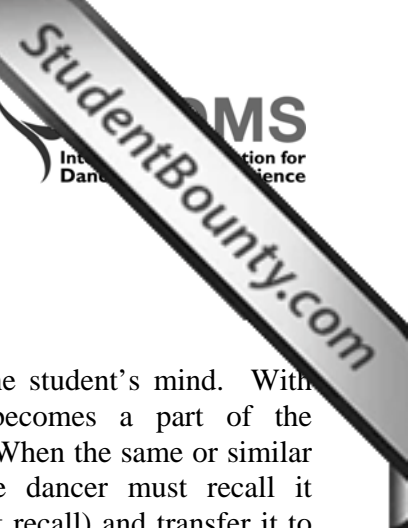


Motor Learning and Teaching Dance

by the International Association for Dance Medicine and Science

www.DanceEducation.org



Defining Motor Learning

In the fourth edition of *Motor Learning and Performance: A Situation-based Learning Approach* published in 2008, Schmidt and Wrisberg define motor learning as “the changes associated with practice or experience, in internal processes that determine a person’s capability for producing a motor skill.” These changes are relatively permanent, that is, stored in long-term memory, and are associated with exercise or repetition of motor skills. Although the result of this learning is permanent, the motor system remains ‘plastic’ or capable of change throughout the lifespan. In dance, motor learning is the process that allows dancers to learn and execute basic and sophisticated skills that are not acquired through normal human motor development. Specific examples include pirouettes, large jumps, and balances. Additionally, the aim of teaching dance is to train these skills with the specific intent to improve the quality of performance by enhancing smoothness, coordination and accuracy. Thus, the quest of the dancer is not simply to learn a skill, but to become skilled to a level of proficiency that enhances the quality of the learned movement. This might involve learning how to use core support during balances to allow for increased control and ease, or it might involve a new strategy to improve the aesthetic appearance of a balance, such as translating the pelvis laterally during the weight shift, rather than tilting or tipping the pelvis. The focus of this paper will be to explore the various stages and processes in motor learning, and to assist dance teachers in becoming familiar with the variety of possible teaching and learning strategies to increase effectiveness in their practice.

There are various stages that are essential in the motor learning process including attention and observation (perception) of a demonstrated skill, replication (execution) of what has been observed, feedback (knowledge of results/performance and additional explanation), and repetition (further practice). In most formal dance classes, the teacher provides the initial information, that is, a dance combination is demonstrated and explained. The student then performs the movements, and those

movements are encoded in the student’s mind. With repetition, that movement becomes a part of the dancer’s long-term memory. When the same or similar movements are required, the dancer must recall it mentally (referred to as covert recall) and transfer it to physical execution (referred to as overt recall). By the time the motor skill is imbedded in long-term memory, it is an image or concept of the task that is recalled at this level of execution, rather than a complicated series of details, multiple body parts, or individual muscle activation. This step is the final goal of the motor learning process.

The example that will be used in this paper is a shift from standing in first position to a balance on one leg with the gesture leg in retiré. This skill has been selected because it incorporates a weight shift and a one-legged balance, as well as serves as preparation for the pirouette. There are also many physiological components necessary to achieve this skill, such as sufficient strength in the hip musculature, but these issues will not be covered in this paper. The focus will remain on motor learning components.

Perception

As the teacher demonstrates the combination or skill for the dance students, the process of motor learning starts with attention and perception. Perception has two components: first, one observes and organizes one’s present experience, and second, meaning is attached to that observation based on past experience. Perception is dependent on the senses (sight, touch, smell, hearing, tasting). The dancer sees the teacher demonstrate the shift from first position to retiré, and might relate it to any number of childhood games in which she attempted to balance on one leg. The dancer also hears the music for the exercise, giving the movement a temporal context. It is likely that the first attempts would include some wobbling and adjusting, as the brain seeks strategies to accomplish this shift in a smooth, coordinated way as demonstrated by the teacher.

Additionally, the bones, muscles, tendons, ligaments, joints, and skin all have specialized tissues (nerve cells) that receive information during stance and movement. The transmission of this information to the brain, and the processing of this information, is called

proprioception. Proprioceptive information is integrated with input from the vestibular mechanism of the inner ear and the vision accorded by the eyes. Balance, and the ability to transfer weight through space, are major components of dance, and highly dependent on well developed and well integrated proprioceptive, vestibular, and visual systems. Dance teachers should realize that these three systems do not integrate until after seven years old, and are not fully mature until much later, probably late teens or even early adulthood. Therefore, giving a retiré balance to a child of five or six years old and expecting a smooth and stable shift to occur is unrealistic. There are considerable fluctuations in the ability of the brain to utilize proprioceptive information during some of the adolescent years, and deficits are noticeable during growth spurts. It is not uncommon to see dancers regress in ability to balance on one leg during these growth spurts. If the dancer is already accomplishing multiple pirouettes, and a growth spurt occurs, she may suddenly find she can no longer achieve this task; the teacher may consider encouraging the dancer to do fewer turns during this phase and attend to other motor or artistic components of the skill.

The integration of all these physical experiences and ascribed meanings form the basis of perception. Perceptual skills include hand-eye coordination, rhythm, visual discrimination, spatial discrimination, body control, and balance. These perceptual skills are inherited rather than learned but can be enhanced by training. Thus, the goal of the teacher is to take the innate skills that students bring to class and fine-tune these abilities. For example, some dance students will have an innate ability to balance easily before any training has occurred, but they may do the given task by lifting the hip of the gesture leg and leaning the torso off to the side. The teacher can fine-tune the skill by providing feedback (to be discussed later) that encourages a vertical alignment of the torso, and a translation of the pelvis onto the standing leg. Additionally, each child brings to class a specific set of learning tools. The child's ability to stay 'on task' (known as task persistence), her personal sense of rhythm and musicality, her preferred speed of moving, and her spatial preferences all must be taken into account in teaching. While it is impossible to design a class that addresses each individual learning variation, if the teacher has an awareness of the range of tools the students bring, the teacher can provide a better range of material and presentational approaches.

Finally, children have specific capabilities that should be enhanced by teaching at the pre-elementary school level. A general model of exploration in rhythm,

space, balance, and locomotion. This model would include formal training in the vernacular of ballet, and a modified technique. This approach would make the retiré balance training process-driven as opposed to process-driven. It is likely that if general locomotor skills are learned in early dance training, specific and complex skills will be more easily learned as the dancer matures. For example, in this early training stage, having children run and stop in a one-legged balance, improvising their own shapes, would be an excellent way to introduce the concepts that will be required later for the retiré balance.

From Perception to Movement

Motor learning is set in motion by perception and continues with replication. The teacher must make the most critical aspects of the movement apparent, and a variety of strategies can be employed to help the dancer succeed. People learn any new material in small pieces so it is best if the teacher can focus initially on specific points – arms, or the rhythm, or the spatial pattern – and progress to more complexity over time. The teacher may want to emphasize only the shape of the legs (the standing leg fully straight, the gesture leg arriving cleanly in the triangle-shaped retiré) for the first attempts. Another teacher may choose to emphasize the quick dynamic, and the arrival of all the parts at once.

Learning a dance or movement skill is, in part, dependent upon how the information is presented. What is called instructional cuing can take three forms: visual, verbal, and kinesthetic. In other words, the teacher can demonstrate the shift to retiré to the students, verbally explain the process and proper execution to the students, and use hands-on touch to assist in achieving the task, such as helping to level and align the pelvis. Verbal instruction tends to be the most often used strategy in dance class, although it may not be the most effective when used alone. Research has stressed the importance of a visual model (*i.e.*, having a more advanced dancer to observe) for students to imitate. The imitation needs to be guided by the teacher with regard to organized goals and insights, and the teacher can emphasize that the desired result is not to try to look exactly like the demonstration, but to take that visual model and apply it to the student's own physique and attributes. For example, the teacher may want to explain that each dancer's retiré will arrive at a slightly different position in space. Some legs will go more directly side while others will be forward of that side position, and this is dependent on each dancer's personal anatomical attributes. It is also of great benefit for dancers to observe their peers attempting the material and working through problems and errors. Rv

seeing others correct and improve the attempted skill, the dancers can see what constitutes a successful strategy, and try applying it to their own experiences. This process has the added benefit of encouraging the idea that making mistakes is a natural part of the process, a necessary component of learning to dance. When students develop an overwhelming fear of making mistakes, it can be limiting to their progress.

Feedback and Repetition

'Watching and doing' should be the predominant strategy in teaching, and verbal instruction should be secondary, especially when the dancers are seeing and learning a task for the first time. After the initial attempts at the movement task, dance training involves considerable repetition. It is at this stage that verbal input can be an important factor in the learning process. Knowledge of results is the term used in motor learning when the learner is given information relating to what the execution of the movement has actually achieved. In sports, this might mean learning that their attempted shot at the basket was off to the left. In our dance example, it might mean telling the dancer that she did not shift her pelvis far enough onto the standing leg to achieve balance. This feedback is an important component of the motor learning process. Repetition of material without feedback does not necessarily result in improved performance. The challenge for the teacher is to give sufficient feedback to enhance improvement without overloading the student with too much information.

One of the most important things that research in motor learning has revealed is an understanding of repetition. Research on dance skill acquisition indicates that continuing practice can improve a motor skill. Once the appropriate neurological pattern is set up (*i.e.*, the movement is being executed correctly and efficiently), repetition will ingrain the skill into the body, much the same way as walking on the neighbor's perfect yard will wear a path through it. The negative aspect of this effect is that if dancers practice incorrectly (whether this is about alignment or poor movement patterns), these too will become deeply ingrained, and retraining can be difficult, frustrating, and time consuming. The importance of setting up appropriate neural patterning in the first place cannot be overemphasized. While there are many theories about the amount of repetition needed before movement patterns become part of the long-term or 'habitual' memory, this is probably dependent in part on the individual student's innate abilities, focus and concentration, and kinesthetic awareness.

Teachers should realize that the learning movement has a limited capacity for information. Visual cues need to be specific and short to avoid this quality in the student. Clearly, the novice dancer would reach attention and information overload sooner than an advanced dancer, so the teacher would address these classes differently. Additionally, younger dancers would reach attention overload sooner than older dancers. An advanced dancer might be able to receive feedback that corrects the alignment of the pelvis, changes the placement of the arms, and alters the speed of the moving gesture leg, but a young or beginning dancer would probably be unable to attend to all of these corrections at once. Additionally the teacher should try to provide this information in a variety of ways, cueing the dancer verbally, visually and kinesthetically, regardless of the dance form or level. Employing a range of feedback mechanisms is the most effective method of enhancing motor learning.

As the student matures from recreational to pre-professional to professional, teachers should instill the capacity and knowledge for the dancer to 'self-instruct.' The teacher can accomplish this progression initially by asking questions: What can you observe about your attempts? Do you consistently fall in the same direction? Why do you think this might be occurring? As dancers become more and more advanced in their movement capacity, they should become less and less dependent on the teacher for actual teaching of skills, but make use of the teacher's artistic expertise for coaching the detailed idiosyncratic elements of a movement (tilt of the head, timing, dynamics) and artistic qualities. The teacher can encourage this transition by placing more responsibility on the dancer for analysis of the personal process, and shifting the teacher's feedback to the artistic realm.

Mental practice (seeing oneself doing the movement before execution) or mental rehearsal is another strategy that can enhance learning. When dancers or athletes practice combinations or exercises mentally, certain areas of the brain that fire on the muscles used for these movements will activate. It has been demonstrated that mental practice can enhance skill development beyond what can be accomplished through physical practice alone. It should also be noted that mental practice of a skill is not effective if the student has never actually executed the skill, so this strategy of mental practice is more useful to skilled dancers than untrained ones.

Setting Goals and Motivating Dancers

While goal-setting and motivation belong in the dance psychology realm, they play a role in motor learning by enhancing and focusing attention, and by increasing one's willingness to participate in repetition. Perceptions are modified by the maturity of the dancer, past experiences of the dancer, the social and cultural context in which learning is taking place, the motivation of the dancer, and the feedback and goals provided by the teacher.

Establishing goals, set and explained by the dance teacher for the short term (class) and long term (month or season), would also be an effective and efficient teaching tool in the motor learning process. Even before the dancers are attempting pirouettes, they may be more inclined to practice and refine their retiré balances if they see pirouettes and know that this is the goal. This forward-looking strategy creates excitement and anticipation, and motivation is key in skill acquisition. It has been suggested that performance-oriented, competitive climates are linked to unproductive or negative behaviors (such as the damaging effects of neurotic perfectionism). Thus, in addition to setting goals for dance class, the teacher can provide a positive atmosphere that will be conducive to learning and achieving. Feedback should balance critical observations of areas that need improvement with supportive approval. If the dancers attempt their retiré balance after receiving corrections, and they manage a cleaner weight shift to the one-legged balance, but the arms are still not correct, it might be an opportunity to praise the improvement of the shift, rather than criticize the arms, and save that information for another trial.

Additional Factors Affecting Motor Learning

Transfer of Training

Motor learning as it relates to dance involves the concept of transfer of information, or what is called transfer of training. The ballet dancer practices skills at the barre that are repeated in the centre. Similarly contemporary or jazz dancers sometimes practice skills on the floor that are repeated in center work. It has been suggested by more than a few researchers and dance teachers that this transfer of information does not occur as dance teachers may expect. Specific research on muscular effort at the barre and centre indicate that the functioning of the gesture leg is quite similar in a développé à la seconde under both circumstances (barre and centre). However, the muscular effort of the standing leg was substantially different in these two circumstances, indicating that barre training may have a

negative transfer effect on centre work. In other words, the barre work is preparing the gesture leg for centre work but might not be preparing the standing leg adequately. Similarly, it can be hypothesized that practicing skills on the floor can teach motor skills to the spine and limbs, but may not be preparing the balancing mechanisms that will need to underlie these skills once the dancer is standing.

For all dance forms, traveling through space adds yet another dimension to coordinating and organizing movement. It is crucial that the teacher allows sufficient time in class to practice and integrate the complex mechanisms involved in weight transfer through space. The teacher should also understand that certain fundamental patterns (turnout, use of the feet and arms, etc.) might diminish as students attempt moving through space, but these setbacks are temporary.

It has also been long presumed that ballet class promotes even development of the right and left sides of the body. However, recent research on lateral bias indicates that right and left sides of the body are not trained as symmetrically as one would presume. The right side is often the side that the teacher and student both use to demonstrate and mark combinations. The number of repetitions of an exercise on the left side of the body can be substantially less in most dance classes of all levels. An additional consideration is the issue of reversing combinations after learning the first side. Motor learning research suggests that transfer of information from the non-preferred side to the preferred side is more effective. Since most students are right-handed, learning material on the non-preferred (left) side first might make it easier to reverse the combination.

Learning Styles

Each child also brings to class a specific set of learning tools and cognitive behaviors. As mentioned previously, each child has preferences regarding a wide variety of dance-related elements, such as rhythm, speed of movement, and use of space. She uses different strategies or methods to learn dance, given these preferences. The wide variety of learning strategies is often referred to as multiple intelligences and has been brought to the forefront of educational considerations by Howard Gardner. These intelligences include:

- Linguistic: the use of words, be they written or spoken
- Logical/mathematical: ability to reason, consider abstractions, use numerical skills

- Spatial: awareness of space and how objects (and the self) occupy space
- Musical: a sense of rhythm, pitch and musical composition
- Kinesthetic: a sense of the body and movement ability
- Interpersonal: interactions with others
- Intrapersonal: awareness of self and personal goals and standards

Understanding how much variation exists in the way that dance students learn and process information is the first step for the teacher in broadening one's teaching strategies. Some children might learn the retiré more easily if the teacher emphasizes rhythm and musical context. Other children might have more success if they are informed with a sense of the shape design of the movement. Others might do well working in pairs and assisting each other. As with types of cueing, teachers can be more effective if they can recognize these learning styles and accommodate them, providing a broad spectrum of methods to perceive and attempt the same skill.

Questioning and Enhancing Traditional Teaching

As knowledge of how dancers learn expands and awareness of anatomy and physiology is heightened in the dance teacher, it is important to consider traditions that have been passed down for generations. These include:

- Grand plié – Studies have shown that a complete flexion of the knees, as is accomplished in grand plié, has a deleterious effect on the knees. While this topic is not specifically a motor learning issue, dance teachers might begin to question what particular skills the grand plié is designed to support, and if there might be other movements that can develop the same motor patterns so that fewer grand pliés are incorporated into the daily class.
- Laterality and bilateral transfer – It is traditional to begin all combinations on the right side, but the ballet class is not symmetrical in the execution of combinations, with the right side or first side often doubling in repetition as compared to the left or second side. Teachers might consider learning material on the left side

on alternate days, or double the repetitions on the left side, if the material is initially on the right side.

- Barre versus centre– It is expected that information rehearsed at the barre will transfer to centre. Research has shown that holding the barre carries a significant amount of pressure and the standing leg works less during a barre sequence as compared to the same sequence at centre. While barre serves important educational functions in the ballet class, teachers can examine whether or not they are spending sufficient time in center and traveling work to ensure transfer of barre-learned skills to all contexts.
- Use of mirrors – It has long been assumed that using mirrors enhances learning, but there is evidence that visual information from the mirror is distorted (two-dimensional), which may diminish kinesthetic awareness and learning. Additionally, there is evidence in the psychology field suggesting that constant use of the mirror may negatively affect self-esteem in young dancers.

The traditional dance class provides many excellent opportunities to train the dancer and develop young artists. Teachers can use current research about motor learning to evaluate their practice, assess their assumptions, and refine the class structure and intention. The field of motor learning has much to offer dancers and dance teachers in creating classes that are productive and exciting.

Written by Virginia Wilmerding, Ph.D. and Donna Krasnow, M.S., under the auspices of the Education and Media Committees of IADMS.

Virginia Wilmerding is at the University of New Mexico, Albuquerque, New Mexico, USA.

Donna Krasnow is at York University, Toronto, Ontario, Canada and California State University, Northridge, California, USA.

This paper may be reproduced in its entirety for educational purposes, provided acknowledgement is given to the "International Association for Dance Medicine and Science."

©2009 IADMS and Virginia Wilmerding, Ph.D., and Donna Krasnow, M.S.

References:

1. Batson G. *Proprioception*. Resource Paper. International Association for Dance Medicine and Science. 2008. Available at www.iadms.org/associations/2991/files/info/proprioception.pdf
2. Chatfield SJ, Krasnow DH, Herman A, Blessing G. A descriptive analysis of kinematic and electromyographic relationships of the core during forward stepping in beginning and expert dancers. *J Dance Med Sci*. 2007;11(3):76-84.
3. Enghausser R. Motor learning and the dance technique class: Science, tradition and pedagogy. *J Dance Ed*. 2003;3(3):87-95.
4. Farrar-Baker A, Wilmerding V. Prevalence of lateral bias in the teaching of beginning and advanced ballet. *J Dance Med Sci*. 2006;10(3-4):81-84.
5. Kandel ER, Schwartz JH, Jessell TM (Eds). *Principles of Neural Science* (3rd ed). New York: Elsevier Science Publishing Company, 1991.
6. Krasnow D, Monasterio R, Chatfield SJ. Emerging concepts of posture and alignment. *Med Probl Perform Art*. 2001;16(1):8-16.
7. Laws K, Sugano A. *Physics and the Art of Dance: Understanding Movement* (2nd ed). New York: Oxford University Press, 2008.
8. Mouchnino L, Aurenty R, Massion J, Pedotti A. Coordination between equilibrium and head-trunk orientation during leg movement: A new strategy built up by training. *J Neurophysiol*. 1992;67(6):1587-1598.
9. Monasterio RA, Chatfield SJ, Jensen JL, Barr S. Postural adjustment for voluntary leg movement in dancers. Master's thesis, unpublished. University of Oregon, 1994.
10. Nolan L, Grigorenko A, Thorstensson A. Balance control: Sex and age differences in 9-to 16-year-olds. *Dev Med Child Neurol*. 2005;47(7), 449-454.
11. Peterson ML, Christou E, Rosengren KS. Children achieve adult-like sensory integration during stance at 12-years-old. *Gait Posture*. 2006;23(4):455-463.
12. Poretz S. Psychomotor research and the dance teacher. In: Clarkson PM, Skrinar M. *Science of Dance Training*. Champaign, IL: Human Kinetics Books, 1988, pp. 279-288.
13. Radell SA, Adame DD, Cole SP. The impact of mirrors on body image and classroom performance in female college ballet dancers. *J Dance Med Sci*. 2004;8(2):47-52.
14. Ryman R, Ranney D. A preliminary investigation of two variations of the grand battement devant. *Dance Res J*. 1978/79;11: 2-11.
15. Schmid M, Conforto S, Lopez L, D'Alessio T. Cognitive load affects postural control in children. *Exp Brain Res*. 2007;179(3):375-385.
16. Schmidt RA, Wrisberg CA. *Motor Learning and Performance: A Situation-based Learning Approach* (4th ed). Champaign, IL: Human Kinetics, 2008.
17. Shumway-Cook AS, Woollacott MH. *Motor Control: Theory and Practical Applications*. Baltimore, MD: Williams and Wilkins, 1995.
18. Steindl R, Kunz K, Schrott-Fischer A, Scholtz AW. Effect of age and sex on maturation of sensory systems and balance control. *Dev Med Child Neurol*. 2006;48:477-482.
19. Viel S, Vaugoyeau M, Assaiante C. Adolescence: A transient period of proprioceptive neglect in sensory integration of postural control. *Mot Contr*. 2009; 13:25-42.
20. Wilmerding M, Heyward VH, King M, Fiedler KJ, Stidley CA, Pett SB, Evans B. Electromyographic comparison of the développé devant at barre and centre. *J Dance Med Sci*. 2001;5(3):69-74.
21. Wieczorek N, Casebolt JB, Lambert CR, Kwon YH. Resultant joint moments during a dégagé with and without a barre. In R. Solomon & J. Solomon (eds): *Proceedings of the 17th Annual Meeting of the International Association for Dance Medicine and Science*. Canberra, Australia: IADMS, 2007, pp. 318-323.
22. Woollacott MH, Shumway-Cook A, Williams HC (eds). *Development of Posture and Gait Across the Lifespan*