

REACH-to-GRASP MOVEMENTS IN CHILDREN.



HALLIWICK APPROACH FOR POSTURAL CONTROL AND LEARNING.

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Therapy Lecturers

IATF



1st European Conference
on Evidence Based
Aquatic Therapy



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Izmir / TURKEY

Balgova Thermal Hotel



GOALS AT THE END

This workshop will cover:

- Knowledge about postural control framework
- Design target goals. ICF-CY categories influenced by fluidmechanics constraints.
- Knowledge and experience dynamic trunk stability in all directions (from medio-lateral to multidirectional)
- Thinking about randomized learning principles involve
- Halliwick handling techniques to achieve the best safety-challenge ratio?

BACKGROUND. PRE-REQUISITES-COMPONENTS

INTRODUCTION. POSTURAL CONTROL, REACH AND GRASP

SKILLS DEVELOPMENT IN CHILDREN

REQUISITES-COMPONENTS

KINEMATIC FEATURES. ALLOCATION

PROBLEMS IN REACHING AND GRASPING

ASSESSMENT

LEARNING

THEORY

PRACTICE

GOALS AND TARGETS

THERAPEUTIC STRATEGIES IN HALLIWICK

PROPOSALS

OPTIONS&VARIATIONS

BACKGROUND

- Trunk is very active in water. Colado 09, 08. Bressel 12. Berger 07.
 - Main body structure category to be treated in pediatrics in water. Güeita 13.
1. Facilitate arm activity to develop (upper) trunk control. von Hofsten&Woollacott 89
 2. Core Stability/Dynamic Trunk Stability allows activities, so...Develop arm/hand function itself. Reach-to-Grasp Movements in water. Lack of support in aquatic...

PRE-REQUISITES

- Normal Age from 4 months. Mental age to reach.
- Adequate trunk control is not necessary to sit on land or even to walk
- There is good cognition and the children can understand, imitate a bit and concentrate
- Mouth control is good
- Pictograms
- 75% = reaching to grab (food and bring it back to the mouth)
- 25% = supporting / equilibrium reaction / gesticulation: signs, symbols, copying / clapping or rubbing hands

INTRO .DEFINITIONS

POSTURAL CONTROL. Anticipation&adaptation. Anticipatory Postural Adjustments (APAs)

Kandel 2000.

REACH TRUNK TRANSPORT

GRASPING

Shumway-Cook&Woollacott 2007.

MANIPULATION

POSTURAL CONTROL

- Every action or movement we make is embedded within a framework of postural support (Gahery & Massion, 1981; Reed, 1989).
- Forward movement of the arm during a reach, typically prompts a forward displacement in the body's center of gravity that, if not offset, will destabilize the body and undermine the reaching act itself (Bernstein, 1967).

Children first rely on reactive postural control to maintain balance during movement and only gradually establish **prospective control**.

LINES OF ACTION TO STIMULUS DURING REACH-TO-GRASP



The postural stability is ensured by:

- Anticipatory postural adjustments (pAPAs)
- Peripheral elasticity
- Muscle reflexes
- Preprogrammed postural corrections * (aAPAs)
- voluntary corrections

Latash, M. Motor Control. Motor synergies. 2008.

Vertical Posture Lines of Defense

Mechanism	Typical time delay	Important features
APAs	<0 ms	Based on predicting a perturbation
Muscle and tendon elasticity	0 ms	Can be modulated (preflexes)
Monosynaptic reflexes	30 ms	Poorly controlled
Polysynaptic reflexes	50 ms	Low gain
Pre-programmed reactions	70 ms	Approximate correction
Voluntary actions	150 ms	Late!

Latash, M. Motor Control. Motor synergies. 2008.

- Voluntary movements of a limb are preceded and accompanied by **Anticipatory Postural Adjustments (APAs)** that prepare the body for the expected disturbance of the center of mass that will be produced by that movement.
- APA as a counter-perturbation in static=Halliwick RC or BS
- APA as perturbation during gait

(Bouisset and Zattara 1981; Horak and Macpherson 1996; Massion 1992 Bouisset 2008).

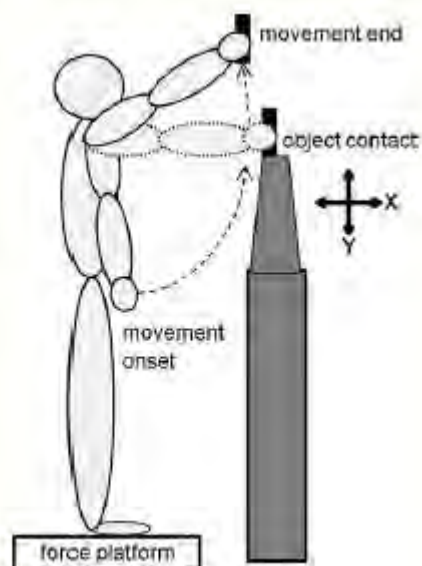
ANTICIPATION & ADAPTATION PROCESS ON LAND/IN WATER



- The postural adjustments **that precede** the movement, often by more than 100 ms: **preparatory APAs (pAPAs)**.
- The postural responses that occur **during** the movement and that serve to stabilize the body or body segment during the execution of the movement itself: **accompanying APAs (aAPAs)= Synchronous Postural Adjustment (ergonomic studies)**

These postural responses are also anticipatory in nature because they occur before there is any possibility of feedback from the movement itself influencing the response.

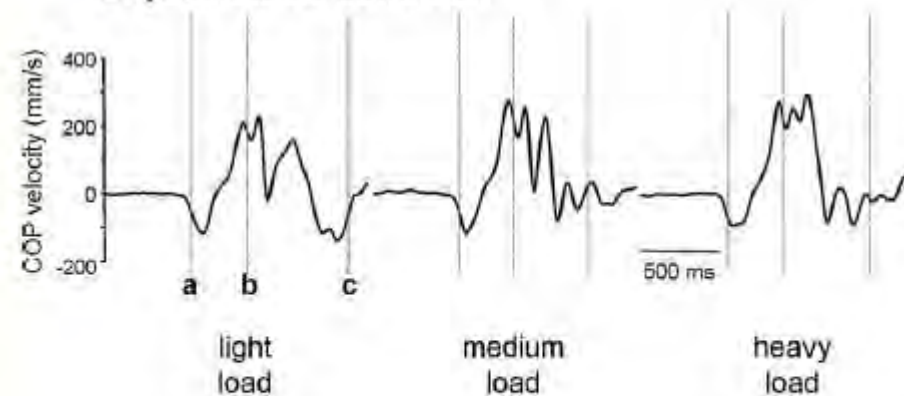
- Both regulated **by brain stem reticular formation**



Predictable condition



Unpredictable condition



a: movement onset
b: object contact
c: movement end

Aimola 2011

onset of COP velocity prior to arm movement onset (1), the first peak COP velocity (2), and the first minimum in COP velocity occurring after object lift (3).

INFANT FORWARD REACH RESEARCH

Infants 9 m of age, show activation of the postural muscles of trunk in advance of most reaching movements.

(von Hofsten & Woollacott 1989)

Infant on the thigh of parent. Toy on the end of a wood rod was moved toward the infant

EMG responses of postural muscles show, Trunk Extensor (TE) and arm muscle anterior deltoid (AD)

TE is activated in advance of the AD

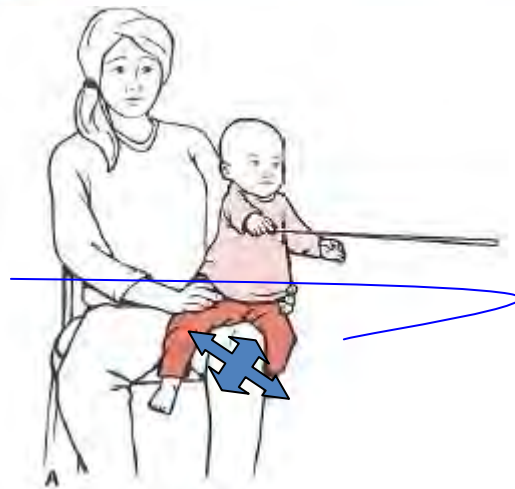
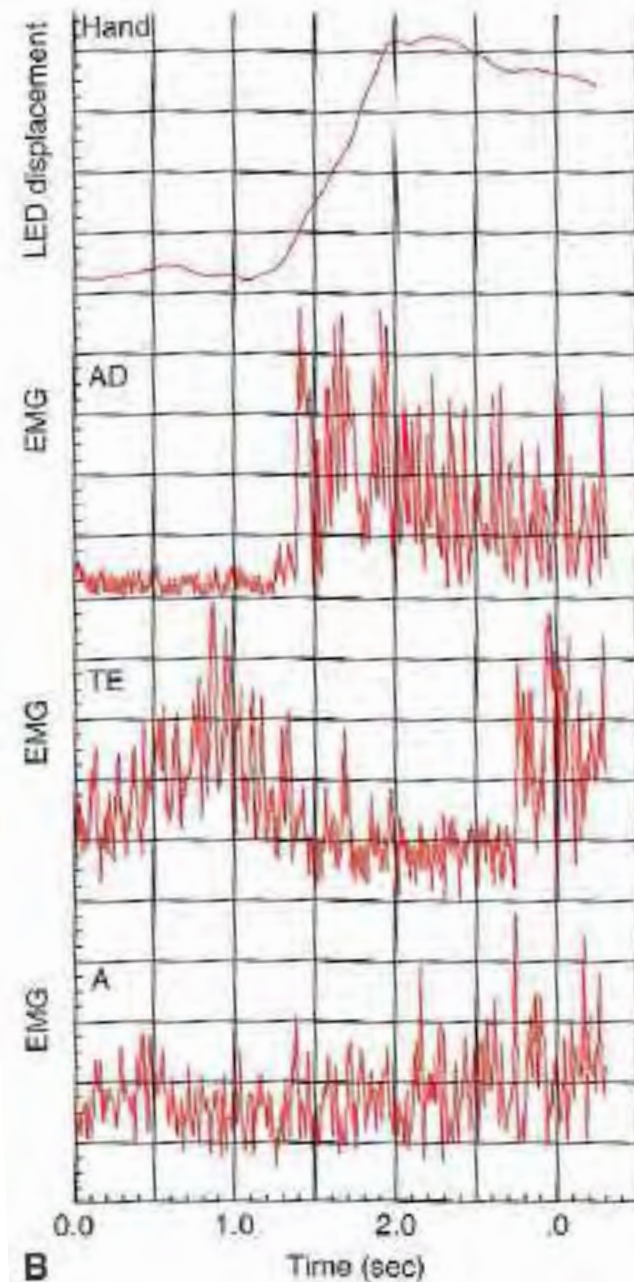


FIGURE 8.18 A, Experimental setup for a study of anticipatory postural control during reaching movements. A, The infant was balanced on the thigh of a parent, with support only at the hip, while toys on the end of a wood rod were moved toward the infant (Hofsten & Woollacott, 1989). B, EMG response of the postural muscle, the trunk extensor (TE) and the arm muscle, the anterior deltoid (AD) during a forward reach. Note that the TE is activated in advance of the AD. A = abdominal muscle; LED = light-emitting diode attached to the toy.



Shumway-Cook&Woollacott 2007

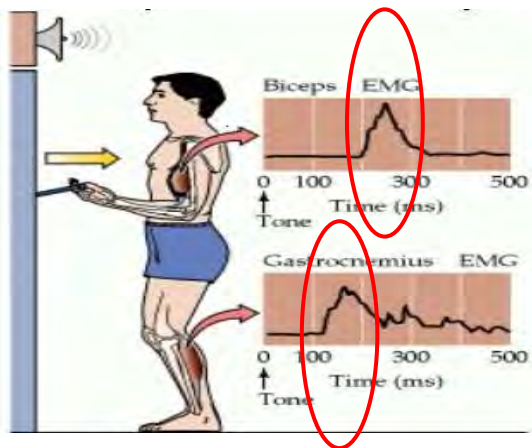
ANTICIPATION & ADAPTATION.



Preparatory Anticipatory Postural Adjustments (pAPAs)

On land

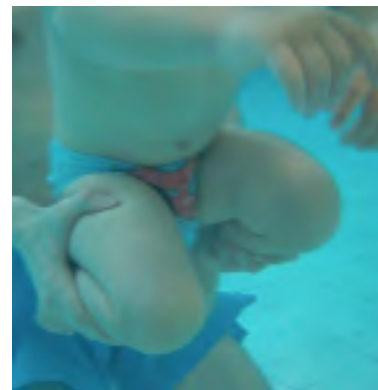
Early activation of gastrocnemius before biceps to ensure postural stability



Shumway-Cook & Woollacott
2007

In water

Early activation of Quadriceps (a) / hamstrings (b) and Trunk extensor in both, to ensure postural stability before anterior deltoid to reach



(a)



(b)

No references in children in
water. No EMG...so..

aAPA'S (ACCOMPANYING ANTICIPATORY POSTURAL ADJUSTMENTS)



Early:

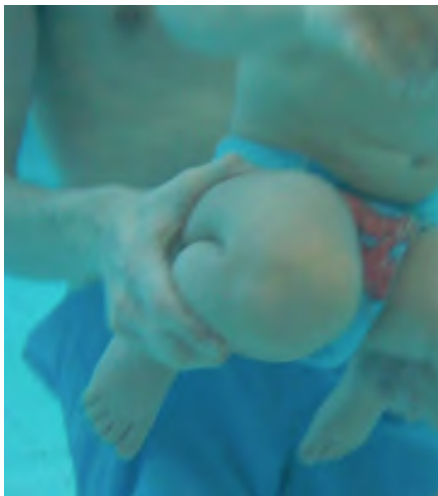
- trunk
- Hamstrings/quadriceps



Later:

- quadratus lumborum during reach
- Limbs of Contralateral side
- Head

No references in water





REACH

- Transport to the object
- Depending position, functional reach distance, radius, base of support, aAPA's, etc.
- In water, more time and distance to plan, move and correct

KIND OF GRASP



- Closed-grasp.
- Hold-grasp





COMPONENTS (reach&grasp).

Pre-requisites for doing reach&grasp:

Elementary
Components.

Musculoskeletal
Components.

Neuronal
Components.

ELEMENTARY COMPONENTS.



**POSTURAL
CONTROL**

Locate an objective.

Visual relation, requiring the
coordination of eye-head-
trunk movements.

HALLIWICK ROTATION



**POSTURAL
CONTROL**

Reach

Transport arm and hand in
space and posture support.

HALLIWICK ROTATION



Grasp

Includes forming grip, grasp
and release.

FINE TUNING



MUSCULOSKELETAL COMPONENTS



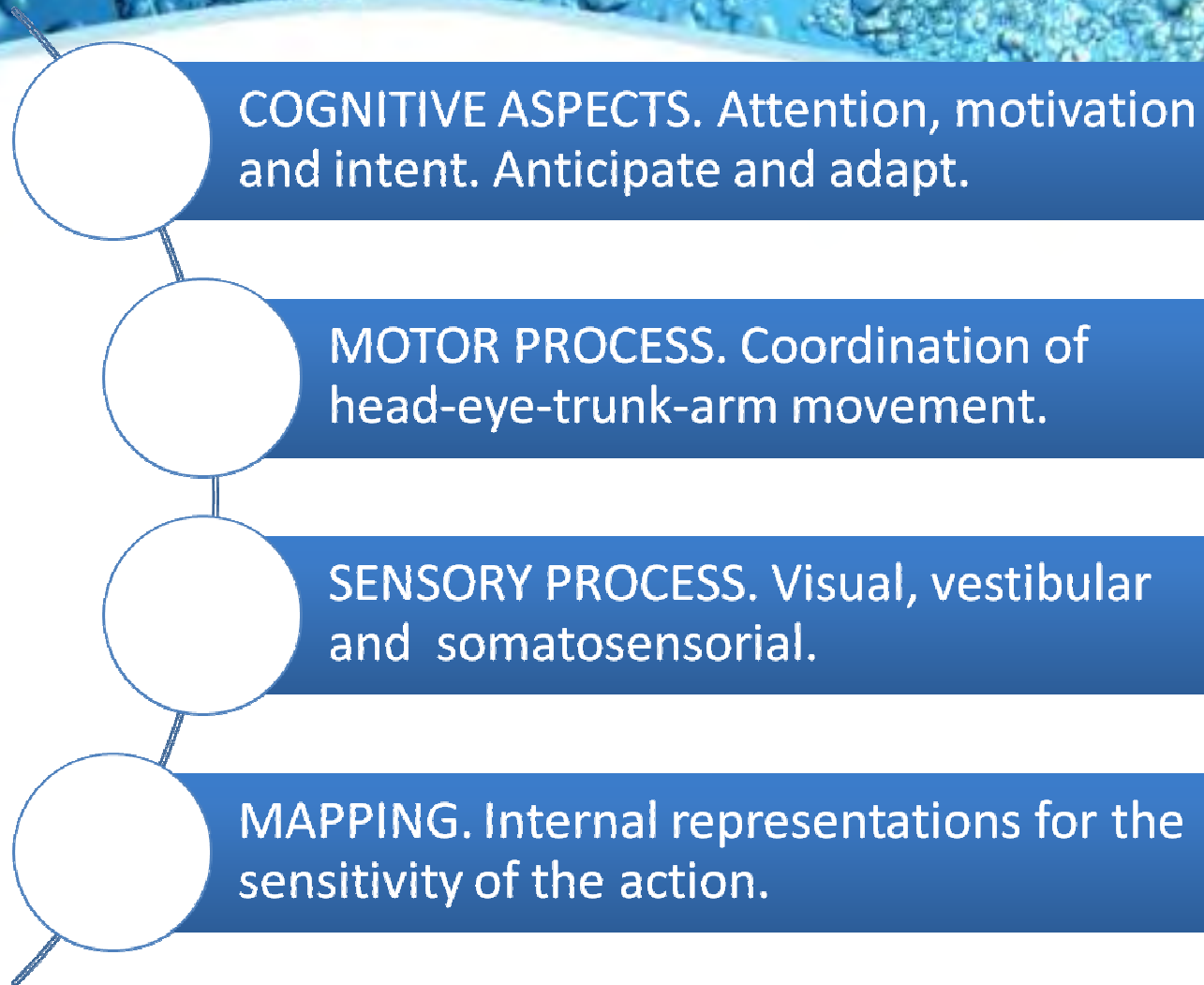
ROM

Spine
flexibility

Muscle
Properties

Biomechanical
body
segments.

NEURONAL COMPONENTS



KINEMATIC FEATURES ACCORDING TASK AND ENVIRONMENT. OBJECT ALLOCATION



Eye-head-trunk Coordination

The act of reaching and grasping an object is made using two forms of selection (2 different Areas in brain):

1. Object
selection
as
target.

2. Task
selection
to
develop.

Perception

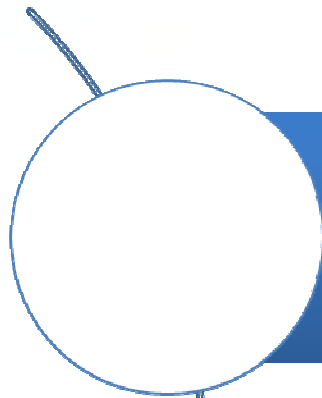
VISION

Action

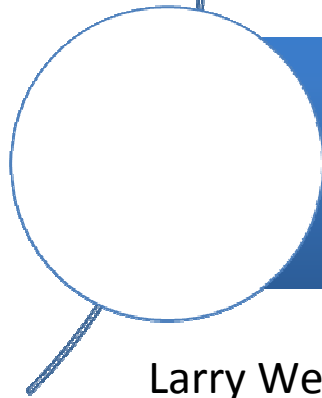
KINEMATIC FEATURES ACCORDING TASK AND ENVIRONMENT



2 visual uses:



To plan the movement according visual information: orientation, size, position, etc. PERCEPTION.



- Information during movement execution: adjust and correct. ACTION.

Larry Weiskrantz (Visual cortical model).

PROBLEMS

- 1. Hypertonia: Static Or Dynamic.
- 2. Stiffness: (Thixotropy)
- 3. Weakness
- 4. Shortening
- 5. Hypotonia
- 6. Coordination problem

HALLIWICK REACH-TO-GRASP ACTIVITIES

d1 CHAPTER 1 LEARNING AND APPLYING
KNOWLEDGE

Problem, Decisions, Attention...

d2 CHAPTER 2 GENERAL TASKS AND
DEMANDS

Single task, multiple task.

d3 CHAPTER 3 COMMUNICATION

Non verbal messages

d4 CHAPTER 4 MOBILITY

Fine hand use

d9 CHAPTER 9 COMMUNITY, SOCIAL AND
CIVIC LIFE

Play, games

ASSESSMENT. Items being tested



Hand function and Postural Control

Radial palmar grasp
Scissor grasp
Pincer grasp
Handle two objects
Abnormal hand/arm movements

Posture in supine
Sitting unsupported
Equilibrium during sitting
Shoulder retraction during sitting
Hyperextension when in sitting position
Rotation during sitting
Straightening of the back muscles during ventral suspension
Posture in supine
Sitting unsupported
Equilibrium during sitting

The influence of postural control on motility and hand function in a group of 'high risk' preterm infants at 1 year of age. Samsoma, G. Early Human Development 2000

ASSESSMENT

CATEGORICAL PROFILE ASSESMENT

global goal:

Cycle goal 1:

Cycle goal 2:

Cycle goal 3:

ICF categories - Intervention targets

b BODY FUNCTIONS					
b1 CHAPTER 1 MENTAL FUNCTIONS					
		b114 Orientation functions			
		b140 Attention functions			
		b147 Psychomotor functions			
		b156 Perceptual functions			
		b167 Mental functions of language			
		b176 Mental function of sequencing complex movements			
b2 CHAPTER 2 SENSORY FUNCTIONS AND PAIN					

problems ICF Qualifier* 0 1 2 3 4

	b720	Mobility of bone functions
	b730	Muscle power functions
	b735	Muscle tone functions
	b750	Motor reflex functions
	b755	Involuntary movement reaction functions
	b760	Control of voluntary movement functions
	b765	Involuntary movement functions
s7	CHAPTER 7 STRUCTURES RELATED TO MOVEMENT	
	s720	Structure of shoulder region
	s730	Structure of upper extremity
	s740	Structure of pelvic region
	s760	Structure of trunk
d1	CHAPTER 1 LEARNING AND APPLYING KNOWLEDGE	
	d110	Watching
	d115	Listening
	d120	Other purposeful sensing
	d130	Copying

ASSESSMENT



The Berg Balance Scale and the Pediatric Balance Scale

Berg's Balance Scale Items		Pediatric Balance Scale Items	
1	Sitting to standing	1	Sitting to standing
2	Standing unsupported	2	Standing to sitting
3	Sitting unsupported	3	Transfers
4	Standing to sitting	4	Standing unsupported
5	Transfers	5	Sitting unsupported
6	Standing with eyes closed	6	Standing with eyes closed
7	Standing with feet together	7	Standing with feet together
8	Reaching forward with outstretched arm	8	Standing with one foot in front
9	Retrieving object from floor	9	Standing on one foot
10	Turning to look behind	10	Turning 360 degrees
11	Turning 360 degrees	11	Turning to look behind
12	Placing alternate foot on stool	12	Retrieving object from floor
13	Standing with one foot in front	13	Placing alternate foot on stool
14	Standing on one foot	14	Reaching forward with outstretched arm

• PEDIATRIC BALANCE SCALE



12. Pick Up Object From The Floor From A Standing Position

INSTRUCTIONS: The child is asked to pick up a chalkboard eraser placed approximately the length of his/her foot in front of his/her dominant foot. In children, where dominance is not clear, ask the child which hand they want to use and place the object in front of that foot.

EQUIPMENT: a chalkboard eraser
a taped line or footprints

- () 4 able to pick up an eraser safely and easily
- () 3 able to pick up eraser but needs supervision (spotting)
- () 2 unable to pick up eraser but reaches 1 to 2 nches from eraser and keeps balance independently
- () 1 unable to pick up eraser; needs supervision (spotting) while attempting
- () 0 unable to try, needs assist to keep from losing balance or falling

14. Reaching Forward With Outstretched Arm While Standing

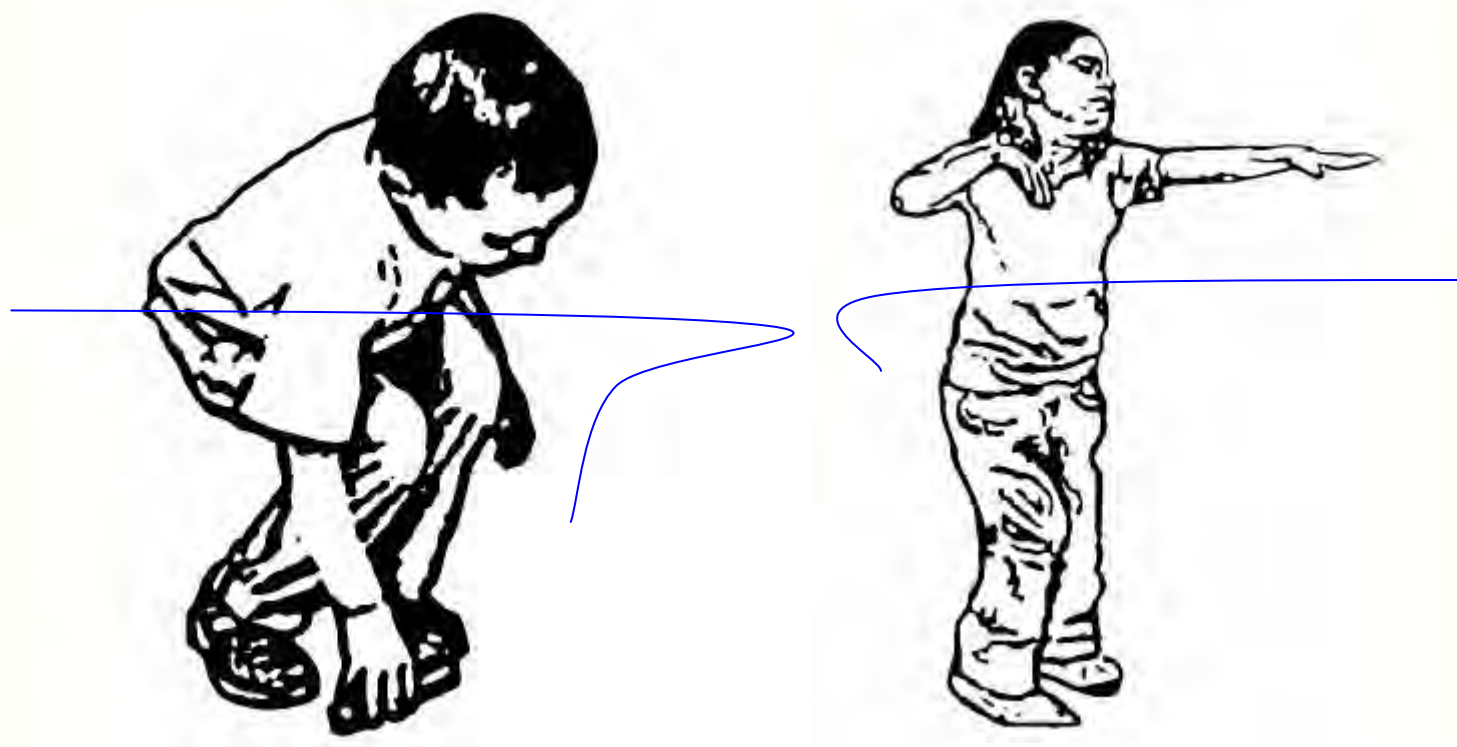
General Instruction And Set Up: A yardstick affixed to a wall via Velcro strips will be used as the measuring tool. A taped line and/or footprints are used to maintain a stationary foot position. The child will be asked to reach as far forward without falling, and without stepping over the line. The MCP joint of the child's fisted hand will be used as the anatomical reference point for measurements. Assistance may be given to initially position the child's arm at 90 degrees. Support may not be provided during the reaching process. If 90 degrees of shoulder flexion cannot be obtained, then this item should be omitted.

INSTRUCTIONS: The child is asked to lift his/her arm up like this. "Stretch out your fingers, make a fist, and reach forward as far as you can without moving your feet."

3 Trials Average Results

EQUIPMENT: a yardstick or ruler
a taped line or footprints
a level

- () 4 can reach forward confidently >10 inches
- () 3 can reach forward >5 inches, safely
- () 2 can reach forward >2 inches, safely
- () 1 reaches forward but needs supervision (spotting)
- () 0 loses balance while trying, requires external support



WOTA 1, 2



7 "Splashing" water

4. With hands and/or legs. Does not recoil from water around the face
3. Splashes "carefully" and recoils from water around the face
2. Does not splash, has no "feel" for the water
1. Is not able to perform

10 Progression along pool edge using hands:

Legs or feet against the wall. Moves along wall one and a half meters.

4. Yes, without support
3. Yes, with help in initiation by hands or trunk support. Holds on to edge without support
2. Yes, help in initiation by hands or trunk support. Does not hold on to edge unsupported
1. Does not initiate movement or pushes away from the wall

12 Holding rope:

Water at chest level.

4. Progresses by reciprocal hand over hand movement or sideways
3. Holds on with both hands during swinging – 10 seconds
2. Requires side trunk support during swinging – 10 seconds
1. Does not hold the rope: unable and/or does not initiate

+ All the Halliwick Control Rotation Items with reach intention

MOTOR LEARNING

- 1. REPETITION
- 2. ACTIVE PARTICIPATION
- 3. ALLOWING MISTAKES/SOLUTIONS
- 4. POSTURAL CONTROL
- 5. MEMORY
- 6. INTRINSIC AND EXTRINSIC
FEEDBACK

LEARNING



- **Explicit** (declarative)- medial temporal lobe, sensory cortex and hippocampus.
 - Based on knowledge of the movement: therapist explains and guides. FNP, Perfetti, Bobath ... **Internal focus of attention**
 - Could you feel the extension of elbow?
- **Implicit** (Nondeclarative)-Reflex, amygdala, Cerebellum, premotor cortex, striatum
 - Focus is on the result of the movement, not specified movement. Spend quality. Therapist designs the environment (here Halliwick and CIMT). **External focus of attention.**
 - Could you grasp the toy?

INSTRUCTIONS FOR MOTOR LEARNING: DIFFERENTIAL EFFECTS OF INTERNAL VERSUS EXTERNAL FOCUS OF ATTENTION



- **External focus** of attention (motion effects) are more effective than internal focus (focus on the movement themselves)
 - **Enhancing motor learning through external-focus instructions and feedback.** Human Movement Science (1999)
- The **external focus** group demonstrated more effective learning than the internal focus group, as evidenced by more accurate tosses on the transfer test.

Instructions that induce an external focus of attention can enhance motor learning in children with IDs.

- **An external focus of attention enhances motor learning in children with intellectual disabilities.** J Intellect Disabil Res. 2012

CONCLUSIONS



- Humans can learn without sensory feed back
- New movements are learned, based on a scheme
- Practicing under different conditions for the same purpose (taking different types of glass, + / - filled, positions ...) Improves pattern ...repeat without repetition.

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**THANKS FOR YOUR ATTENTION
ANY QUESTION?**

