

MOTOR LEARNING & PRACTICE

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The field of motor learning has tremendous implications for pediatric therapy. Since one of the primary aims of therapy is the acquisition of functional motor skills, the study of motor learning should help to guide our interventions. The MOVE curriculum is directly concerned with learning motor skills through specific training and practice.

Assumptions and Definitions

At the beginning of this chapter a few important assumptions must be clearly stated:

ASSUMPTION 1: Learning is one of the most significant ways that we know in which change can be induced in the CNS in response to the environment (which includes the therapist) or the actions of the individual. Strong support for this assumption may be found in the field of neural plasticity (which is covered in the following chapter.)

ASSUMPTION 2: The majority of children with severe, multiple disabilities have some capacity for learning, even though they are starting with a damaged system. Their rate of learning may be slow, they may require many repetitions to learn, and they may not generalize skills easily, but they *are* able to learn.

ASSUMPTION 3: There is a similarity between the processes involved when a non-disabled person learns a motor skill and when a child with a severe disability learns a simple motor skill. In other words, we assume that motor learning concepts and techniques developed with non-disabled subjects can be applied to our population as well, with appropriate modifications. There is currently a lack of clear research documentation of the similarities and differences in motor learning processes in disabled and non-disabled populations, which means that this assumption remains simply an assumption. However, there has been discussion of this point by several authors who feel that “motor learning” and “recovery of function” are similar in several respects, and that similar neural mechanisms may be involved (Schmidt, 1991; Shumway-Cook & Woollacott, 1995; Winstein, 1991b). Gentile (2000) suggests that therapists

should use caution in applying principles derived from research with non-disabled subjects, and Winstein (1991b) suggests that these principles be used as guidelines rather than as exact recommendations in clinical practice. Further research is needed to clarify this point.

The term *motor learning* can be described as “the acquisition of new skills with practice.” (Schmidt, 1991, p. 49) Note that this definition includes several important characteristics. First, the “acquisition” of skills reflects a relatively permanent change, rather than a transitory change in behavior. Second, “skills” are being acquired, as opposed to movement patterns isolated from their functional significance. Lastly, note the inclusion of the word “practice.” Motor learning describes skills that are learned through practice; these skills do not emerge because of other factors such as neural maturation, passively imposed movements, or the integration of primitive reflexes. A more detailed definition of motor learning, also from Schmidt is, “a set of processes associated with practice or experience leading to relatively permanent changes in the capability for movement.” (Schmidt, 1999, p. 264) This definition emphasizes that the changes occurring with motor learning are relatively permanent, and that they involve the internal “capability” for movement rather than the directly observable performance.

Among children with severe disabilities, simple functional motor abilities that most of us take for granted are often lacking. In typically developing children these motor skills emerge without specific training, although many of these skills may indeed be learned through practice. Motor learning is a powerful tool with which we can help children with severe disabilities gain functional motor skills.

PRACTICE

Practice is the active process of attempting to perform a task, and it leads to the acquisition of skill. In order to be effective, practice trials usually need to be repeated many times. We will discuss the nature of repetition in more depth later on, but it is important to note that the *process of problem-solving* needs to be repeated for effective learning, rather than simply the repetition of a movement. There are many practice variables that affect learning, such as the amount of practice, practice scheduling, and variations in the task and context of practice.

Amount of Practice

Probably the most important question we will discuss in this chapter is, “How much practice is needed to learn a movement skill?” Children with severe disabilities lack many functional motor skills. I suggest that many of these children would benefit from more opportunities to practice their motor skills. Factors affecting motor learning in this population include the inability to practice many motor skills without assistance or physical support, and slower rates of learning. Common sense would suggest that increased practice of a task would enhance learning and skill acquisition in that task. The experts on motor learning agree, as shown in the following quotations:

One practice variable dwarfs all the others in terms of importance, and it is so obvious that it need hardly be mentioned at all – practice. Clearly, more learning will occur if there are more practice trials, all other things being equal. Perhaps we do not need to say any more about the amount of practice than this: in structuring the practice session, the number of practice attempts should be maximized. (Schmidt & Lee, 1999, p. 286)

It is probable that some of the failure of rehabilitation is due to too little time actually being spent in practicing motor tasks using guidelines provided by the therapist. (Carr & Shepherd, 1987, p. 52)

Typically, the more practice you can give a patient, the more the patient learns, with other things being equal. (Shumway-Cook & Woollacott, 1995, p. 35)

Practice is essential for motor learning and the development of motor programs. In general, increased practice leads to increased learning. (O’Sullivan, 1994, p. 239)

Learning is directly determined by the amount of practice. (Gentile, 2000, p. 173)

In short, the most powerful way we can enhance skill acquisition would appear to be *increasing the amount of practice*. All of the other variables that we discuss in this chapter such as practice scheduling, feedback, modeling, etc., although they can be manipulated to benefit learning, are not as important as this one factor. No one disputes that practice has a positive effect on learning, or that more practice results in more learning. However, these principles of motor learning are not yet being adequately applied with our population. One of the biggest benefits of the MOVE curriculum is that it gives a structured way for practice of mobility tasks to be incorporated consistently throughout the day. (Bidabe, 1999)

Transfer-Appropriate Training

One question that we must address is, “What should we practice?” This question clearly relates to the goals of therapy: the target behaviors which the person will need to perform in the future. As therapists we hope that the abilities acquired during our intervention will *transfer* over to functional activities outside of therapy. When we ask a child to maintain sitting balance on a therapy ball while responding to motion provided by the therapist, we presumably hope that this will lead to improved sitting balance in other functional situations, such as while sitting on a chair and reaching for something. Is this a realistic expectation? No! These are two different tasks. Sitting on the therapy ball requires the child to *react* to imposed motion to maintain balance, while the second task requires *predictive* control to maintain sitting balance during reaching. What can we say about transfer between tasks?

Clearly, the ideal way to learn a target behavior would be to practice that same behavior. Transfer-appropriate training relates to training in such a way that the amount of transfer to the target behavior is maximized. Carr and Shepherd give an excellent description of a motor relearning program for stroke designed to maximize transfer. Their program involves four steps:

1. Analysis of task
2. Practice of missing components
3. Practice of task
4. Transference of training

(Carr & Shepherd, 1987, p. 72)

Especially the last step, transference of training, gives increased opportunities for the learner to practice the skill in the natural contexts where it will be used. This basic scheme of a motor learning approach is certainly appropriate for children with severe disabilities as well, and it is very similar to the steps followed in the MOVE curriculum.

Practice Scheduling

Research in motor learning has shown that variations in practice scheduling may affect learning. Here we will look at two different factors: the amount of rest between practice trials (massed vs. distributed practice), and practicing a number of different tasks in random order or one at a time (blocked vs. randomized practice).

When practice is *massed* there is more time spent in work (actual practice) than in resting between the trials. When a greater amount of time is spent in the rest periods than in practice trials, it is called *distributed* practice. The phenomena associated with practice distribution have been studied extensively in continuous tasks. In general, if the amount of time spent actually practicing remains the same, longer rest periods enhance performance and learning. (Schmidt, 1999) In other words, there are significant benefits to using distributed practice. Studies using retention and transfer tests have shown that there is a long-term learning effect from practice distribution, and that the difference is not only due to the fatigue experienced during massed practice. Note that distributed practice takes more time than massed practice, if the amount of work is to be kept constant. In discrete tasks (those with a clear beginning and end) the effects of distributed and massed practice are less clear. (Schmidt, 1999)

When an individual practices a number of activities, practice may be scheduled in a number of ways, including: blocked practice (drilling one activity for many repetitions) or random practice (alternating practice of the different activities during a session). A significant amount of research has focused on the different effects of these two methods of practice scheduling. This is one area where the performance / learning distinction is very important. If short-term performance changes only are measured, there is a significant benefit to blocked practice. As a subject acquires a skill, the performance improves more rapidly with blocked practice than with random practice. However, retention tests show enhanced learning with random practice when the skills are tested after several minutes, hours or days have passed. (Schmidt, 1991; Shea & Morgan, 1979) This may have clinical applications for our children who are attempting to learn motor skills. It may be necessary to practice a skill initially using blocked scheduling until the child begins to have some success at achieving the movement goal, but thereafter

random practice should be more beneficial for long-term learning of the skill. [see figure]

Difficulty of Practice

The findings regarding the superiority of random practice for learning indicate that effective practice needs to involve a certain depth of processing, or repeating and refining the problem-solving process itself. Bernstein describes this very well:

The process of practice towards the achievement of new motor habits essentially consists in the gradual success of a search for optimal motor solutions to the appropriate problems. Because of this, practice, when properly undertaken, does not consist in repeating the means of solution of a motor problem time after time, but in the process of solving this problem again and again by techniques which we changed and perfected from repetition to repetition. (Bernstein, 1967, p. 134)

If we require the learner to repeat the problem-solving process rather than simply repeating a movement, practice will often be somewhat difficult and require effort. Of course, as a skill is learned it becomes easier and more automatic, and the attention requirements and effort decrease. The key points to remember are: it is not always beneficial to structure practice so that it is easy for the learner, and factors that improve short-term performance do not necessarily improve learning. Richard Schmidt, in discussing the benefits of random practice, says:

Related to this point is the notion that practice, if it is to be effective, needs to be somewhat difficult and effortful: practice should not be so difficult that the learners simply cannot function, of course, but also not so easy that important information processing activities are avoided. (Schmidt, 1991, p. 54)

This concept that practice should be difficult, is also incorporated into the MOVE curriculum, which advocates practicing skills at the “just manageable difficulty” level when a child is beginning to learn a new motor skill. (Bidabe, 1999) This initial stage of learning requires effort and concentration, but that should not deter the student or therapist.

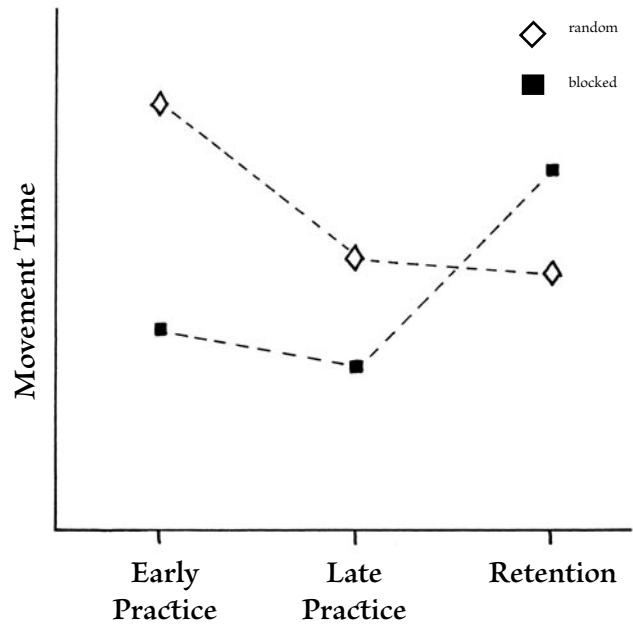


Illustration of the effects of randomized practice during early and late practice, and in retention. Note that randomized practice worsens performance during practice, but enhances retention (learning).

Context of Practice: Variability

In the chapter on Motor Control, we saw how movements can be classified according to their context. Gentile's classification of tasks examines the presence or absence of motion and intertrial variability in the environmental context of a movement. Tasks with no motion and no intertrial variability are called "closed" tasks, while those with motion and intertrial variability are called "open" tasks. (Gentile, 2000) Intuitively, it would make sense that practicing open tasks under variable conditions would be helpful for learning; however there is evidence that variability in practice is important for closed tasks as well (ie, practicing the target task and closely related tasks as well). (Schmidt & Lee, 1999) As would be expected, during practice of a task, performance is much better under constant conditions than under variable conditions. However, the skill is retained better following practice under variable conditions. Transfer to similar tasks is also enhanced by variable practice. Research with both adults and children has examined the effects of variability on skill acquisition, and the benefits of variable practice vs. constant practice seem even stronger in children than in adults. (Schmidt & Lee, 1999)

How might this affect motor skills training for our population? If our goal is to enhance learning and the ability of the child to generalize the skill, we should practice under varying conditions. One aspect of variability that is important for this population is to practice motor skills with different people. If a child works on certain motor tasks only with the occupational therapist, for example, he or she may become dependent on that person for performing those tasks. This is one benefit of the MOVE curriculum, where all the members of the team help the child to practice the same skills.

Adaptive and Part-task Training

In the therapy setting, practice of motor tasks is often modified in one of two ways: either the task is adapted to make it easier, or the task is broken down into simpler "parts" which can be practiced separately. Carolee Winstein in her review of motor learning principles (Winstein, 1991a) points out that adaptive training is not well supported by the literature. Practicing less difficult variations of the task may encourage control strategies that are not appropriate for the transfer task. For example, when you walk very slowly, you must significantly change the way you shift weight compared to walking at your typical, preferred speed. Children with severe disabilities often are unable to practice a motor skill unless the task is modified or external support is given. We do need to be aware of the limitations of adaptive practice and try to make the control requirements of the adapted task as similar as possible to the task we are trying to teach.

Part-task practice also has limitations, although for complex tasks it is beneficial to practice parts which are natural subunits of the task. (Winstein, 1991a) It is necessary to carefully consider if the subtask is indeed a "part" of the whole task. For example it is very doubtful that "reciprocal lower extremity motion" as practiced on a tricycle is a natural subunit of ambulation.

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