Can a Prescribed Turnout Conditioning Program Reduce the Differential Between Passive and Active Turnout in Pre-Professional Dancers?

Astrid J. Sherman, F.I.S.T.D., Erika Mayall, M.P.T, HBSc (Kin)., Susan L. Tasker, Ph.D

A detailed scientific study was set-up to explore whether a prescribed *turnout conditioning program* could facilitate an increase in the active use of turnout by pre-professional dancers using their own individual turnout potential. While of some debate, it is reported in the scientific literature that many dancers may use less turnout than that available to them when professionally measured,[1-4] and that significant individual differences also exist across dancers in the amount of "total turnout" they access while dancing.[1,2,5] Key muscle recruitment required for successful stronger turnout was the focus of the *turnout conditioning program* and that exercises were introduced in a manner that, theoretically, should stimulate appropriate activation patterns for proper turnout biomechanics. Dancers make use not only of their innate range of turnout (passive turnout) but also the ability to activate and hold turnout dynamically (active turnout). Consequently, there is a notion that many dancers use less active turnout than that available to them when measured passively.[6-8] This work should be of interest to dance teachers generally but especially those who teach pre-professional ballet and contemporary dance students. Most dance genres demand form and function of active turnout. The study provided some positive evidence that participation in a turnout conditioning program focused on mobilization; strength; flexibility; motor co-ordination and anatomical understanding can produce an increase in the total active turnout and overall performance of dancers' use of turnout.

Components of Turnout and its Development and Training

Turnout is the *sin qua non* of several dance genres, ballet in particular, entrained from the beginner level with the introduction of the codified positions of the feet.[9] Ballet uses the five externally rotated positions as a base for movements in training and choreography. In the world of 21st century classical ballet, "perfect" turnout is now defined as a 180° angle of the feet. The amount of active turnout used by a dancer, which is reflected in the position the dancer assumes, is described as "functional" turnout. Turnout also gives the dancer added aesthetic quality and range for holding a leg in extension (devant, arabesque, or à la seconde), increased freedom of movement and easier transference of weight in travelling sideways, forwards, and backwards. The dynamic alignment of turnout has become the *de facto* cornerstone aesthetic for classical ballet and its training.[6,7] The execution of perfect turnout, however, is an anatomically and biomechanically rare attribute with various studies showing the average functional turnout of dancers to be measured as approximately 133° to 136°.[6,8,10]

However, turnout is comprised of more than just the degrees achieved from positioning of the feet. It includes both hip and non-hip components, with skeletal (bony) and soft tissue (ligamentous and muscular) structures also contributing to the degree of turnout. Skeletal limitations include: (a) the orientation and depth of the hip socket (acetabulum); (b) the shape of neck of the femur bone (femoral neck); (c) the degree of femoral torsion; and (d) the degree of tibial torsion. Looking at these four limitations one by one, we see the following. Firstly, regarding the orientation and depth of the hip socket – the further to the side it sits in the pelvis and the shallower its depth, the greater the passive external rotation.[2,10] A deeper hip socket provides greater stability but may limit external rotation.[2,5] Secondly, long concave (curving inward) femoral necks compared with those that are shorter and less concave permit increased external rotation before bony contact occurs with the rim of the hip socket.[2,5] Thirdly, if the angle of femoral torsion (the angle caused by "twisting" of the head and neck of the femur relative to the shaft of the femur when viewed from above), is less than the average adult measure of 15° to 20° anteversion, this is called retroversion.[2] Retroversion

This article was generated from Sherman AJ, Mayall E, Tasker SL. Can a prescribed turnout conditioning program reduce the differential between passive and active turnout in pre-professional dancers? J Dance Med Sci. 2014 Dec;18(4), 159-68.

results in greater turnout as the knees and feet tend to face outward. Anteversion above 20° is the opposite and often will cause someone to toe-in with knees and feet facing inward. [2] Lastly, the presence of increased tibial torsion (a natural retroversion or external rotation along the shaft of the tibia), can increase natural toe-out of the foot relative to the tibia and enhances turnout range.[4]

Soft tissue limitations to turnout include the joint capsule and associated ligaments (particularly the iliofemoral ligament or "Y-ligament"), which become taut with external rotation. The muscle groups that cross the hip especially the internal rotators and adductors when tight, will restrict range of motion to turnout.[2,3,5,7] The primary muscles used to turnout are the six deep external rotators (piriformis; obturator internus; obturator externus; quadratus femoris; gemellus superior; gemellus inferior) and the gluteus maximus. Other secondary muscles are the sartorius; biceps femoris and posterior fibres of the gluteus medius which function to assist and support external rotation, depending on limb placement (e.g., the sartorius can assist in turnout for low height—not higher than 45°—extension devant and biceps femoris can assist in holding and gaining more turnout out in plié and attitude derrière turnout by its function of resisting internal rotation of the knee).[5,11] In all positions however, it is preferable for dancers to be taught to use the deep external rotators as primary turnout muscles. Inefficient muscle patterns are set up by over-recruiting external rotation muscles that have other primary jobs, for example, many dancers using the gluteus maximus will have a "tucked" pelvis,[12] and the resulting tension limits turnout range. Similarly, tightness and over-recruitment of the sartorius and gluteus medius can cause "hip lifting" (hitching up of the iliac crest), which is not a desired aesthetic in most schools. Detrimental strain can also be placed on the body from the creation of artificial turnout at the knee and ankle instead of being focused mainly from the hip. Another point to remember is that in ballet, the lifted leg needs to also be able to display turnout devant, à la seconde, and derrière, and thus different muscle groups come into play at different times.[12] Finally, overly tight turnout muscles ultimately decrease ability to achieve full range, therefore all muscles that cross the hip should be stretched.

Further to soft tissue contributions to functional turnout, studies indicate two important factors: adequate strength and appropriate activation patterns of key muscles for the optimizing of correct mechanics of turnout.[4,5,12] For example, many dancers' natural turnout may be greater than that which they have the strength to hold and muscles tend to be weakest at their end ranges. This is precisely where many dancers desire to position their turnout.[4] Inefficient muscle activation patterns result from many dancers' inability to isolate or properly use the six deep rotators (the prime movers), which in turn leads to over-recruitment of secondary muscles. Researchers and orthopaedic surgeons suggest that 50% to 70% of the desired 90° turnout from each leg is contributed by the hip, with 10% to 40% coming from the lower extremities.[2,7] When the knee is straightened, the foot and lower leg naturally assume a turned-out position of 15° to 30° in the average person. This primary non-hip component of turnout is tibial torsion, which, for the average dancer, facilitates the turning out of the feet by 15° to 20° more than the knee without creating excessive torsion stresses at the knee.[5,6,7,13,14]

As most dancers are unable to achieve ideal turnout from the hips alone, the use of compensatory strategies is common, including pronating the feet, tilting the pelvis anteriorly (forward) and "screwing the knees" (achieving the desired turnout from below the knee). Compensated turnout has been strongly linked to overuse injuries in dancers.[5,7,11] For example, forcing turnout from the feet is associated with knee injuries: if the foot is forcibly turned out beyond the range available in the hip joint and torsional forces occur that exceed tolerance of the knee joint, often resulting in medial meniscus issues. Screwing the knees involves failure to rotate the femur externally within the hip socket, resulting in the patella facing forwards and the creation of a torque action on the knees. To minimize compensated turnout and associated injuries some orthopaedic surgeons hold the opinion that a minimum of 60° hip external rotation is required by age 15 for a safe career in classical ballet.[7,15] This may be a strong argument, and it does reinforce the concept that 180° turnout might not be possible or "safe" for all ballet students.

The Turnout Conditioning Program

Female pre-professional dancers (13 to 17 years old, training 20 to 25 hours a week) were measured before and after the 7-week program for total passive turnout and active turnout. Passive turnout is defined as turnout movement produced by a tester/measurer without assistance from the dancer and active turnout is defined as turnout movement produced by the dancer through active muscle recruitment. Active turnout was measured in both a static range (measured by the physiotherapist when standing in first position on paper), and a dynamic range (measured by the physiotherapist standing in first position on rotational Balanced Body® discs).

The conditioning program included a selection of exercises from experts in the field of dance conditioning, plus some from both authors' repertoires. These specific exercises can be easily substituted with other equivalent exercises, however this may impact upon the effectiveness of the programme, as determined by this specific research study. The conditioning program comprised the series of exercises listed and described below. Mobilization was always done first, followed by strengthening, then stretching exercises, and culminating in an application exercise. The program developed as the dancers gained more familiarity with it. Not all exercises could be introduced in the first lesson; an attempt was always made to have a balanced representation from all the sections. More repetitions and exercises were added as dancers progressed. Readiness to progress was determined by the program instructor through observation of secure execution;

Figure 1 Correct side-lying posture with supported waist and hip-on-hip placement.

Figure 2 Theraband band resistance exercise in partners.

specifically, a participant progressed when she was observed to be consistently executing an exercise proficiently in terms of placement and alignment. Not every exercise was included in each session. In the actual study, this 45-minute session was delivered for 7 weeks, 3 times per week.

Detailed anatomical explanation was provided when exercises were first taught. As the participants gained familiarity with the exercises, kinesthetic, auditory, visual, and mastery imagery cues were given as reminders and encouragement. For example, to feel the gluteals as "baggy" and the rotation just coming from a deep underlying muscle "nipping" at the bottom of the dance leotard elastic.

1. Warm-up Series[1]: (5min)

Exercises emphasising inward and outward rotation in an easy "movement" format:

a) Standing with "relaxed" knees stepping feet in, in, out, out with alternate feet.

b) Sitting with legs parallel, knees flexed and feet on the floor, drop knees alternately down to "froggy" (soles of feet together, knees flexed, hips externally rotated) and back up (down, down, up, up).

c) Sitting in "froggy", gently bounce the knees in a relaxed motion.

d) Sitting starting as for (b), use pressure from hands to gently push to "froggy" and then close.

2. Strengthening Series: (20min)

For all exercises, it is important to include the use of imagery (kinesthetic, auditory, visual, and mastery imagery cues given as reminders and encouragement) and anatomy together with breathing patterns and abdominal engagement. All exercises emphasise activating the six deep external rotators as *primary turnout* muscles:

a) Sidelying Combination[2,3] (Fig. 1)

Feel the work beneath the top layer of gluteals (deep external rotators); the top gluteals should not be tensed. The gluteus maximus can function as an external rotator, but its main function is hip extension. Focus on rotating lower at the bottom of the buttocks and deeper – more specific and less forceful: think of bringing the greater trochanter back toward the ischium or "sits" bones.[2]

1. Flex knees up to body to about a 60° angle, body lying on right arm in lengthened spine position, left hand balancing the body. Externally rotate left top hip to turnout retiré without upsetting "hip on hip" placement and thus using functional range.

2. Stretch bottom leg and bring top leg to 90° angle to chest and parallel to the floor; repeat the retirés, feeling the greater trochanter of the femur rotate toward the sit bones. Focus on a functional use of turnout.

3. Straighten the top leg with plantar flexion (pointing) of the foot to just above stretched bottom leg and rotate the leg inward and outward in the hip socket.

4. Press top leg to hip extension (dégagé derrière) then slight flexion (dégagé devant), add slight attitude and stretch and rotate inward and outward.

B) Resistance Exercises[4] (Fig. 2)

1. Ball exercise: Dancer lying prone (on stomach) with one leg in retiré. Place a small soft ball under the foot (or

knee) of the retiré leg. With abdominals engaged, lengthen the retiré knee away from centre and try to get both hips on the floor. Those who can get both hips on the floor are to try to lengthen the thigh bone of the retiré leg away and to slightly raise the knee.

2. Theraband resistance: in partners or tying theraband to a barre leg, rotate femur by aiming foot toward retiréposition. To strengthen deep external rotators, keep hips down and abdominals engaged. This exercise offers excellent balance and proprioception training for standing student as well. (The standing student can try "eyes closed" proprioception to challenge balance).

c) Supine (Lying on Back)[1]

Movements are smooth and controlled to fullest range, basic posture must be maintained. Arms can be in a "V" next to body, palms down or first/fifth position, abdominals engaged. Start with legs turnout demi-plié heels together and feet dorsiflexed. Open/abduct legs to a wide second position fully extending knees in line with pelvis, feet plantar flexed (pointed), as the maximum is reached, adduct and close medially rotating and flexing knees, feet remain plantar flexed (close legs to parallel retirés with pointed toes). Vary speed in a 3-count rhythm.

d) Prone (Lying on Stomach) Combination[1]

1. Cross hands under forehead, legs parallel on the floor, feet plantar flexed, abdominals engaged (because the back muscles will be engaged in this exercise, pushing the belly button to the spine will engage the abdominals so that they work synergistically with the back muscles), (Fig. 3). Hyperextend the right leg, lengthening out of the spine, isolate in hip and externally rotate, flex knee to a small attitude, extend to wide second position, rotate in and out return to parallel then down. Use alternate legs (this is a challenge to maintain trunk stability as working unilaterally with one leg at a time drags on the pelvis), then with both legs.

2. With arms abducted to 90° and palms facing the floor position, knees flexed to 90° and feet dorsiflexed, raise legs slightly off the floor keeping knees together (Fig. 4); abduct legs, extending knees to turnout second as wide as possible, inwardly rotate, externally rotate, reverse back to starting position.

3. Stretching Series: All Muscles that Surround or Connect in the Hip Area: (15 minutes)

All muscles that cross the hip should be stretched. As noted earlier, in ballet, the lifted leg is required to present turnout devant, à la seconde and derrière, and thus different groups come into play at different times.[2,3] Overly tight and tense turnout muscles ultimately decrease ability to use the full range of motion:

a) Include a Stretch/Release for Each of the Following:

1. Iliopsoas, hip flexors and quadriceps
2. Hamstrings
3. Iliotibial band
4. Gluteals and deep rotators
5. Adductors

b) Tension release[3]

Using a 2.5-inch plastic or dense rubber ball and lying with the ball under the hip, roll the ball everywhere from sacrum, around sides of pelvis and middle lower buttocks. Stop at areas of "knotty" pain until the muscle relaxes. This

Figure 3 Prone position supporting head on arms with abdominals engaged.

Figure 4 Prone position with arms abducted to 90° and palms facing the floor.

Figure 5 Standing stabilizers in battements fondus.

can be done against a wall as well, or use of a foam roller.

4. Application/Carry Through Exercises: (5 minutes)

Examples of how to utilize some of the imagery and anatomy in **any** ballet type exercise:

a) Standing Stabilizers in Battements Fondus[3] (Fig. 5)

Focusing on the turnout of the supporting leg will keep dancers from injuring knees and ankles and give strength to control a turned-out supporting leg in the centre. Explore the turnout in both the supporting and working leg, feel where the deep external rotators work on the supporting leg and where the accessory turnout muscles (sartorious devant, biceps femoris derrière) can aid these rotators in the working leg.

Rising on the supporting foot can add more control challenge and the use of dorsiflexion in the gesture foot can be added to feel extra rotation.

b) Plié in Second Against Wall Combination[2]

Standing with back against wall, feel back on wall: engage abdominals for correct pelvic placement. Rotate femurs with deep external rotators before starting descent into plié. Engage adductors on ascent to aid deep external rotators in maintaining turnout in stretching the legs. Also, use this with first position demi-plié to feel how turnout of the femur "starts" the plié.

Discussion

Students showed encouraging improvements in the repeat measurements taken after the study compared to the before measures. As a group, participants showed an improvement in their active turnout measured in a static range (standing in first position on paper) and a significant improvement in dynamic range with turnout attained and securely sustained (standing in first position on the rotational discs). These improved measures of active turnout are meaningful given that the dynamic alignment of turnout is the *de facto* cornerstone aesthetic for classical ballet and its training.[6,7] Our findings of improvement on active measures following the training program suggest that the inclusion of additional exercises in dancers' training to facilitate hip mobilization, strengthen muscles and their activation patterns, and gently stretch the hip musculature and associated soft tissues can facilitate improved functional range and control of active turnout. High quality and healthy practice in training and developing functional turnout is important for mastering both the aesthetic and practical execution and control of turnout in dancers aspiring to professional careers in ballet. Emphasis must be on both quantity and quality of turnout.

To be noted, we found no change in the passive turnout measures (the individual dancer's unique and innate range of turnout) following the training program. However, this was expected, given the age-group of our participants. By the time they are 13 years of age, most pre-professional dancers will be working within their maximal zone accrued from the training, strengthening, and stretching of the involved soft tissue during early dance training years. Various studies[14,16] theorize that early training before age 11 years of age may be able to affect change in bony constraints, allowing for a modelling and shaping of femoral torsion. Beyond this age, improvement would result from the stretching of soft tissue constraints. As stated earlier, all participants in the present study were pre-professional dancers who had been dancing from the ages of 5 to 8 years of age. For the most part, it was their range of motion and flexibility that allowed them to progress into pre-professional training. In summary, we suggest our findings indicate that the development of functional turnout in dancers appears to rest on a combination of their innate anatomical capacity

and sound, technically-correct training and the inclusion of additional turnout targeted exercises to facilitate active turnout capacity.

Imagery

Dance teachers in general use imagery (especially metaphorical imagery) more spontaneously in their instruction than coaches of other athletes.[17,18] Imagery is a skill that serves both cognitive and motivational functions,[19] and is endorsed in the sports psychology literature as an important component of training across all levels of participants.[17] In particular, the use of imagery might have contributed to the increase the instructor observed in participants' cognitive understanding and application of turnout in their regular ballet classes following completion of the Turnout Conditioning Program. In each session of the Turnout Conditioning Program, the instructor discussed the muscles involved and used visual, kinesthetic, auditory, and mastery imagery to describe the "look," "feel," "sound," and pictured "usage" of turnout.

Conclusion

In summary, individual anatomical turnout capacity, and sound technically correct training are central to the development of functional turnout in dancers. However, the inclusion of additional exercises in dancers' training programs that (a) facilitate hip mobilization, (b) stretch the hip capsule and associated turnout muscles and (c) strengthen muscles to enhance their activation patterns, may facilitate improved functional range and control of active turnout, and would be beneficial for pre-professional dancers and their teachers. Teachers should note that there was a high degree of variability observed in all measures in the present study and it should serve as reminder that all dancers are highly individual, hence, teachers will do well to allow individual variation in the degree of active turnout each dancer can use in an ambitious, yet safe, and proficient manner. Also, dancers and teachers are encouraged to remember that because joint range of motion is unlikely to improve after age 11 years, the major focus of a turnout conditioning program should be exercises that retain the natural flexibility of the dancer's joints rather than trying to improve it. Then, working from well-maintained natural turnout and flexibility bases, exercises that stimulate strength can be successful in improving perhaps the quantity, but certainly the quality and control, of active turnout available to dancers.

Physical *and* cognitive components are important elements of turnout. By helping dancers to become aware of, think about, and visualize their natural and true passive range of turnout, they can be encouraged to consciously and effortlessly explore and use more of their natural range of turnout. The explicit inclusion of imagery cues in turnout conditioning programs can help cultivate dancers' cognitive insight into the "why" and "how" of biomechanics and the "look" and "feel" of their individual active turnout practice and control. As dancers expand their cognitive understanding of the mechanics and kinesthetic sense of turnout, they may find greater motivation to condition and retain turnout flexibility and strength, and enjoy increased proficiency and confidence in their use and control of turnout.

References

1. Bennell K, Khan KM, Matthews B. Hip and ankle range of motion and hip muscle strength in young female ballet dancers and controls. Br J Sports Med. 1999 Oct;33(5):340-6.
2. Champion LM, Chatfield SJ. Measurement of turnout in dance research: a critical review. J Dance Med Sci. 2008 Dec;12(4):121-35.
3. Gilbert CB, Gross MT, Klug KB. Relationship between hip external rotation and turnout angle for the five classical ballet positions. J Ortho Sport Phys Ther. 1998 May;18(5):339-47.
4. Grossman G, Waninger KN, Voloshin A, et al. Reliability and validity of goniometric turnout measurements compared with MRI and retro-reflective markers. J Dance Med Sci. 2008 Dec;12(4):142-52.
5. Clippinger K. *Dance Anatomy & Kinesiology.* Champaign, Illinois: Human Kinetics Publishers, Inc., 2007.
6. Hamilton D, Aronsen DP, Løken JH, et al. Dance training intensity at 11–14 years is associated with femoral torsion in classical ballet dancers. Br J Sports Med. 2006 Apr;40(4):299-303.
7. Huwyler J. *The Dancer's Body: A Medical Perspective on Dance and Dance Training*. McLean, Virginia: International Medical Publishing, Inc., 1999.
8. Negus V, Hopper D, Briffa N. Associations between turnout and lower extremity injuries in classical ballet dancers. J Orthop Sports Phys Ther. 2005;35(5):307-19.
9. Lawson J. *The Principles of Classical Ballet.* London: A & C Black Ltd., 1979.
10. Watkins A, Woodhull-McNeal AP, Clarkson PM, Ebbeling C. Lower extremity alignment and injury in young, pre-professional, college, and professional dancers: Part I. turnout and knee-foot alignment. Med Probl Perform Art. 1989 Dec;4(4):148-58.
11. Fujii M, Sato H, Takahira N. Muscle activity response to external moment during single-leg drop landing in young basketball players: the importance of biceps femoris in reducing internal rotation of knee during landing. J Sports Sci Med. 2012 Jun;11(2):255-9.
12. Vogel D. *Tune Up Your Turnout: A dancer's guide*. Oberlin, Ohio: White Owl Publishing, 2005.
13. Khan KM, Bennell K, Ng S, et al. Can 16-18-year-old elite ballet dancers improve their hip and ankle range of motion over a 12-month period? Clin J Sport Med. 2000 Apr;10(2):98-103.
14. Stephens RE. The etiology of injuries in ballet. *In:* Ryan AJ, Stephens RE (eds): *Dance Medicine: A Comprehensive Guide* Chicago: Pluribus Press, Inc., 1987, pp. 16-50.
15. Brown T, Micheli L. Dance: where artistry meets injury. Biomechanics.1998;5(9):12-25.
16. Sammarco J. Diagnosis and treatment in dancers. Clin Orthop Relat Res. 1984 Jul-Aug;187:176-87.
17. Nordin SM, Cumming J. The development of imagery in dance. Part II: quantitative findings from a mixed sample of dancers. J Dance Med Sci. 2006 Mar-Jun;10(1&2):19-34.
18. Overby LY, Hall C, Haslam I. A comparison of imagery used by dance teacher, figure skating coaches, and soccer

coaches. Imagin Cogn Person. 1997-1998; 17:323-37.
19. Monsma EV, Overby LY. The relationship between imagery and competitive anxiety in ballet auditions. J Dance Med Sci. 2004 Mar;8(1):11-8.

Acknowledgments

The authors thank the young dancers from Pro Arte Center who participated in this study and Leighton Mathews for his photography. Much appreciation is also extended to Pat Gush and Lisa Howell for their kind permission to include selected exercises in the turnout conditioning program used in the present study.

Exercise List Acknowledgments

1. Gush P. Turnout - External Rotation of the Femur, and therefore the whole leg, from the Coxal Joint, as used in Classical Ballet Technique. Johannesburg Dance Medicine Conference, July 2008.
2. Clippinger K. Dance Anatomy & Kinesiology. Champaign, Illinois, Human Kinetics Publishers, Inc., 2007.
3. Vogel D. Tune up your turnout: A dancer's guide. Ohio: White Owl Publishing, 2005.
4. Howell L. The Front Splits Fast Flexibility Program. The Perfect Pointe Book. n.d. Available at: http://perfectpointe.wordpress.com/about/. Accessed October 22, 2009.