Performance and motor control of fundamental skills

Part II: Gait & Bimanual Control
Gait

People put too much emphasis on the emergence of upright independent walking.

People assume that if the child walks sooner, he or she is advanced in their motor development. This notion has not been proven.

Let’s examine the stages one take in developing an upright independent walk and various related motor control issues.
Development of the Upright Independent Gait

First we need to remember that we develop cephalocaudally.

We need to first understand the acquisition of voluntary head movements.
- **1 month** of age little or not control
- **2 months** elevates the head when phone with effort
- **3 months** positions head left to right or right to left when prone
- **5 months** elevates head when spine

Control of the head enables infants to scan their surroundings.
Little or no control of the head. The head and neck needs to be supported by the child care giver.
Head Control

2 months
Head Control

2–3 months
Head Control

By 5 months the child should be able to control their head. At 5 months the child can raise their head when in the supine position (lying on one’s back).
Development of the Upright Independent Gait

Once the child has the ability to elevate their chest and head, the child has gained some control of their arms, hands, and fingers.

Once the chest can be elevated the child will attempt to roll from a supine position to a prone position. This is important because it enables the child to attain a proper position for crawling.
Development of the Upright Independent Gait

*Upright independent sitting* is an important milestone. It frees the hands so the child can reach, grasp, and release objects.

For early sitting to occur one must support the lower back and abdomen.

By 5 months the lumbar control has stabilized and the child can hold an external object.

By 8 months the child has gained sufficient movement ability to set independently without assistance.
Development of the Upright Independent Gait

6-7 months
Development of the Upright Independent Gait

Self-support sitting is associated with eye-hand coordination (Rohart, 1992).

Upright posture will follow self-support sitting. Following skills will then emerge:

- ability to pull their body from a sitting to standing position

-period of experimental standing with the aid of external objects such as a chair or furniture

- Standing position will be characterized with a high arm carriage and wide base of support.
Development of the Upright Independent Gait
Development of the Upright Independent Gait

Being able to position the body so one can move from one location to another occurs in a predictable progression:

First Crawling
- emerges around 7 to 8 months of age
- involves thrusting the arms forward and then flexing so they drag their body along the surface

Then Creeping
- is elevated crawling with the only the arms and knees.
- contralateral (limbs in opposition) or homolateral (limbs on the same side moving in the direction).
Development of the Upright Independent Gait

8-10 months
Development of Upright Independent Walking

1. **7-10 months** - Walk with assistance
2. **11 months** – Walk by being led
3. **12 months** – Walking independently

Children who have smaller bones or linear frames walk somewhat earlier than large boned or large framed children.

Keys to developing walking is lateral stability. Heel strike and ground reaction forces pattern of walking similar to that of an adult occurs between 2-3 years of age.
Stages of Upright Walking

7 months

10 months
Stages of Upright Walking

11 months
Stages of Upright Walking
Development of the Upright Independent Gait

When the child begins to walk:
- the arms have a high carriage
- very wide base of support
- knees are in the flexed position
- toes pointed out
- length of strides are highly inconsistent.
- lateral stability is poor
Development of the Upright Independent Gait
Development of the Upright Independent Gait
Motor Control of Upright Independent Gait (Walking & Running)

Central pattern generators in the spinal cord controls human gait. Evidence is found:

- Decerebrated cats (severing the spinal cord from the brain) can still walk and perform locomotor rhythmic muscular activity (Sherrington, 1906).
Motor Control of Upright Independent Gait

There is a distinct rhythmic relationship that exists:

- Between the arms and legs due to walking speed.
  - 2:1 ratio (two arms swing to each leg stride) exists for slow walking then it changes to
  - 1:1 ratio exists for fast walking

Pelvis and thorax move as one in slow walking but independently in fast walking.

Knowing that distinct rhythmic relationship exist is important in measuring coordination problem in Parkinson’s disease patients or determine the effectiveness of reconstructive knee.
Motor Control of Upright Independent Gait

Head stability is key factor of the Gait.

The head contains the sensory and motor nervous system components that helps us navigate through an environment and in maintaining one posture.

Maintaining a stable head during locomotion optimizes the use of vision so we can tracking a ball, catch an object, and avoiding objects.

Adults with neurological impairment adopt an abnormal posture and gait as a means to maintain head stability (Holt, et al., 1995)
Motor Control of Upright Independent Gait

Walk to run or run to walk transitions occur at different speeds.

These changes are spontaneous transitions but they vary between people. Why?

It is not due to physical limitations. The spontaneous transition occurs at a speed where we minimize metabolic energy consumption (VO2).

This assumption has not been totally supported but spontaneous transition remains a puzzle for researchers to solve.
Bimanual Control

Bimanual movements involve the limbs moving in same similar pattern (symmetric) or moving each limb differently (asymmetric).

Examples:
- Playing a guitar
- Tying a shoe
- Drummer
- the Serve in tennis
Bimanual Control

Whether we perform symmetric or asymmetric bimanual skills, the two limbs prefer to do the same thing at the same time.

- Rub your stomach with one hand while at the same time tap your head with the other hand. Gradually increase the speed of each action…What happens?
Bimanual Control

Bimanual skills do not apply to Fitt’s law.
- The more difficult task will influence the performance of the less difficult task.
- Temporally moving both limbs eventually overcame the influence of the speed accuracy trade off relationship.

Many bimanual skills occur when one limb performs a more difficult task while the other performs an easier task. The more difficult task will always influence the less difficult task.
Bimanual Control

Bruner examined bimanual control in infants through early childhood.

• By 4 to 5 months children could only manipulate one toy at a time.
• By 6th month the children could reached and grasped two toys.
• By the 9th month, the child can manipulate 3 toys.
• By 18 months, the child is using both hands about 30% of the time.
Bimanual Control

How do we become proficient (uncoupled) in performing bimanual skills?

Answer is we learn to become uncoupled (dissociate) our limbs and begin moving the limbs asymmetrically.

Uncoupling is a difficult process for people but given proper instruction, feedback, and practice one can become asymmetric.
The End