Principles of Practice Specificity

Many of the issues addressed in this chapter reveal a common dilemma for those designing practice settings—deciding how to establish performance conditions in the acquisition phase that will best prepare the learner for the criterion conditions under which the learning will be applied. The general hypothesis, that we should attempt to match those conditions in acquisition practice with those expected in the criterion "test" performance, is an old one based on common sense. It has been called the *specificity of learning hypothesis* in motor behavior (e.g., Barnett et al., 1973), stemming from Henry's (1958/1968) work on individual differences (see chapter 9). The view holds that because skills are very specific (i.e., generally uncorrelated with each other), changing the conditions under which a task is performed will require a substantial shift in the underlying abilities. Therefore, because practicing a task under one set of conditions and then performing it as a criterion task under different conditions would require a shift in abilities, the conditions in practice and "test" should be equated whenever possible. In other areas, this view has been called the hypothesis of *state-dependent learning*. A number of researchers have examined whether learning (usually verbal) materials in one state (under the influence of drugs or tobacco, or in a particular mood, or even in a particular room) would be more effective if the test conditions used that same state and less effective if the state were changed at the time of criterion test (see chapters in Davies & Thomson, 1988).

However, the astute reader will recall some evidence presented earlier in the chapter that seems to violate this specificity effect. For example, distributed-practice conditions were better for retention than massed practice when the retention trials were conducted in a distributed fashion (which is consistent with specificity predictions), but also when the retention trials were *massed* (Bourne & Archer, 1956)—a finding that is opposite to a strict specificity prediction. A similar finding is obtained in relation to the contextual interference effect; random practice produces better retention performance than blocked practice under conditions in which retention trials are either blocked or randomly ordered.

What is happening here? We suggest that these different practice effects are related to different types of specificity phenomena that emerge as a function of the interaction between certain conditions of practice and the conditions of retention (or transfer). These different types of specificity are discussed next.

Sensory and Motor Specificity

Although the topic is not often discussed in relation to *motor learning*, evidence from exercise physiology studies shows that performance assessment following muscular adaptations to training reveals the largest strength gain in the specific exercises that were done during training. For example, findings in this literature generally show large specificity effects when training and performance comparisons involve the same types of exercise (e.g., isometric and concentric exercise), the same ranges of motion, and to a lesser degree, the same movement velocity (Morrissey, Harman, & Johnson, 1995; Sale & MacDougall, 1981). The similarity of these specificity effects to those seen in motor learning experiments is quite remarkable. However, the degree to which these divergent fields of study address common processes (e.g., neural adaptations to practice) is a topic that awaits further research.

Motor learning studies suggest a different type of neural specificity of practice. These effects are illustrated nicely in a series of studies by Proteau and his colleagues in which subjects aimed a stylus at a target. Subjects in different conditions practiced this task with KR for varying numbers of trials (ranging from very few trials to several days of practice); they were then asked to perform retention trials without KR. The various practice conditions manipulated the amount of inherent visual feedback the subject was able to gather before, during, and after the movement. These conditions included full vision of the subject's arm, the stylus, and the target, at one extreme, to a condition with absolutely no visual feedback at the other extreme. Various other visual conditions have been included in other experiments (e.g., Elliott, Lyons, & Dyson, 1997; Proteau, 1992, 1995). In general, these studies show that after practice, if the transfer test has required subjects to perform without visual feedback, then the groups that do the best are the ones that learned the task with the least amount of vision during practice; typically, the worst performance is by the group that had the most vision available.

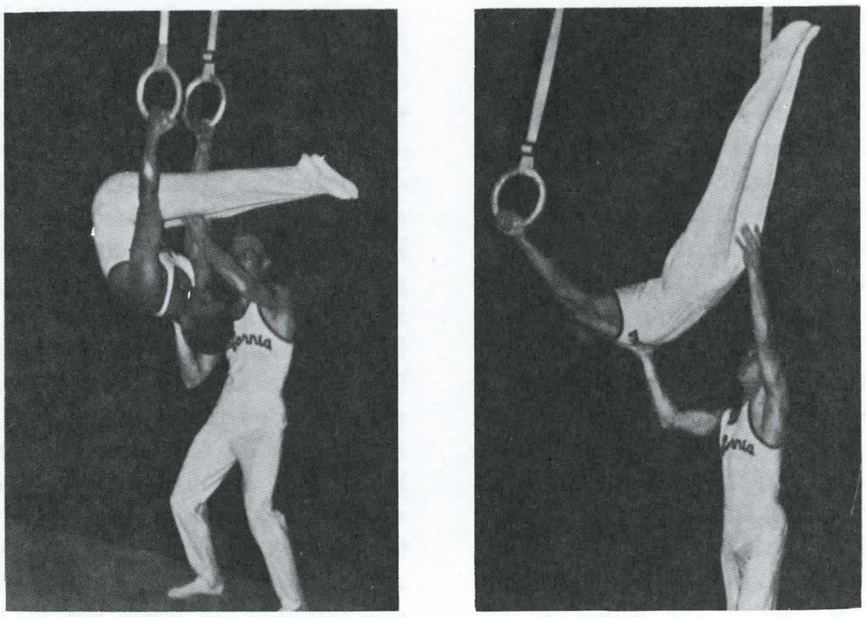

Figure 11.13. Guidance in learning a gymnastics stunt.

These findings are not surprising, as we know that vision tends to dominate all other sensory modalities when it is available. Thus, when practicing with vision the subject may come to rely on its availability to support performance, and then will suffer when performing in the absence of vision. However, Proteau and his colleagues took their research one step further, showing that when vision was *added* in transfer, performance deteriorated considerably for the groups that had performed in the absence of vision during practice (Proteau, Marteniuk, & Lévesque, 1992). Findings such as these have led Proteau and colleagues to suggest that learning involves a *sensorimotor representation* that integrates the motor components with the sensory information available during practice. This sensorimotor representation results in specificity during transfer such that performance is optimized to the degree that the conditions available during transfer match those conditions available during practice.

Context Specificity

A logic similar to Proteau's is used to look at the nature of specificity of practice conditions in a more general way. This research has been done often in psychology and reveals a kind of "mixed bag" of effects. For example, various environmental factors that compose a study *context* (heat, color, room conditions, etc.) seem to have an influence on remembering the information that has been learned. When a person attempts to recall the information later (e.g., in an exam), the same contextual information, if present, can serve as cues to help retrieve the information (Davies & Thomson, 1988).

The evidence for context specificity in motor learning is not abundant, although it does appear to be consistent with the general set of findings in cognitive psychology. For example, subjects in a study by Wright and Shea (1991) learned sequences of key press patterns, with the computer monitor providing stimulus cues specific to each pattern (i.e., the information about which keys to press was presented in different colors, shapes, and positions on the screen and was accompanied by auditory cues that were specific for each pattern). Performance in retention was maximized when the cues were matched with the same patterns as had been practiced, leading to the conclusion that the stimulus information provided a *context* that was learned as part of the representation for the movement sequence (see also Wright & Shea, 1994).

One possible relation of this research to practical experience is the so-called *home advantage* in sport. The typical finding in most professional team sports is that a team achieves a higher proportion of its wins (or points) when playing at home than when playing on the road. This finding has been well documented in the literature: it has been remarkably consistent for many years, across the various major team sports, and is found at both the college and professional levels (Courneya & Carron, 1992). Several potential hypotheses for the home advantage seem to be ruled out, such as effects of travel, crowd size, and aggressiveness. But one factor that could not be ruled out is related to the idea of context specificity—that certain factors related to the court or field on which the game is played (and on which the home team practices) provide a home advantage (Courneya & Carron, 1992). Perhaps the contextual information provided by the surroundings of the practice area constitutes an advantage when games are played in the same venue. This hypothesis must be viewed quite cautiously, however, as the evidence that lends support to it is weak (e.g., Pollard, 1986).

Processing Specificity

The specificity effects presented in the preceding sections seem to provide some guidelines for establishing certain constraints on the effectiveness of practice, when considered in light of the conditions under which retention or transfer conditions will be conducted. However, trying to anticipate the conditions of retention or transfer, and then matching practice conditions to them, is often difficult if not impossible in the real world. A rather different kind of specificity in *learning* has to do with the *processing* that a learner undertakes during practice.

The idea of processing specificity is similar to a concept that has been labeled "transfer-appropriate processing" by Morris, Bransford, and Franks (1977; Bransford et al., 1979; Lee, 1988). The idea is that the effectiveness of the practice activities can be evaluated only in relation to the goals and purposes of the transfer test. We can evaluate "relative amount learned" only with respect to some particular transfer task or transfer conditions; acquisition conditions that might be "good" for one transfer test might be "bad" for another.

We have seen processing specificity in a number of instances in this chapter. Distributed practice is better than massed practice for retention under both distributed and massed retention trials. Variable practice can be better for retention of a specific task than specific practice on that task alone. Random practice is usually better than blocked practice for both random and blocked retention orders. And we also saw that observational learning can be enhanced by watching a learning model as compared to an expert model (e.g., McCullagh & Caird, 1990; figure 11.2). A processing-specificity view explains this latter finding as follows: the observer can view how the learning model attempts to perform the task, can receive information about the results of the model's performance, and can see how the model uses that information to make adjustments on the next attempt. In other words, the observer is drawn into the *same problem-solving process* that he or she will encounter when actually performing the task (Adams, 1986). In contrast, observing an expert engages the observer in a kind of processing that will be very different from the processing involved in the trial-and-error, problem-solving activities one performs when attempting to learn the motor skill.

The notion of processing specificity addresses more than just the obvious, contextual, or incidental similarities between practice and retention/transfer situations. Processing specificity suggests that it is the similarity of the underlying *processes* (not simply the superficial *conditions*) between acquisition and criterion transfer performance that will be the critical determinant of the "goodness" of practice. In these cases, the "best" practice conditions are those that require subjects to practice and learn the same underlying *processes* that will be ultimately used in the retention or transfer test. That is, practice will be best if it fosters the processes most *appropriate* to performance on the transfer test. Sometimes, of course, when the superficial environmental conditions described by the specificity of learning hypothesis are the same in practice and transfer, the underlying processes are the same as well. But often this is not the case.

In relation to all the practice variables noted previously, though the superficial conditions in acquisition versus transfer may differ, the gain provided by learning some new appropriate processing capability overshadows any switch in conditions, so that the overall result is improved performance on the transfer test. This hypothesis of processing specificity does not identify the nature of the appropriate processes learned in acquisition, however, and these still must be discovered by research. But it is a step forward from other specificity hypotheses that are stated only in terms of matched environmental or internal conditions. It appears that designers of training settings must understand the *processes* underlying the criterion transfer performances and attempt to generate activities for practice that will use the same (hence appropriate) processes.

Summary

This chapter deals with the major independent variables that affect the learning of motor skills and thus those variables that have an influence on the design of instructional programs. Of most importance is the amount of practice itself. One can do a considerable amount of learning before actually physically practicing a motor skill. Much of this learning involves the performer's trying to *figure out what to do.* Perceptual presentations of information prior to practice seem to be generally more effective than verbal descriptions. However, methods engaging the learner in information-processing activities that encourage problem solving will likely help to benefit the use of prepractice augmented information.

The structure of practice also has very important influences on learning. Distributed practice facilitates performance and learning more than massed practice does, although these effects seem to be specific to the learning of continuous tasks. Practice sequences in which the task conditions are deliberately varied from trial to trial are slightly more effective than constant-practice conditions for adults and far more effective for children. Randomly ordered practice is detrimental to performance as compared to blocked practice, but facilitates retention and transfer. Mental practice, though not as effective as physically practicing a task, does facilitate learning when physical practice is not possible. Decisions about whether to break a task down into its component parts for practice or whether to practice the task as a whole depend entirely on the nature of the task. If practicing the parts means changing the task itself, then whole practice will probably be more effective. And guidance can be a useful aid in some situations, but overuse of guidance techniques can also be detrimental to learning.

We have emphasized often that the value of practice sessions must be assessed mainly in tests of retention and transfer. Complicating this evaluation of learning is the fact that the relation between the nature of practice and the nature of the retention and transfer conditions also influences performance. Specificity in learning suggests that the sensory-motor, contextual, and processing activities of the retention and transfer tests influence to a considerable extent the "value" that we attribute to certain practice conditions.