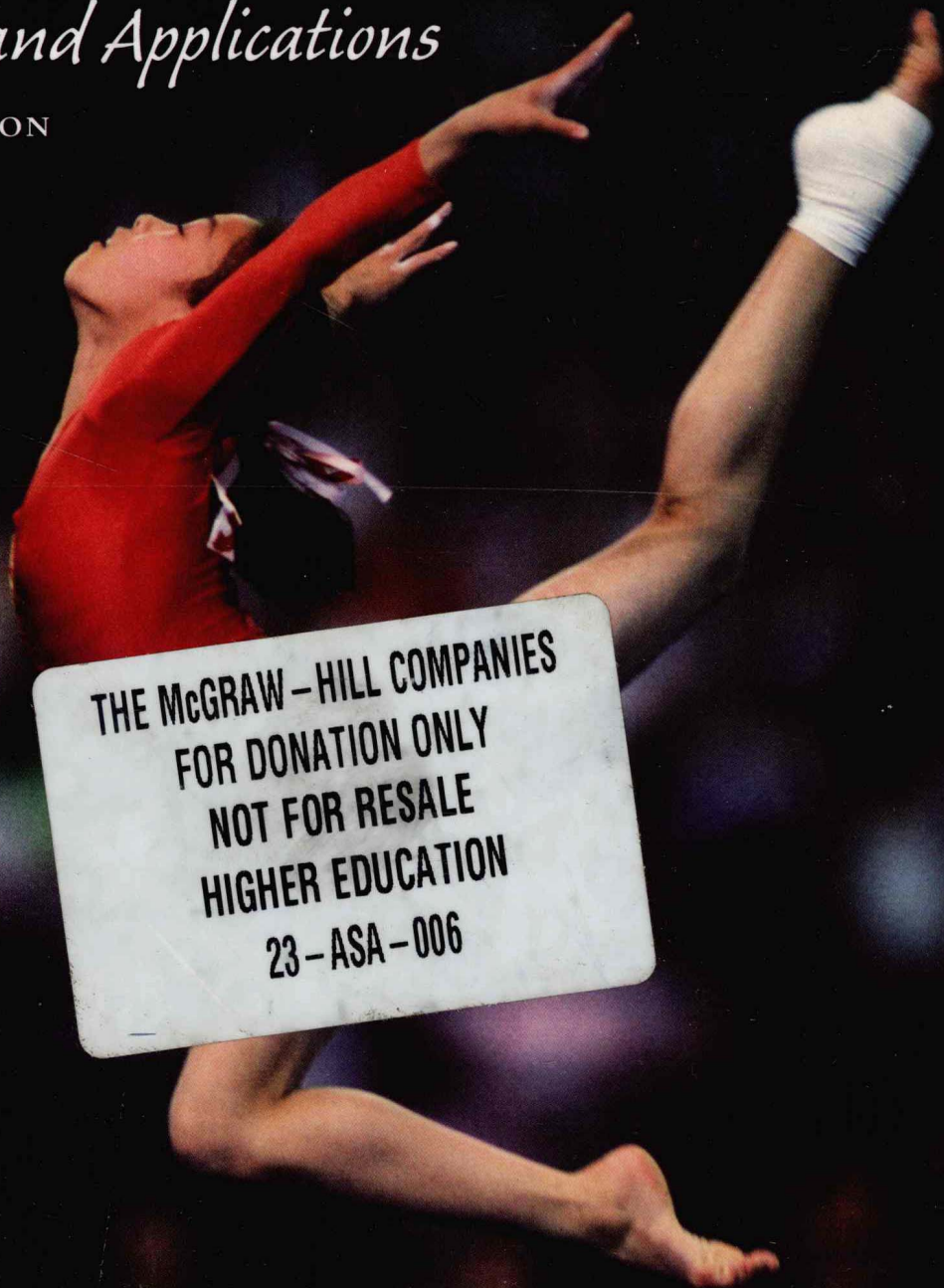


Motor Learning and Control

Concepts and Applications

SEVENTH EDITION



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Richard A. Magill

MOTOR LEARNING AND CONTROL CONCEPTS AND APPLICATIONS

SEVENTH EDITION

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PREFACE



The goal of this text continues in the path of earlier editions: to offer an introduction to motor learning and motor control for students who aspire to become practitioners in a variety of professions. In some of these professions, individuals will work with people who perform motor skills very well, such as elite athletes; in others, they will work with people who have difficulty performing motor skills, such as those with physical disabilities. Regardless of the characteristics and needs of the people with whom the practitioner works, he or she will need a solid understanding of the concepts and applications of motor learning and motor control. With this understanding as a foundation, the practitioner can adapt to the specific demands of each professional setting.

This edition includes specific changes designed to enhance the quality of the book as well as the educational experience of the student. The changes are the result of welcomed comments from instructors who use the book in their classes and from the reviewers of the previous edition.

NEW TO THIS EDITION

New Title

This new edition features the term *motor control* added to the title. The incentive to add this term came from reviewers of the text, who indicated they were not aware that motor control issues are included in the book. However, a comparison of the chapter titles in this seventh edition with the titles

in previous editions shows that motor control issues such as motor control theories, motor control of complex skills, the roles of proprioception and vision in the control of motor skills, and action preparation, have consistently been included in previous editions. It is important for users of previous editions of this book to understand that the title change does not mean that the emphasis of this edition has changed; only the title has been changed to reflect the content of the book more accurately.

Chapter Restructuring

Reviewers of the sixth edition expressed their concern that the book contained more chapters than could be covered in a typical one-semester course. Although it is difficult to write a textbook that would be an exact fit for every user's semester or instructional term, I have addressed this issue by reducing the number of chapters. The seventh edition includes 18 chapters, rather than 23 chapters, as in the sixth edition. This reduction was achieved by combining several of the sixth-edition chapters:

- Chapter 8 (Attention) combines the separate chapters on attention and visual selective attention.
- Chapter 11 (The Stages of Learning) combines the sixth edition's chapters on the stages of learning and predicting performance for later learning stages.
- Chapter 14 (Augmented Feedback) combines the three chapters that formerly addressed this topic.

- Chapter 16 (Amount and Distribution of Practice) combines the sixth edition's chapters on the amount of practice and the distribution of practice.

In addition to the combining of several sixth-edition chapters, this new edition reverses the order of two chapters in the first unit: Chapter 2 (The Measurement of Motor Performance) was Chapter 3 in the sixth edition, and Chapter 3 (Motor Abilities) was Chapter 2 in that edition.

New Research

One of the exciting aspects of the study of motor learning and motor control is the amount of research activity that takes place throughout the world. In fact, this activity appears to be increasing every year. Therefore it becomes especially important to regularly update this textbook in order to offer the students the most current information. Each chapter in the seventh edition includes an updating of research in the text, the A Closer Look boxes, and the Related Readings section.

Greater Emphasis on Motor Skills Applications

As in previous editions, numerous types of motor skills are used as examples throughout the book to allow students to apply the various motor learning and control concepts to specific motor skills with which they are familiar. However, the number of practical applications has been increased to demonstrate how teachers, coaches, physical and occupational therapists, and athletic trainers can use motor learning and control in their fields.

My own teaching experience with undergraduates has convinced me that students acquire a better understanding of the concepts discussed in this book when they can relate them to their own skill performance or learning experiences. Because of the variety of backgrounds, interests, and professional aspirations of students who use this book, the specific skills included throughout the book relate to a wide range of types of motor skills, including activities of daily living, physical education, fitness activities, sports, and dance.

Chapter Objectives

Each chapter now begins with a list of chapter objectives. This new feature encourages students to focus on the key topics, making it easier for them to learn and review the content of each chapter.

Lab Links

The Online Learning Center developed for this book includes a laboratory manual that features laboratory experiences designed for most chapters in this text. To direct students' attention to these activities, this edition includes a Lab Links box that highlights a specific online laboratory activity that corresponds to a particular chapter topic. Most of the chapters have one Lab Links box, and some have more than one.

NEW OR EXPANDED TOPICS

This new edition has undergone a thorough revision that includes updating in all chapters. Each chapter features topics that are either new to this revision or covered in greater depth than in the last edition. Following is a sampling of these new or expanded topics:

Chapter 1: The Classification of Motor Skills

- New figure to illustrate examples of skills associated with the three motor skill classification systems based on one dimension of motor skills
- Revised table presenting skill categories of Gentile's taxonomy to include examples of motor skills
- New A Closer Look box to offer examples of use of Gentile's taxonomy to evaluate movement capabilities in physical therapy and physical education

Chapter 2: The Measurement of Motor Performance

- New A Closer Look box to present example of calculation and use of absolute error, constant error, and variable error
- New figure to illustrate calculation of radial error

- Revised figure showing displacement, velocity, and acceleration with examples based on wrist movement in dart throwing
- Expanded discussion of kinetics
- Expanded discussion of EMG

Chapter 3: Motor Abilities

- Expanded discussion of specificity view of motor abilities
- Expanded intercorrelation table (Drowatzky and Zuccato experiment) with added descriptions of balance tests
- Added section on balance and timing as motor abilities
- New A Closer Look box presenting Henry's 1961 study of the relationship between reaction time and movement time
- New table focusing on definitions, tests, and motor skill examples of the perceptual-motor abilities categories of Fleishman's taxonomy

Chapter 4: Motor Control Theories

- Expanded discussion of the definition of *coordination*
- New A Closer Look box presenting a demonstration used by Bernstein to demonstrate the degrees-of-freedom problem
- Added discussion of the relationship between invariant features and parameters of a generalized motor program
- Revised figure showing the results of a study by Shapiro and colleagues to illustrate the differences between relative time characteristics of walking and running
- Added discussion concerning intrinsic coordinative structures
- Expanded discussion of perception-action coupling
- Revised discussion of the present state of the control theory issue

Chapter 5: Performance Characteristics of Complex Skills

- Revised figure of examples of tasks with different indexes of difficulty to show approximate movement times

- New A Closer Look box to describe a study investigating initial difficulties people have trying to control upper-extremity prostheses when performing a prehension task
- New section on head stability and locomotion

Chapter 6: Proprioception and Vision

- Expanded discussion of the role of proprioception in control of human movement
- New A Closer Look box featuring the use of eye tracking in the study of eye and hand movements
- Expanded discussion of the roles of central (foveal) and peripheral vision in control of human movement
- Added discussion on maintaining of postural balance and the role of optical flow
- New A Closer Look box describing an experiment that demonstrates how skilled gymnasts use vision on the balance beam
- New A Closer Look box highlighting research evidence concerning the information that vision provides people during stair climbing
- New A Closer Look box describing mathematical models that answer the question, What control strategy does a person use to catch a ball that requires running some distance to catch it?
- New A Closer Look box featuring conclusions derived from research concerning the question, Do general vision training programs for athletes improve sports performance?

Chapter 7: Action Preparation

- New A Closer Look box presenting a historical look at the use of reaction time to study action preparation
- Added discussion of the Stroop effect in the section on stimulus-response compatibility
- Expanded discussion of postural preparation
- Added discussion of setting of the amount of force in preparation for manipulating an object

- Added discussion of preparation of sequences of simple movements

Chapter 8: Attention as a Limited Capacity Resource

- New A Closer Look box featuring a recent research study on attention and cell-phone use while driving a vehicle
- New A Closer Look box describing a physical therapy study that demonstrates the use of dual-task procedure to investigate attention demands of gait for people with Parkinson's disease
- New discussion of a comparison of focusing attention on movements versus movement effects
- Added discussion of visual search and intended actions
- New A Closer Look box about a study concerning the influence of distractors on prehension and implications for physical rehabilitation treatment protocols

Chapter 9: Memory Components, Forgetting, and Strategies

- New A Closer Look box to describe a series of studies concerning the influence of proactive interference on gymnastic judges
- Expanded discussion of the use of visual imagery and verbal labels to aid motor skill learning
- Chapter content revised and reduced for clarity

Chapter 10: Defining and Assessing Learning

- Clarification of examples of performance curves for kinematic measures
- Expanded discussion of assessing learning based on coordination dynamics

Chapter 11: The Stages of Learning

- Expanded and updated terminology in the discussion of Gentile's model
- Expanded discussion of the relationship between the degrees-of-freedom problem (Chapter 4) and the freezing of degrees

of freedom as an early stage of learning strategy

- Revised and expanded discussion of changes in energy cost
- Expanded discussion of changes in visual selective attention
- Expanded discussion of changes in error detection and correction capability
- New discussion of specificity of use of sources of feedback as a performer characteristic that does not change across stages of learning
- New A Closer Look box presenting views of researchers and practitioners about the use of mirrors in dance studios and weight training rooms

Chapter 12: Transfer of Learning

- Expanded discussion on assessing effectiveness of practice conditions
- New discussion concerning what constitutes "component part" of a skill
- New A Closer Look box describing research study concerning use of bilateral transfer as occupational therapy treatment strategy

Chapter 13: Demonstration and Verbal Instructions

- Expanded discussion of frequency and timing of demonstrations
- Revised and expanded discussion of auditory modeling
- Expanded discussions of cognitive mediation theory and dynamic view
- New discussion of the action effect hypothesis in relation to verbal instructions
- New A Closer Look box describing a research study concerning the use of implicit learning-based instructional strategy to train anticipatory skills in tennis
- New A Closer Look box focusing on potential instruction-related problems experts may expect with beginners

Chapter 14: Augmented Feedback

- Expanded discussion of types of augmented feedback
- New A Closer Look box featuring a research study that describes the stages skilled athletes progress through in learning to use videotape replays as augmented feedback
- New A Closer Look box to describe some forms that concurrent augmented feedback can take, with examples
- Expanded discussion of self-selected augmented feedback
- Revised discussion of summary technique to include average augmented feedback technique

Chapter 15: Practice Variability

- Expanded discussion of future performance benefits of practice variability
- New A Closer Look box to describe an experiment comparing constant and variable practice for learning to shoot free throws in basketball
- New A Closer Look box to describe an experiment demonstrating the application of the contextual interference effect for physical therapy for stroke patients
- Expanded discussion of explanations for the contextual interference effect
- New A Closer Look box to discuss the relationship of practice variability to practice specificity and contextual interference

Chapter 16: The Amount and Distribution of Practice

- Expanded discussion of how overlearning strategy can lead to poor test performance
- New section on explanations for distributed practice benefit in relation to distribution of practice sessions across days

Chapter 17: Whole and Part Practice

- More motor skill examples in discussion of practicing skills involving asymmetric limb coordination

- Expanded discussion of methods for reducing task difficulty as practice strategy

Chapter 18: Mental Practice

- Expanded definition of the term *mental practice*
- New A Closer Look box to describe an experiment demonstrating the use of mental practice in a physical therapy treatment program
- Expanded discussion of mental practice and imagery ability

SUCCESSFUL FEATURES

Motor Learning and Control: Concepts and Applications offers the following helpful features to enhance student learning.

Definition Boxes

Key terms, which are highlighted in the text in boldface type, are defined in corresponding boxes for easy reference. Other important terms in the text appear in italics for emphasis.

Applications

Each chapter begins with an Applications section that explains the chapter concept in practical terms. This feature helps students understand the relevance of the concept to professional practice.

Discussion

This section explains how the chapter concept will be presented. It gives students the rationale for this presentation, making the concept easier to understand at the outset.

Summary

Each chapter concludes with a summary that presents the main ideas and their significance. Using this tool, students can return easily to a chapter topic for clarification or study.

Related Readings

For students who want to know more about a particular topic, this list at the end of each chapter offers carefully selected journal articles and books for exploration.

Study Questions

A set of questions appears at the end of each chapter to encourage students to review and analyze the chapter content.

Glossary

At the end of the text, all terms that are defined in the definition boxes are included in a comprehensive glossary. This glossary is useful for quick reference and helpful for review in preparation for examinations.

Name Index

In addition to the regular subject index, this book features a name index, which highlights important names in the field of motor learning and control—both past and present.

SUPPLEMENTS

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— ■ —

TO MY LOVELY WIFE
SUSAN RUTH KOFF

— ■ —



Higher Education

MOTOR LEARNING AND CONTROL: CONCEPTS AND APPLICATIONS, SEVENTH EDITION

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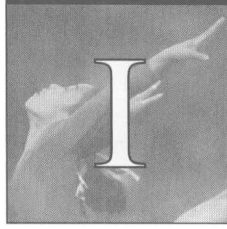
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UNIT



INTRODUCTION TO MOTOR SKILLS AND ABILITIES

CHAPTER 1

The Classification of Motor Skills

CHAPTER 2

The Measurement of Motor Performance

CHAPTER 3

Motor Abilities

CHAPTER



The Classification of Motor Skills

***Concept: Motor skills can be classified
into general categories***

After completing this chapter, you will be able to

- Define and distinguish the terms *action* and *movement*, and give examples of each
- Describe the one common motor skill characteristic for each of three motor skill classification systems, the two categories of skills in each system, and examples of motor skills in each category of each system
- Describe the two dimensions used to classify skills in the Gentile taxonomy of motor skills and the classification characteristic included within each dimension
- Discuss ways to use the Gentile taxonomy of motor skills in physical rehabilitation or physical education and sport contexts

Application

When people run, walk with an artificial limb, throw a baseball, hit a tennis ball, play the piano, dance, or operate a wood lathe, they are engaged in the performance of a type of human behavior called *motor skills*. In this book, the focus is on helping you understand how people learn, and how you can help people learn, motor skills such as these.

As you engage in this study, you will find it useful to draw general conclusions, applying what you learn to a broad range of motor skills, rather than making many specific statements about many skills. The starting point for doing this is the classification of motor skills into broad categories that

emphasize the similarities rather than the differences among skills.

For example, the skill of maneuvering a wheelchair through a crowded hallway and that of hitting a pitched baseball seem quite distinct. However, both skills have one characteristic in common. People must perform both skills in an “open” environment. This means that to perform the skill successfully, a person must adapt certain aspects of his or her movements to changing characteristics in the performance environment. For the wheelchair skill, this means that the person must be able to maneuver successfully through a crowded hallway in which people are walking. For the baseball-hitting skill, the changing environment involves the ball

itself as it moves toward the person. For both of these skills, performance success requires the performer to adapt quickly and accurately to changing conditions. When we view them in terms of this common characteristic, we can see that these two seemingly diverse skills are related.

Discussion

To begin your study of motor learning, you should understand some things about the skills that are at the heart of this study. To enhance this understanding, two important points about motor skills will be discussed. First, we will define motor skills, considering what distinguishes them from other skills; as we do so, we will define some other commonly used terms related to the term *motor skill*. Second, we will discuss four different approaches to classifying motor skills into categories that identify common characteristics of various skills. The benefit of classifying skills is that it can provide you with an appropriate basis for establishing generalizations, or principles, about how we perform and learn motor skills. These generalizations will enable you in turn to develop theories about skill performance and learning. Additionally, they help establish guidelines for instructors, coaches, and therapists who must develop effective strategies that will enhance motor skill learning and rehabilitation.

SKILLS, ACTIONS, AND MOVEMENTS

Several terms in the motor learning literature are related to the term *motor skills*. These are *skills*, *actions*, and *movements*. Each term is used in a specific way you should understand and use correctly.

Skills and Actions

The term **skill** is a commonly used word that you will see in this text denotes a *task that has a specific goal to achieve*. For example, we commonly say that “multiplication is a fundamental skill of mathematics,” or “playing the piano is a skill that takes practice.” Of these two examples, the skill of

piano playing includes a **motor skill** because it is *a skill that requires voluntary body, head, and/or limb movement to achieve its goal*, which is to play the piano. Looked at this way, the skill of piano playing involves the goal of striking the correct keys in the proper sequence and at the appropriate time, and it requires finger and hand movement to achieve that goal.

In the motor learning and control research literature, a term that has become increasingly more common to designate a specific motor skill is the term *actions*. For our purposes, we can consider this term as synonymous and interchangeable with the term *motor skills*. That is, **actions** are *goal-directed activities that consist of body, head, and/or limb movements*.

Note several characteristics that are common to motor skills. First, there is *a goal to achieve*. This means that motor skills have a purpose. Sometimes you will see the term *action goal* used to refer to the goal of a motor skill. Second, the types of motor skills of interest in this text are *performed voluntarily*; in other words, we are not considering reflexes as skills. Although an eye blink may have a purpose and involve movement, it occurs involuntarily and is therefore not a skill in the sense in which we are using the term. Third, a motor skill *requires body, head, and/or limb movement* to accomplish the goal of the task. This characteristic is especially important because it is the basis for distinguishing motor skills from other types of human skills. For example, although solving math problems is a skill, it does not *require* body and/or limb movement to achieve its goal. We commonly refer

skill (a) an action or task that has a specific goal to achieve; (b) an indicator of quality of performance.

motor skill a skill that requires voluntary body and/or limb movement to achieve its goal.

action a goal-directed activity that consists of body and/or limb movements.