

# Effective Use of Turnout

## Biomechanical, Neuromuscular, and Behavioral Considerations

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### Abstract

This article offers a specific example of the benefits that might result from integrating scientific principles into the daily practice of dance training. Using the mastery of turnout as our focus, we 1. describe the anatomy of turnout in terms familiar to the dance artist, 2. explore conditioning and imagery work designed to improve the use of turnout, and 3. outline a practical strategy for helping dancers use new turnout skills while they are dancing.

Over the past 70 years, our understanding of the science of human movement has blossomed. In the world of sports, the scientific method is frequently used to create and inform new approaches to training. Examples include teaching new motor skills, improving performance (speed, agility, and power), reducing injury risk, and optimizing the results of rehabilitation. Athletes, and those who help them achieve exceptional levels of human performance, have come to embrace science for the advantages it can provide.

As a group, dancers are just beginning to appreciate

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the potential for using science and its spin-off technologies to improve dance training and performance. In addition to the benefits above, some of the specific performance improvements the movement sciences may be able to help dancers achieve include higher extensions and arabesque, longer leaps, cleaner turns, and more effective use of turnout. Once dancers, and those who train them, begin to experience some of the benefits of using science to inform the dancer's approach to training the instrument of their art form, the human body, the adoption of science-based enhancements is likely to become as popular among dancers as it is among athletes.

The purpose of this article is to offer a specific example of the benefits that might result from integrating scientific principles into the daily practice of dance training. Using the mastery of turnout as our focus, we will describe the anatomy of turnout in terms familiar to the dance artist, explore conditioning and imagery work designed to improve the use of turnout, and outline a practical strategy for helping dancers use new turnout skills while they are dancing.

Confusion regarding the use of turnout is prevalent. Dancers are frequently uncertain how much turnout they have or how to use it properly. Medical practitioners measuring turnout may find discrepancies between the amount allowed by the dancer's bones and joints and the amount the dancer tries to use. Dancers may create discrepancies by forcing turnout at the feet or, if a dancer has more turnout in one hip than the other,<sup>1</sup> by forcing rotation on the less rotated leg to create the impression of symmetry at the feet.<sup>2</sup> It is also common for dancers to tolerate risky alignment compensations at the feet, pelvis, and lower back to create the illusion of greater turnout.

Finally, dancers, compensating or not, may be unable to control turnout in important movement situations such as landing from a jump.

While certain forms of dance are less concerned with turnout, using it effectively in the forms that do employ turnout is critical to a dancer's health and likely to increase performance potential. Science-based approaches to managing turnout may help.

### **Anatomy and Biomechanics of Turnout Bones and Joints**

Virtually all of the bones and joints between the spine and the toes contribute to externally rotating the dancer's leg. The weight of the body is transmitted through the bones of the spine to the pelvis, the femur, the tibia, the ankle, and ultimately is borne by the foot. Motion does not occur in the bones however, but in the joints. The joints that are relevant to turnout are the joints of the foot and ankle, the knee, the hip, the spine, and the joint between the spine and the sacrum. The anatomical and biomechanical contributions to turnout will be described beginning with the foot and moving up the leg ending with the spine.

Within the foot and ankle there is complex and interactive motion. The foot consists of 26 bones and 31 joints. The shape of each joint varies to allow great mobility and yet retain the potential to absorb nearly any stress placed upon it. Pronation (dropping the arch toward the floor or "rolling in") is a combination of motions generated within the foot.<sup>3</sup> Pronation is a normal component of walking, running, and other forms of locomotion because as the arch drops toward the floor forces are distributed throughout the foot. Pronation becomes a problem when excessive, prolonged, or when it is a compensation for another movement that is biomechanically unsound. Excessive and prolonged pronation is common when turnout is forced or poorly managed. For example a dancer can over pronate the foot to increase forefoot abduction (the toes are pushed outward) to promote the illusion of increased turnout. A pronated foot is easy for dancers and teachers to see. When the foot is neutral (without pronation) the toes lie flat on the floor, are not pushed outward, and the toenails face directly upward, smiling at the ceiling. The medial border (inside edge which consists of the great toe, the bony prominence at the highest part of the arch, and the inside of the calcaneus) is in a straight line. Immediately above the foot is the ankle joint. The ankle is a hinge joint and like the hinge on a door it moves on only one plane. The primary motions possible at the ankle joint are dorsiflexion (flexing the foot) and plantar flexion (pointing the foot).<sup>3</sup>

The knee is a modified hinge joint. The primary actions of the knee joint are flexion (bending the leg) and extension (straightening the leg). The knee joint, unlike the ankle joint, has a small rotary com-

ponent. External rotation of the tibia (shin bone) on the femur (thigh bone) is a natural consequence of straightening the leg.<sup>4</sup> The purpose is to lock the knee to give it more stability when standing. This small amount of external rotation is usually imperceptible to the dancer and is fully utilized when the leg is completely straight. This action is a biomechanical event; it cannot be voluntarily controlled, enhanced, or restricted.<sup>4</sup> Knee external rotation can be forced beyond normal with the knee bent due to ligamentous laxity. However, this places stress on the joint and is generally considered an unsafe practice. External tibial torsion (twisting of the shin bone) contributes to the overall degree of turnout.<sup>5</sup> We advise dancers to find and use the turnout they have with the knee straight, the hip extended, and the ankle dorsiflexed, such as when standing in the first position. The first position incorporates contributions from tibial torsion and only the amount of knee external rotation that is normal to the biomechanics of the joint. Any external rotation beyond this amount is forcing the knee past its natural limits.

The hip is a ball and socket joint with a large degree of motion and great stability. The hip can flex and extend (i.e., the thigh can move forward and back), abduct and adduct (the thigh can move away from and toward midline), and internally and externally rotate. The stability of the hip joint is due to the bony configuration of the top of the femur and the pelvis and the soft tissue.<sup>6</sup> Most investigators agree that approximately 60% of turnout is generated at the hip joint and is affected by bony shape and soft tissue laxity. It is unknown if bony structures can be altered as a consequence of dance training or if dancers who are genetically predisposed to greater turnout chose dance idioms that better suit their bodies.<sup>7</sup> The configuration of bones cannot change after the growth plates close sometime between puberty and the late teenage years. The safety of attempting to increase turnout by trying to modify bony shape while the dancer is growing is questionable so we recommend against it.

The bony structures of the hip joint are encased within a thick capsule. Intertwined within the front of the capsule is the Y ligament. The Y ligament is the strongest ligament in the body and cannot be stretched. It is strong enough for paraplegics, who have little or no muscular control, to lean on it when ambulating. The function of the Y ligament is to limit hip extension and external rotation. The Y ligament becomes taut when the hip is extended (in line with the trunk) or the thigh is turned out and it becomes slack when the hip is flexed or the thigh is turned in.<sup>4,8</sup> Usually the Y ligament will limit hip extension before the foot comes off the floor in *tendu* back.

The spine is divided into three distinct sections: the cervical spine, the thoracic spine, and the lumbar

spine. Actions in the lumbar spine and its relationship with the pelvis effect pelvic stability and core support. The lumbar spine can flex, extend, and side-bend, but there is limited rotation in this region.<sup>3</sup> The pelvis is attached to the spine by way of the sacrum, so any pelvic movement will produce spinal motion. The pelvis consists of a right and left half. Both sides demonstrate slight independent movement. In unison they move forward and backward relatively freely because the joint between the sacrum and the lowest lumbar vertebra allows it.<sup>9</sup> When both halves of the pelvis incline forward, the position is anterior pelvic tilt with concurrent lumbar hyperextension. To imagine this position, think of the pelvis as a bowl full of water, and then pour the water onto your feet by tipping the front of the pelvis down toward the floor and pushing the low back forward into a C shape.

It is important for dancers and their teachers to realize that the actions of the hip, pelvis, and spine are interdependent. Proper use of turnout provides an excellent example. When a dancer turns out properly, it may be possible for dancers to get stability assistance from the Y ligament resulting in less overall muscular effort. A taut Y ligament completely limits any additional hip extension and external rotation. Less muscular effort is needed to stabilize the turned out position when the dancer has found this end range of movement. Dancers may attempt to gain a few degrees of additional rotation by decreasing tension on the Y ligament with slight hip flexion, which lowers the anterior brim of the pelvis into anterior tilt and pulls the lumbar spine into hyperextension. By doing this they sacrifice the stability gained from the Y ligament and alter neutral pelvic and spinal alignment. A dancer can feel the difference in stability by simply comparing a neutral pelvis with one in anterior tilt. First the dancer can stand on one leg with the hip extended, fully turned out, and the pelvis in neutral and sense the stable hip. Then observe the stability decrease by tipping the pelvis forward (slight hip flexion). With a neutral pelvis and a properly turned-out hip the dancer may state that he is really “on” the leg, and may have a sensation of pressure, stretch, or length in front of the hip joint. The anterior aspect of the hip joint, where the thigh meets the pelvis, may appear flattened to the dancer’s teacher. (For a description of how to find neutral pelvis, see the section titled “Core Support and Pelvic Alignment.”)

### Muscular Contributions

There are many muscular contributions to alignment and the proper use of turnout. Pelvic alignment is affected by the hip flexors and the abdominal muscles. The hip flexors attach to the pelvis and the femur; these muscles flex the hip joint or, when tight, pull the pelvis into anterior tilt. Sub-optimal hip extension

from tight hip flexors (the pelvis is in anterior tilt, the hip is slightly flexed, and the leg cannot line up with the trunk) creates increased stress on the lumbar spine during certain dance activities. For example, when the dancer’s leg moves to the back (such as *tendu battement* to the back and in *arabesque*) and hip extension is restricted, the pelvis is pulled into anterior tilt and the spine hyperextends. The less hip extension a dancer has, the more contribution from the lumbar spine is required for all posterior movements of the femur.

The abdominal muscles attach to ribs and the pelvic brim. Contraction of these muscles raises and allows controlled lowering of the pelvic brim. Weakness of the abdominal muscles results in an inability to maintain correct pelvic alignment during the execution of certain dance movements.<sup>10,11</sup> Proper pelvic alignment in dancers requires that the abdominal muscles and the hip flexor muscles cooperate. Strong abdominal muscles cannot level the anterior pelvic brim when the hip flexors are tight nor can stretched hip flexors prevent anterior pelvic tilt if the abdominal muscles are too weak.

In addition to potentially unsafe mis-alignments, anterior tilt may interfere with maximal strength of certain muscle groups. The length-tension relationship of muscle means that muscles are strongest at their resting or mid-range and weaker when elongated or shortened. Anterior pelvic tilt is counterproductive because the abdominal and hip extensor muscles are lengthened and the hip flexor muscles are shortened. These muscle groups are at a mechanical advantage for maximal strength when neutral pelvic alignment is maintained.

Beyond a mechanical advantage for optimal function, the bones and joints of the trunk are acted on by muscles working in concert with one another in a coordinated symphony called core support. The pelvic floor, *transversus abdominus* (the deepest abdominal muscle whose fibers runs horizontally), and *lumbar multifidus* (small tendon laden spinal muscles responsible for spinal stability) must work together to stabilize and distribute the forces encountered by the trunk. Coordination of these three muscle groups may be lacking in some individuals with spinal dysfunction, including dancers. Cooperation of the *psoas* and *abdominals* contributes to core support because the *psoas* pulls the spine forward (hyperextension) and the *abdominals* generate an opposite force by lifting the anterior brim of the pelvis thereby pulling the spine backward (flexion). When strong, these opposing forces help stabilize the spine and pelvis.<sup>12</sup>

Muscles also affect turnout by acting on the hip to turn the leg out or by providing a stabilizing counter force on the hip and trunk. The six deep rotators are the muscles closest to the hip joint, the small-

est, but most efficient, muscles to turn the leg out. With a fixed femur, they lift the pelvis off the femur.<sup>6</sup> When the six deep rotators are recruited, the dancer may sense “space” deep in the hip joint. The gluteus maximus and the posterior gluteus medius, the larger, superficial rotators, also turn the leg out in hip extension/hyperextension. However, because they attach above the hip joint on the pelvis and below the hip joint on the femur, when contracted they subject the hip joint to a compressive force. Hence the gluteals do not provide a sense of lift. One of the challenges for optimizing turnout is teaching dancers how to recruit the deeper, more refined external rotators of the hip instead of overusing the larger, surface muscles which can cause misalignments such as tucking.

There are other muscles that act directly on turnout or provide a stabilizing counterforce. The inner thighs (adductor muscle group) help to turn the leg out and balance the pelvis by simultaneously pulling the pelvis forward (anterior tilt/hip flexion) and backward (posterior tilt/hip extension). The outer thigh muscles (abductor muscle group) prevent sitting into the hip and stabilize the joint between the pelvis and sacrum. Balancing the strength and motor organization of these muscles groups is crucial for a dynamically stable hip.

The muscles of the foot and ankle also contribute to a stable turned-out position, affect correct alignment of the lower extremity, and provide arch support. Dancers require adequate dorsiflexion, approximately 10° past neutral standing or a 90° angle, for normal biomechanics and shock absorption.<sup>13</sup> Tightness in the calf (common with ballet dancers) or inflexibility in the Achilles tendon are possible restrictions of dorsiflexion resulting in a shallow plié.<sup>2,10,11</sup> Pronation (dropping the arch downward) increases the depth of the plié because it places the Achilles tendon on slack. But as discussed, this compensation alters normal alignment and has potentially damaging consequences to the health of the bones and soft tissue. A healthier choice to increase range of motion is simple calf stretching. Arch support is provided mainly by bony and ligamentous structures during standing. It is theorized that the strength of certain invertors and evertors (muscles on both sides of the ankle joint) and the intrinsic muscles in the foot may help to prevent excessive pronation by supporting the arch during gait<sup>4</sup> and other movement situations dancers may experience from a simple relevé to landing a leap.

### Weight-Bearing Chain

With these structures in mind, envision a perfect world, one in which the pelvis hangs erect beneath a stable trunk, the thighs turnout with little effort, and there is no strain on the legs and feet as they are placed with perfect stability and alignment upon

the floor. This is the weight-bearing chain without compensations. Compensations in the weight-bearing chain are common in human beings, and dancers are no exception. Correction of restrictions or compensations will permit the dancer’s body to achieve a properly aligned weight-bearing chain that is less prone to injury and better able to control dance movement. Problems of mal-alignment can often be corrected with simple exercises or stretches that can be added to the dancer’s daily regimen.

The dancer must have adequate length and strength in the structures around the trunk, the hip joint, and the ankle joint. Stretching the hip flexors can help the dancer achieve enough hip extension for the purpose of leveling the pelvis and finding the stability gained by a taut Y ligament. Core support and recruitment of the deep rotators are required elements of a lifted and level pelvis coupled with a stable yet beautifully turned-out leg. Motor organization should include the pelvic floor muscles, the lumbar multifidi, the transversus abdominus, and the hip adductors. The hip abductors help by functioning as lateral stabilizers. Once the restrictions of turnout are corrected the musculature will need to be sufficiently strong to support the joints. Fortunately, an effective conditioning program will remedy tightness, weakness, or lack of motor organization.

The problems described above are common compensations that dancers employ to achieve the illusion of greater turnout or are common restrictions to optimum use of turnout. Corrective exercises should be simple, effective, and easy to perform. The following conditioning program is designed to meet these criteria and can be performed at the dancer’s convenience without the need for specialized equipment.

### Conditioning to Improve Turnout

When conditioning was initially introduced to dancers, it included exercises that could enhance performance by improving levels of muscular strength and endurance, developing the flexibility of soft tissues (thereby increasing range of motion), and improving the capacity of the cardiorespiratory system. Today the concept of conditioning has expanded to include a wide range of neuromuscular aspects, such as coordination, proprioception, re-alignment and muscle balancing, movement re-patterning, muscle recruitment, and tension release. Each of these muscular and neuromuscular areas of conditioning contributes to optimizing the individual dancer’s range, recruitment, and integration of turnout into complex movement patterns through space. The purpose of this section is to provide an overview of useful conditioning exercises and imagery work for improving turnout. The exercises and imagery in this article are divided into three areas: 1. core support and pelvic alignment nec-

essary for optimal use of turnout; 2. hip musculature conditioning specifically related to external rotation of the hip joint; and 3. lower limb considerations.

### Core Support and Pelvic Alignment

While core support and pelvic alignment are related, they incorporate different muscle groups and demand a variety of conditioning exercises and images. To begin, it is important for the dancer to understand how to find and maintain what is known as the "neutral pelvis."

Start by lying on the back (supine) with the arms and legs extended. Allow the breath to be natural and the body segments to lie with as little tension as possible. Imagine the pubic bone directly above the tailbone, and the back of the head, ribcage, and sacrum heavy and in contact with the floor. There will be spaces under the neck and low back due to the natural curves of the spine. Draw the thighs toward the pelvis by bending the knees, allowing the feet to stand in parallel on the floor. Be conscious of maintaining the placement of the pelvis during this action; if the pelvis tilts anteriorly (increased lumbar space) or tucks (decreased lumbar space), repeat the reach and draw of the legs until the action can be done with the pelvis quiet. Roll both legs to one side, allowing them to drop toward the floor easily. Then roll the legs back to the parallel stance position, imagining weight in the sacrum, and experiencing the space under the lumbar spine. Roll the legs to the other side and again back to center. This action can be done several times, always establishing neutral pelvis in the stance position, not rounding the lumbar spine so that it drops to the floor. The same action can be done with a slight variation. Start with both legs to one side. Move the top leg to the opposite side like a clam opening and, when it has gone to its full range, bring the other leg across to meet it, like the clam closing. Go side to side with this action of one leg initiating, the second leg following. Observe that the legs will be in the fully open diamond position when the pelvis is centered. Once again, using the image of a weighted sacrum, establish a neutral pelvis. Finish the process back in neutral parallel stance, knees flexed to the ceiling, feet on the floor.

Now image a narrowing of the waist and a sinking or hollowing in the front of the pelvis. This is the action of the deepest abdominal muscle, the transverse abdominus (TA). There will be a subtle sensation of the waist and front of the body drawing or collecting inward. This muscle does not significantly flex or extend the spine so the drawing action should be accomplished without visible movement of the pelvis. There is some disagreement currently as to whether it is best to exhale or inhale on the hollowing and narrowing action. Probably the best advice is to make sure that you are continuing to breathe and not hold-

ing the breath, and that the breathing is natural and not forced. Eventually, while dancing, the TA must be recruited during the full cycle of inhaling and exhaling, and hence should be learned in whatever pattern is easiest for the dancer, and then attempted throughout the cycle.

The next stage is to learn to recruit this deep muscle during spine action. Begin by hollowing and narrowing and then immediately roll the pelvis into posterior tilt, or full lumbar flexion. Solomon<sup>14,15</sup> calls this movement the "undercurve." Be aware of maintaining contact with the floor and keeping the focus of muscle action on the abdominals, rather than squeezing or pushing with the gluteus maximus. It is useful to imagine the pubic bone being drawn toward the low back just below the navel by elastic bands, or the image of a huge ice cream scooper digging out the front of the pelvis. After the spine flexion action, return the pelvis to neutral each time. When this exercise has been achieved, add the remainder of range of motion in flexion/extension. From the undercurve, go beyond neutral pelvis to the overcurve, a full arching of the lumbar spine, but maintaining the hollowing throughout so that the front of the pelvis does not bulge outward but there is an image of the elastic bands being pulled taut across the arch. If the breathing becomes forced or is held, sounding and vocalizing can assist in keeping the breathing natural. It should be noted that it is essential for dancers to learn hollowing in the overcurve, as this underlies so many dance movements, such as arches, arabesque, and leaps.

Now turn over and lie prone with the forehead lying on top of stacked hands. The lumbar multifidi are easier to recruit in spine extension or even slight hyperextension. Begin first by engaging the pelvic floor. Many teachers describe this activity as the action we do when attempting to stop urination. Consider adding to this idea the image of a flow of energy being drawn up into the center of the body from the pelvic floor. Add to this drawing up the narrowing and hollowing experienced in the previous exercise so that there is a magnet or vacuum in the center of the pelvis drawing the waist in, the front of the pelvis toward the spine, and the pelvic floor in and upward toward the center as well. Some dancers will experience a sensation of connection or closing of the space on either side of the lumbar vertebrae and this is the multifidi activating. Not all dancers will be able to feel this muscle action, however, and this is not crucial.

While the above series deals with the deeper muscles important for core support, there are three other abdominal muscles that need adequate levels of strength and flexibility to allow for good pelvic alignment in stance and traveling work, as well as appropriate recruitment and release. The oblique ab-

dominals and rectus abdominus can be strengthened using variations on curls, and curls with twists, while lying supine with flexed (bent) knees. (It is highly recommended that the hollowing and narrowing be done simultaneously with these exercises, to continue to reinforce that core support work with spine action, and there should also be attention to continuous breathing.) Wide elastic bands or cords can be used to increase loading. Tie the elastic band to the barre and lie on the back with the head toward the barre, legs parallel, and the knees flexed. Hold the end of the elastic band and do the curl, using the pull of the band to increase the resistance. This exercise should not be attempted unless there is already adequate strength to maintain a rounded spine and the activity of hollowing during the curl, and should not be done with straight legs, as it can place too much stress on the spine. (In fact, for dancers who are unable to maintain the rounded spine and the hollowing activity during a curl, they can turn around and face the barre, and use the elastic band to assist them in curling up until they have gained sufficient strength to do a correct curl on their own.) Physioballs can be used to add challenges to balance and enhance proprioception. It is not recommended that the curling action come all the way to vertical sitting, as this moves the activity to the hip flexors, and the focus should remain the abdominals. With very advanced dancers who already have good abdominal strength and alignment, curls can be done on the ball starting in a full arch of the spine and curling to flexion, going through full range of the muscle action.

As suggested, the dancer needs adequate length in the hip flexors to achieve neutral pelvic alignment. Hip flexor stretching can be done in a long low lunge, with the front leg parallel and the back knee resting on a mat, not the hard floor. Straightening the back leg engages the rectus femoris, which would compromise the effectiveness of this stretch. The pelvis should be maintained as neutral as possible and the image of the plumb line floating upward can help to keep the spine long. This area of the hip can also be stretched lying supine on a bench or table with the edge of the table or bench bisecting the two hip joints. Hold one leg at the chest to stabilize the pelvis and allow the other leg to hang off the end of the table, imagining the hanging leg heavy and released, the hip flexors melting and lengthening. Hip flexor stretching is vitally important to dancers in order to achieve neutral pelvis and to be able to use turnout effectively.

If the dancer has tilted the pelvis as described above to try to increase turnout incorrectly, the low back (the lumbar extensor muscles) might also become tight. Lumbar stretching can be done sitting on the floor, hanging forward, or lying on the back hugging the knees to the chest. For a more intense stretch,

one can sit in a chair and hang forward with the legs separated, but this should not be done if there is low back pain. Lumbar stretching can also be done standing in parallel position in plié, holding onto the barre, or kneeling over a physioball. If there is excessive tension, the dancer can lie on small balls, placing them in areas of greatest tension, and then breathe and release the weight into the balls. Sometimes by doing the hip flexor stretches and allowing the pelvis to drop to neutral, the lumbar extensors will begin to release tension without doing stretches for this area.

It is important to remember that even after the muscles have been sufficiently strengthened and stretched to allow for good alignment, the neural patterning must still be addressed. There is literally an infinite supply of images and the key is to individualize the image for the dancer. Some dancers work better with images that focus on the diamond formed by the tail bone, pubic bone, and "sitz" bones, visualizing this diamond remaining parallel to the floor during movement. Another image using bony landmarks is for the ASIS (anterior superior iliac spines, or the two bones that protrude on the front of the pelvis) to line up vertically over the pubic bone. Other dancers relate more easily to images of the pelvis as a bowl of water, and not spilling water in any direction. Still others can use the image of the elastic bands from the pubic bone to the low back, and adjust the length of those elastic bands to arrive at neutral. Dancers carrying tension in the lumbar extensors or hip flexors can benefit from images of water pouring down the low back or the front of the hips softening and opening like taffy. Teachers should provide a variety of images so dancers can choose the one(s) that work best for them. Often the best images are the ones the dancers create themselves.

### Hip Joint

As with core support and alignment of the pelvis, there are many useful exercises and approaches to conditioning the various muscles that affect turnout. The following series allows for recruiting and experiencing the external rotation at the hip first without weight bearing, and in conjunction with a variety of hip movements, including flexion, extension, abduction, and adduction.

Begin lying supine with the knees flexed, legs parallel, and the feet on the floor. Open the knees fully, and flex the feet, placing the heels together and just off the floor so that the body is lying in what would be a grand plié when standing. Imagine that there are two magnets on the inner thighs that are drawn together and roll toward the ceiling as the legs slowly extend along the floor, pelvis staying neutral. Image that the legs are being pulled by a partner and that the outer thighs are soft and silky and long as the feet

move further out in space. At the end of the extension, imagine that the heels are glued together, and slowly flex the feet. This is now standing first position, turned out.

Return to the starting position (knees flexed, legs parallel, and the feet on the floor) and staying parallel, slide one leg out along the floor. Maintaining neutral pelvis, keep that leg straight and flex the hip to approximately 45°, so that the knees are at the same level. In this position, rotate the hip fully out and in (beyond parallel), exploring the full range of movement of hip joint rotation. It is important to maintain a quiet pelvis and not allow any accommodating movement in the pelvis. Images of weight and of the sacrum attached to the floor can assist this stabilization. Now bring that same extended leg to a higher position, flexing the knee and hip so that the leg is now in front attitude, and repeat the rotation out and in. In addition to stabilizing the pelvis, it is important to focus the effort on the rotary action of the hip joint. With the knee flexed, the ligaments will allow for additional rotation at the knee, but this exercise is designed to pattern hip external rotation for standing demi plié. Encouraging knee and foot compensations will not be useful. There are two advantages to exploring hip rotation in full flexion lying on the back: the deep rotators have a greater chance of being effectively recruited and there is the opportunity to receive visual feedback about hip versus knee and foot action, and to make appropriate changes in habitual behavior.

Now roll up onto the side of the body. Fold both knees so that the feet are directly under the pelvis, and the knees are in front of the body, the same position as hook lying used earlier, but now lying on the side of the body. Check that the alignment of the pelvis and spine are neutral, and create a small space under the waist. Maintaining neutral pelvis, rotate the top leg fully out (by lifting the knee toward the vertical, keeping the feet together, like the action of a clam opening) and back down. To increase the difficulty and demand, do the same exercise with the bottom leg extended along the floor and turned out. This increases the balance and torso stabilization challenge.

Third, roll onto the front of the body, hands under the forehead. Begin with the legs parallel. Lift one leg at a time, imagining that the leg elongates along the floor before it lifts, and that the front of pelvis is glued to the floor. Next, lift one leg parallel, rotate it out fully, rotate back to parallel, and place it down. You should alternate the legs, maintaining neutral pelvis. Embellishments can be added, such as flexing the feet, bending and extending the knee, and finally, allowing the gesture hip to come off the floor, but keeping the ribcage facing the floor, and the standing hip connected to the floor. This use of turnout in full hip extension requires body awareness and organiza-

tion. The adductors must be involved to keep the leg directly behind the hip. The pelvis will rotate to allow a greater range of motion, so the upper torso will need to rotate in opposition. The extensors on the “standing” side will need to activate to maintain that hip placement on the floor. The full core support group needs to be recruited by the dancer to encourage stability and prevent lumbar injuries. And even the muscles that encourage alignment in the scapulae and upper limbs participate in this full body organization.

Return to the supine position in grand plié and do a series of développés and ronde de jambe exercises, imagining that the pelvis is a sandbag and the sand can pour into any part of the pelvis needed to give weight to that area and maintain neutral alignment. For example, as the right leg extends to the side développé, all of the sand pours into the left hip, so that the pelvis does not rotate to the extending leg. Imagine the extending leg as light and long, sending energy out the foot into the distant space, and continually rotating externally, as an activity and not a position.

Both the external rotators and the internal rotators need to be stretched by dancers. The external rotators can get tight from overuse and can be stretched lying on the back, bending one knee and drawing that parallel leg across the body, keeping the pelvis on the floor. For some people, however, this stretch is irritating or ineffective, and a version of the yoga “pretzel” can be used instead. Sit with one leg folded on the floor, and cross the opposite leg over, placing that foot on the floor. Turn the body to face the knee that is off the floor, and using the opposite arm, draw the knee toward the shoulder trying to maintain both “sitz” bones on the floor.

The internal rotators, if tight, can limit range of motion in external rotation. Since they are also hip abductors, an effective way to release them is to place the hip in an adducted, externally rotated position, which can be achieved lying on the back. Bring one leg up toward the chest with the knee bent, turn out, and slowly draw it across the body, maintaining the turnout and keeping the pelvis on the floor. It is important to stabilize the pelvis and to remain externally rotated or the stretch will not be effective for the target muscles (gluteus medius and minimus). Another useful stretch can be done in hip extension, which adds the tensor fascia latae. Start in the hip flexor lunge stretch described previously. Slightly turn out the front leg and rotate the pelvis to face that leg, placing the opposite hand (as front leg) on the floor for support. Lower the pelvis toward the floor, bending the body sideways in the opposite direction. You might need to move around in this position slightly until the stretch in the target area is experienced.

To strengthen the adductors of the hip, additional support muscles for turnout, start lying supine with

the knees bent, legs parallel, and feet on the floor. Place a small ball (like a tennis ball) between the knees. Begin with the hollowing and the undercurve of the pelvis, as described above, but continue rolling the pelvis up until the spine is in a long line while maintaining the sensation of the undercurve, hips as high as the knees, but ribs not rising higher than the hips. During this rolling action, squeeze the ball to engage the adductors. This exercise also benefits the hamstrings, gluteals, and core support musculature. Roll back down one vertebra at a time. It is important to keep breathing throughout the movement and to be conscious of unnecessary neck and shoulder tension. Eventually, remove the tennis ball, and imagine that it is still there, and squeeze it during the rolling up and down. The knees should not touch; they should maintain the space of the imaginary ball.

Return to lying on the side of the body with the legs long and parallel. Imagine you are lying on a balance beam with the top arm and head, the ribcage, the side of the pelvis and the lower leg (that is, the leg in contact with the floor) all on the beam. Create a small space under the waist. Bend the leg that is on the floor so that the knee stays directly under the pelvis and the foot is directly behind the knee staying in contact with the floor. Flex the foot of the top leg and do straight leg lifts of that leg, staying parallel or slightly turning in and maintaining the space under the waist. (This stabilizes the pelvis so that the hip abductors are the target group and the pelvis is quiet.) Extend the leg that is on the floor and turn out both legs. Bend the top leg, placing that foot in stance on the floor, either in front or in back of the leg that is on the floor. This time do leg lifts of the leg that is fully extended along the floor, keeping it turned out, to recruit the adductors of that leg. The demand of these exercises can be increased by adding light weights to the ankles or by using elastic bands. These same exercises can be done standing with elastic bands, challenging balance while recruiting these important hip muscles.

Come to standing in first position, turned out. Take some time to experience the alignment of the pelvis and the organization of the legs in relation to the spine. Move into a demi plié imagining a huge diamond widening the knees out over the feet. Without thinking about straightening the legs, imagine that the pelvis is floating upward as the waist narrows and hollows and that the magnets on the inner thighs are being drawn together and forward. Imagine the thighs sliding down the front of the leg and the buttocks sliding down the back of the leg as the inner thighs gather under the rising pelvic floor.

### Lower Limbs

It is important to strengthen the muscles of the foot and ankle to correct or prevent foot pronation, so

common in dancers with poor use of turnout. Lie on the back, and take the legs to parallel attitudes above the hip joints with flexed feet. Organize the legs so the hip, knee, and center of the foot are in alignment. Point the feet sequentially through the heel, ball, and toe, in a rolling action. On the reverse, however, instead of starting at the toes, squeeze the toes while pulling back to ankle dorsiflexion and only allow the toes to release into the extended position at the very end. To assist this coordination, imagine that the feet start flexed with pencils balanced across the feet at the junction of the toes to the metatarsal heads. As you point, push the pencils away and at the end of the movement grab the pencils with the toes and pull them back toward you, releasing them back to the balance point.

Now create the letter U with the feet by circling them down and out and then down and in. This activates the supinators and pronators of the feet. The exercise can be made more demanding by first spreading the toes on the outer part of the circle, squeezing the toes on the inner part of the circle, and then reversing the toe action. Note that both this exercise and the one above can be done sitting, or standing on one leg, with or without support. These actions can also be done with elastic bands for increased resistance. And it is important to remember that the habitual pattern of standing in pronation must be addressed through awareness, imagery, and a new understanding of turnout support from the core and the hip joint, and not by forcing the feet backward. If additional work is needed for the doming action of the arch, spread a towel out on the floor and place weights on it. Keeping the toes spread and long, gather the towel by drawing the arches up like suction cups and pulling the towel toward you. After doing the above exercises for the pronators and arches, stand in parallel first, imagine water or sand coming out of the floor on the inside of the feet at the arches, pouring over the top of the foot, and sinking into the floor by the fifth metatarsals. Roll gently to the inside and outside of the foot until you can arrive at the place where the weight is centered on the feet. Now turn out in first position and demi plié. See a line or string dropping from the center of the kneecap down to the part of the foot near the second toe. (Note that this image will not work for dancers with significant tibial torsion. A physical therapist or dance conditioning specialist will be able to provide specific guidance to dancers who have this twisting of the lower leg bones.) Using the earlier images to go between straight legs and plié, now bring awareness to the feet and to the weight centering.

As a final note, to address limited plié and stretch tight calf muscles, one can do lunges at the wall with both extended and flexed back knee with toes pointing forward or slightly turned in. By addressing tightness



in these muscles, calf stretches may also assist in avoiding pronation.

For readers interested in learning more about the underlying principles of physical conditioning, such as duration, intensity, and overload, there are excellent publications that can be consulted.<sup>8,16-18</sup> There is also literature, particularly in the somatic practices, supporting approaches using awareness, whole body integration and connectedness, and imagery to assist in the neuromuscular aspects of conditioning.<sup>12,13,19-28</sup> Many of the exercises described in this article can be found on the C-I Training videos,<sup>25</sup> and there are many excellent sources in the literature that can provide endless alternatives to these exercises,<sup>8,14-18,29,30</sup> as well as exercises from Pilates, the Gyrotonic Expansion System®, and Zena Rommett Floor-Barre™. All contain safe and thorough ways to condition and realign the body for improved technique. It is then the goal of the dancer and dance educator to transfer the newly acquired skills and improved facility from conditioning work to dance practice.

### Promoting Transfer and Maintenance of Turnout Skills

We opened this article with an explanation of the mechanical complexities of managing turnout. In the second section, we described exercises for helping dancers acquire the capacities needed to manage turnout competently. Sometimes knowing what to do and why is sufficient; often it is not. Even with careful biomechanical assessment and skillful training, new dance abilities often do not transfer from physical therapy or conditioning class to technique classes, rehearsals, and performances. Dancers can execute a new skill in the clinic or on the Pilates Reformer, for example, but they often revert to old movement habits when they return to dance classes and rehearsals. In this section, we will suggest a strategy for helping dancers learn to use new turnout skills in all their dancing. The use of a new skill in settings other than the initial training setting is referred to as skill transfer or generalization.<sup>31-33</sup>

Much of what we have described implies approaches to promoting the transfer of new turnout skills. The strategy is based in the applied science of behavior. It is practical rather than theoretical, focusing on what fitness trainers, teachers, and dancers can do to encourage the general use of good turnout skills. The recommendations are extrapolations from research in other domains and, therefore, speculative for dancers until relevant experimental research can be conducted. The strategy includes six components, each intended to complement the others. We have separated the components to facilitate description. In practice, some of the components are implemented concurrently and interactively.

### Sustain Training until Threshold Levels of the Essential Capacities are Achieved

Many of the new capacities dancers develop to improve their use of turnout will be sustained by regular dance activity once they reach a level that permits them to be used effectively while dancing. Such a level might be considered a threshold for practical use. Until the threshold is reached, the new capacity will remain susceptible to atrophy. For example, once dancers acquire enough strength, awareness, and motor control in the muscles that control neutral alignment at the foot in turned-out relevé, most will use neutral alignment because it works better. By using the new capacity while dancing, dancers will sustain or continue to improve their ability to hold neutral foot alignment. Dancers whose muscles remain too weak to achieve neutral alignment while dancing are likely to compensate with misalignments and inefficient movement patterns that can exaggerate their imbalances. It is therefore essential for dancers to continue to exercise new capacities until maintenance thresholds are reached.

Some physical capacities are called upon so infrequently that dancers may need to train them outside of technique class for their whole careers. For example, strengthening the muscles that control foot alignment through the full range of motion may help a dancer who one day finds herself in a precariously over-balanced position to save the movement and avoid a sprain. Unusually demanding dance movements that are rehearsed infrequently point to capacities that may require supplementary training.

Once dancers are taught relevant turnout exercises, the next step is to help them to continue rehearsing the skills until their new physical capacities can be used reliably in technique class. One-visit physical therapy or fitness training is often not enough. Multiple initial training visits and periodic follow-up may be needed to insure that new capacities will develop to practically useful levels. Such follow-up visits could also help dancers *acknowledge progress* (Step 5) if the training specialist re-measures the dancers' capacities during return visits.

### Establish a Consensus on the Desired Performance

An important challenge for those who wish to help dancers improve their use of turnout is to get dancers and their teachers to agree on what constitutes effective use of turnout. Without a consensus, dancers may use their new skills only when the trainer is present and teachers who are not involved in making the corrections may inadvertently un-train new turnout skills the trainers have worked to establish.<sup>34</sup> As described above, effective use of turnout involves a balanced engagement of the most efficient outward

rotators of the hip and the absence of misalignments or compensations that can result from dancers trying to work beyond their body's physical capabilities.

In addition to agreeing on what constitutes effective use of turnout, dancers and their teachers must also agree that learning to use turnout effectively is a worthy enterprise. The explanation of the mechanics of turnout and the implications of poor control of turnout offered earlier will allow dancers and teachers to compare advantages and disadvantages. If a dancer and her teachers cannot agree to work collaboratively to promote the effective use of turnout, individual work with a trainer is likely to have a temporary effect at best. If the dancer is interested, but some teachers are not, the dancer may need additional strategies for working independently. If the dancer is not interested in changing the way he or she uses turnout, the most important problem is probably not a physical deficiency, but a conflict in priorities.<sup>35</sup> In this case the trainer's time might be better spent helping the dancer reassess priorities.

#### Agree on Indicators of Effective Use of Turnout

Often dancers need to be taught to see the effective use of turnout and the compensations that result when turnout is not approached properly. This can involve making subtle discriminations. For example, dancers who are over-developed in the gluteals or those who have a pelvic structure that causes the gluteals to protrude, may actually pass neutral and tuck their pelvises. Other dancers can tilt their pelvises forward so slightly that the misalignment of the bony structure is difficult to see and other indicators such as tension holding patterns must be used to detect misalignment. Assessing correct use of turnout also involves learning not to be distracted by conspicuous but deficient indicators, such as placement of the feet on the floor, when trying to assess outward rotation at the hips. Using some training time to teach your dancer how to see correct alignment and correct use of turnout may be an important step in helping them establish healthy life-long habits.

Once dancers can see the effective use of turnout (while looking in a mirror, for example), they need to learn to feel it in their bodies so they can use the sensation to guide their efforts when mirrors and teachers are unavailable. Many of the image-based instructions in the exercise section above are designed to focus attention on sensations dancers can use to encourage the integration of new skills into habitual movement patterns.<sup>22,26</sup> While sensation-based cues require discriminations at least as subtle as some vision-based cues, they may be more salient for dancers because they occur within the dancers' own bodies in reliable patterns. Teaching dancers to notice these sensations may be all that is needed to encourage their use.

Before leaving the topic of indicators, we want to describe a transitional phase dancers may pass through while adopting a new way of working. When a dancer learns a new alignment, it may look and feel wrong at first. We sometime hear, "This doesn't feel right" or "That's ugly!" Only after *trying-on* a new alignment and getting used to it will the dancer come to recognize its correctness. The challenge can become more complicated if the dancer perceives that the performance of some critical dance skills – pirouettes, extensions, and balances for example – seems to deteriorate during the acquisition of a new alignment. One could argue that if alignment is improving, the overall performance is improving, even if a dancer's perception is different. However, this may be a difficult argument to win with some dancers.

This is a risky period as the dancer has what seems like a good reason to abandon his new way of working. Helping dancers work through these uncomfortable transitions is a potentially critical role for those who train them. Physical therapists, fitness trainers, teachers, and even peers might be enlisted to help dancers overcome the inertia that makes old habits tenacious by alerting dancers to the fact that these problems may occur, by reassuring them that their new way of working really is more effective and that the look and feel will improve as they gain more experience using it, and by congratulating them when they make improvements. This requires trust and a willingness to suspend judgment, so anything trainers can do to build trust and a willingness to experiment might help. Once a dancer begins to experience the benefits of a more efficient alignment, which may take several days or weeks, a new inertia will support further change in the desired direction.

Learning to tolerate temporary discomfort on the way to achieving long-term gains is a life skill that most dancers can probably afford to improve. If a dancer is having difficulty tolerating even temporary discomfort with a new alignment, another choice is to give the dancer an excuse for not looking the way the dancer thinks she should look. A dancer might, for example, be encouraged to use *therapeutic turnout*, an amount the trainer is sure the dancer can manage effectively, and to tell teachers that is what she is doing, temporarily. As the ability to manage turnout increases, the dancer's turnout target can be increased. If the dancer's world does not fall apart as a result of using therapeutic turnout, she may eventually be willing to work in a range that is realistic for her physical structure.

#### Eliminate Unnecessary Distinctions between Training and Dancing

The fourth component of the skill transfer strategy is to minimize differences in cueing so dancers are react-

ing, as much as possible, to the same cues whether training on a Reformer, participating in a technique class, or performing in a rehearsal. If the cueing is similar in all dance settings, new skills learned in one setting will be more likely to be used in other settings.<sup>33</sup> Two general strategies are useful in pursuing this purpose. The first is to make the training activity as much like dancing as possible. A few examples may help reveal the variety of approaches available to dancers and their teachers.

One specific approach is to adapt dance movements for use as training exercises. Zena Rommett, for example, teaches an adapted ballet barre with dancers lying in one position or another on the floor.<sup>36</sup> Another approach is to modify exercises known to improve dancer capacities to make them feel more like dancing. Dancers training on the Reformer can, for example, be encouraged to “Do two more repetitions but do them as though you are dancing with the machine.” Trainers can also use language that matches the language dancers hear in technique classes so a side leg lift becomes a parallel battement to second, for example, or “now engage the deep rotators on your standing leg as well as on the leg that is gesturing.” Another possibility is to add a rhythmic component to conditioning work so the supplemental training has the same musical sensations as dancing. Some conditioning approaches for dancers incorporate music and rhythm.<sup>14,25</sup>

While exercising, dancers might be encouraged to use the same holistic attention to detail they use in technique classes. An emphasis on focused attention may be one reason why training approaches like those developed by Joseph Pilates, Zena Rommett, and Juliu Horvath have become popular with dancers. Finally, training can be designed to link exercises to their related dance skills by, for example, following the rehearsal of an exercise with rehearsal of its related dance skills so the new awareness it generates can be transferred immediately to dancing.

Evidence in other domains suggests that using a variety of training approaches encourages new skills to generalize to other settings.<sup>33</sup> The mechanism probably involves minimizing irrelevant discriminations between training and non-training settings. If dancers can learn to control turnout during a variety of training activities and, for a variety of trainers, then they will have a better chance of taking their new skills with them into technique classes and rehearsals. This means that, while a set routine of carefully chosen exercises may be more efficient when teaching new alignments and movement patterns, variety may need to be introduced after the new skills have been acquired to facilitate the transfer of those skills to other dance settings.

To review, the first strategy for minimizing differences between training and dancing involves using movements, language, images, and the same attention to detail that is used in technique classes. The second strategy is to use cues while training that can also be used during technique classes, rehearsals, and even performances to remind them of the alignments and muscle recruitment patterns that promote the effective use of turnout. Trainers can create new cues, teach them to dancers during training sessions, and then arrange for the dancers or their teachers to use the same cues during technique classes and rehearsals. Cues can be verbal, such as teaching a dancer to say to herself, “Toes under knees,” or they can be visual, such as teaching a dancer to see where the knee is in relation to the foot below it while in a lunge. Cues can also be kinesthetic or image-based so the dancer learns to feel the engagement of the deep muscles of the hip, the dropping of the greater trochanter, the tracking of the knees directly over the center of the feet, or the spiral of energy around the extended leg.<sup>25,37</sup> Touch cues might be used to facilitate transfer from the physical therapy clinic or conditioning studio to technique class, but they eventually must be faded since they cannot be used conveniently in most rehearsals and performances.

Canadian researchers Martin and Hrycaiko<sup>38</sup> demonstrated the benefits of using a verbal self-cueing procedure with elite figure skaters. The skaters created their own cues for challenging movements and learned to use them audibly during skill acquisition and rehearsals. As they prepared for a performance, they suppressed the overt components of the cueing. There is no reason why a similar strategy would not work with dancers.

The variety of approaches available for fulfilling this phase of the skill transfer strategy are open to creative invention, as long as the focus remains on making supplemental training look and feel like dancing. Creating new choreography, images, and verbal cues are skills most dance teacher have mastered. Using these skills to encourage skill transfer would involve only a modest refinement in teaching approach.

### Acknowledge Effective Use of Turnout during Technique Classes

The fifth component of the skill transfer strategy is intended to support new turnout skills while they are still tentative in the dancers' repertoire. Once dancers use a new skill often enough to have experienced its benefits, the skill is likely to become a habit. Until then, supplemental reinforcement can help dancers persist in the effort to refine their new skills. Dancers are ultimately responsible for building their own new habits, but their teachers can help.

Dancers can assess their performance of new turn-

out skills during breaks in technique classes, such as when the teacher is checking notes or when the dancer is waiting in line for her turn to cross the floor. Some checking may even occur while the new skills are being used to perform the dance movements given in class. Recognizing successes, even small ones, will promote the integration of new skills into the dancers' repertoires. To optimize the use of this behavioral tool, dancers need to learn to focus on acknowledging successes and improvements and resist indulging in negative critiques of their performance. Negative critiques can be distracting and could even punish efforts to engage in the assessments at all.

This approach can be amplified by arranging for technique teachers to watch for and acknowledge improvements too. Teachers might be enlisted – by a physical therapist or fitness trainer, or even by a courageous dancer who is determined to improve – to provide this type of support for new turnout skills, at least intermittently. Teachers may need to be cautioned to avoid negative critiques when trying to help a dancer transfer newly acquired turnout skills since comments that feel abrasive may cause the dancer to try to avoid the teacher's eye.

A third approach is a little more complicated to implement but potentially more powerful because it employs more viewers in the assessment. Partners can be taught to see improvements and acknowledge them during class. For this approach to succeed, the partners will have to be taught the specific, well-defined role of acknowledging successes. Research has shown the positive effects of peer tutoring procedures in other learning situations and the tutors seem to benefit as much as those they tutor.<sup>39</sup>

### Recycle Through the Phases of the Strategy

A dancer undergoing change is a complex system and any system – physical, biological, or social – requires periodic adjustment to optimize performance. Well-honed systems run well because someone is continually honing them. A dancer undergoing a change in the way she uses turnout is likely to benefit from similar attention.

Some of the motor skills taught in the clinic or conditioning studio will need to be retrained when they deteriorate. Either the dancer did not fully comprehend the skills when they were first taught or the skills were inadvertently untrained later. One possibility is to revisit special training exercises periodically as part of or just before technique class. This can help dancers remember important aspects of the exercises and help them to see aspects of the exercises they were not ready to learn previously. The need for retraining should be anticipated.

In addition, some of the indicators of ideal alignment and execution may work for a while and then

cease to yield improvements. With repeated use, some indicators may lose their ability to produce the focused attention required for proper use of turnout skills. Or, some dancers may progress beyond the level where an initially crude indicator will suffice. Refining the indicator may rekindle improvement. If repeated retraining is necessary, it may be useful for the dancer to revisit her physical therapist or trainer for a follow-up assessment. Perhaps something else needs fixing. Some dance programs have implemented screening procedures to detect injury risks before they can lead to a serious injury and to help dancers continue to improve their movement skills.

Finally, those who wish to help dancers improve their control of turnout should be prepared to adapt and refine the skill-transfer strategy. New research will expand our understanding of the mechanisms that encourage skill transfer and practice with the techniques will reveal opportunities for refinement and amplification. Remaining open to, yet critically demanding of, new ways of helping dancers use turnout competently will insure a constantly improving approach to this important training challenge.

### Summary

Science can help us improve our approach to the complex task of training dancers. With effective use of turnout as our sample skill, we described its biomechanical features and a collection of capacities dancers need to develop in order to use turnout effectively. We then described a program of exercises and imagery aimed at helping dancers acquire these capacities and the awareness needed to use them. Finally, we described an approach to helping dancers transfer their new turnout skills from the clinic and conditioning studio to technique classes and beyond. We hope you will find applications for at least some of the ideas presented in this article and, if they help you train dancers more effectively, we hope you will look to the dance sciences for new ideas in the future.

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