

# Basic Concepts of Applied Motor Learning and Performance



## OBJECTIVES

- Define motor learning and its relationship to other related disciplines
- Define motor control, motor development, motor behaviors, and motor performance
- Understand how learned motor learning principles can be applied to various professions such as physical education, exercise and sports science, sports coaching, physical therapy, the military, police and special forces, ballet and other dance forms, recreational activities, etc.
- Understand the importance of using new technology or training methods for the enhancement of the motor learning process
- Understand the factors contributing to motor learning performance
- Understand the importance of research methods and know the nature of experimental and descriptive research methods
- Understand the characteristics of this applied motor learning and performance textbook
- Understand some of the important terminology used in research

## INTRODUCTION

At the 2012 London Olympic Games, Ms. Gabby Douglas won an individual all-around Olympic gold medal, Michael Jordon, a basketball legend, enralls us with his skills, and Bruce Lee's lightning-quick actions knocking down multiple opponents within a second (Picture 1, 2, and 3) have stunned the sports world. How can these athletes perform such fascinating movements so flawlessly? What kinds of learning processes brought these athletes to such levels? Is any human being capable of performing such incredible movements with the proper training?



From a motor learning perspective, the majority of human movements are learned skills (Enoka, 2009; Payne & Isaacs, 2008). The human body has a total of about 656 skeletal muscles and these muscles must be coordinated with each other to produce designated movements. All human actions or movements are the result of a neuromuscular integrated brain and body controlled process (Voight, Hoogenboom & Preventice, 2007). In other words, the nervous and skeletal muscle systems work together to perform

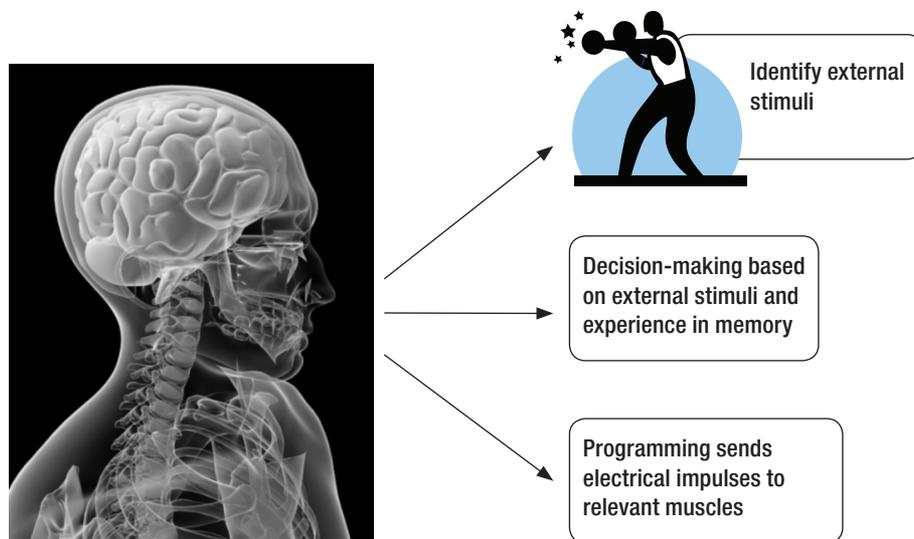


the designated and coordinated human movements. According to Lundy-Ekman (2007) and Bear, Connors, and Paradiso (1996), there are billions of nerve cells coordinated and working together from various regions of the human brain. Certainly, it is a tremendous challenge for a novice to learn the fundamental motor skills required to eventually become an elite athlete who can execute extraordinary coordinated movements precisely and perfectly. When performing certain motor skills such as those required for football, gymnastics, free-style aerial skiing, ultimate fighting, martial arts, combat sports, etc., any slight deviation from the planned movements can result either in failure to perform the designated motor skills successfully or in injury, possibly fatal. Without proper training, it is almost impossible for any human being to engage

in those coordinated movements. For example, kicking a ball, throwing a rock, or shooting a basketball are considered to be easy motor tasks to execute. But, without learning, children cannot even perform these simple motor tasks properly. Consequently, motor learning is essential for the majority of human movements, especially for many movement-related professions.

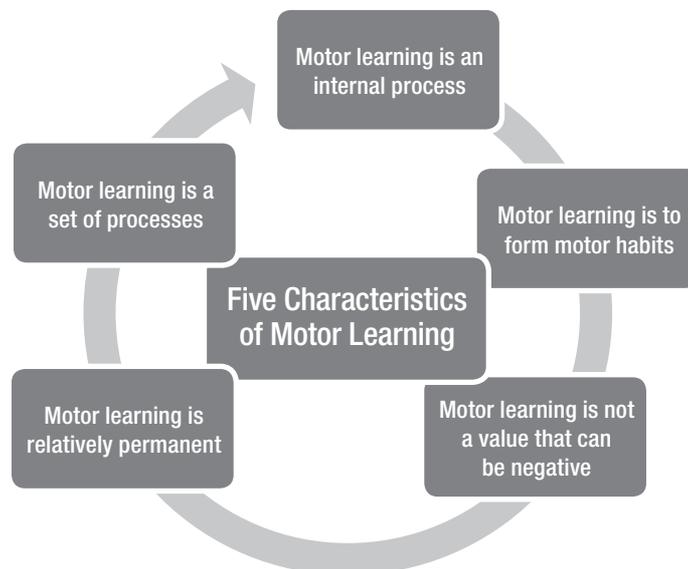
Motor learning refers to the relatively permanent gains in motor skill capability associated with practice or experience (Schmidt & Lee, 2005). Motor learning is an essential subject for many different professions. Especially, students who major in physical education/kinesiology, exercise or sports science, coaching education, physical therapy or the pedagogy of movement, as well as people in the military, the police and special forces, etc. should have a concrete understanding of the proper motor learning processes related to particular motor skills. In sum, *motor learning* is a multifaceted set of internal processes that effect relatively permanent change in human performance through practice, provided the change of motor skills cannot be attributed to a human's maturation, temporary state, or instinct (Kluka, 1999). In other words, the main objective of motor learning is to make a permanent change in the neurological functions which happen in the brain (see Figure 1.1).

In our society, people attempt to learn many different motor skills for a variety of purposes. Some skills are very complex and difficult to perform while others are easily learned. Sport scientists are always searching for the most effective training approaches to help learners efficiently master the required motor skills in the minimal time. The following are the five characteristics of the motor learning process (Figure 1.2; Schmidt & Wrisberg, 2008).



**FIGURE 1.1.** Brain's three stages of information processing in responding to the above attack.

- 1) Motor learning is an internal process that cannot be observed from an external perspective. This means that how much an athlete has learned is an unknown factor from an outsider's perspective because motor learning takes place inside the learner's brain and the muscular movements are only a reflection of brain activities. Observing motor performance provides only an indirect assessment of the learning progress of a learner.
- 2) Motor learning is a set of processes for the purpose of reaching specific learning objectives. Obviously, different types of learning will produce different results and sports scientists continuously search for the best motor learning processes for particular motor skills based on individual differences.
- 3) The goal of motor learning is to form the designated motor behavioral habits through proper training.
- 4) Once a motor skill is learned, it becomes relatively permanent and will not be easily forgotten. For example, once an individual has learned how to ride a bike, he/she will never forget how to do it (Schmidt & Wrisberg, 2008).
- 5) According to Wang & Yang (2012), motor learning is not value free and it can be negative to form a bad habit that is extremely hard to be changed once it is formed.

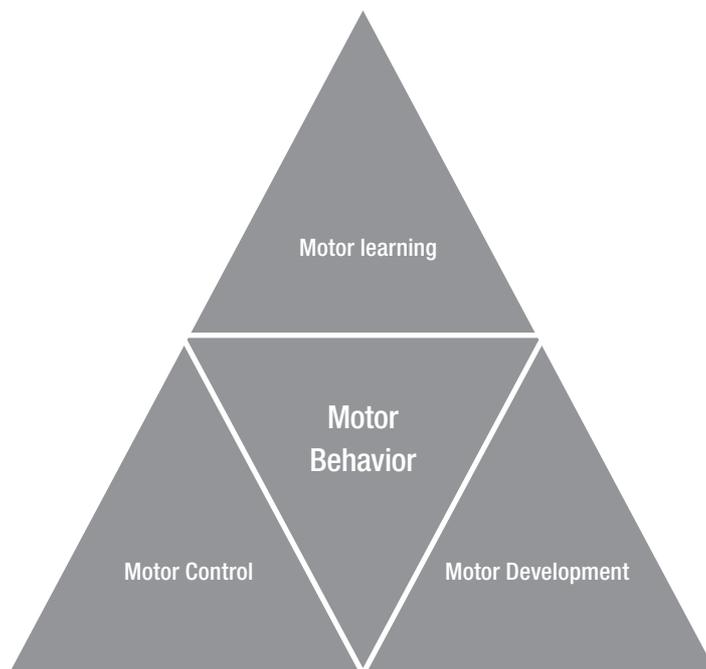


**FIGURE 1.2.** Five characteristics of motor learning.

### Basic Concepts of Applied Motor Learning and Performance

From the perspective of the discipline of kinesiology, several other academic disciplines are related to motor learning, namely motor behavior, motor control, motor development, and motor performance. At the graduate level, kinesiology departments usually offer these courses separately, even though these disciplines are interrelated. However, at the undergraduate level, many schools only offer motor learning and motor development. To provide a comprehensive understanding of motor learning and its related disciplines, an introduction to the concepts of the various disciplines has been described as follows.

Motor behavior can be considered the study of executed human performances and postures that are the result of integrated internal process that lead to a relatively permanent change in performance (Figure 1.3; Kluka, 1999).



**FIGURE 1.3.** Motor behavior's relationship with the related subjects.

*Motor control* is the study of postures and movements and the mechanisms that underlie them (Rose & Christina, 2006). Also, motor control can be defined as the study of how an individual can execute designated motor skills through the neuromuscular control process in response to external environmental demands (Haywood & Getchell, 2009; Latash & Lestienne, 2006). For example, a race car driver's brain activities include quickly processing external information (seeing the opponents' cars) to find an open space through which to get ahead of the others and achieve success. Specifically, motor control deals with issues such as information processing, attention and interferences, the mechanism of

**TABLE 1.1.** Three components of motor control areas of human movements

| Motor Control   |  |  |
|---|--|--|
| Neuromuscular control mechanism of responding to external stimuli | Neuromuscular mechanism of decision-making in advance for taking actions | Unconscious control mechanism for controlling reflex movements |

muscular coordination, sensory contributions to motor performance, and production of movements through neuromuscular systems (Table 1.1).

In sum, if researchers could understand the control mechanisms of the human brain for producing coordinated muscular movements, a motor learning process could be scientifically designed according to the characteristics of the neuromuscular control systems. For example, the neuromuscular control mechanism of high jumping is quite different from that of boxing because the action of high jumping can be planned in advance, while a boxer's action must rely on immediate external stimuli (opponent's actions). Needless to say, the advanced planning and consistency of movement control should be the high jumper's main concern in training; conversely, for boxing, speed, timing, and accuracy of response to an opponent's attack should be emphasized in training. More specifically, extero- and proprio-sensory information recognition, speed of decision-making, and programming of an action should be carefully examined to achieve the designated goals of boxing. Hence, motor control mechanisms for high jumping and boxing are vastly different. The human brain is a control center for carrying out movements and motor control studies how the brain controls coordinated movements in response to varied external environmental demands.

*Motor development* refers to the continuous, age-related process of change in movement, as well as the interacting constraints (or factors) in the individual, environment, and task that drive these changes (Haywood & Getchell, 2009). From a comprehensive perspective, motor development not only deals with the growth and developmental process of human movements, it also studies how the learning process affects the developmental process. Specifically, such study addresses both the process of change and the resultant movement outcome. With a complete understanding of the normal growth and developmental process as it relates to the motor learning process, teachers and practitioners can teach motor skills effectively to populations ranging from preschoolers to older adults.

*Motor performance* is an end result or outcome of executing a motor skill that can be observed from an external perspective. For example, coaches can see how a tennis player actually plays a game and how he/she performs during practice or competition. A tennis player's motor skills for performing a forehand or backhand stroke or for serving can be purposefully observed or assessed by instructors. Practically speaking, since motor

**TABLE 1.2.** Three components contribute to motor performance

**Factor Contribute to Motor Performance**

| <b>Learner's Characteristics</b><br>(age, gender, experience, cognitive ability, genetic traits, psychological characteristics, etc.) | <b>Instructor's Competence</b><br>(sports science background, athletic experience, knowledge of sport, administration and communication skill, human relation skills, etc.) | <b>Learning Environment and Conditions</b><br>(Undistractive learning environment, facility and equipment, sports field and settings, organization of training) |
|---|---|---|
|   |   |   |

learning takes place in an internal fashion in a learner's brain, one of the effective ways for an instructor to understand how much a student has learned is to observe his/her performance, which indirectly reflects the student's learning progress (Table 1.2.). In addition, other approaches such as asking students to explain the proper motor skill structures or to distinguish between correct or incorrect motor skill demonstrations can be used to test the extent of their understanding of motor skill concepts.

### **APPLICATIONS OF MOTOR LEARNING TO RELATED PROFESSIONS**

Motor learning is a subject with broad implications from which people teaching in many fields can benefit, ranging from the elementary school to the Olympic level, from recreational sports to the military, from non-competitive to combat institutions, from individual to team sports, etc. The emphasis in teaching can be quite varied and is based on the purpose of the motor learning, the particular motor skills required, and the needs of the learners. For example, at the elementary school level youngsters are taught basic motor skills such as kicking, throwing, jumping, running, catching, or climbing and these learned skills can then be transferred to various sports-related movements in the future. At the Olympic level, the purpose of motor learning is to achieve peak performance in competition. The following sections illustrate certain professions in which motor learning is an essential component.

In the area of physical education, from elementary school to the college level, students learn the different motor skills of various sports to keep fit, have fun, and develop a healthy lifestyle (NASPE, 2004). Learning proper motor skills is one of the most important objectives of physical education programs in school settings. With limited time available for physical education classes, teachers would be wise to teach students the proper motor skills for exercise and sports. According to Harter's perceived competence motivation theory (Harter, 1978; Harter, 1981), when an individual perceives himself/herself to be good at doing something, his/her motivation to engage in this activity is enhanced as well. The more successful the students are at mastering motor skills, the more likely they are to keep



playing sports as their life-long leisure activities. In other words, the effective teaching of motor skills to students in school settings will directly impact their future lifestyles and exercise habits. Thus, school physical education teachers should understand motor learning principles in order to teach students the correct motor skills.

With a thorough knowledge of motor learning, exercise and sports science professionals can effectively help their clients design training programs that incorporate the ideal movement activities required for the particular situation. One of the major responsibilities of these specialists is to engage the athletes, who play different sports, in strength and conditioning training; with an understanding of motor learning principles, they can properly design appropriate training programs for these athletes.

Likewise, an understanding of particular motor skills in relation to fitness benefits enables exercise science practitioners to design training programs that are enjoyable and help clients achieve their personal training goals. Participants in certain sports, such as football, soccer, ice hockey, boxing, martial arts, gymnastics, etc., are vulnerable to injuries. Using their knowledge of the structure of various motor skills, sports scientists can effectively advise these athletes on ways to avoid injury. In so many practical settings, exercise programs have direct correlations with the particular sports skill training chosen. Therefore, it would be very advantageous for exercise science specialists to know the motor learning principles for their teaching or consultation activities.

In the coaching arena, one of the major responsibilities of coaches is to enhance athletes' technical skills since their performance is mainly determined by these skills, along with their physical ability and psychological well-being. Athletes' technical abilities play a crucial role in whether they win or lose in competitions. Not only should a coach teach proper technical skills, he/she should also be continuously developing creative new

training methods to give the athletes an extra advantage in competition. This is because today's superior technical routines could be out of date in a few years. History has repeatedly shown that the human limits of performance of motor skills are constantly being surpassed. For example, today's gymnastic routines could have been perceived to be impossible to execute in the past. Likewise, the 10 seconds of 100-meter race records have been repeatedly broken in the recent Olympic Games. Due to the efforts of sports scientists and coaches, the level of technical training is now so far ahead that motor skills which once seemed impossible to learn have now become attainable. These accomplishments can, in part, be attributed to the advancement of our knowledge in the area of motor learning and its relationship to human movement potentials. Motor skill learning in the coaching arena has always been one of the most important factors of training for achieving peak performance in competition.

When injuries occur, physical therapists assist patients to recover through the appropriate rehabilitation processes. By assessing whether patients are capable of performing certain movements or motor skills, they are able to determine the most effective treatment methods. Sports injuries are sometimes unavoidable; millions of athletes from amateurs to professionals are injured while participating in sports activities. For many athletes, a speedy recovery from an injury is crucial for regaining their physical condition, maintaining skill routines, regaining self-confidence, and achieving peak performance. Hence physical therapists' knowledge of motor learning plays a vital role in enabling them to properly evaluate the degree of injury, design rehabilitation strategies, and assess the recovery progress. Based on their evaluation, they can provide accurate recommendations as to whether an athlete is capable of resuming certain technical training after an injury. When physical therapists understand the structures of the various motor skills and potential volatile factors related to the injury, they can develop effective treatment strategies to aid their patients' recovery and provide them with valuable advice on how to avoid injuries in the future with the correct movements.

Motor learning principles can be also used widely in military settings because soldiers must engage in combat with the enemy, either with bare hands or weapons, under severe or critical conditions; many times, any slight delay in their actions in battle could cost them their lives. Thus, soldiers' efficient, forceful, and timely reaction to the enemy's attacks and their swift fighting abilities play a significant role not only in winning battles but also in saving their lives. Military, special forces and ground soldiers, as well as police officers, are required to learn various motor skills to carry out their job responsibilities. With knowledge of motor learning principles, the professionals who train them can purposefully develop appropriate training regimes to fit the needs of their job requirements.

Ballet and other forms of dance involve artistic, beautiful, and swift kinematic movements that usually take years to perfect. In fact, many dancing movements are very difficult

to learn and master. Dancing instructors should learn human anatomy and motor learning concepts in order to understand the relationship between a dancer's anatomical capability and the performance of these movements. By using scientific principles, dancers can speed up their learning progress, especially for difficult and challenging movements that require perfect coordination among different dancers, split-second timing of the jumps and turns, and excellent body kinematics of the movements. Since dancing movements are consid-

**Kinematic movement – refers to a technique, body posture, movement pattern, process of movement, or structure of movement, which can be only evaluated by subjective approaches.**

ered to be process-oriented motor skills, dancers are unable to observe their own movements during practice or performance so they must rely on their instructors' accurate feedback to find out how well they are progressing. Without this external feedback, learning cannot occur. Consequently, if the instructor cannot grasp the key structures of certain motor skill rou-

tines, learning progress will be significantly compromised. Dancing instructors should understand more clearly the critical components of dancing routines and properly teach the skill transitions accordingly. In fact, dancing is great exercise for youngsters and adults; many people truly enjoy dancing for pleasure, competition, or exercise.

In addition to the aforementioned professionals, many amateur athletes regularly engage in different recreational sports or other physical activities in their spare time and they also would like to learn motor skills to enhance their enjoyment or for self-improvement and competition. Besides that, many of these amateur athletes serve as club coaches teaching sports skills to children, training them to improve their skills, and running competitions. In fact, there are thousands of sports clubs or sport organizations around the world providing opportunities for people of all ages (from the very young to older adults) to actively participate in sports activities. Having the necessary motor learning knowledge would be very beneficial for these athletes and coaches. The range of professions that involve motor skill related activities is much broader than we could possibly cover here.

## **UNDERSTANDING BASIC SCIENTIFIC METHODS IN THE MOTOR LEARNING PROCESS**

Practitioners regularly have to face challenges and solve practical problems they may experience. Generally speaking, they gain their knowledge either through scientific approaches or from real-life experiences through trial and error approaches (Weinberg & Gould, 2011). Any knowledge they gain based on their experience must be validated through scientific methods and then the knowledge gained can become theory. If this knowledge is not validated through scientific methods, it is called empirical knowledge. The advantages of the empirical approach for gaining knowledge are that it is convenient, flexible, and case-oriented. The disadvantages are that the results may be biased, invalid, or unreliable.