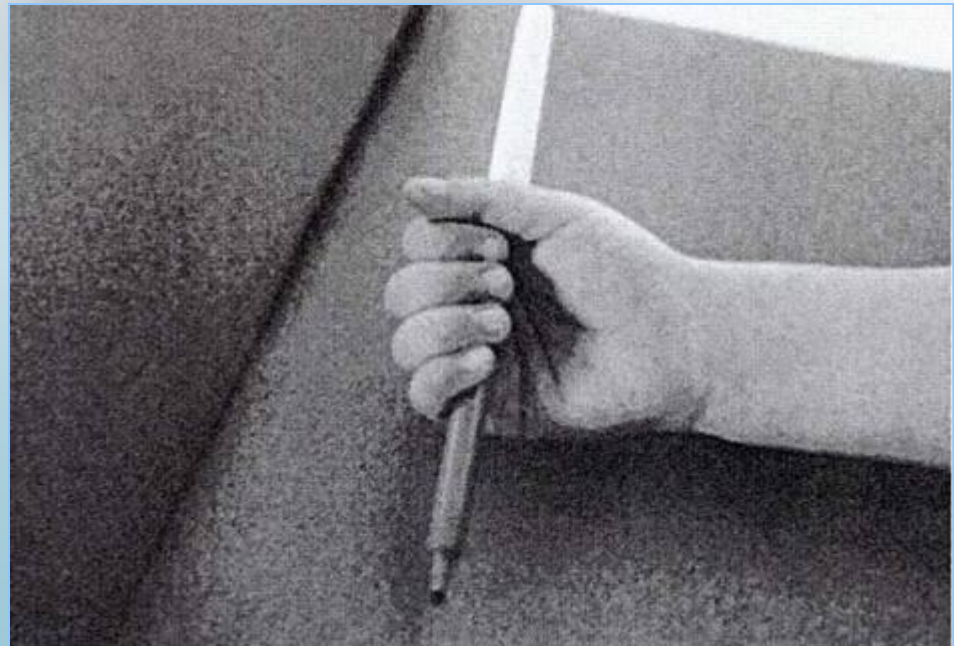
- There is a sequential development of movement technique for manipulation of writing or drawing implements (pencils, crayons)
- The development is universal
- The rate of acquisition of the stages of movement ability varies

# Writing

- Develops between 2 to 6 years of age
- As writing ability develops, the hand moves closer to the tip of the pencil
- At first, children hold the pencil away from the tip and movements come from the shoulder
- Later, the elbow produces more movement
- Finally, the fingers and thumb gain control (*dynamic tripod*)
- Mature writing pattern observed by 7 yr

# Holding a Writing Implement

- *Supinate grasp*
- 1<sup>st</sup> stage in holding a writing implement
- Involves all four fingers and thumb wrapped around pencil in a fist



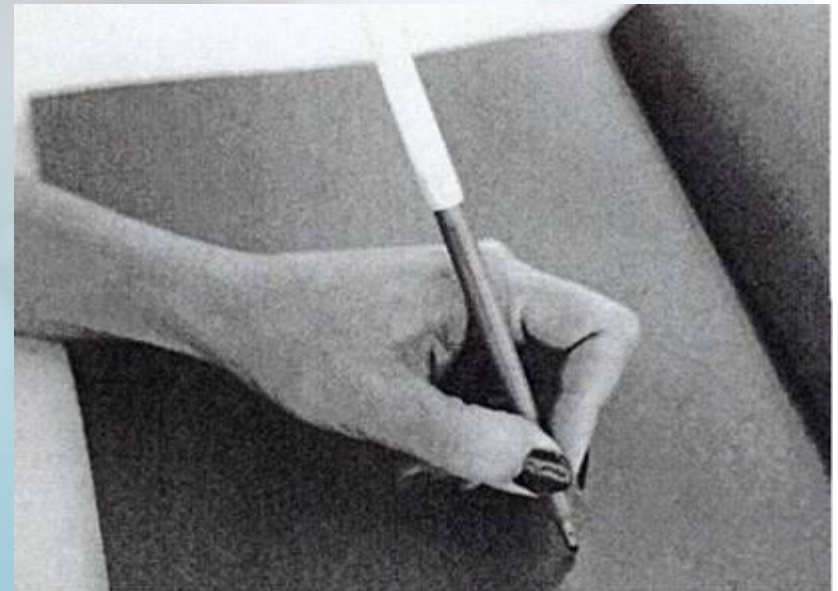
# Holding a Writing Implement

- *Pronate grasp*
- 2<sup>nd</sup> stage in holding a writing implement
- Palm-down hand position



# Holding a Writing Implement

- The *dynamic tripod*
- The third and final stage of holding writing implement
- Present by age 7 yr



# Holding a Writing Implement

- As children advance in handwriting there is an increase in
  - Upright posture
  - Trunk and hand stability
  - Hand is better positioned in line with the forearm
  - Forward lean of trunk

# Holding a Writing Implement

- Yakimishyn & Magill-Evans (2002) observed children had a more mature manner in holding a writing implement if the object was short (crayon vs. long pencil)
- These researchers also found a more mature pattern of writing when children wrote on a vertical surface (easel)



# Cross-cultural Comparison of the Dynamic Tripod

- Japanese children attain the dynamic tripod by 35 months
  - Children learn to use chopsticks early in life
- British children attain the dynamic tripod at age 48 months
- Cultural factors?

# Cross-cultural Comparison of the Dynamic Tripod

Stage 1	Palmar grasp Movement from elbow and shoulder
Stage 2	Incomplete tripod
Stage 3	Tripod position with extensive wrist movement No finger coordination
Stage 4	Dynamic tripod Finger coordination

Developmental writing stages in Japanese children

*Could the use of convenient devices (electric toothbrushes, pencil sharpeners, push-button devices) decrease cultural differences in the stages and ages at which a child learns to manipulate a writing implement?*

# The Dynamic Tripod

## From 6 to 14 years

- The age of changing from the immature to mature characteristics of both the finger flexion and the forearm positioning was found to be approximately 10 years
- In general, the dynamic tripod does continue to be refined between the ages of 6 and 14 years

# Drawing and Writing: Movement Products

- Children learn to draw before they attempt to form the letters of the alphabet
- Drawing stages follow a definite progression, but the specific age norms for drawing are not easy to determine

# Drawing and Writing: Movement Products

- Drawing is partly a function of mental age
  - Children with brain injury (lower mental age) will have difficulty drawing compared to peers
  - Children with lower mental age display immature drawings because the brain sends conflicting stimuli to the hand

# Drawing and Writing: Movement Products

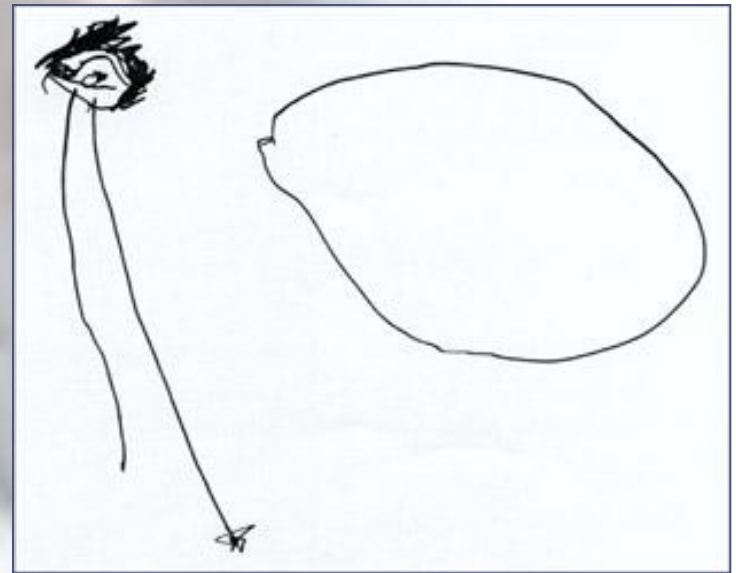


(Kellogg, 1969)

- Four major stages of drawing development as determined by the product of the act of drawing
- Stage 1: *scribbling stage*
  - May occur by accident

# Drawing and Writing: Movement Products

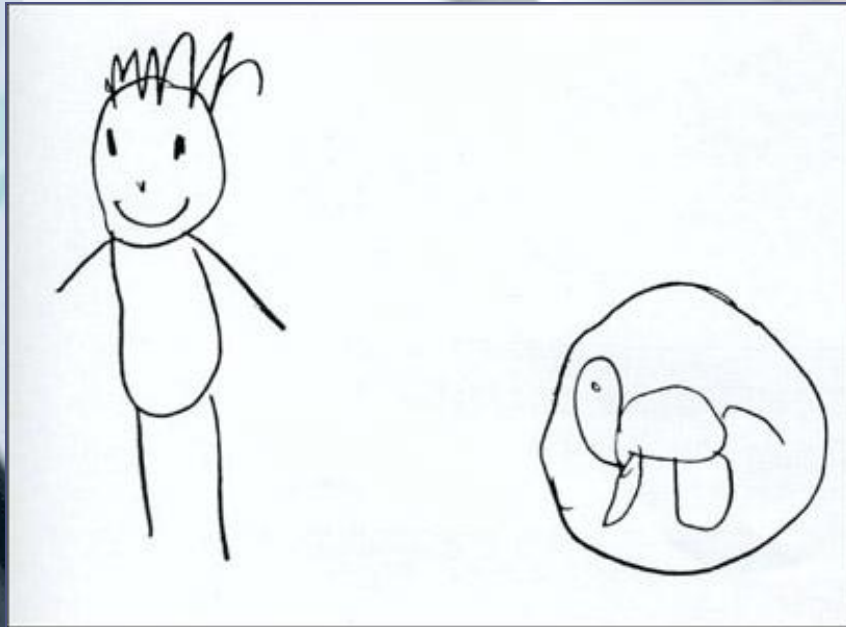
- Stage 2: *combine stage*
  - Construction of diagrams, geometric figures, and combinations of shapes
  - Eventually shapes form some familiar object; a house, etc.



(Kellogg, 1969)



# Drawing and Writing: Movement Products



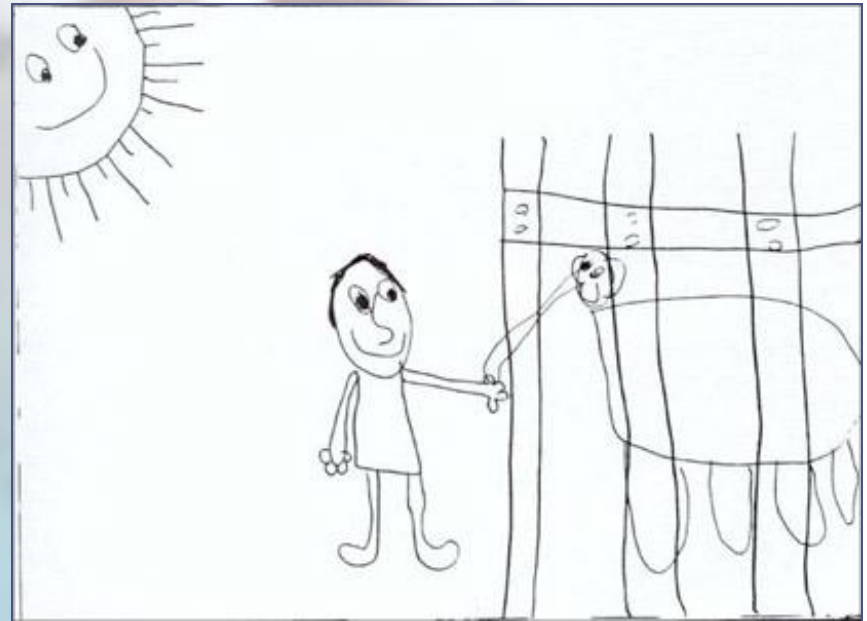
(Kellogg, 1969)

- Stage 3: *aggregate stage*
- Child combines diagrams and figures in combinations of three or more
- More complex drawings can be created

# Drawing and Writing: Movement Products

- Stage 4: *pictorial stage*
- Pictures are drawn with more precision and complexity
- Compare this human form to the previous drawing

Drawn by an 8-9 year-old child

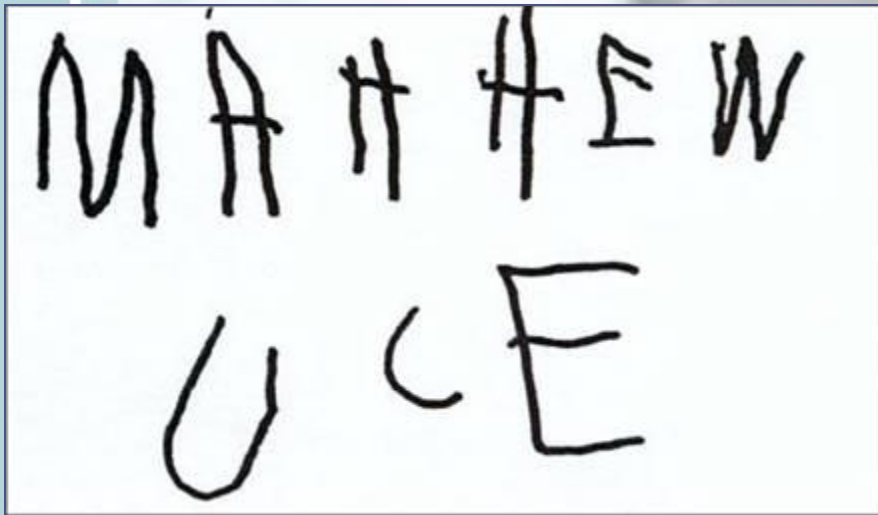


(Kellogg, 1969)

# Drawing and Writing: Movement Products

- Home environment is one of the most important factors affecting the level of drawing development
  - Child observes others drawing
  - Availability of writing implements
  - Drawing skills develop earlier

# Handwriting: The Product



Letters a child forms when approximately 4 years old  
Uppercase, large, unorganized

- Handwriting is preceded by the initial attempt at drawing
- The letters a child forms when 4 years of age are often uppercase, large, and unorganized on a page

# Handwriting: The Product

- By 5 yr., the child has mastered name printing
- By 6 yr., child prints large letters, but smaller than a 5 year old
- By age 7yr., children are able to write much smaller letters and can print lowercase letters effectively

# Handwriting: The Product

- Children in the 2<sup>nd</sup> grade can master uppercase letters and printing their name
  - Lowercase letters continue to be difficult even into the 3<sup>rd</sup> grade
- Spacing between letters is not mastered until the child is 9 years old

# Finger Tapping

- An important indicator of fine motor coordination
- Used to diagnose neurological difficulty

# Finger Tapping

- Finger-tapping tasks are categorized into repetitive and successive movements
  - Repetitive – repetitions of the same movement (thumb and finger tapping together) as rapidly as possible
  - Successive – a series of similar movements performed rapidly (thumb then finger tapping)



# Finger Tapping

- Finger tapping improves with age
- Girls out-perform boys (kindergarten through 2<sup>nd</sup> grade)
- Speed and coordination of performance occur over the first years of life
  - Plateaus at 8 to 10 years of age
  - Training increases tapping speed, not endurance

# Fine Motor Slowing in Late Adulthood

- Speed and coordination of many fine motor movements plateau in early life
- No major motor changes are observed until late adulthood
  - Degeneration of neurons
  - Arthritis
  - Osteoporosis
  - Reversal of the proximodistal progression

# Fine Motor Slowing in Late Adulthood

- Exceptions
  - Physically fit and/or healthy adults maintain their speed of movement
  - Practice inhibits the slowing process
  - Movement involved in the creation of vocal responses shows fewer signs of slowing

Salthouse, 1985)

# Fine Motor Slowing in Late Adulthood

- Fine motor changes are noted in the later stages of life
- There is a reversal of the proximodistal trend in development
- Neural degeneration may contribute to slowing and decreased coordination
- Physical fitness and practice can attenuate or eliminate the slowing process

“a life of physical activity  
*appears* to play a more  
dominant role in simple  
and discriminate reaction  
time and movement  
time and age”

Spirduso, 1977, p.435