Maximizing the benefits of Pilates-inspired exercise for learning functional motor skills

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Abstract Joseph Pilates (1880–1967) created a system of fitness exercises that are still practiced in a more or less modified form. Within the last two decades, there has been a significant increase in the popularity of such Pilates-inspired (PI) exercises. This paper describes current claims for the effectiveness of PI exercises and comments on their validity. Motor learning principles and findings are applied to make recommendations for using PI exercises to enhance the execution of functional movement tasks. The learning-performance distinction, augmented information feedback, contextual interference, skill transfer and augmented verbal cues are discussed. Finally, suggestions are made for aspiring PI practitioners seeking training and certification. © 2000 Harcourt Publishers Ltd

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Joseph Pilates and Contrology

Joseph Pilates was born in Germany in 1880. A sickly child, he used physical exercise to turn himself into a fit adult. In 1912, Pilates moved to the UK and held a variety of occupations, including boxer and self-defense trainer. During World War I, while interned in a prison camp for German nationals, he taught his fitness exercises to inmates. Upon returning to Germany after the war, he gave exercise classes to police and military personnel and interacted with members of the avant-garde dance community, such as Rudolf von Laban and Hanya Holm. In 1926, he moved to New York City and soon opened an exercise studio with his wife Clara. Pilates wrote a slender volume (1934) outlining his system of Contrology, which he described as a set of healthful lifestyle changes and corrective exercises. A later booklet (Pilates & Miller 1945) features a number of the exercises. His methods and specialized fitness equipment achieved popularity with dance professionals such as George Balanchine and Martha Graham, but were largely unknown to the general public. Pilates died in 1967. A handful of students have carried on his teachings and influenced numerous other individuals to learn and teach his exercises. As a result, the name Pilates has become associated with a form of movement

that is increasingly popular in clinical and fitness settings.

Pilates (1934; Pilates & Miller 1945) made bold claims for the benefits of Contrology. For example, he stated that it would prevent coronary heart disease, increase muscular power, and reduce the risk of respiratory ailments. He also stated that it would result in complete voluntary control of the body. He described Contrology as a 'balance' or 'complete coordination of body, mind, and spirit' achieved by relinquishing strenuous exercises and deliberately performing functional activities in a posturally appropriate manner. Despite Pilates' assurances (1934, Pilates & Miller 1945) that he had 'scientifically' proven the effectiveness of his approach, he did not subject his claims to experimental testing and maintained that such testing was unnecessary.

Within the last two decades, there has been a significant increase in the popularity of exercises based on Pilates' teachings. In the USA alone, more than 700 studio and rehabilitation sites use his methods (Larkam & Brownstein 1998). A directory of UK practitioners (Body Control Pilates 1999) lists roughly 100 studios. Practitioners can also be found in Africa, Asia, Australia and New Zealand, Europe and South America. In order to understand the significance of Pilates for functional skill improvement, it is necessary to be aware of claims made by current practitioners regarding the learning benefits of their exercise sessions. This can serve as a basis for practical recommendations about improving the quality of sessions. Such recommendations can generically be derived from the findings of existing experiments on motor skill learning. However, more Pilates-specific recommendations can only emerge with scientific study of Pilates-type exercises themselves. Considering the widespread application and adaptation of these exercises, there is a growing need to objectively assess their outcomes and benefits.

The purpose of this paper is to evaluate current claims on the learning benefits of exercises derived from the system developed by Pilates. Motor learning principles and findings will be used as a model to make recommendations for administering Pilates-type exercises to enhance functional movement skills. Finally, suggestions will be made for aspiring practitioners of these exercises seeking training and certification.

Claims on the learning effectiveness of Pilates-inspired exercises

The legacy of Pilates

Pilates was influenced by hatha yoga, gymnastics, modern dance and other movement systems. He designed about 40 mat exercises and hundreds of exercises for his specialized equipment (Larkam & Nichols 1999). His exercises have been further influenced by fields as diverse as physical therapy, somatics (e.g. Feldenkrais Method™, Body/Mind Centering®, Bartenieff Fundamentals), and Chinese medicine. Today, these (more or less modified) exercises are known collectively as Pilates, Pilates-based or Pilates-evolved. It is not the goal of this paper to distinguish among different exercise styles that are based on Pilates' teachings. Rather, all exercises emanating from those established by Pilates will be defined as Pilates-inspired (PI). There is an ongoing discourse between Pilates' central ideas and movement routines, and other systems of movement and rehabilitation. The defining characteristics of PI exercises are listed in Box 1. Examples of equipment and exercises based on Pilates' designs are shown in Figures 1–5.

Current claims for Pilates-inspired exercises

A sampling of relevant sources reveals three categories of claims on the benefits of PI exercises: enhanced physiological functioning, enhanced psychological functioning and learning or re-learning of functionally effective postural sets and motor patterns (e.g. Robinson & Thomson 1997, Balanced Body® 1999, Gallagher & Kryzanowska 1999, Physicalmind Institute 1999, Stott Conditioning 1999, The Balanced Body Studio 1999, Pilates

Box 1 Defining characteristics of Pilates-inspired exercises

- Progressively enhance breath, core (body center), shoulder girdle, and limb control.
- Movements are slow and deliberate, with few repetitions (usually 5–10).
- Programs are highly individualized. One-on-one, dyad, and small group sessions are conducted.
- Exercises are done on floor mats and equipment.
- Exercises are done from lying, sitting, kneeling, standing and other postures.
- Some equipment uses springs to provide variable resistance.
- Main piece of equipment is the Universal Reformer, a frame with a padded carriage that slides back and forth within the frame. Adjustable springs attach from the carriage to the frame. The carriage may be moved by pushing it, or by pulling on straps placed around arms or legs.
- Other large pieces of equipment include the TrapezeTable (Cadillac), Combo (Wunda) Chair, Ladder and Step Barrels, and Ped-a-Pul.
- Small pieces of equipment include exercise balls, foam rollers, rotating disks, balance boards, resistance rings, small arcs, and boxes.

Fig. 1 A golfer has been diagnosed with spinal facette lock. During rehabilitation, the therapist is giving verbal and tactile information to guide her to the appropriate position of spine extension and rotation. The patient is lying on the Trapeze Table and is using the spring-loaded pedals of the Combo (Wunda) Chair to assist her action. Desired functional activity might be a golf swing. Reproduced by kind permission of Balanced Body®, Inc. (1999) and Polestar® Education$_{LLC}$ (1999).

Box 2 Claims made on the effectiveness of Pilates-inspired exercises

Enhanced physiological functioning
- flexibility and range of motion
- muscular strength
- muscular endurance
- muscular power
- cardiorespiratory fitness

Enhanced psychological functioning
- mood
- motivational state
- attentional focus
- enjoyment of life
- energy and zest

Enhanced motor learning
- core control
- static and dynamic posture
- intralimb and interlimb coordination
- aesthetically pleasing movement form
- body awareness
- static and dynamic balance

Institute 1999). To give an idea of the extent of these claims, examples are listed in Box 2.

Of specific interest to this paper are claims related to motor learning. A main aspect of PI sessions marketed to the fitness consumer is the aesthetic benefit of a longer, leaner appearance that comes from improved posture. Dancers are told they can develop more graceful movement patterns. Athletes are assured they will maximize their biomechanical efficiency through more appropriate muscle synergies. A growing number of rehabilitation professionals are attracted to PI exercises due to the promise of regained function after events that disrupt normal coordination, such as orthopedic surgery, stroke, and head trauma. They also see PI exercises as a possible tool for management or improvement of physical ailments including multiple sclerosis, fibromyalgia and chronic pain.

The claims made by current PI practitioners regarding the motor learning benefits of their exercises are overwhelmingly unsubstantiated. Only a small number of published experimental studies document measured improvements in posture or functional tasks that are unequivocally attributable to PI exercises (Parrott 1993, Fitt et al. 1994, Krasnow et al. 1997, McMillan et al. 1998). Roughly an equal number of studies also report the failure of PI exercises to elicit improvements (Fitt et al. 1994, Krasnow et al. 1997, McLain et al. 1997). Despite the lack of supportive, research-based data on PI exercises, anecdotal reports by practitioners and clients indicate that significant benefits do indeed exist. It is therefore worthwhile to make preliminary recommendations for maximizing the benefits of PI exercises to enhance coordination, sensory awareness, and performance on functional tasks. These recommendations are derived from the field of motor learning, which deals with the experimental study of skill acquisition and performance.

Recommendations to practitioners of Pilates-inspired movement

Practitioner goals

PI practitioners have three important learning goals, which are

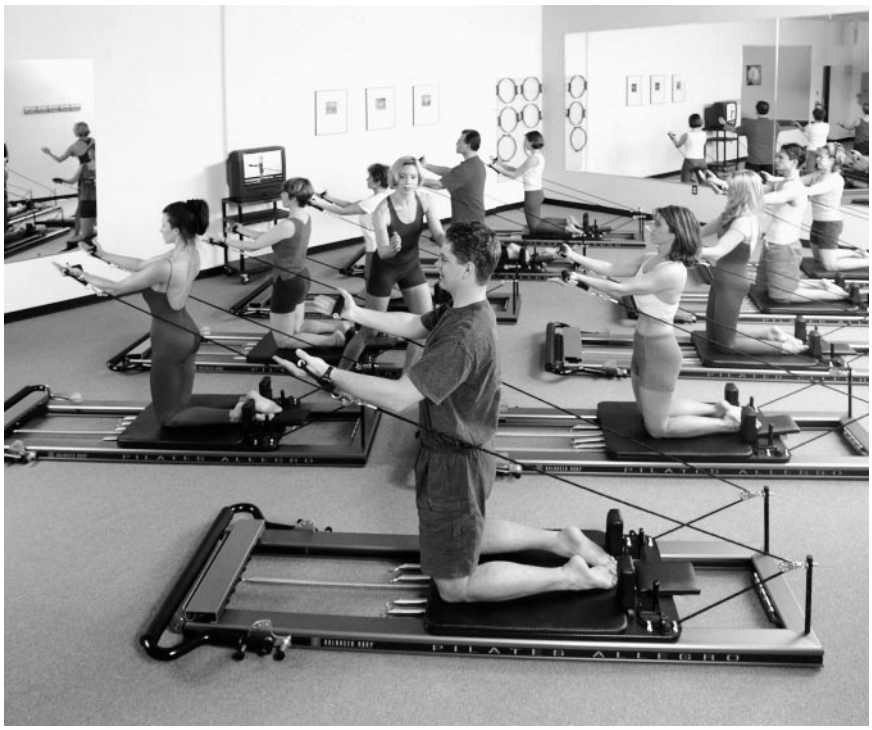

Fig. 2 In a health club, clients are kneeling on the spring-loaded carriages of portable Reformers and using their pectoral, biceps brachii, and anterior deltoid muscles to pull against the arm straps. This action results in a backward movement of the spring-loaded carriage. Equal attention is paid to concentric and eccentric contractions. The group exercise instructor is providing verbal cues and imagery. Desired functional activities include any actions requiring dynamic trunk and scapular stabilization. Reproduced by kind permission of Balanced Body®, Inc. (1999) and Polestar® $\text{Education}_{\text{LLC}}$ (1999).

outlined in Box 3. First, they want clients to *retain* the exercises they are teaching. In other words, they want clients to develop independent control of new movement patterns.

Second, practitioners want clients to be able to *transfer* the coordination patterns and sensory awareness learned during sessions to functional tasks outside of the practice environment. Such tasks include walking, reaching, lifting and other activities of daily living and work. They also include complex movement sequences executed by athletes and performing artists. Third, practitioners want to *structure practice* to facilitate retention and transfer.

Box 3 Learning goals of Pilates-inspired practitioners

- Clients retain PI exercises taught by practitioner and can perform PI exercises without practitioner's corrections.
- Breathing, core control, body awareness, and coordination patterns learned from PI exercises transfer to functional tasks.
- Practice is structured to facilitate retention and transfer.

Box 4 How to increase the effectiveness of Pilates-inspired exercises

- Observe the learning-performance distinction.
- Use augmented verbal cues, self-talk and imagery.
- Use augmented information feedback judiciously.
- Vary the context of practice trials.
- Use the right practice tasks to maximize transfer to functional tasks.

Though practice by itself is often considered the most important variable for successful retention and transfer-hence the adage that practice makes perfect-it is certainly not the only one. The conditions under which practice takes place have a great influence on the amount of skill learning. Some practice conditions appear to have a positive effect on learning, whereas others seem to result in less successful learning. It is beyond the scope of this paper to provide a thorough discussion of all practice conditions. For more in-depth information, the reader is referred to several appropriate sources (Feltz & Landers 1983, Landin 1994, Magill 1998, McCullagh 1993, Rose 1997, Schmidt & Lee 1999, Shea et al. 1993). The structure of practice becomes all the more relevant for PI routines, because the latter rely on low numbers of repetitions. Pilates (1934, Pilates & Miller 1945) stressed the importance of few repetitions (usually less than 10 per exercise). Instead, he emphasized deliberate practice during which conscious attention is focused on relevant task-related stimuli and processes. Current PI practitioners follow his lead and recommend 5–10 repetitions for most exercises (e.g. Robinson & Thomson 1997; Evans & Stott Merrithew 1998a, 1998b; Gallagher & Kryzanowska 1999). Hence, the amount of practice may be less critical for learning than the conditions of practice, and PI practitioners play an essential role in structuring these conditions. Five important recommendations for how practice conditions may be

Fig. 3 In a studio setting, a client is straddling the Ladder Barrel. She is lifting the pelvis off the barrel by activating her adductors, hamstrings, pelvic floor muscles, and external rotators. This complex posture can also be done with feet parallel. The instructor may provide cues or feedback. Examples of applications include ballet and horseback riding. Reproduced by kind permission of Elizabeth Larkam and Balanced Body®, Inc. (1999).

structured, in order to accomplish the goals of retention and transfer, will be described in the following paragraphs. Recommendations are summarized in Box 4.

Recommendations for practitioners

Recommendation 1: observe the learning-performance distinction

Motor learning has been defined as 'a set of processes associated with practice or experience leading to relatively permanent changes in the capability for movement' (Schmidt & Lee 1999). One important aspect of this definition is the so-called learning-performance distinction. Learning is not a merely a change in behaviour, because changes can be transient. For instance, *augmented information feedback* (AIF) can be provided to learners about the success of their movements in the environment, or about the quality of their movement patterns. An

Fig. 4 In a studio or rehabilitation setting, a ballet dancer is using the Trapeze Table (Cadillac) to increase awareness of proper hamstring and hip extensor activation, in conjunction with core control and spine articulation. She is pressing with her left foot against a spring-loaded bar. A therapist may spot for safety by placing a hand over the dancer's left foot to prevent it from slipping off the bar. This exercise can be done in many variations to facilitate intratask transfer. Reproduced by kind permission of Elizabeth Larkam and Balanced Body®, Inc. (1999).

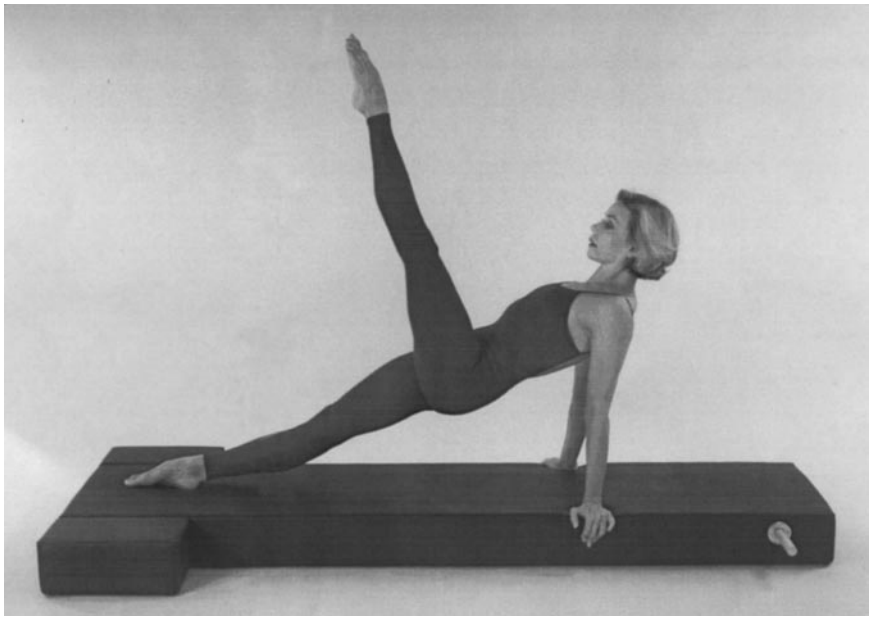

Fig. 5 During an advanced mat class, a fitness client is executing a front leg pull. This action requires activation of deep abdominal and spinal musculature, as well as posterior shoulder girdle stabilizers. It can also be done prone (facing down) as well as sidelying. Switching among different postures assists the client in maintaining axial elongation and core control during a variety of upright functional activities and is a precursor to sport-specific conditioning. Reproduced by kind permission of Elizabeth Larkam and Balanced Body®, Inc. (1999).

example of AIF might be a practitioner's verbal or tactile information about the degree of spine extension and rotation achieved during the prone Chair exercise depicted in Figure 1. Until recently, it was thought that providing a lot of AIF was better for learning. Indeed, laboratory experiments show that when learners receive AIF after each practice trial, their performance is usually better when compared to that of learners who receive feedback after fewer trials. However, once AIF is removed and learners must rely on their own recollection of the movement, those who received less in practice are typically more successful (Salmoni et al. 1984, Schmidt 1991a, Schmidt & Lee 1999).

It is evident from the example of AIF that one cannot always predict learning from the quality of performance during practice sessions. Rather, the temporary and relatively permanent influences of instructional methods must be taken into account. The learning-performance distinction is a crucial aspect of evaluating the success of any rehabilitation or conditioning system. Practitioners should strive to be aware of this distinction and understand that clients may be performing PI exercises or functional tasks very differently when not in the rehabilitation center or studio. One way to assess learning is to ask the client at the beginning of the session to demonstrate an exercise or functional activity that was practiced last session. This type of approach can give an estimate of how much was learned.

Recommendation 2: use augmented verbal cues, self-talk, and imagery

Augmented verbal cues (AVC) are concise phrases, often consisting of one or two words, which are used by instructors to direct the learner's attention to task-relevant stimuli and to prompt correct task execution (Landin 1994). Furthermore, cue words can be used by learners themselves prior to carrying out a task, in which case they are referred to as *self-talk regimens* (STR). Short-term memory is considered to be limited to five to nine separate pieces of information (Miller 1956; Rose 1997). The number may be lower for some populations, such as stroke patients. Therefore, too many instructions may overload a learner trying to attend to task-relevant stimuli and organize a new response. AVC are somewhat like instructions, but because they consist of fewer words and only address a few important aspects of the task, they are thought to place less load on short-term memory and increase chances that the learner will retain the correct motor pattern. For example, in the Reformer group exercise depicted in Figure 2, the practitioner might use the cue '*funnel* your *ribs* into your pelvic bowl.' Such a cue might be more effective than giving a detailed explanation on how to use the deep abdominal, spinal and pelvic floor muscles for dynamic trunk stabilization. Similarly, in the Ladder Barrel exercise in Figure 3, the phrase '*sit tall* in the *saddle*' may be more effective in constraining the body's degrees of freedom than telling the client to activate a variety of separate muscle groups.

Although AVC and STR have not been as extensively studied as some other instructional methods, research evidence (Landin 1994) suggests they are quite useful. Landin makes several recommendations for using verbal cues: First, he suggests using two words or less for STR, and up to four words for AVC. Second, if cues address different parts of a task, it is important to consider how those

parts are interrelated. Cues should not disrupt the normal rhythm of the movement pattern by drawing too much attention to one part of the task and creating artificial breaks between parts. For example, breathing relies on a smooth transition between in-breath and out-breath. Too much emphasis on the in-breath can create breath holding and destroy the movement's flow. Landin's third recommendation is to consider the variability of the environment and whether it is important for the learner to focus on internal body stimuli, or external environmental stimuli, or both. Many tasks in sport and everyday life require switching attention between internal and external stimuli (Nideffer 1993). PI exercises typically focus the learner entirely on internal body sensations, which may be necessary during initial phases of recovery or conditioning, or when an exercise is first introduced. However, if switching between an internal and external focus is part of the functional activities the client must perform, practitioners should create situations that require switching. Fourth, Landin states that STR can be used in some cases to supplant AIF by priming the correct action before it takes place. This is particularly useful in group exercise classes, outside of class when the instructor is not present, or if there is only one chance to 'do it right', a situation that exists in many competitive sports. Finally, skill level must be considered when designing cues. Beginners need cues that reflect their less refined understanding of the task and allow them to get the general idea of the correct action, whereas more advanced learners may need to focus on specific errors. Rose (1997) makes the additional recommendation that cues should help evoke task-relevant *imagery*. Mental imagery can be used during physical practice. It can also be used by itself, in which case it is called mental practice. Although not always effective, telling learners to mentally imagine or mentally practice the correct movement pattern frequently appears to have positive effects on retention Feltz & Landers 1983, Schmidt & Lee 1999). Therefore, cues such as 'funnel your ribs' or 'sit tall' may act like mnemonic prompts that help evoke task-relevant muscular activity during exercises or related functional activities.

Recommendation 3: use augmented information feedback judiciously

As already stated, AIF is task-related information that helps the learner correct errors in the movement's outcome and pattern. Research suggests that it should be used judiciously. First and most importantly, too much information about errors may overload the learner's short-term memory, direct attention away from important sensory stimuli, and prevent the development of proper coordination patterns. Therefore, PI practitioners should resist the temptation to point out all the errors a learner is making and suggest corrections. It is more useful to select one or two errors appropriate to skill level. For example, beginners might need corrections related to breathing and maintaining a neutral spine while doing supine leg circles on the mat. More advanced clients might need pointers on how to maintain dynamic trunk alignment and scapulo-humeral rhythm when doing any exercises involving trunk lateral flexion and arm reaching. A second recommendation for using AIF is to taper off the amount of feedback as the learner becomes more proficient and can increasingly rely on internal representations and sensory awareness of the correct action (Winstein & Schmidt 1990). A third guideline for AIF is that the learner must know how to interpret it (Schmidt 1991b). A person with little knowledge of anatomy will not be able to understand a statement such as 'you aren't using your intercostals.' Finally, giving AIF during, or right after, a movement may not always be a good idea. A learner who is trying to master an exercise involving all four limbs while maintaining core control, such as the Trapeze Table exercise in Figure 4, may be overly distracted if the practitioner interrupts with helpful advice. For extended PI routines that last 30 s or more, it may be best to give AIF periodically. For discrete PI movements like doing a head and spine roll-up to a sitting position, it may be best to wait a few seconds after a trial before giving AIF. This may give the learner an opportunity to focus on the fleeting sensory impression of what the movement felt like, before receiving information about its correctness (Swinnen et al. 1990).

Recommendation 4: vary the context of practice trials

Whereas practice conditions such as frequent AIF temporarily enhance performance but degrade learning, others have the opposite effect. One example for this occurs when *contextual interference* is manipulated during practice. Low contextual interference occurs when all repetitions of Task A are followed by all repetitions of Task B, all repetitions of Task C, and so on. For example, a client might do 8 supine leg presses on the Reformer, followed by eight toe raises and eight jumps. By contrast, high contextual interference is present when one repetition of Task A is followed by one repetition of Task B, one repetition of Task C, and so on. In other words, a leg press is followed by a toe raise, a jump,

another leg press, another toe raise, another jump, and so on. High contextual interference is thought to represent a number of 'real-life' movement conditions with constantly alternating tasks.

Compared to low contextual interference, high contextual interference tends to depress performance during practice. Beginners sometimes report feeling frustrated or confused by high contextual interference. It is therefore tempting to conclude that it also causes less skill learning. However, numerous experiments have shown that even for beginners, high contextual interference is often more beneficial to skill learning than low contextual interference (Magill 1998, Schmidt & Lee 1999). Therefore, practice under high-interference conditions may actually be preferable in the long run. Practitioners should be aware that learners will be often be performing functional tasks under conditions of high contextual interference and should create routines that progressively approximate these conditions. Using the example of the mat exercise in Figure 5, a client might do 1–2 repetitions of a posture that requires supine trunk and shoulder girdle stabilization, followed by 1–2 repetitions of the same posture in a prone position, and 1–2 sidelying. The client is challenged to exert sensory awareness, and proper control of core and shoulder girdle muscles, while switching tasks.

Recommendation 5: use the right practice tasks to maximize skill transfer

Learning is typically evaluated through retention and transfer tests. Retention involves executing a given movement at a later time, whereas transfer is the application of a previously acquired movement skill to new situations. Formally, transfer has been defined as a gain or loss in the capability for performing a criterion task as a result of prior experience with a practice task (Ellis 1965, Schmidt & Young 1987). One goal of practice is to develop the capability to adapt a previously learned action to new settings, or to perform variations of the action. This is called near transfer or *intratask transfer* (Sage 1984, Magill 1998, Schmidt 1991b). For example, during the hip extensor and hamstring exercise performed on the Trapeze Table in Figure 1, positive intratask transfer means successfully doing the movement with internal or external hip rotation, with the entire spine resting on the Table, with both legs at once, and other modifications. On the whole, intratask transfer as described above tends to be positive, though not always very large (Schmidt & Young 1987).

A second goal of practice is to use prior experience with one action to successfully execute a different action. This is called far transfer or *intertask transfer* (Sage 1984, Magill 1998, Schmidt 1991b). The overall similarity of coordination patterns seems to be one of several factors determining the degree of positive intertask transfer. Very different patterns, such as swimming and volleyball, do not transfer positively to one another (Nelson 1957, Schmidt & Lee 1999). The same principle probably applies to two PI exercises that use both different pieces of equipment and different body parts, such as lateral trunk flexion on the Reformer and seated leg extension on the Chair. When movement patterns are reasonably similar, intertask transfer is frequently small-to-moderate and positive (Schmidt & Lee 1999). For example, doing a pelvic bridge on the mat may transfer positively to doing the same exercise on the Reformer.

However, even when movement patterns appear similar, positive transfer can be negligible. For example, supine jumps on the Reformer are practiced to prepare dancers and athletes for standing vertical jumps. Yet research indicates that supine jumping practice does not necessarily result in positive transfer to upright jumping (McLain et al. 1997). The authors of the latter study remarked that a during a jump on the Reformer, the legs may be placed up to 30 degrees above the plane of the body, creating significant differences in jump strategies between the supine and standing conditions and possibly reducing successful transfer. In a biomechanical study, Self et al. (1994) found a different relationship between force and knee angle during a supine plié on the Reformer and a standing plié, suggesting that the two tasks are different.

PI practitioners should bear in mind that two overtly similar tasks may in fact require different muscle synergies and be accompanied by different sensory input. Experience with one task may not give the learner the necessary capability to do the other task. Conversely, two tasks that appear dissimilar may actually involve similar underlying muscle synergies, sensory stimuli, or cognitive strategies. This principle is referred to as *transfer-appropriate processing* (Lee 1988, Rose 1997). Practitioners should ask themselves whether the exercises they assign provide learners with an opportunity to practice the internal processing they will need for functional activities in sport, dance, or everyday life. Care should be taken to ensure a transition from supine, non-weight bearing activities to bipedal weightbearing activities (Loosli & Herold 1992). Practice with supine exercises alone may not translate into improved alignment or stability when standing up.

Box 5 Checklist for aspiring practitioners

- Investigate a number of programs.
- Consider program availability, cost, and duration.
- Trainers and certifiers must have sufficient experience with the desired client population.
- Instructional modules dealing with anatomy, physiology, and clinical populations should be overseen by individuals with proper training.
- Certification examinations should include oral, written, and case study portions.
- To avoid conflict of interest, trainers should not have dual roles as certifiers.
- Trainers should have up-to-date knowledge of motor learning principles and findings.

Summary and recommendations for the future

In the preceding paragraphs, several recommendations for maximizing the learning benefits of PI sessions were introduced. However, these recommendations are only preliminary. To date, no published studies have been conducted in which an attempt was made to discover causal links between practice conditions, such as the ones described in this paper, and improvements on PI exercises or functional skills. This oversight should certainly be remedied.

A second critical issue is the training and certification that PI practitioners receive. Assumptions about learning, and the instructional techniques that practitioners themselves are taught, may be the most important sources of influence on their own teaching methods and behaviours (Larkam 1999). Therefore, the selection of a suitable training and certification program is critical for the aspiring practitioner. A checklist of important considerations is provided in Box 5. Training courses typically introduce the practitioner to functional anatomy, a wide range of mat and equipment exercises, and supervised hands-on teaching experiences. Written and/or oral certification examinations are also provided (e.g. Body Control Pilates 1999, Physicalmind Institute 1999, Pilates Institute 1999, Pilates® Method 1999, Polestar® Education 1999, Stott Conditioning 1999). Some training centers also mention practice conditions and teaching strategies in their informational literature (e.g. Physicalmind Institute 1999, Polestar® Education 1999, Stott Conditioning 1999, The Pilates Center 1999), which suggests that the trainers have some formal knowledge of motor learning principles. However, it is best for prospective students to inquire before beginning any program.

This paper was intended to provide an overview of current claims on the effectiveness of PI exercises. Readers were introduced to several practice conditions and principles of motor learning that may enhance the usefulness of PI exercises for improving functional movement. Suggestions were made for aspiring practitioners seeking training and certification. Finally, it must again be stated that controlled experimental studies are urgently needed to verify the effectiveness of PI exercises for enhancing functional skills in a diversity of populations.

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