Motor Learning Strategies: Impact on Motor Skill Learning

PICO Question:
Do children who have disabilities learn motor skills more rapidly when they have variable vs. constant practice?

How was the review conducted?
A database literature search was conducted in December 2007 using the following search terms: motor learning and (pediatrics or child). The searches included articles published from 1990 to 2007 and were conducted in the following databases: Ovid Medline, PSYCHINFO and Cochrane Library. Sixty-nine articles were identified and reviewed to determine applicability to the topic. Thirty-six articles were selected as applicable to the PICO question and their abstracts were reviewed. Many articles were eliminated as they focused on types of feedback used instead of type of motor learning strategies used. Of the remaining articles we selected the three articles with the highest level of evidence potential (i.e., methodology). Two additional articles were interesting but not reviewed due to being unavailable. The three articles were reviewed by Journal Club participants and their summaries are included on pages 2 and 3. Finally, Journal Club participants discussed these articles and implication for practice during a Journal Club meeting in January 2008 (page 3-4).

TAKE-HOME MESSAGE
Many of the components of motor learning and practice are an integral part of related service providers’ work with children. The information offered in the articles reviewed can guide the method that related service providers use to help children learn new motor skills. The level of evidence for motor learning strategies of the articles reviewed is 2b. When teaching a motor task, it seems to be most advantageous to practice a defined task for a period of time that will allow the child to learn the task and with enough variability that they learn to accommodate for contextual interference. Consider simplifying the task when initially teaching the skill. Consider using blocked practice initially and as soon as the essential components of the skill are learned, add variability. This can often be done naturally by allowing natural variability in the environment or child performance to occur.
Section 1 – Summaries and Critiques of Articles Reviewed


Twenty-four students diagnosed with learning disability participated in a randomized study to determine the effects of constant versus variable practice on motor learning and performance. The sample was selected from students who were attending self-contained classrooms. There were 3 females and 21 males with a mean age of 10.8 years (range: 9-12 years). The students were taught three different versions of the same serial skill. The skill was duplicating a design using 9 5-inch colored squares. Students’ response time was measured by a Dekan Automatic Performance Analyzer Model. Testing was completed on two days with one day in-between. On Day 1, the subjects in the constant practice group practiced the same pattern for 10 consecutive trials before switching to the next practice sequence until they reached 30 trials. The subjects in the variable practice group were presented the different patterns in random fashion for 30 trials. On Day 2, both groups received the designs in random fashion to determine which group had the greatest degree of transfer. The constant practice group performed better (p > .05) on Day 1 compared to the variable practice group. There was no significant difference between the groups on Day 2. Thus, constant practice seems to influence performance but not learning of a serial-type motor skill in individuals with learning disabilities. Limitations of the study include: the small sample size; the dependent variable of time which may not have been the most sensitive measure of improvement; and the speed of response which could have brought in other psychological variables that may have affected learning.


Method: This randomized clinical trial studied blocked, random and combined practice in relation to complexity of tasks' effect on acquisition, retention and transfer of motor skills. Ninety-six typically developing children, ages 7.5-9.5 years, were randomly assigned to complex or simple task groups to practice the task of throwing beanbags. The simple task group had one parameter change during the trials (i.e., weight of bean bags). The complex task group had three parameters changed (i.e., the weight and size of the bean bags, and the order in which the targets were presented for each task). The dependent variable was the time to complete each trial. On Day one, all participants performed 30 acquisition trials. One day later, 9 acquisition trials of the same activity from the previous day were completed and followed immediately by 4 transfer trials. The transfer trial tasks were different based on acquisition group. Both groups used different weight beanbags for the task. The simple task group used the new bean bags in the same size order and target order as during the acquisition trials while the complex task group had bean bag size and target order presented in a new order. Half of the acquisition groups practiced the retention and transfer tasks in a blocked fashion and half practiced in a random fashion. Results: The speed of performance during the acquisition phase among the Simple Task groups was not found to be statistically significant (P<.01) among the subgroups. The subgroup which practiced in a blocked practice pattern from the Complex Task groups performed significantly (P<.01) faster than those in the other two subgroups during acquisition phase. During the acquisition phase, the students in the random and combined practice patterns from the Simple Task group performed the skills faster than the same practice pattern groups in the Complex Task group. The results related to retention of skill indicated that the Simple Task group performed faster than the Complex Task group, with the random and combined practice subgroups performing statistically significantly (P<.05) faster than those from the Complex group. During the transfer phase there was no statistically significant difference among the practice subgroups. The random practice subgroup from the Simple Task group was statistically faster (P<.05) than the random practice subgroup from the Complex Task group. Analysis of Variance indicated a significant (P<.001) task complexity effect, meaning that the complexity of the task produced contextual interference and impacted negatively on learning the task. For the children who practiced the complex task, it seemed that the low contextual interference practice context (blocked practice) was more beneficial for retention and transfer. The limitations of the study include: a limited number of trials, the task may not have been a meaningful motor task, and measure of time to perform the task may not be the best measure of learning.
The purpose of this study was to determine whether randomizing practice during motor skill acquisition would lead to better retention and transfer of motor skills. This is a case-control study using pre, post and retention test measures. The sample population included 71 children, all 6-years-old, from 4 regular physical education classes within the same school who were considered “normal and healthy”. Sensorimotor deficits and abnormalities were ruled out based on results of physical exams and psychological testing performed regularly at school every 2 years. The children were divided into 4 groups based on their pre-test scores to ensure no group had more skilled students than another group. All groups of students were given practice sessions of throwing balls at a target. For two groups, the practice sessions involved varying the task, either by using different balls or moving the targets. The remaining two groups practiced throwing the same ball at the same target placement for the entire practice session. Practice sessions took place for 6 weeks, during 18 regularly scheduled Physical Education classes, each lasting 50 minutes. Two weeks following the 6 weeks of practice sessions, the children were tested for retention using the same activity, followed by a transfer test in which the children threw bean bags to a flat target. The data collected were points given for accuracy of throwing. The study found that the group of children who had varied practice had statistically significant (P<.05) different scores. They were better at retaining the skill of throwing at a 3 meters vertical target as well as transferring the skill to throwing bean bags. The authors also concluded that the length of practice influences the learning process. No limitations were noted in the article. Within the conclusion, the authors compared their study results with a study by Jarus et al that used different distances for their throwing tasks then made some conclusions related to why the results from the two studies were different and thus recommended future research to determine which study hypothesis was correct.

Section 2- Implications for Practice

1. Summary of Research Findings:
All three studies reviewed looked at random or variable practice in comparison to blocked or constant practice and found that constant or blocked practice has positive impact on skill performance. Each study was different in terms of the tasks being taught, how the tasks were modified, and the complexity of the tasks, thus it is difficult to compare results from study to study. Two of the studies look at students who were typically developing while one study looked at children who were diagnosed with having learning disabilities.

Two of the studies had time as the dependent variable and one study had accuracy of throwing as the dependent variable. One study started to measure accuracy of throwing, but because it was difficult to measure, dropped that measure and used time to complete the task as their sole measure of skill development. Two of the tasks were throwing to targets while one study looked at copying designs using colored squares. For the studies that had time as the dependent variable, there may have been the psychological factor of time impacting on motor performance and learning.

Reviewers and Journal Club participants agreed that speed of task completion is not the best measure of learning a motor skill. Two of the studies had one day of practice and retention testing within one to two days. One study had 6 weeks of practice within physical education class prior to 2 weeks break before retention testing. For the two studies that did retention testing after 1 day of practice there was no significant difference between groups. For the study that had 6 weeks
of practice there was a significant difference for the variable practice group having better accuracy at the 3 meters target, but not at the 5 meters target. The children who used variable practice had much higher scores than the group who had blocked practice. For this study, the students who used variable practice also had significantly higher scores on a transfer task (performing a new task) than the students who used blocked practice.

2. Validity of studies’ results:

All three studies were generally well designed. The studies’ authors did not sufficiently justify their decision to use of “time to throw” and “accuracy of throwing” as outcome measures. The Journal Club participants questioned the validity of these measures as a mean to assess skill acquisition/motor learning.

Most of the studies’ subjects were typically developing children. Therefore results of these studies must be interpreted cautiously when trying to apply these results to intervention for children with disabilities.

3. Level of Evidence:

Given the literature reviewed, the levels of evidence for random versus blocked practice for children to motor learning task is a level 2b (low quality random control study) according to the criteria from Sackett and colleagues (2000). The actual level of evidence could be higher as not all relevant studies were reviewed.

The current studies provide moderate level of evidence that: (1) blocked practice helped to enhance skill performance; (2) random practice, given a sufficient amount of time to learn a skill, enhanced children’s abilities to accurately perform a throwing task; and (3) random practice enhances transfer to new task more efficiently than blocked practice.

More research is needed to identify the ideal level of contextual interference to maximize motor learning and the efficacy of motor learning strategies with children with special needs.

Definitions:

- **Motor learning** was defined by Richard Schmidt in 1988 as “a set of processes associated with practice or experience leading to relatively permanent changes in the capability for responding” (page 346).
- **Motor Performance** is when there is skill improvement within a treatment session.
- **Retention** is when the skill can be performed following a period of time with no practice.
- **Transfer** is when the motor learning from one task will influence the learning of a novel task.