

Brain and Learning a Motor Skill

How do we go from
Reflex to Coordinated movement
To Complex Skills?

SKILLED MOTOR PERFORMANCE

One who can produce a fast output of high quality movement - accomplishing a predetermined objective.

LEARNING

Learning is an internal phenomenon that cannot be observed directly; it can only be inferred from the observation of a person's performance.

For example:

- **Smile infers happiness**
- **Crying infers sadness or (very happy)**
- **Red face infers embarrassment (or anger)**
- **A yawn in class infers a person is bored or tired!**

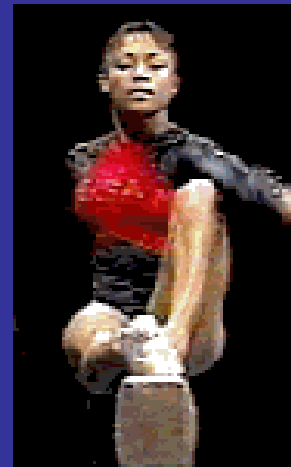
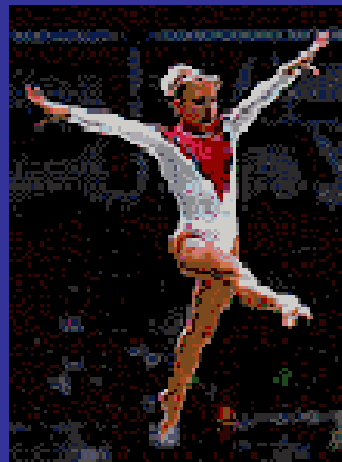
SKILLED MOTOR PERFORMANCE

1. Organized sequence of movements which requires:
 - a. **Spatial organization** - arranging effective movement patterns through the selection of appropriate muscle groups to execute the selected movement



SKILLED MOTOR PERFORMANCE

3. Sequence occurs whereby each muscle group functions or responds at the proper time.



Reflex

- The most basic form of movement is a reflex
- These are considered hard-wired, ie pre-existing connections of motor neurons
- These are mostly responses to
 - external
 - internal stimulus
- The reflex action can be as minimal as a mono synaptic firing of motor neurons that brings about a standard movement response

Reflex

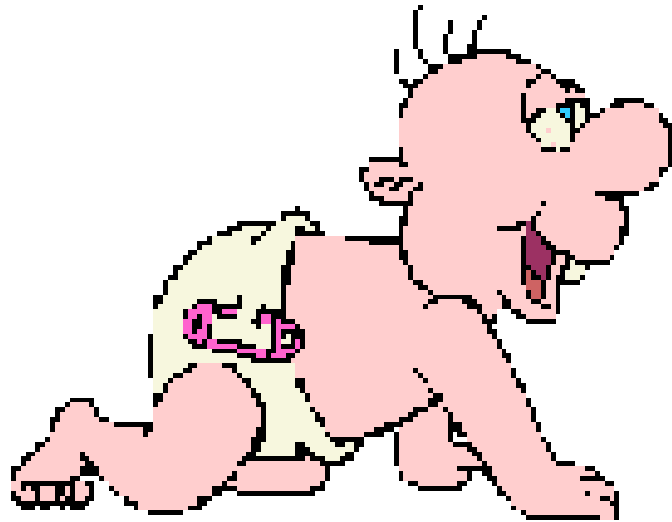
- We are born with reflexes, ie. not learnt
- These tend to be All or Nothing
- We cannot regulate consciously, ie start modulate, stop
- Generally, reflexes are not under our conscious control (volitional)

Reflex

- These hard-wired **pathways** are thought to be the basis for development of the eventual more complex skilled movements
- Which leads us to the answer to the question

Motor Skill Acquisition

How do we go from



Reflex

to

Some motor programs are stored at the spinal level in their entirety:

A decorticate cat in a harness will still run almost normally on a treadmill in response to the movement of the belt under its feet (Shik and Orlovskii, 1976), and will adjust its gait almost normally when a paw hits a simulated obstacle (Forssberg, Grillner, & Rossignol, 1975).

Motor Skill Acquisition

How do we go from

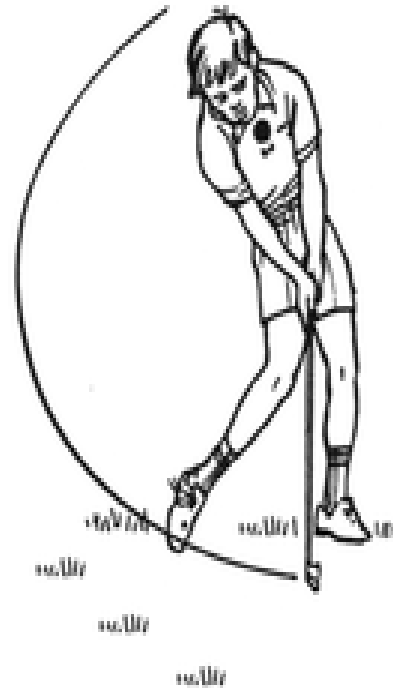


Coordinated movement

to

Motor Skill Acquisition

Complex Skills



Skill Acquisition

. “... if the world asks you to do the same thing over and over, you develop circuits dedicated to that task.”

van Mier H, Tempel LW, Perlmutter JS, Raichle ME, Petersen SE (1998).

Changes in brain activity during motor learning measured with PET: Effects of hand of performance and practice. Journal of Neurophysiology, 80, 2177-2200.

The research was funded by the National Institutes of Health and Washington University's McDonnell Center for the Study of Higher Brain Function

Motor Skill Acquisition

How Does It Happen?

Major factors

- Two facilitation systems:
 - **Pyramidal system**
 - **Extra-pyramidal system**
- **Engrams** (basic component)

Skill Acquisition

- By trial and error a baby learns to associate sensory perception, reflex motor patterns, and perception of effort by the **pyramidal system**, as the pyramidal system facilitates a reflex activity. Gradually the baby learns to augment that movement **voluntarily** through the **pyramidal system**, this learning to augment and later initiate movement voluntarily occurs in the first few months of life.

Skill Acquisition

Pyramidal system

- That part of motor system over which we are able to exercise control. It's qualities are:
 - Demands our attention and effort
 - Is limited in the amount and complexity of movement
 - Is used in the beginning stages and other learning stages of skill acquisition

Skill Acquisition continued

- The child practices the pattern repeatedly for the reward of a sense of successful performance, in so doing begins to develop an automatic **engram (motor pathway)**.
- As the **engram** is perfected it is progressively less necessary for the child to consciously attend to the activity being performed.

Skill Acquisition

- Once a movement is learnt (**engram** established)
- Another movement can be learnt and that **engram** established
- **Engrams** are combined to make newer more complex **engrams**
- Final movement which will run as one unit or motor program consists of many smaller **engrams** each combined
- Once established, changes are difficult to make and necessitate an almost surgical approach to altering

Skill Acquisition

Engram

- A motor **engram** is a pathway of inter-neuronal linkages involving activation of certain neurons and muscles to perform a pattern of motor activity in a specific sequence of speed, strength, and motion at the same time **inhibition of other neuron** pathways so that muscles which should not be participating in the pattern remain quiet.

LEARNING

Is a relatively permanent change in behavior that occurs as a result of experience and practice, and is not attributable to maturation.

Skill Acquisition

Extra-pyramidal system

- Repetition of performance develops an **engram** in the extra-pyramidal system of the same activity that has been practiced, if the practice has been erratic, the **engram** will be poor and unreliable.
- One important aspect of practice is the **inhibition** of muscles which are not required in the pattern.

Skill Acquisition

- Extra-pyramidal system
 - Not under conscious control
 - Unlimited capacity
 - Motor programs (**engram**)
 - Requires little attention from performer
 - Once established difficult to alter/ change
 - Frees capacity to concentrate on other actions

SUMMARY

- The basic neural pathways for movement are in place (**reflexes**)
- Parts of these pathways are then co-opted, modified, or developed upon to produce extensions under volitional control (**pyramid system**)
- Each conscious movement pattern establish its own **engram**

SUMMARY

- Once an **engram** is automatic it is no longer necessary to be under conscious control, moved to **extra-pyramidal system**
- **Engrams** are combined to make more and more complexity
- Changes to an established movement pattern may affect the whole of that pattern

SUMMARY

- **The Pyramidal** system now is able to focus on other things, but will still be involved in movement initiation, monitoring, and termination.