Constrains of movement

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INTRODUCTION

- Movement is a critical aspect of life.
- It is essential to our ability to walk, run, and play; to seek out and eat the food that nourishes us; to communicate with friends and family; to earn our living in essence to survive.
- The field of motor control is directed at studying the nature of movement, and how movement is controlled.

- Physical and occupational therapists have been referred to as **applied motor control physiologists‖** (Brooks, 1986):

➢ spend considerable amount of time retraining patients who have motor control problems producing functional movement disorders.

➢ understanding motor control and, specifically, the nature and control of movement is critical to clinical practice

Motor control

- Motor control is defined as the ability to regulate or direct the mechanisms essential to movement.
- The process of initiating, directing, and grading purposeful voluntary movement.
- motor control is studying neural mechanism &processes by which movement are controlled.

- **According to Roller et al (2012)** the production and control of human movement : Is a process that varies from a simple reflex loop to a complex network of neural patterns that communicate throughout the Central Nervous System (CNS) and Peripheral Nervous System (PNS).

Answer the questions

1. How does the central nervous system (CNS) organize the many individual muscles and joints into coordinated functional movements?
2. How is sensory information from the environment and the body used to select and control movement?
3. What is the best way to study movement?

MOTOR LEARNING

- Acquisition or/ and modification of skill as consequence of practice.
- a set of cognitive processes associated with **practice, training, or experience** that results in relatively **permanent changes in motor behavior**

UNDERSTANDING THE NATURE OF MOVEMENT

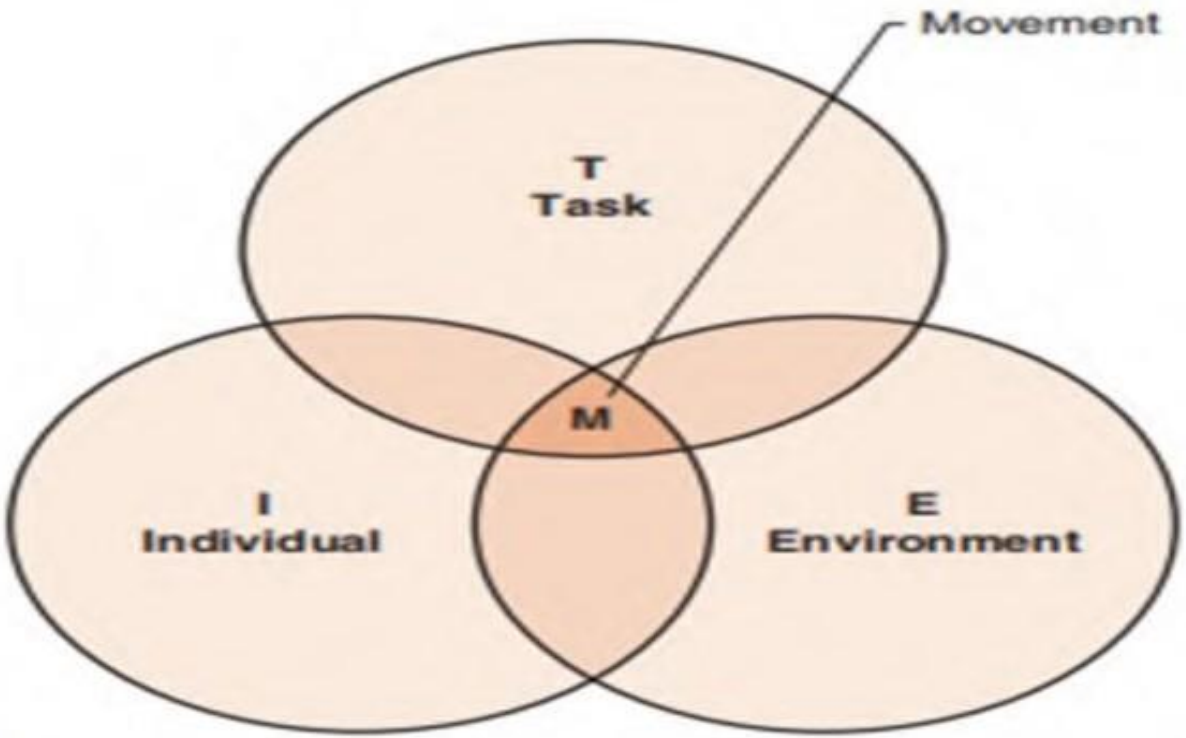


FIGURE 1.1 Movement emerges from interactions between the individual, the task, and the environment.

- Movement emerges from the interaction of three factors: the individual, the task, and the environment.
- Movement is organized around both task and environmental
- The individual generates movement to meet the demands of the task being performed within a specific environment.

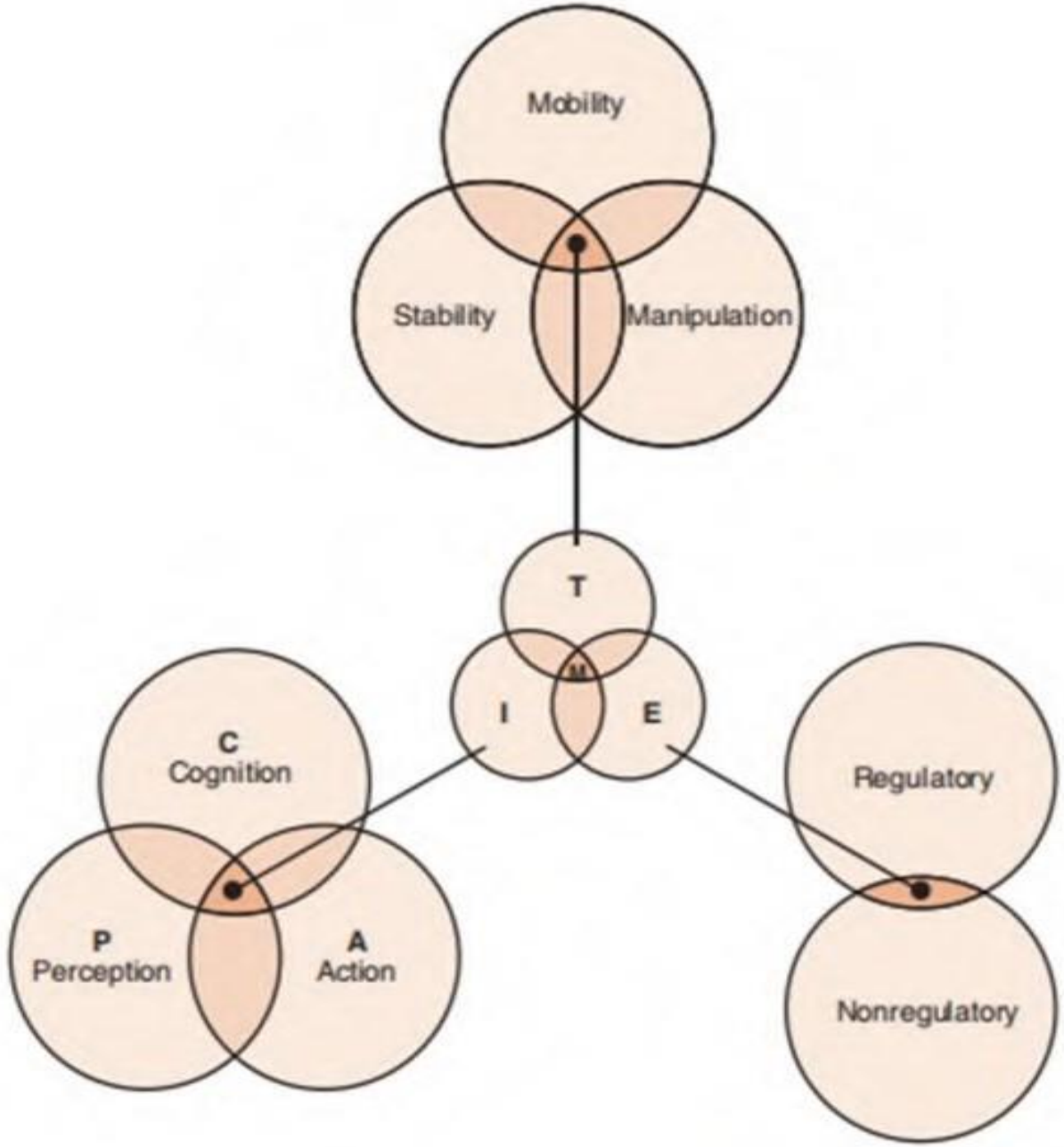


FIGURE 1.2 Factors within the individual, the task, and the environment affect the organization of movement. Factors within the individual include the interaction of *perception, cognition,* and *action (motor) systems.* Environmental constraints on movement are divided into regulatory and nonregulatory factors. Finally, attributes of the task contribute to the organization of functional movement.

A- Factors within the Individual That Constrain Movement:

- Movement arises from the interaction of multiple processes, including those that are related to perception, cognition, and action.

1) Movement and Action

- Movement: Accomplishing a particular action.
- Action **“goal directed movement”**
- As a result, motor control is usually studied in relation to specific actions or activities. e.g walk.
- Understanding the control of action implies understanding the motor output from the nervous system to the body‘s effector systems, or muscles. all of which must be controlled during the **execution of coordinated, functional movement.**

- There are also multiple ways a movement can be carried out (**multiple equivalent solutions**).
- This problem of choosing among equivalent solutions and then coordinating the many muscles and joints involved in a movement has been referred to as the **degrees of freedom problem** (Bernstein, 1967).
- So, the study of motor control includes the study of the systems that control action.

2) Movement and Perception

- Perception **is essential to action,** just as action is essential to perception.
- Perception is the integration of **sensory impressions** into **psychologically meaningful information**.
- Perception includes both peripheral sensory mechanisms and higher-level processing that adds interpretation and meaning to incoming afferent information.

- Sensory/perceptual systems **provide information about the state of the body** .e.g. (the position of different body parts in space) and features within the environment critical to the regulation of movement.
- It is an integral to the ability to act effectively within an environment.
- Understanding movement requires the study of systems controlling perception and the role of perception in determining our actions.

3) Movement and Cognition

- Cognitive processes are essential to motor control.
- Mental function and goal establishment (movement is not usually performed in the absence of **intent**).
- Cognition include: **Attention, planning, reasoning, judgment, memory, problem solving, motivation, and emotional aspects of motor control.**
- It is necessary to analysis the different components of motor control (perception, action, and cognition).

B-Task Constraints on Movement

- The nature of the task performed in part determines the type of movement needed.
- Therapeutic strategies that help the patient (re)learn and recover the function following CNS damage.

1) Mobility tasks, functional tasks

- Changing the position either:

➢ Bed mobility e.g. Rolling, supine to sit.
➢ Transfer tasks e.g. from chair to bed and back.
➢ ADL training (dressing , feeding ...).
➢ Discrete movement tasks (e.g. kicking a ball or moving from sitting to standing) (have a recognizable beginning and end) OR Continuous movements such as walking or running.

2) Stability or mobility tasks

- Movement tasks have also been classified according to whether the base of support is still or in motion.
- **Stability** tasks such as sitting or standing are performed with a non moving base of support, while **mobility** tasks such as walking and running have a moving base of support.
- In the clinic, tasks involving a nonmoving base of support **lowest attentional demand** (e.g., sitting and standing) are often practiced prior to mobility tasks such as walking **attentional demands increase.**

3) Manipulation(Skills)

- The addition of a manipulation task increases the demand for stability.
- Tasks might be sequenced in accordance with the hierarchy of stability demands (e.g., standing, standing and lifting a light load, standing and lifting a heavy load).

4) Movement variability

- **Open movement task** (constantly changing, unpredictable environment)(playing soccer or tennis) **performed after Closed movement task** (stereotyped, showing little variation , with fixed environments and predictable environments).

TABLE 1.1 A Taxonomy of Tasks Combining the Stability–Mobility and Closed–Open Task Continua

	Stability	Quasimobile	Mobility
Closed predictable environment	Sit/stand/ nonmoving surface	Sit to stand/kitchen chair w/arms	Walk/nonmoving surface
Open unpredictable environment	Stand/rocker board	Sit to stand/Rocking chair	Walk on uneven or moving surface

C-Environmental Constraints on Movement:

Regulatory features

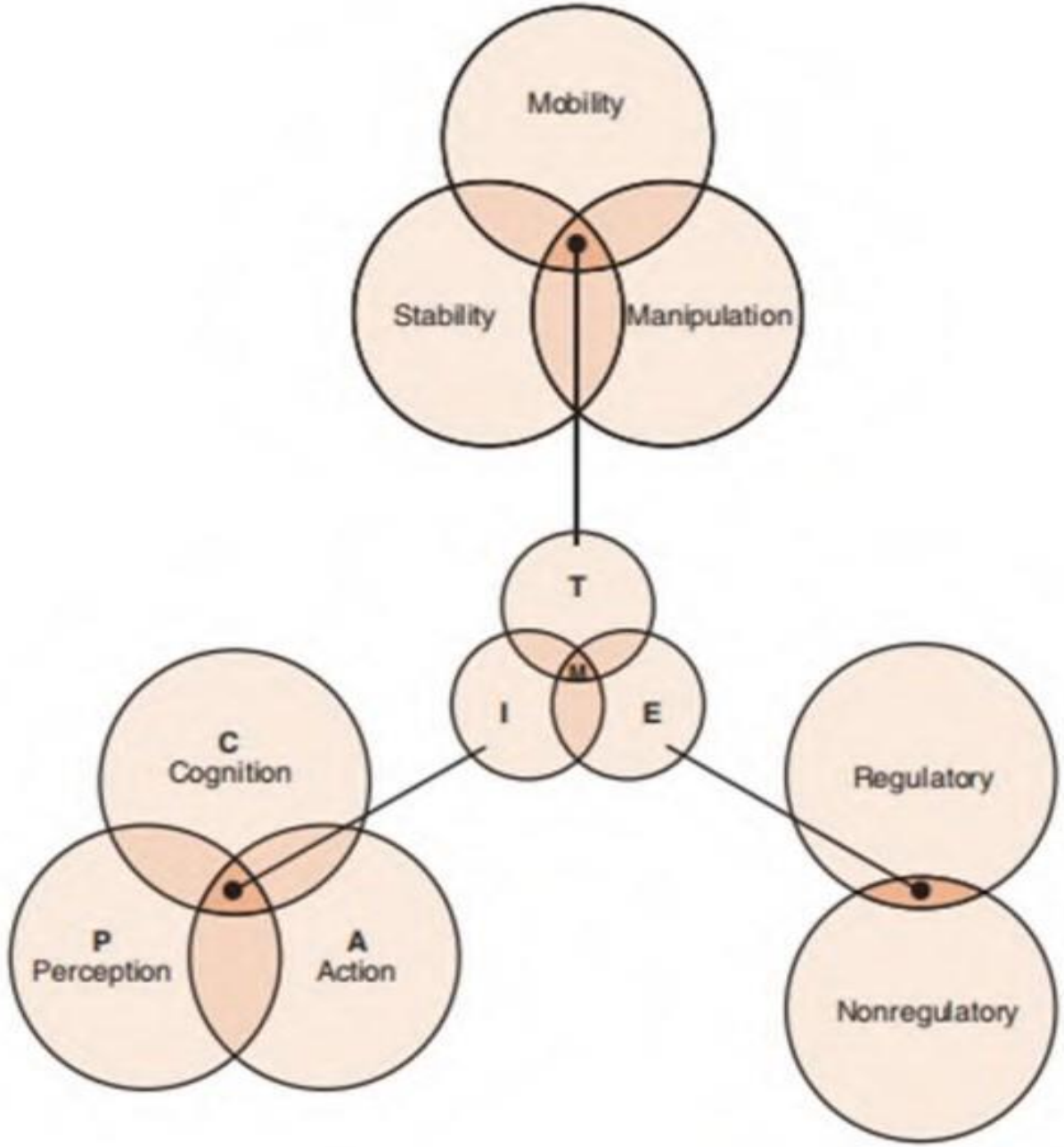
Non regulatory features

1) Regulatory features

- characteristics in environment directly influences the movement required to reach a goal.
- Task-specific movements must conform to regulatory features of the environment in order to achieve the goal of the task.
- e.g. Size, shape, and weight of a cup to be picked up and the type of surface on which we walk (Gordon, 1997). (e.g. Angle of walking surface)

2) Non regulatory features

- Characteristics in environment do not directly shape the movement required to reach a goal.
- May affect performance.
- e.g. background noise, the presence of distractions and air temperature.



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Environment

- Features of the environment can in some instances enable or support performance, or alternatively, they may disable or hinder performance.
- For example, walking in a well-lit environment is much easier than walking in low light conditions or in the dark because the ability to detect edges, sizes of small obstacles, and other surface properties.
- Thus, the movement we observe in patients is shaped not just by factors within the individual, such as sensory, motor, and cognitive impairments, but also by attributes of the task being performed and the environment in which the individual is moving.

Motor program

- Motor programs are stored in long-term memory. Essentially, all of the commands must be sent to the muscles to perform a certain skill.
- This may also be split into sub-routines.
- For example, in tennis, the motor program gives instructions to the muscles in the arms and legs about where and when to contract. There are also sub-routines, such as the ball toss, the backswing of the racket, the jump, and the final hit and follow-through. together, these subroutines make up the motor program.

- A set of pre-structured muscle commands that, when initiated, results in the production of a coordinated movement sequence (learned task).
  - Signals transmitted through efferent and afferent pathways allow the central nervous system to anticipate, plan or guide movement.

N.B It takes 500 hours to invoke a motor pattern before it becomes unconscious.

N.B It takes 25-30 thousand reps to break a bad motor pattern.

Repetitions

N.B

- It takes about 1000 reps just to learn that pattern, and tens of thousands to perform it well.
- We need at least 300-400 reps per session to begin rewiring the brain to provide meaningful outcomes.
- In fact, in the book Motor Learning (1991) Dr Schmidt states that it takes approximately 300- 500 repetitions to develop a new motor pattern. Conversely, once bad habits are in place, he states that it'll take about 3000-5000 repetitions to re-write and correct a bad motor pattern.

Motor plan

- An overall strategy for movement; an action sequence requiring the coordination of several motor programs.
- Made up of several component motor programs.
- It is a skill that allows us to remember and perform steps to make a movement happen ,we use motor planning for all physical activities. These include everyday tasks like brushing teeth or washing hands.

- For example, a motor plan for getting dressed would include steps for putting on socks—including knowing this comes before stepping into shoes; putting shoes on the correct feet, and so on.
- Difficulty in motor planning is known as dyspraxia/ apraxia>>> subjects have normal strength and muscle tone but struggle with the planning necessary to use their muscles.

Feedforward control

- Is the sending of signals in advance of movement to ready a part of the system for incoming sensory feedback or for a future motor command (expectation).
- It allows for anticipatory adjustments in postural activity.
- An example of a feedforward system is the preadaptation for exercise, changing the activity of postural muscles and of the vascular system(cardiopulmonary fitness) in order to ready the body for the movement when it occurs.

e.g Salivation in response to taste or smell or even thought of food/response to cold weather by shivering .

Feedback

- Is response-produced sensory information received during or after the movement and is used to monitor movement output for corrective actions.
- To determine presence of error or used directly in the modulation of movements reflexively(during the movement).
- To determine the success of the response and contribute to motor learning(after the movement).