Instruction and Augmented Feedback

UNIT FIVE

CHAPTER 14

Demonstration and Verbal Instructions

Concept: Effective methods of providing instructions for helping a person to learn motor skills depend on the skills and the instructional goals.

After completing this chapter, you will be able to

- Describe what an observer perceives from a skilled demonstration of a motor skill and procedures researchers have used to arrive at this conclusion
- Discuss the influence of beginners observing other beginners as they practice a skill
- Identify the main features of the two predominant theories about how observing a demonstration helps a person learn a motor skill
- Give examples of how instructions can influence where a person directs his or her attention when performing a motor skill
- Define *verbal cues* and give examples of how they can be used in skill learning or relearning situations

APPLICATION

If you wanted to instruct someone about how to perform a skill, how would you do it? Probably, you would demonstrate the skill, verbally describe what to do, or use some combination of both approaches. But do you know enough about the effectiveness of these different means of communication to know which one to prefer or when to use each one or both?

Demonstrating skills is undoubtedly the most common means of communicating how to perform them. We find demonstrations in a wide range of skill acquisition situations. For example, a physical education teacher may demonstrate to a large class how to putt in golf. A dance teacher may demonstrate to a class how to perform a particular sequence of movements. A baseball coach may show a player the correct form for bunting a ball. In a rehabilitation context, an occupational therapist may demonstrate to a patient how to button a shirt, or a physical therapist may demonstrate to a wheelchair patient how to get from a bed into the chair. Consider also some examples of how practitioners in other professions use demonstration as an instructional strategy. Aerobics and fitness instructors often demonstrate to their clients how to perform specific activities. Pilates and yoga instructors show their clients how to perform specific movements. And athletic trainers commonly demonstrate taping techniques to student trainers.

The practitioner demonstrates a skill because he or she believes that in this way the learner receives the most helpful, and the greatest amount of, information in the least amount of time. But, we should know when demonstration is effective and when it may be less effective than some other means of communicating how to perform a skill.

Similarly, the instructor should know when verbal instructions are an effective means of communicating how to perform a skill. And if verbal instructions are given, what characterizes the most effective instructions?

Application Problem to Solve Describe a motor skill that you might help people learn. Describe how you would provide them with information about how to perform the skill before they begin practicing the skill. Indicate why you would present this information in this way and not in some other way.

DISCUSSION

It is ironic that although demonstration is a very common method of providing information about how to perform a skill, there is not as much research related to it as we might expect. However, in recent years researchers have shown an increased interest in the role of demonstration in motor skill learning.

There seem to be at least two reasons for the increased interest in demonstration and skill learning. One reason is the phenomenal growth of interest in the role of vision in skill learning. Because demonstrating how to do a skill typically involves visual observation on the part of the learner, researchers have been able to use the study of demonstration and skill learning to assess how the visual system is involved in skill acquisition and performance. Another reason for the current interest is that we know so little about how to effectively implement this very common instructional strategy. As a result, researchers have been making an increased effort to improve our understanding of the role of demonstration in skill instruction and learning.

DEMONSTRATION

The terms **modeling** and **observational learning** often are used interchangeably with the term *demonstration*. Because *demonstration* is more specific to the context of instruction about how to perform a skill, we will use this term in this text.

In comprehensive reviews of research investigating the role of demonstration in motor skill acquisition, McCullagh and Weiss (2001) and McCullagh, Law, and Ste-Marie (2012) discussed evidence that indicates demonstration is more effective under certain circumstances than under others. And in an article that reviewed research concerning instruction of sports skills, Williams and Hodges (2005) questioned many popular beliefs that influenced practice and instruction in the coaching of soccer. One of the beliefs they questioned, which the researchers listed as "myths," was "Myth 1: Demonstrations are always effective in conveying information to the learner" (p. 640). Thus reviews of research related to the effectiveness of demonstrations as an instructional strategy concluded that the practitioner should use demonstration only after determining that the instructional situation indeed warrants the use of demonstration, rather than some other form of providing information about skill performance. In the following sections, we consider some of the concerns that practitioners need to take into account before making this instructional decision.

What the Observer Perceives from a Demonstration

The decision about the situations in which demonstration would be preferred should be based on our knowledge of what a person actually "sees" when a skill is demonstrated. Note the use of the word "sees" rather than "looks at." What we see and what we look at can be very different. What we "see" is what we *perceive* from what we look at. This distinction is particularly relevant to the discussion of demonstration, because what a person perceives from a skill demonstration is not necessarily something that he or she specifically looks at or looks for. It is also important to keep in mind that what we perceive may be at a conscious or nonconscious level of awareness. For example, when people are asked later to describe verbally what they saw in

modeling the use of demonstration as a means of conveying information about how to perform a skill.

observational learning learning a skill by observing a person perform the skill; also known as *modeling*.

A CLOSER LOOK

Perceiving a Throwing Action from Observing a Point-Light Display

An experiment by Williams (1988) provides an example of the use of the point-light technique. Eighty adults (ages eighteen to twenty-five years) and eighty children (ages fourteen to fifteen years) observed a video point-light display of a side view of the arm of a seated person throwing a small plastic ball at a target (see figure 14.1). The video showed only dots of light at the shoulder, elbow, and wrist joints of the person throwing the ball. The author showed participants the video three times and then asked them what they had seen. Results showed that 66 percent of the children and 65 percent of the adults responded that they had seen a throwing motion. An additional 25 percent of the adults and 23 percent of the children made this response after seeing the video one additional time.

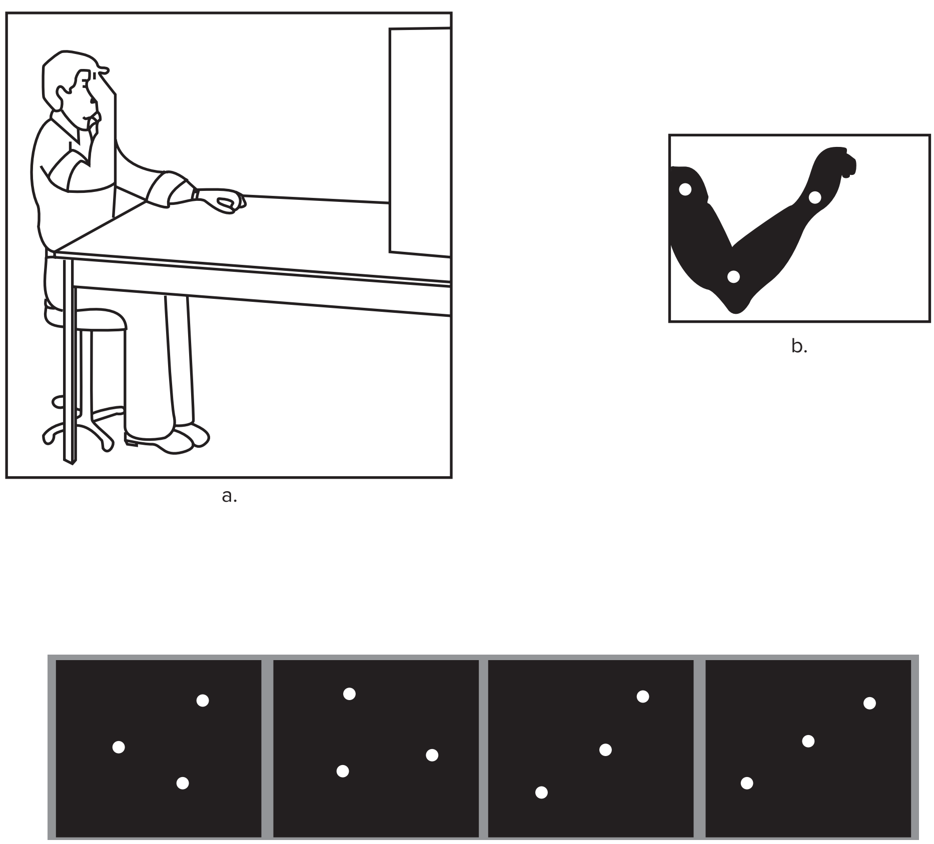

FIGURE 14.1 An example of use of the point-light technique in motor learning research. (a) The model demonstrating the throwing of a small ball at a target. (b) A static image of the point-light display of the model's arm with lights at the shoulder, elbow, and wrist joints. (c) Four still frames of the video shown to subjects. From left to right, these depict the arm at the start of the throw, at maximal flexion, at release of the small ball, and at completion of the throw. *Source:* From Williams, J. G. (1989). Visual demonstration and movement production: Effects of timing variations in a model's action. *Perceptual and Motor Skills, 68,* 891–896.

a demonstration that helped them perform a skill, they do not always give a very accurate accounting.

Research evidence has shown consistently that the observer perceives from the demonstration information about the coordination pattern of the skill (e.g., Ashford, Bennett, & Davids, 2006; Horn & Williams, 2004). More specifically, *the observer perceives and uses the invariant relative motions that characterize the coordinated movement pattern* to develop his or her own movement pattern to perform the skill.

Two types of research evidence support this view. One involves the investigation of the visual perception of motion; the other is the investigation of the influence of demonstration on learning a complex skill. Taken together, these two types of research indicate that the visual system automatically detects in a movement pattern invariant information for determining how to produce the observed action. In some manner, which scientists do not fully understand and continue to debate, the person translates the perceived information into movement commands to produce the action.

The Visual Perception of Motion

Research investigating the perception of human motion attempts to answer questions about how people recognize movement patterns they see in their world. An important principle developed from this research is that people rarely use specific characteristics of the individual components of a pattern to make judgments about the pattern. Rather, they use relative information about the relationships among the various components.

Using a procedure known as the **point-light technique,** researchers have identified the relative information involved in the visual perception of human movement. This procedure involves placing lights or light-reflecting markers on the joints of a person who is then filmed or videotaped performing an action or skill. Then the researcher plays the film or video so that the person who watches the film or video sees only bright dots in motion. The first reported use of this procedure (Johansson, 1973) showed that people could accurately label different gait patterns, such as walking and running, by observing the moving dot patterns. Later, Cutting and Kozlowski (1977) showed that from observing moving dot patterns, people actually could identify their friends. In addition, Abernethy and Zawi (2007) have shown that expert badminton players could predict the direction of an opponent's strokes in advance of racquet-shuttlecock contact just as well when they viewed full-body videos or point-light displays. An impressive amount of research has shown that observers are able to detect a range of different movements and a range of different movement characteristics based on point-light displays. (For a review of this research see Blake & Shiffar, 2007.) Using a computer simulation, Hoenkamp (1978) showed that the movement characteristic people use to identify different gait patterns is not any one kinematic variable, but the *ratio of the time duration between the forward and return swings of the lower leg.*

This groundbreaking research on the perception of human movement provided two important conclusions that help our understanding of observational learning. First, people can recognize different gait patterns accurately and quickly without seeing the entire body or all the limbs move. Second, the most critical information people perceive in order to distinguish one type of gait pattern from another is not any one characteristic of the gait, such as velocity of the limbs. Instead, people use the invariant relative time relationship between two components of gait. The question that naturally arises, then, is if people use relative motion information to recognize movement patterns, is the provision of this source of information in a demonstration the most effective way to bring about changes in coordination?

point-light technique a research procedure used to determine the information people use to perceive and identify coordinated human actions; it involves placing LEDs or light-reflecting material on certain joints of a person, then filming or videotaping the person performing an action; when an observer views the film or video, he or she sees only the points of light of the LEDs or light-reflecting markers, which identify the joints in action.

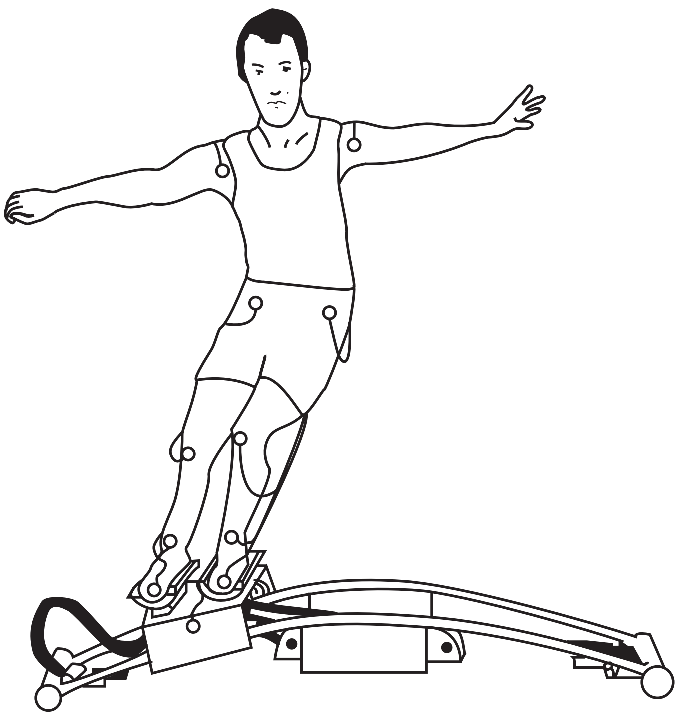

FIGURE 14.2 A person performing on the slalom ski simulator. Note that the person has attached LED markers for movement analysis purposes.

What Movement Characteristics Change When Learners View a Skilled Demonstration?

Having established that perceivers use relative motions to distinguish different patterns of movement, one would expect to see that the learners' pattern of relative motions changes after they have viewed a skilled demonstration. An experiment by Schoenfelder-Zohdi (1992), in which subjects practiced the slalom ski simulator task shown in figure 14.2, supports this expectation. This simulator consisted of two rigid, convex, parallel tracks on which a movable platform stood. A participant stood on the platform with both feet and was required to move the platform to the right and then to the left as far as possible (55 cm to either side) with rhythmic slalom ski–like movements. The platform was connected on either side to each end of the apparatus by strong, springlike rubber bands, which ensured that the platform always returned to the center (normal) position. Thus, the participant had to learn to control the platform movement by using smooth ski-like movements, just as he or she would if actually skiing. Participants practiced this skill for several days after they had either observed a skilled model perform the task or received verbal information about the goal of the task. A kinematic analysis of limb movements showed that participants who had observed the skilled demonstration developed coordinated movement patterns earlier in practice than did those who had not observed the demonstration. Figure 14.3 shows one example of these results. Moreover, in a meta-analysis of 64 studies involving a variety of motor skills, Ashford, Davids, and Bennett (2006) showed that demonstrations convey relative motions required to approximate modeled movement behaviors. Research has also shown that the observation of full-body demonstrations are not necessary to bring about changes in movement coordination. For example, Horn, Scott, Williams, and Hodges (2005) showed equivalent changes in the pattern of relative motions underlying a soccer chipping skill when learners watched a video display or a point-light display of a skilled performer.

Although changes in coordination have been documented following the observation of full-body video demonstrations and point-light displays, learners do not necessarily need to see a model's relative

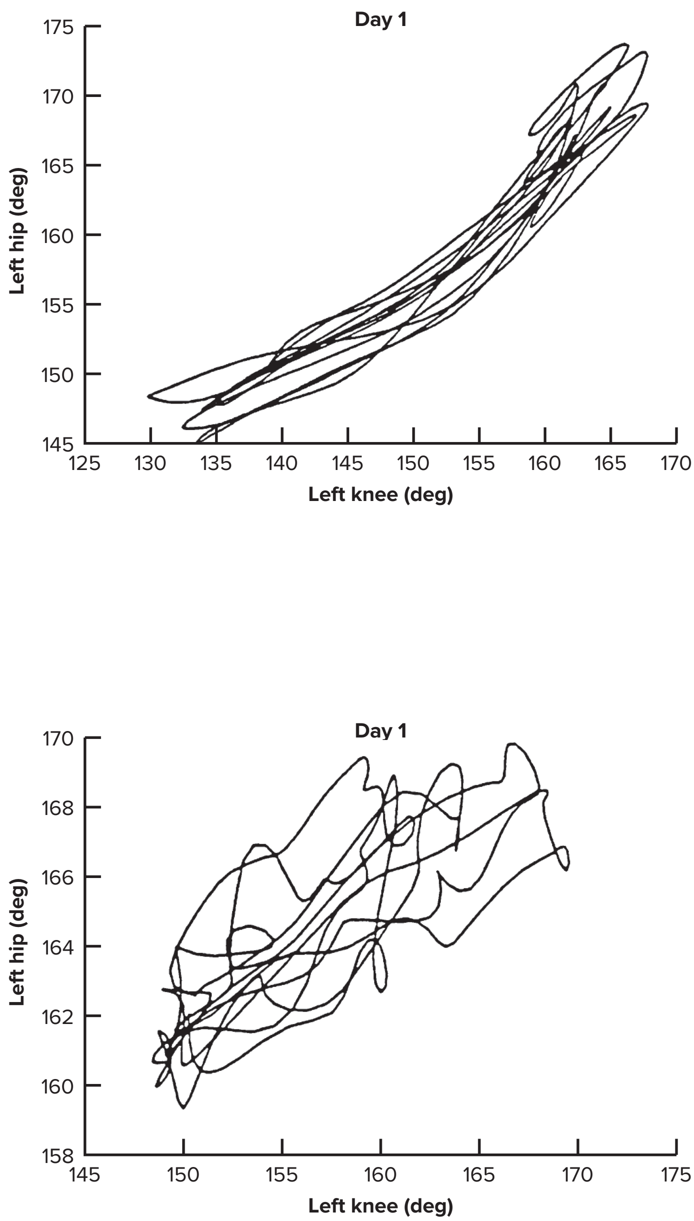

FIGURE 14.3 Angle-angle diagrams of the left knee and left hip for two people practicing on the slalom ski simulator. Both graphs show the relationship of these joints after one day of practice. The top graph is from the person who watched a skilled model demonstrate; the lower graph is from the person who did not watch a demonstration. *Source:* From Schoenfelder-Zohdi, B. G. (1992). *Investigating the informational nature of a modeled visual demonstration,* Ph.D. dissertation, Louisiana State University. Reprinted by permission.

motions to reproduce them. Support for this notion has been provided in an experiment by Hodges, Hayes, Breslin, and Williams (2005) in which participants learned a novel kicking motion that was used by a well-practiced player to "scoop" a soccer ball over a barrier and onto a target. The participants were shown a point-light display of either the knee, ankle, and toe during the kicking task (Leg), just the ankle and foot (Foot), or only the toe (Toe). Results indicated that the group receiving only the information about the toe more closely matched the pattern of hip-knee coordination used by the model than the groups receiving the additional information. The superiority of the Toe group was seen when the learners practiced the kicking motion after the demonstration, when they practiced again after receiving

A CLOSER LOOK

Clinical Implications of a Mirror Neuron System

In a review of mirror neuron research, Pomeroy and colleagues in London, England (Pomeroy et al., 2005), concluded that the existence of a human mirror neuron system in the brain suggests the beneficial use of observation-based therapy for the rehabilitation of upper-arm movement in poststroke patients. The therapy would involve stroke patients observing a healthy person's arm movements during goal-directed activities. Since that proposal, researchers have reported experiments that have found support for the benefit of observational learning (referred to as "action observation" by rehabilitation researchers) for improving arm and hand function of stroke patients, especially when combined with regular physical therapy (e.g., Celnik, Webster, Glasser, & Cohen, 2008; Small, Buccino, & Solodkin, 2012). Researchers have also shown that stroke patients can benefit from observing their own movements using a technique known as *feedforward video self-modeling*. For example, Steel et al. (2018) videotaped stroke patients performing a simple reaching and grasping task with their affected and un-affected arm. The videos were edited such that the patients could observe either their best movements with their affected arm or a video-reversed version of their movements with the un-affected arm that was designed to create the illusion the affected arm could perform the task proficiently. Significant improvements in performance on the task with the affected arm and in movement self-confidence were seen after the patients simply watched the videos three times per day over one week.

a full-body point-light display of the kicking motion, and when they actually kicked the ball over the barrier toward the target. Interestingly, larger changes in knee-ankle coordination in the Leg and Foot groups were seen when the learners had to kick the ball than when they were shown the full-body demonstration. In other words, the constraint imposed by the ball had a greater influence on the acquisition of the coordination pattern than did viewing the pattern of relative motions of the well-practiced player's whole body.

The findings reported by Hodges et al. (2005) are consistent with Latash and Turvey's (1996) claim that people are generally concerned about controlling the distal point of the limb during the execution of everyday movements. Hodges, Williams, Hayes, and Breslin (2007) have provided additional examples of coordination changes induced by observing the motions of end effectors and, consistent with the *action effect* and *constrained action* hypotheses introduced in chapter 9, have also suggested that demonstrating movement effects (e.g., the trajectory of a ball) might be as effective in inducing coordination changes as providing end-point information in a demonstration. Hodges et al. (2007) also note, however, that modeling end-point information is not always more effective than modeling relative motion information in facilitating the acquisition of new patterns of coordination. Rather, the effects seem to be task specific and potentially also specific to the learner's skill level. Clearly, more research is needed to resolve exactly what sources of invariant information should be provided to learners and when they should be provided during the learning process. In the meantime, practitioners should be aware that it is important to consider potential differences in how movement is perceived (recognized) versus how it is controlled, particularly during the early stages of skill acquisition, when determining the most appropriate information to provide to learners in a demonstration.

The Influence of Skill Characteristics

Research has produced equivocal findings about the effectiveness of demonstrations for learning new skills. Some researchers have found that demonstration leads to better skill learning than other forms of instruction; others have found that it does not. But as Magill and Schoenfelder-Zohdi (1996) pointed out, a closer inspection of that research leads to the conclusion that the influence of demonstration on skill acquisition depends on characteristics of the skill being learned. The most important characteristic that determines whether a demonstration will be beneficial is whether the skill being learned requires the *acquisition of a new pattern of coordination.*

A CLOSER LOOK

Beginners Learn by Observing Other Beginners: Learning the Tennis Volley

An experiment by Hebert and Landin (1994) nicely illustrates how practitioners can facilitate skill acquisition for beginners by having them observe other beginners.

Participants: Female university students who had no previous formal training or regular participation in tennis.

Task: Tennis forehand volley with the nondominant hand.

Practice procedures: All participants first saw a brief instructional videotape that emphasized the basic elements of the volley.

- *Learning model group:* Participants practiced the volley for fifty trials; the instructor provided verbal feedback after each trial. Each student in this group had a student, who was not in this group, observe and listen to a videotape of her practice trials.
- *Observer groups:* After observing the learning models, participants were divided into two groups and began their own fifty trials of practice.
  —*Observer group with verbal feedback:* Participants in this group received verbal feedback from the instructor after each practice trial.
  —*Observer group without verbal feedback:* Participants in this group did not receive verbal feedback from the instructor after each practice trial.
- *Control group:* Participants in this group practiced fifty trials of the volley without having observed the learning model participants or receiving verbal feedback from the instructor.

Results: On a posttest of the volley given after the practice trials, both observer groups performed better than the control group.

Conclusion: Having beginning tennis players observe other beginners practice a skill before they begin to practice will facilitate their learning of the skill.

We see this clearly when we organize into two categories the results of research investigating the effect of demonstration on skill learning. In one category are those experiments in which participants learned more quickly after demonstration than after other forms of instruction. In experiments in this category, participants typically learned skills requiring them to acquire new patterns of limb coordination. In the other category are experiments in which participants usually learned skills no better after observing demonstrations than after receiving other forms of instruction. In these experiments, the participants practiced skills that required them to acquire new parameter characteristics for well-learned patterns of limb coordination.

The Neural Basis for Observational Learning: Mirror Neurons in the Brain

In the early 1990s, neuroscientists in Italy, led by Giacomo Rizzolatti, discovered that when monkeys observed another monkey reach out its arm to grasp something, neurons in the F5 area of their premotor cortex became active (see Miller, 2005; Rizzolatti & Craighero, 2004). These neurons, known as *mirror neurons*, are a specific class of visuomotor neurons in the brain. The important question for understanding the neural basis for observation learning by humans is this: Does the human brain contain mirror neurons? Several studies have provided evidence that supports mirrorlike neurons in the human brain.[1]

In an early study, a group of neuroscientists in Los Angeles, California, pooled data from seven fMRI studies in which people observed and imitated simple finger movements (Molnar-Szakacs, Iacoboni, Koski, & Mazziotta, 2005). The researchers noted that during observation, specific areas activated in the *inferior frontal gyrus (IFG),* which is in the inferior frontal lobe of the cerebral cortex. Two sections of the IFG activated during observation (the pars triangularis and the dorsal section of the pars

[1]For a review of evidence supporting mirror neurons, see Giese and Rizzolatti (2015).

opercularis) but not during the movement imitation. Subsequent research by Catmur, Walsh, and Heyes (2009) showed that theta-burst transcranial magnetic stimulation of the IFG disrupts automatic imitation of finger movements. Interestingly, the IFG includes the region of the brain known as Broca's area, which is important in speech production.

Researchers in Germany (Zentgraf et al., 2005) used fMRI to assess brain activity during the observation of whole-body gymnastics movements. Their results showed that when participants were asked to observe with the intent to imagine themselves imitating the movements, activation was recorded in the *supplementary motor area (SMA)* of the cortex. Interestingly, when the participants were asked to observe the movements with the intent to judge their accuracy and consistency, the pre-SMA area activated. Other fMRI research has found mirror-like neuron activity in the *parietal cortex,* which is involved in interhemispheric visuomotor integration (Iacoboni & Zaidel, 2004), and *lateral temporal cortex,* which is involved in processing complex visual motion (Beauchamp, Lee, Haxby, & Martin, 2003). In addition to using fMRI, researchers have also used EEG recordings to provide evidence of the involvement of a mirror neuron system during action observation (e.g., Calmels, Hars, Holmes, Jarry, & Stam, 2008; Denis, Rowe, Williams, & Milne, 2017).

Taken together, these brain activity recording methods indicate the existence of a mirror neuron system, although many questions remain unresolved concerning its specific characteristics and functions. (For a more complete review of research on the mirror neuron system and its implications for physical rehabilitation, see Iacoboni & Mazziotta, 2007.)

It is important to keep in mind that the areas of the brain that contain mirror neurons are not the only areas of the brain that might contribute to the motor learning effects associated with action observation. For example, Jeannerod's (2001) *simulation theory* proposed that the same brain regions were recruited during action observation, motor imagery, and movement execution. These regions were thought to include the prefrontal, premotor, primary motor, and parietal cortices, and the basal ganglia and cerebellum. Recruitment of these areas during action observation was presumed to be the basis for improvements in motor learning that follow from watching others perform motor skills. More recent analyses have shown that despite similarities in the brain regions recruited during action observation and movement execution, distinct differences also exist. For example, in a meta analysis that included 595 action observation experiments and 142 movement execution experiments, Hardwick, Caspers, Eickhoff, and Swinnen (2018) showed that observing and executing simple movements of the arms, legs, and face consistently recruited similar premotor and parietal cortical networks. However, less than half of the premotor-parietal network for movement execution was also involved in action observation. Moreover, action observation did not recruit sub-cortical structures, like the basal ganglia, or the cerebellum, which consistently participate in movement execution. These findings suggest that previous researchers have overestimated the similarities in the brain networks involved in observing and executing movements, and they raise interesting questions about the neural contributions that action observation makes to motor learning.

Observing Skilled Demonstrations

A common guiding principle for demonstrating a skill is that the demonstrator should perform the skill correctly. Why would more accurate demonstration lead to better learning? Two reasons are evident from the research literature. The first reason follows our discussion of perception of information in the preceding section. If the observer perceives and uses information related to invariant movement patterns, it is logical to expect the quality of performance resulting from observing a demonstration to be related to the quality of the demonstration. Another reason is that in addition to picking up coordination information, an observer also perceives information about the strategy used by the model to solve the movement problem. Typically, the observer then tries to imitate that strategy on his or her initial attempts at performing the skill.

Novices Observing Other Novices Practice

Although the theoretical predictions and the empirical evidence indicate that it is preferable for beginners to observe skilled demonstrators, evidence indicates that beginners can derive learning benefits even from observing unskilled demonstrators, especially if both the observers and the models are beginners. What this means is that the models are "demonstrators" only in that the observers are watching them practice.

One proposed benefit of using demonstration in this way is that it discourages imitation of a skilled model's performance of the skill and encourages the observer to engage in more active problem solving to determine the most effective movements to achieve the action goal of the skill. We can trace evidence for the benefit of this approach to the 1930s (e.g., Twitmeyer, 1931), although widespread interest in this approach did not develop until Adams (1986) published some experiments. Since then, others have pursued the investigation of the use and benefit of observing an unskilled model (e.g., McCullagh & Meyer, 1997; Pollock & Lee, 1992; Ste-Marie, Law, Rymal, O, Hall, & McCullagh, 2012; Weir & Leavitt, 1990). This research has consistently shown that beginners who observe other beginners practicing a skill will perform at a higher level when they begin to perform than the beginners they observed.

One way to effectively implement this use of demonstration is by pairing students, athletes, or patients in situations where one of the pair performs the skill while the other observes. After a certain number of trials or amount of time, the pair switches roles. On the basis of what we know from the research literature, learning of the skill can be facilitated for both the performer and the observer by having the teacher, coach, therapist, or some other knowledgeable person provide verbal feedback to the performer. Another effective strategy is to provide the observer of the pair with a checklist of key aspects of the skill. The observer should look for each aspect, check it on the list, and then provide some feedback to the performer. Under these conditions, the observer actively engages in problem-solving activity that is beneficial for learning. The learner observes what the unskilled model does, what the "expert" tells him or her is wrong with the attempt, what the model does to correct errors, and how successful he or she is on the succeeding attempts. Wulf, Shea, and Lewthwaite (2010) provide a good discussion of how this type of dyad practice can be used to enhance medical education.

LAB LINKS

Lab 14 in the Online Learning Center Lab Manual provides an opportunity for you to experience how a beginning learner observing another beginner practice can facilitate the learning of the observer when he or she begins to practice the skill.

Another way to have a novice observe a novice is to use *self-observation* via video replay, a technique that can also be classified as video feedback because learners watch themselves perform a task rather than another person (Anderson, Rymal, & Ste-Marie, 2014). Researchers have shown that this type of observational practice, which is always done alongside physical practice, can be particularly effective if it is combined with observation of a skilled performer demonstrating the task (Robinson, St. Germain, & Ste-Marie, 2018).

The Timing and Frequency of Demonstrating a Skill

One of the reasons for demonstrating a skill is to communicate how to perform the skill. For the beginner, demonstration provides an effective means of communicating the general movement pattern of the action or skill. As we discussed in chapter 12, Gentile considered this to be the goal of the first stage of learning. When applied to the use of demonstration, Gentile's view suggests two things. The first is that it is beneficial to demonstrate a skill *before the person begins practicing it.* The second is that the instructor should *continue demonstrating during practice as frequently as necessary.*

Earlier, we pointed out that a skilled demonstration communicates the invariant characteristics of a movement pattern, which suggests that more than one observation is essential. If this is the case, then we would expect that the more frequently a beginner observes a skilled demonstration, the more opportunity the beginner will have to acquire the movement pattern. At least three research studies support this latter point. One, by Carroll and Bandura (1990), involves the learning of complex movement patterns of a computer joystick. Another, by Hand and Sidaway (1993), involves the learning of a golf skill. A third experiment by Hebert (2018) involves the learning of a cup stacking task. All three experiments provided evidence that more frequent observations of the model yielded better skill learning. The Hebert (2018) experiment revealed particularly interesting findings because learners practiced the task in groups of three, such that the first learner received no demonstration, the second learner observed the first learner complete all practice trials, and the third learner observed the first and second learners complete all practice trials. The second learner performed the task significantly faster than the first learner and the third learner performed significantly faster than the first and second learners during the acquisition phase of the experiment.

An experiment by Weeks and Anderson (2000), which investigated the issue of the timing of demonstrations, provides some additional insight into both the timing and frequency questions. The demonstrated skill involved a skilled volleyball player hitting an overhand serve. Participants, who had no previous experience hitting this serve, observed a video of ten demonstrations and performed thirty serves. The all-prepractice group watched all ten before performing the thirty serves; the interspersed group observed one demonstration and then performed three serves, in series throughout the practice period, and the combination group viewed five demonstrations before performing fifteen serves, then viewed five demonstrations before performing the final fifteen serves. All participants performed in two retention tests, which were 5 min and 48 hr, respectively, after the practice session. The results (figure 14.4) showed the benefit of the combination

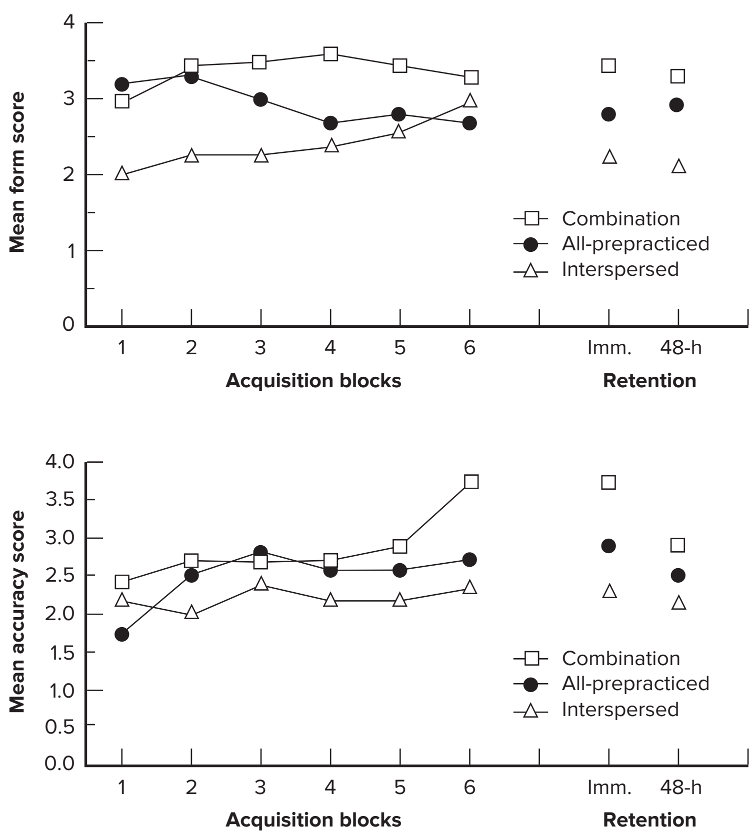

FIGURE 14.4 The results of the experiment by Weeks and Anderson showing form and accuracy scores for practice trials and retention tests for an overhand volleyball serve for three groups that observed ten skilled demonstrations in different amounts and at different times before and during practice. The form scores represent the mean of ten aspects of form, each rated on a scale of 0 to 5, with 0 indicating a complete absence of the aspect, and 5 indicating the aspect was performed as recommended.
Source: Figures 1 (p. 266) and 2 (p. 267) in Weeks, D. L., & Anderson, L. P. (2002). The interaction of observational learning with overt practice: Effects on motor learning. *Acta Psychologica, 104,* 259–271.

and all-prepractice conditions, as both led to better form and accuracy scores than the interspersed condition. In terms of the timing and frequency of demonstrations, these results indicate that several demonstrations should precede practice. Although it would be interesting to see how these demonstration schedules would have influenced learning had they been implemented in several days of practice, the results for one practice session reveal the importance of prepractice demonstrations.

A twist on the way in which demonstrations are scheduled has been to allow learners to self-select when they receive demonstrations. We will see in chapter 15 that this technique originated in the context of providing augmented feedback. Interestingly, when learners are given this opportunity they tend to request demonstrations very infrequently, often preceding less than 10 percent of the trials on which they could potentially request them. Ong and Hodges (2012) provided a summary of this research and highlighted some of the important gaps in our understanding of how to schedule observational practice.

Auditory Modeling

Our discussion so far has focused on visual demonstration. However, there are skills for which visual demonstration is less effective for learning than other forms of demonstration. An example is a skill for which the *goal is to move in a certain criterion movement time or rhythm*. For these types of skill, an auditory form of demonstration seems to work best.

A good research example of the effectiveness of auditory modeling when the goal is a specific movement time is an experiment by Doody, Bird, and Ross (1985). The task required people to perform a complex sequential movement with one hand in a criterion movement time of 2.1 sec. Visual and auditory demonstration groups observed a videotape of a skilled model before each practice trial. The visual demonstration group saw only the video portion of the tape and heard no sound. The auditory demonstration group heard only the audio portion of the modeled performance but did not see the model perform the task. Results indicated that the group that heard the audio portion of the performance did better than the visual demonstration–only group.

Three research examples showing the benefit of auditory modeling for learning a rhythmic sequence involve a sequence of dance steps, a golf putting task, and a laboratory task. In an experiment by Wuyts and Buekers (1995), people who had no prior dance or music experience learned a sequence of thirty-two choreographed steps. For acquiring the rhythmic timing of this sequence, participants who heard only the timing structure learned it as well as those who both saw and heard the model perform the sequence. The second experiment by Bieńkiewicz et al. (2019) focused on learning the rhythm of the golf putting stroke. Participants practiced with either an auditory template of the motion of the putter head, a visual template that used sequentially illuminated LEDs on a trackway positioned adjacent to the ball and aligned with the direction of the putter head, or with no template. The participants in the auditory and visual template groups showed larger improvements in putting performance than participants in the control group that received no template, though the differences were subtle. In addition, participants who practiced with the auditory template tended to retain their improvements better than those who practiced with the visual template. The third example is an experiment by Lai, Shea, Bruechert, and Little (2002) in which they found that auditory modeling enhanced the learning of a sequence of five time intervals when two keyboard keys were alternately depressed. Before each practice trial, participants heard a sequence of tones that represented the timing sequence they were to learn.

How the Observing of Demonstrations Influences Learning

In terms of learning theory, an important question is this: Why does observing demonstrations benefit motor skill learning? Two different views propose answers to this question.

Cognitive mediation theory. The predominant view is based on the work of Bandura (1986) concerning modeling and social learning. This view, called the **cognitive mediation theory,** proposes that when a person observes a model, he or she translates the observed movement information into a symbolic memory code that forms the basis of a stored representation in memory. The reason the person transforms movement information into a cognitive memory representation is so that the brain can then rehearse and organize the information. The memory representation then serves as a guide for performing the skill and as a standard for error detection and correction. To perform the skill, the person first must access the memory representation and then must translate it back into the appropriate motor control code to produce the body and limb movements. Thus, cognitive processing serves as a mediator between the perception of the movement information and the performance of the skill by establishing a cognitive memory representation between the perception and the action.

According to Bandura, four subprocesses govern observational learning. The first is the *attention process,* which involves what the person observes and the information he or she extracts from the model's actions. Because of the importance of the attention process for learning, directing full attention to the demonstration rather than the mere observation of it is important for optimal learning. The second is the *retention process,* in which the person transforms and restructures what he or she observes into symbolic codes that the person stores in memory. Certain cognitive activities, such as rehearsal, labeling, and organization, are involved in the retention process and benefit the development of this representation. The *behavior reproduction process* is the third subprocess; during it, the person translates the memory representation of the modeled action and turns it into physical action. Successful accomplishment of this process requires that the individual possess the physical capability to perform the modeled action. Finally, the *motivation process* involves the incentive or motivation to perform the modeled action. This process, then, focuses on all those factors that influence a person's motivation to perform. Unless this process is completed, the person will not perform the action.

Several research studies have provided support for the cognitive mediation theory by demonstrating evidence that is in line with predictions of the theory. For example, Ste-Marie (2000) provided support for the prediction that *attention* is an important process in observational learning. In a series of four experiments, participants who had to divide their attention between performing a cognitive secondary task (counting backward by threes) and observing a model did not learn the skill as well as those who did not perform a secondary task. In an experiment discussed in chapter 10, Smyth and Pendleton (1990) showed that the prevention of the *rehearsal* process hindered learning a skill. In their experiment, some participants engaged in movement activity during the interval of time between the demonstration of a sequence of movements and their attempts to reproduce those movements. These participants recalled fewer movements than those who did not engage in activity during this time interval. Finally, Blandin and Proteau (2000) provided evidence that observational learning involves the development of effective *error detection and correction,* which the cognitive mediation theory describes as an important function of the memory representation that develops during observational learning. In two experiments, prior observation of a model permitted learners to estimate their errors as effectively as learners who had physically practiced the tasks.

Dynamic view of modeling. The second view is based on the direct perception view of vision proposed many years ago by J. J. Gibson (1966, 1979). Scully and Newell (1985) adapted Gibson's view to the visual observation of a skilled demonstration and proposed the **dynamic view of modeling** as an alternative to Bandura's theory. The dynamic view questions the need for a symbolic coding step (the memory representation step) between the observation of the modeled action and the physical performance of that action. Instead, it maintains, the visual system is capable of automatically processing visual information in such a way that it constrains the motor control system to act according to what the visual system detects. The visual system "picks up" from the model salient information that effectively constrains the body and limbs to act in specific ways. The person does not need to transform the information received via the visual system into a cognitive code and store it in memory. This is the case because the visual information directly provides the basis for coordination and control of the various body parts required to produce the action. Thus, the critical need for the observer in the early stage of learning is to observe demonstrations that enable him or her to perceive the important invariant coordination relationships between body parts. Additional observations of the model will benefit the learner by helping the person learn to parameterize the action.

Which view is correct? Unfortunately, there is no conclusive evidence in the research literature that shows one of these two views of the modeling effect to be the more valid one. As you saw in the discussions of each view, both have research support for some specific assertions. As a result, until we have research evidence that one view cannot explain, we must consider which view is a possible explanation of why modeling benefits skill acquisition. The cognitive mediation theory has been the more prominent of the two, receiving more attention in motor skills research. However, the dynamic view has attracted a number of proponents.

Final Caveats

Though considerable evidence indicates that patterns of coordination can be acquired more quickly when learners are provided with demonstrations, we should keep in mind that there are potential downsides to providing demonstrations. For example, in discussing what they referred to as the "ideal form myth," Spaeth (1972) and J. Higgins (1977) argued that so many factors influence how movements are organized, it is highly unlikely that a single, universal way of performing a skill is appropriate for every learner. Consequently, what researchers consider a skilled demonstration does not necessarily represent the ideal form for every learner. In a related vein, S. Higgins (1991) has argued that providing learners with other people's strategies for solving movement problems, via demonstrations, can actually subvert the problem solving that is so central to learning. Finally,

To teach goalkeeping skills, the instructor must decide when to use demonstrations and when to provide verbal instructions.

Stephen Mcsweeny/Shutterstock

Kardas and O'Brien (2018) have shown in a series of experiments that watching skilled performers can foster a potentially dangerous illusion of skill acquisition. Importantly, the illusion does not coincide with the observer's actual ability to perform the skill that was observed. The more observers watch the skilled performer, the stronger is the illusion of skill acquisition. This illusion can be especially dangerous when observers attempt to perform skills that are clearly beyond their capabilities and that pose risks for injury. Such skills might include skateboard tricks, gymnastics stunts, or Parkour maneuvers–skills that can be readily viewed on platforms like YouTube.

cognitive mediation theory a theory for explaining the benefit of a demonstration proposing that when a person observes a skilled model, the person translates the observed movement information into a cognitive code that the person stores in memory and uses when the observer performs the skill.

dynamic view of modeling a theoretical view explaining the benefit of observing a skilled model demonstrate a skill; it proposes that the visual system is capable of automatically processing the observed movement in a way that constrains the motor control system to act accordingly, so that the person does not need to engage in cognitive mediation.

VERBAL INSTRUCTIONS AND CUES

Verbal instructions rank with demonstration as a commonly used means of communicating to people how to perform motor skills. Research supports the value of verbal instructions for facilitating skill acquisition. However, it is important to note that several factors are important for developing effective verbal instruction. Some of these factors are discussed in the following sections.

Verbal Instructions and Attention

An important performer characteristic we discussed in chapter 9 that relates to giving verbal instructions is that the person has a limited capacity to attend to information. Because of this limitation, practitioners must take into account several characteristics about the instructions they give. We will consider some of these in the following sections.

The quantity of instructions. It is easy to overwhelm the person with instructions about what to do to perform a skill. We can reasonably expect that a beginner will have difficulty paying attention to more than one or two instructions about what to do. Because the beginner will need to divide attention between remembering the instructions and actually performing the skill, a minimal amount of verbal information can exceed the person's attention-capacity limits. In addition to concerns about attention capacity, the instructor should be aware of other important attention-related considerations when giving verbal instructions, some of which are discussed in the following sections.

Verbal instructions to focus attention on movement outcomes. An important function of instructions is to direct learners' attention to focus on the features of the skill or environmental context that will enhance their performance of the skill. A key point with regard to the content of these instructions relates to our discussion of attention and consciousness in chapter 9. Recall that attention can be either conscious or nonconscious, with the person either aware or not aware of what is being attended to. When we relate this point to attention focus during the performance of a motor skill, we need to review research we briefly discussed in chapter 9, which showed that a key part of skill learning is *where* a person directs his or her conscious attention when performing a skill. That research evidence was based on investigations of the *action effect hypothesis* (Prinz, 1997), which proposes that actions are best planned and controlled by their intended effects. The hypothesis predicts that actions will be more effective when a person focuses his or her attention on the intended outcomes of an action, rather than on the movements required by the skill. To test the action effect hypothesis in motor skill learning situations, researchers have designed experiments in which instructions that direct participants' attention to their own movements (i.e., internal focus of attention) are compared to those that direct attention to the movement outcome (i.e., external focus of attention) (see Wulf, 2007, 2013, Wulf & Lewthwaite, 2016, and Wulf & Prinz, 2001, for reviews of this research).

The following research examples illustrate two types of experiments that have tested and supported the action effect hypothesis. And they demonstrate *two different ways to give verbal instructions to direct attention to movement outcomes.* The first involves instructions presented in a way that establishes a *discovery learning* situation. This means that the instructions focus the learner's attention on the action goal of the skill. Then, as the learner practices the skill, he or she "discovers" how to move to achieve that goal. The second example involves the *use of metaphoric imagery* (sometimes called *verbal analogies*) in instructions, which directs the learner's attention to move according to the image, which is the intended movement outcome of the skill. Recall that we discussed the use of metaphoric images in chapter 10 as a strategy for enhancing memory.

In a study reported by Wulf and Weigelt (1997) participants practiced the slalom ski simulator task (described earlier in this chapter and pictured in figure 14.2). Everyone was told that the goal of the task was to continuously move the platform for 90 sec as far as possible to the left and right at a rate of one complete cycle every 2 sec. Participants in one group were also told to try to exert force on the platform after it passed the center of the ski simulator, based on a movement characteristic of people who demonstrated high performance levels on the ski simulator. Another group was not given this additional instruction, which means the only instructions they received concerned the action goal (i.e., the desired effect of their movements). Because they were told only about the action goal, this group experienced a discovery learning situation.

As figure 14.5 shows, the additional movement attention-directing instructions led to poorer performance during practice trials and on a transfer test in which participants performed under stress (they were told they were being observed and evaluated by a skiing expert). Interestingly, in a follow-up experiment, which was based on the assumption that more experience with the task would allow participants to direct more attention to the specific information in the instructions, the attention-directing instructions were given after three days of practice. But, once again, rather than aid learning, the instructions had a negative effect.

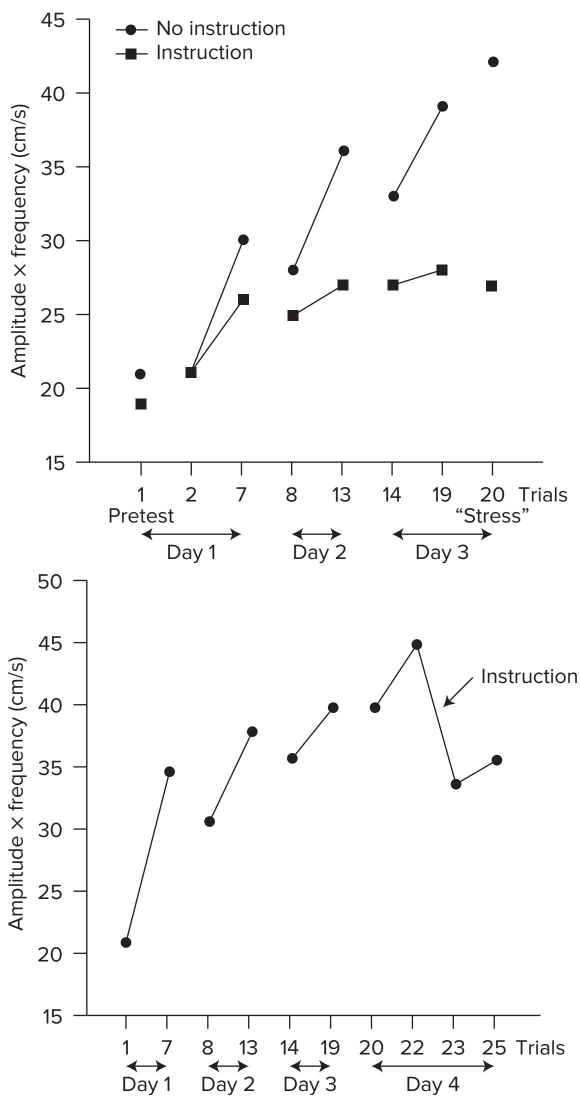

FIGURE 14.5 The top graph shows the results of the first experiment by Wulf and Weigelt which compared a group that received instructions about a movement component of the slalom ski simulator task and a group that did not receive the instructions. The bottom graph shows the results of their second experiment in which one group received the movement component instructions on the fourth day of practice. *Source:* From *Research Quarterly for Exercise and Sport, 1*(4), 262–367.

A CLOSER LOOK

Ironic Effects in a Soccer Penalty Shooting Task: Focusing on Actions Players Want to Avoid

If you've ever missed a basketball free throw, a golf putt, or penalty kick in rugby or football after explicitly telling yourself "don't miss," you may have been the victim of an *ironic* effect. These effects, which refer to the tendency to perform actions you are intentionally trying to avoid, have important implications for the content of instructions given to performers. Binsch, Oudejans, Bakker, and Savelsbergh (2010) showed that ironic effects during soccer penalty shooting are linked to the "quiet eye" phenomenon that was introduced in chapter 9.

Participants: Thirty-two amateur male soccer players with an average of 12.6 years of playing experience.

Task: To kick a soccer ball at a screen that had a video clip of a soccer goal and a stationary goalie projected onto it. The goalie was either in the middle of the goal or 15 cm or 30 cm to the right or left of center.

Instructions: (1) *Accurate* condition—shoot as accurately as possible; (2) *not-keeper* condition—shoot as accurately as possible and be careful not to shoot within reach of the keeper; (3) *open-space* condition—shoot as accurately as possible and be careful to shoot into the open space. Five shots were taken in each condition for a total of fifteen shots per player.

Results: Fourteen of the thirty-two participants displayed ironic effects, which were deemed to have occurred if the player kicked the ball 10 cm closer to the goalie in the *not-keeper* condition than the *accurate* condition. On average, the players who displayed ironic effects kicked the ball 24.3 cm closer to the keeper in the *not-keeper* condition than the accurate condition and 24.6 cm closer to the keeper in the *not-keeper* condition than the *open-space* condition.

In addition, when ironic effects were observed the average final visual fixation on the open goal space (M = 129 ms) in the *not-keeper* condition was significantly shorter than in the accurate (M = 224 ms) and the *open-space* conditions, respectively. In short, the instruction not to shoot within reach of the keeper seemed to subtly bias attention toward the keeper and away from the open goal space in those players who were susceptible to ironic effects.

The take-home message is that instructions should focus on the actions that performers need to accomplish and *not* on the actions that performers should avoid. A focus on the latter could bias attention away from the critical information that needs to be processed.

Numerous other research investigations have found that instructions that promote an external focus of attention lead to better learning than an internal focus. These studies are especially noteworthy because they have found this benefit for a variety of motor skills, such as swinging a golf club, shooting a basketball, serving a volleyball, passing in soccer, and throwing a dart. In addition, instructions to focus attention externally have been shown to benefit the learning of balance skills by healthy adults as well as those who have Parkinson's disease or who have had a stroke. (For brief reviews of the research showing these results, see Emanuel, Jarus, & Bart, 2008; Wulf, 2013; Wulf & Su, 2007; Wulf, Landers, Lewthwaite, & Töllner, 2009; and Wulf & Lewthwaite, 2016.)

An experiment in which instructions used *metaphoric imagery* to direct attention to the movement outcome was reported by Wulf, Lauterbach, and Toole (1999). Participants, who were university students with no previous experience playing golf, practiced hitting golf pitch shots into a circular target from a distance of 15 m. Everyone was given the same demonstration and instructions about the stance and how to grip the club. But one group was told to focus their attention on the swinging motion of the arms during each swing. These participants also received specific instructions about the various movements involved in the swing and practiced several swings without holding a club before they practiced hitting a ball. A second group was told to focus their attention on the club head's pathway during the back- and downswing (i.e., the "action effect"). They received specific instructions that emphasized the metaphor of the pendulum-like motion of the club. The results showed that the participants who directed their attention to the club movement consistently produced higher target accuracy scores during practice trials and on a 24-hr retention test.

Verbal analogies. Like metaphors, analogies are verbal descriptions designed to highlight the similarities between two things. By highlighting the similarities to something we already know and understand, analogies help us to comprehend something we have not encountered before. For example, we often compare the human brain to a computer to facilitate understanding of how the brain works. Similarly, in the movement domain, we might compare skipping to a "bouncy walk" to give learners an idea of how to perform the movement without overburdening them with excessive verbal descriptions of how the body parts should move.

Richard Masters and his colleagues have argued that movement analogies are effective instructional strategies because they encourage *implicit learning*—a form of learning that occurs without conscious awareness of what is being learned (see the next section for examples). For example, Masters and Poolton (2012) reviewed a body of research showing that implicitly learned tasks tend to be less susceptible to stress or pressure than explicitly learned tasks. The explanation for this finding is similar to the explanation that has been proposed to account for the benefits of an external focus of attention. Masters hypothesizes that when explicitly taught learners are put under pressure, they revert back to a movement-control strategy that is based on explicit, verbalizable rules. This reversion to a highly conscious form of processing, referred to as *reinvestment* (Masters & Maxwell, 2008), interferes with more automatic control processes and destabilizes performance. According to Masters, instructional strategies that minimize the accrual of explicit knowledge about how to move can help learners to bypass Fitts and Posner's (1967) *cognitive stage* of learning (introduced in chapter 12) and avoid reverting to that stage when stressful situations are encountered. Several studies support this assertion (e.g., Lee, Acuña, Kording, & Grafton, 2018).

Liao and Masters (2001) provided an example of how analogies could be used to minimize the accrual of explicit knowledge as beginners learned to impart overspin to a ball during a table tennis forehand shot. Rather than provide instructions about how to move the arm and paddle to accomplish the task, learners were simply told to swing the bat up the hypotenuse of an imagined right-angled triangle each time they hit the ball. The learners who were given this instruction were able to perform the shot more effectively than learners who were given explicit instructions about how to move the arm and paddle, when the groups were put under pressure or asked to concurrently perform a secondary task while making the shot.

Verbal instructions to focus attention on invariant environmental context regulatory conditions. Another issue associated with attention and the content of instructions relates to the selective attention problem of what in the environment to look for that will help perform a skill. The importance of this issue relates to a critical goal of the initial stage of learning, accordingly to Gentile's learning stages model. As we discussed in chapter 12, this goal is to learn the regulatory conditions that direct the movements required to achieve the action goal of the skill.

Sometimes we ask people to tell us what they were looking for or looking at when they performed a skill, so that we can help them correct their visual attention focus. However, research investigating the need for conscious awareness of environmental cues when learning skills reveals that people can learn to select relevant cues from the environment without being consciously aware of what those cues are.

A good example of research demonstrating this result is an experiment reported by Magill (1998). Participants watched a target cursor move in a complex waveform pattern across a computer screen for 60 sec. The participants' task involved pursuit tracking of the target cursor by moving a lever on a tabletop to make their own cursor stay as close as possible to the target cursor. The unique feature was that the target cursor moved randomly for the second

A CLOSER LOOK

Training Anticipatory Skills in Tennis with an Implicit Instructional Strategy

An objective of tennis instruction is to enhance players' capabilities to anticipate as early as possible the direction of a ball hit by an opponent. This objective was at the heart of an experiment by Farrow and Abernethy (2002) in which they compared two training techniques designed to increase junior tennis players' anticipation skills for returning serves. Both techniques were based on the hypothesis that the sources of information used by the skilled players to anticipate serve direction could be used to train less-skilled players. All participants experienced the following sequence of tests and training: *Pretest—Training (4 wks, 3 days/wk)—Posttest—Retention Test (32 days later).*

Tests and Training

Participants watched videotapes of skilled players' serves, which were from the receiver's view. During the tests, their task was to indicate as quickly as possible whether the serve direction was to their forehand or backhand. On some trials they verbally indicated the direction, while on others they moved with their racquets in the direction. Tapes were edited and programmed to stop at one of five time periods before and after racquetball contact (i.e., temporal occlusion): T1—900 msec before ball contact (start of ball toss); T2—600 msec before ball contact (ball toss almost at zenith); T3—300 msec before ball contact (racquet at top of backswing); T4—at ball contact; T5—after follow-through. Each training session consisted of watching temporally occluded videotapes of various professional tennis players hitting serves and then physically practicing the return of 50 serves.

Training Techniques

Explicit instruction: Participants received specific instruction about the relationship between information sources in the server's action and the direction of a serve. These sources were highlighted in instructional videos, verbal and written information, and verbal feedback provided during the physical practice trials.

Implicit instruction: Participants received no specific instruction about the relationship between information sources in the server's action and the direction of a serve. They were told that their task was to estimate the speed of each serve seen on the videotape.

Results

Explicit rule information: Before and after the four-week training period, participants were asked to write down all the rules, coaching tips, and strategies they thought were important for returning serves. After training, the explicit training group wrote an average of 2.5 rules, while the implicit training group wrote an average of 0.5 rule.

Serve direction prediction accuracy: Overall, both training groups improved from the pretest to the posttest. But seven of the eight participants in the implicit training group improved prediction accuracy *at ball contact,* compared to three of eight in the explicit group.

Conclusion

Although the prediction accuracy differences between the two training conditions were relatively minor, their similarity is important. That the implicit training led to test performance that was similar to that of explicit training indicates that the anticipatory information required to predict serve direction can be learned without being consciously aware of the specific sources for the information. However, it is important to note two important characteristics of the implicit training condition:

1. The participants directed attention to the server and the serve on each videotape, because they had to estimate the speed of the serve.
2. The training period involved a large number of trials of observing a variety of servers and serves that were temporally occluded at various times before and after each serve.

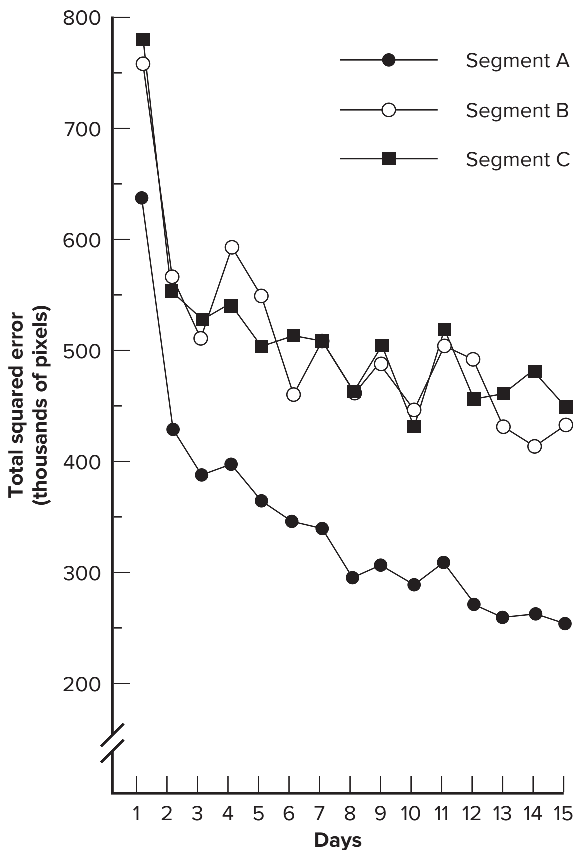

FIGURE 14.6 The results of the experiment by Magill, Schoenfelder-Zohdi, and Hall (1990) showing the superior performance on the repeated segment A compared to the random segments B and C for a complex tracking task.
Source: Magill, R. A., Schoenfelder-Zhodi, B. G., & Hall, K. G. (1990, November) *Further evidence for implicit learning in a complex tracking task.* Paper presented at the annual meeting of the Psychonomics Society, New Orleans, cited and described in Magill, R. A. (1998). Knowledge is more than we can talk about. *Research Quarterly for Exercise and Sport, 69,* 104–110.

and third 20 sec segments on every trial, but it made the same movements on every trial during the first 20 sec segment. The participants practiced this pursuit tracking task for approximately twenty-four trials on each of fifteen days. The results, shown in figure 14.6, indicated that as they practiced, they performed better on the first segment than on the other two segments. But what is more important is that when interviewed, none of the participants indicated that they knew that the target cursor made the same pattern during the first segment on every trial. Thus the participants attended to and used the regularity of the cursor movement during the first segment, even though they were not consciously aware of that characteristic. This lack of conscious awareness of the invariant movement pattern of the target cursor indicates that the participants *implicitly* learned the regulatory environmental context features that directed their movements as they tracked the target cursor.

Although the research just described indicates that people can learn to use relevant environmental context features without being instructed to look for them, there is a common assumption that we can facilitate skill learning by giving instructions that would make people aware of these features. For example, a tennis teacher may tell a student that a certain racquet-head angle at ball contact during a serve indicates a specific type of serve, which the student should try to look for to predict that type of serve. However, what is not so commonly known is that this type of instruction could actually hinder rather than facilitate learning, especially when the specific features looked for occur infrequently in a series of trials.

Green and Flowers (1991) reported an experiment that serves as a good example of the research evidence demonstrating this negative effect. Participants played a computer game in which they manipulated a joystick to move a paddle horizontally

A CLOSER LOOK

Considerations for Experts When Giving Verbal Instructions to Novices

We generally assume that beginners should be taught by people who are highly skilled in the activity to be learned. However, highly skilled performers (i.e., experts) can have problems when they give verbal instructions to beginners. We might expect certain types of problems because of some of the differences between experts and novices that we considered in chapter 12. Two differences that are especially relevant are these:

- *Their knowledge structures about the skill.* Compared to those of novices, experts' knowledge structures tend to be more conceptual and organized, with more interrelationship among the concepts. Novices, on the other hand, tend to have knowledge structures that involve more concrete and specific pieces of information, with few concepts and interrelationships among them.
- *The attention demands required to perform the skill.* Novices need to direct conscious attention to more, and different, aspects of the performance of a skill than experts.

An experiment by Hinds, Patterson, and Pfeffer (2001) provides some evidence and insight about the problems experts can have providing instructions to novices. In this experiment, experts in the domain of electronics instructed novices about how to build an electronic circuit, which involved connecting wires in specific ways to make the electronic components for several different devices, such as a radio or motion detector. Results showed that the experts provided instruction that was too conceptual and included too few concrete details to guide the novices. Interestingly, the experts' self-reported assessment of their teaching skill did not correlate well with the type of instructions they provided.

across the bottom of the monitor to try to catch a "ball," which was a dot of light, that moved for 2.5 sec from the top to the bottom of the screen. The ball moved according to one of eight pathways. On 75 percent of the trials, the ball made deviations from the normal pathway that predicted the specific final position of the ball. Thus, participants' detection of these pathway-deviations characteristics could help them increase their catching accuracy. One group of participants received explicit instructions about these characteristics and their probability of occurring; the other group did not. Participants practiced for five days for a total of 800 trials. The results showed that both groups improved. However, the explicit-instruction group made more errors than the group that had had no instruction. The authors concluded that the instructed participants directed so much of their attentional resources to trying to remember the rule and looking for its occurrence that their performance was disrupted, because they did not have sufficient attention to devote to the catching task itself.

Research has also shown the negative influence of explicit information on the implicit learning of an open motor skill by stroke patients. In an experiment by Boyd and Winstein (2004), patients who had experienced a basal ganglia stroke practiced a pursuit tracking task similar to the one described earlier in the Magill (1998) study, except that a trial was only 30 sec. One group of patients was told about the repeating portion of the pathway. Rather than helping the patients to perform the task better than those who were not given this information, the awareness of this task characteristic led to poorer learning.

Verbal Instructions Influence Goal Achievement Strategies: Speed-Accuracy Skill Instructions

Another factor that we need to consider is that verbal instructions direct the person's attention to certain performance goals of the skill. A good example of this is the way verbal instructions can bias the strategy a person uses to learn speed-accuracy skills which we discussed in chapter 7. An experiment by Blais (1991) illustrates this type of strategy bias. The task was a serial pursuit tracking task in which participants controlled a steering wheel to align a pointer as quickly and accurately as possible to target positions on a screen. Three groups of participants received verbal instructions that emphasized being accurate, being fast, or being both accurate and fast. The instruction emphasis was especially evident during the first of the five days of practice. On this

A CLOSER LOOK

Guidelines for Using Verbal Cues for Skill Instruction and Rehabilitation

- Cues should be short statements of one, two, or three words.
- Cues should relate logically to the aspects of the skill to be prompted by the cues.
- Cues can prompt a sequence of several movements.
- Cues should be limited in number. Cue only the most critical elements of performing the skill.
- Cues can be especially helpful for directing shifts of attention.
- Cues are effective for prompting a distinct rhythmic structure for a sequence of movements.
- Cues must be carefully timed so that they serve as prompts and do not interfere with performance.
- Cues should initially be spoken by the performer.

day, the "speed instruction" group recorded the fastest movement times, whereas the "accuracy group" produced the most accurate performance. The group told to emphasize both speed and accuracy adopted a strategy that led to fast movement times—but at the expense of performance accuracy. And although the "accuracy instruction" group performed the most accurately, its participants did so in a manner that eventually gave them the fastest average overall response time, which included reaction time, movement time, and movement-correction time for errors. Thus, for this task, where both speed and accuracy were equally important for overall performance, instructions that initially emphasized accuracy led to the best achievement of the two-component goal.

The results of the Blais (1991) experiment are consistent with predictions of both the motor program and dynamical systems theories we discussed in chapter 5. To apply the speed-accuracy skill to those theories, the movement accuracy component refers to the movement pattern used to perform the skill. In both theories the movement pattern consists of invariant characteristics that remain the same when the skill is performed at different speeds. For these motor control theories, movement speed can be readily changed according to the demands of the performance situation or intention of the performer. As a result, these theories predict that initial practice for a speed-accuracy skill should emphasize movement accuracy and a later emphasis on the speed component.

Verbal Cues

One of the potential problems associated with verbal instructions is that they can contain too little or too much information and not provide the learner with what he or she needs to know to achieve the goal of the skill. To overcome this problem, instructors can use verbal cues (Landin, 1994). **Verbal cues** are short, concise phrases that serve to (1) direct the performer's attention to regulatory conditions in the environmental context or (2) prompt key movement components of skills. For example, the cue "Look at the ball" directs visual attention, whereas the cue "Bend your knee" prompts an essential movement component. Research has shown these short, simple statements to be very effective as verbal instructions to facilitate learning new skills, as well as performing well-learned skills. Teachers, coaches, or therapists can implement verbal cues in several different ways in skill learning settings.

Verbal cues and demonstrations. One way is to *give verbal cues along with a demonstration* to supplement the visual information (e.g., McCullagh, Stiehl, & Weiss, 1990; Zetou, Tzetzis, Vernadakis, & Kioumourtzoglou, 2002). When used this way, verbal cues aid in directing attention, and can guide rehearsal of the skill a person is learning. An example of a study showing the benefit of this use of verbal cues was reported by Janelle, Champenoy, Coombes, and Mousseau (2003) for learning a soccer accuracy pass. Non-soccer players who observed a skilled model video demonstration

verbal cues short, concise phrases that direct a performer's attention to important environmental regulatory characteristics, or that prompt the person to perform key movement pattern components of skills.

with accompanying verbal and visual cues learned the pass with more appropriate form and outcome accuracy than in five other practice conditions. The verbal cues, which were presented by audiotape along with the video, were short descriptions of the specific movement characteristics of the critical areas of the kick. The visual cues were arrows on the video that pointed to the critical areas of the kick. The comparison practice conditions involved discovery learning (i.e., they were told the accuracy goal of the skill but had to "discover" the best way to pass the ball to achieve the goal), verbal instructions only, a skilled model video demonstration with the visual cues, a skilled model video demonstration with the verbal cues, and a skilled model video demonstration only. Note that in this study the addition of visual cues enhanced the benefit of the verbal cues. Together, the visual arrows and the verbal cues focused the participants' attention to the parts of the skill that were critical to successful performance. Although we are focused on verbal cues here, it is relevant to note that a study by D'Innocenzo, Gonzalez, Williams, and Bishop (2016) showed that the learning of golf swing was accelerated by the use of color patches on a video demonstration that visually guided participants to look at key features of the setup.

Verbal cues that focus attention while performing. Another way to use verbal cues is to *give cues to help learners focus on critical parts of skills.* For example, in an experiment by Masser (1993), first-grade classes were taught to do headstands. In one class, before students made each attempt to swing their legs up into the headstands, the instructor said, "Shoulders over your knuckles," to emphasize the body position critical to performing this skill. The cued students maintained their acquired skill three months after practice, whereas the students who had not received this verbal cue performed the headstand poorly three months later. A similar result occurred in an experiment using verbal cues to emphasize critical parts of the forward roll.

Verbal cues as prompts. Performers also can *use verbal cues while performing* to prompt themselves to attend to or perform key aspects of skills. Cutton and Landin (1994) provided a research example demonstrating the effectiveness of this technique for nonskilled individuals. Instructors taught university students in a beginning tennis class five verbal cues to say out loud each time they were required to hit a ball. These were as follows: "ready," to prompt preparation for the oncoming ball; "ball," to focus attention on the ball itself; "turn," to prompt proper body position to hit the ball, which included turning the hips and shoulders to be perpendicular with the net and pointing the racquet toward the back fence; "hit," to focus attention on contacting the ball; and "head down," to prompt the stationary position of the head after ball contact. The students who used verbal cues learned tennis groundstrokes better than those who did not, including a group that received verbal feedback during practice.

Verbal cues aid skilled performance. Verbal cues have also been used to *improve the performance of skilled athletes*. For example, Landin and Hebert (1999) had university female varsity tennis players use self-cueing to help them improve their volleying skills. Players learned to say the word "split," to cue them to hop to a balanced two-foot stop that would allow them to move in any direction. Then, they said, "turn," to cue them to turn their shoulders and hips to the ball. Finally, they said, "hit," to direct their attention to tracking the ball to the point of contact on the racquet and to cue themselves to keep the head still and hit the ball solidly. After practicing this cueing strategy for five weeks, the players showed marked improvements in both performance and technique.

The purposes of verbal cues. The various uses of verbal cues just described indicate that verbal cues can be used for two different purposes. Sometimes the cue *directs attention* to a specific environmental event or to specific sources of regulatory information (in our example, "ready," "ball," and "hit" are such cues). In other cases, the cue *prompts action,* for either a specific movement ("head down") or a sequence of movements ("turn"). The key to the effectiveness of verbal cues is that as the person practices and continues to use the cues, an association develops between the cue and the act it prompts. The benefit is that the person does not need to give attention to a large number of verbal instructions and can focus attention on the important perceptual and movement components of the skill. A question that remains to be addressed is whether these cues are most beneficial when they encourage an external focus of attention, regardless of whether they pertain to the environment or the movement (e.g., Wulf & Lewthwaite, 2016), or whether cues that encourage an internal or external focus of attention are equally effective.

SUMMARY

In this chapter, we discussed demonstration and verbal instructions and cues as effective means of communicating information about how to perform motor skills.

Demonstration

- A benefit of observing a skilled demonstration is that the observer detects the invariant characteristics of the movement pattern involved in the performance of the skill.
- The point-light technique and research about what an observer perceives from a skilled demonstration shows that demonstration tends to be a more effective means of instruction when the skill being learned requires a new movement coordination than when it involves a new parameter of a well-learned coordination pattern.
- Observing a skill activates some of the same brain networks that are recruited when someone actually performs the skill.
- Observation by a beginner of another beginner practicing a skill can facilitate skill learning.
- Skills should be demonstrated several times before a beginner practices a skill, with additional demonstrations during practice as needed.
- Auditory forms of demonstration are effective for the learning of motor skills that have a specific overall movement time goal or require a specific rhythmic sequence or beat.
- Two prominent theoretical views that propose explanations for the benefit of demonstration on skill learning are
  - ► The *cognitive mediation theory,* which proposes that observation of a demonstration leads to the development of a memory representation of the observed skill that the performer must access prior to performing the skill.
  - ► The *dynamic view,* which proposes that people do not need cognitive mediation because the visual system can constrain the motor control system to act according to what has been observed.

Verbal Instructions and Cues

- Several attention-related factors are important to consider when using verbal instructions to communicate how to perform a motor skill:
  - ► The amount of information included in verbal instructions should take into account learners' attention-capacity limitations.
  - ► According to the action effect hypothesis, verbal instructions should direct the learner's focus of attention to movement outcomes rather than to the movements themselves.
  - ► Novice learners can learn invariant environmental context regulatory conditions without conscious awareness of them (i.e., implicit learning), although attention focus on the environmental context is important.
  - ► Instructions influence the novice learner to direct attention to certain performance goals, which influences the strategies the learner uses to begin practicing a skill.
- Verbal cues are short, concise phrases that serve to
  - ► Direct the performer's attention to regulatory conditions in the environmental context.
  - ► Prompt key movement components of skills.
- Verbal cues can be given by an instructor or the performer to
  - ► Direct an observer's attention during a demonstration of a skill.

- ► Direct a performer's attention to critical parts of skills.
- ► Prompt movements while performing a skill.

POINTS FOR THE PRACTITIONER

- Demonstrations by a skilled model have their greatest influence on skill learning when the skill requires the learning of a new movement coordination pattern.
- People who are in the initial stage of learning a skill can benefit from observing others who are also novices. Consider using this strategy with large groups by having the people work in pairs where one practices the skill for several trials while the other observes, and then they switch roles.
- A demonstration by a skilled model can be done by the practitioner, a person in the group who can perform the skill well, or a skilled model on a video.
- Frequent demonstrations result in better learning than less frequent demonstrations, especially in the initial stage of learning.
- Be certain that the people observing a demonstration can see the critical features of the skill being demonstrated.
- If visual and/or verbal cues are used with a demonstration, keep them simple and focused on the critical features of the skill that need to be emphasized. Avoid providing a running verbal commentary along with a demonstration.
- Use auditory cues to demonstrate timing and rhythm characteristics of skills.
- Verbal instructions should present the minimum amount of information necessary to communicate what a person needs to do to perform a skill. Providing too much information in verbal instructions can be like providing no verbal instructions at all.
- Provide verbal instructions that focus attention on the outcome of a movement rather than on the movement itself.
- When teaching open skills, verbal instructions should focus attention on areas in the environmental context where critical invariant regulatory conditions can be observed. Expect that the detection and perception of much of this critical information will occur without the person's conscious awareness of what he or she perceives.
- To ensure the detection and perception of critical invariant regulatory conditions, allow the person to perform the skill in a variety of environmental contexts and situations.
- Emphasize movement form rather than speed for a person's initial practice attempts when teaching a speed-accuracy skill.

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STUDY QUESTIONS

1. (a) What are two types of research evidence that show that observing a skilled demonstration of a motor skill influences the acquisition of the coordination characteristics of the skill? (b) Discuss what this research evidence tells us that we can apply to the use of demonstrations when teaching motor skills.
2. (a) Describe how observing an unskilled person learning a skill could help a beginner learn that skill. (b) Discuss why a learning benefit should result from a beginner observing another beginner learning a skill.
3. What are the main features of the two predominant theories about why observing a demonstration helps a person to learn a skill? How do these theories differ?
4. What is the action effect hypothesis and how does it relate to instructions influencing *where* a person directs his or her attention when performing closed and open skills.
5. Describe two purposes for using verbal cues. Give an example for each.

Specific Application Problem:
Select a motor skill that you might teach in your future profession. Your supervisor has asked you to develop and defend a plan for providing information to the people you will work with about how to perform the skill. In your plan, describe the skill you will teach and relevant characteristics of the people you will teach, whether you will use demonstrations, verbal instructions, or both, and some specific characteristics of your choice. In your defense of this plan, emphasize why the information you will present and how you will deliver it would be preferable to other ways of providing these people with information about how to perform this skill.