IADMS
International Association for Dance Medicine & Science

The IADMS Bulletin for Teachers

Volume 2, Number 1, 2010

Editors-in-Chief
Gayanne Grossman, P.T., Ed.M., and Marliese Kimmerle, Ph.D.

Associate Editors
Ruth Solomon and John Solomon

Introduction

Articles

Departments

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From the Editors

Dear Dance Educators,

Thank you for the positive feedback and spreading the word. This online publication is frequently downloaded from the IADMS web site. We have received letters from dance teachers as far apart as Sri Lanka and Oregon. Because of your positive response, the *IADMS Bulletin for Teachers* is entering its second year of publication. Ken Endelman of Balanced Body stepped forward to sponsor the publication cost, which allows IADMS to maintain this magazine as a free online publication for dance educators throughout the world. The editors, Education Committee, Media Committee and the IADMS Board of Directors wish to extend our sincere appreciation for this generous support.

The first issue of each year will provide an update on the prolific activities of our Education Committee. This includes a report on many exciting Education Committee projects and a summary of A Day for Teachers activities during the 2009 IADMS conference. We hope you will join us for A Day for Teachers 2010. The last page of the *IADMS Bulletin for Teachers* provides information on the upcoming program, location, date and times. It can be downloaded as an individual document for posting and distribution.

This issue includes papers on hypermobility, stretching and balance. The stretching paper includes a handout, which is the third in our handout series. We encourage dance educators to continue communicating with us to ensure that we answer your questions and address topics that help promote our mission of bringing state of the art dance science research into the dance studio. Please send your letters to: media@iadms.org

The Editors

Dear Editor,

Thank you so much for the articles in Volume 1, Number 2, 2009, online. It is just the necessary information for ballet teachers like me, living in a remote part of Sri Lanka.

Please continue these online infos.

Thanking you,
Hannelore Imig-Jayasundara, Sri Lanka

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Education Committee Activities

Greetings from the Chair of the IADMS Education Committee

Rachel Rist, M.A., Director of Dance, Tring Park School for the Performing Arts, Tring, UK

In the past year, the various subcommittees of the Education Committee have been busy producing resources for dance teachers that will bring useful and important information into the heart of the dance studio. The first set of **posters** has been produced, giving condensed information from the full Resource Papers available on the IADMS web site. More details can be found in the section following this report. These posters are visually stunning and would make a useful addition to any dance studio or administration center, or to give as presents. Work has begun on the next set of posters on Nutrition, Somatics, and First Aid.

The **Resources Papers subcommittee** continues to produce important papers. "Motor Learning and Dance" and "Somatic Studies in Dance" have been added to the existing papers already posted on the IADMS web site. Future topics proposed are "Fitness," "First Aid" and "Turnout." Please make good use of these by downloading them at no charge from the web site and passing them on to students, parents and other teachers. The information they contain has been especially written for dance teachers.

The new **IADMS and Trinity qualification**, *Safe and Effective Dance Practice*, was launched last year and already has been taken by many dance teachers who have been pleased at how user-friendly the qualification is and also how much more confidence it has given them as teachers on a daily basis. This qualification can be used to advertise the dance studio and assure parents and students that the highest possible standards of knowledge and care will be taken in training and that this "gold standard" of training is available at the studio. Please see the IADMS web site or Trinity College web site (www.trinitycollege.co.uk/site/?id=1598) for more information on how to do this.

A very successful **A Day for Teachers** was held at the October 2009 IADMS conference in The Hague (see Sonia Rafferty's report) and we are excited about plans for the 2010 Day for Teachers (see advertisement on the last page).

The stunning success of this **Bulletin** has reached many dance teachers across the globe and we are daily hearing about new countries and places that have found it useful. The **Teacher Liaison subcommittee** has been key in setting up the distribution of the Bulletin, but it needs constant updating so please get in touch with us if you would like us to add your email to our database (education@iadms.org). We also DO want more Letters to the Editors for our team so please continue to send them.

My humble thanks and deep respect to the editors of the Bulletin and to all the members of the Education Committee who work hard for dance teachers. Finally, we would like to hear from you, the readers, with advice, feedback, suggestions and comments.

Rachel Rist
Chair, Education Committee

IADMS Inaugurates Studio Teachers' Network and Educational Posters

The International Association for Dance Medicine and Science (IADMS) aims to enhance the health, well-being, training, and performance of dancers by cultivating educational, medical, and scientific excellence. A further key aim of the association is to disseminate dance science research findings to those working directly with dancers, and IADMS recognizes the vital role teachers play in bridging the gap between research and practice. As such, a number of initiatives have been launched to augment this process, and one of the most recent is the production of a set of educational posters designed for use in dance studios. The posters draw from the previous research and current knowledge outlined in the IADMS Resource Papers (available on the web site at www.iadms.org under Resources) and are aimed at both teachers and students. Three posters will

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be produced per year, with the first three focusing on the Adolescent Growth Spurt, Pointe Readiness, and Proprioception. The posters are large and full-color with beautiful photographs. They contain key information regarding dancers' health and well-being, including suggestions for safe practice and performance enhancement. The posters are available for purchase from the IADMS web site at www.iadms.org/storeindex.cfm.

The second new initiative is the formation of the IADMS Studio Teachers' Network. Teachers who join the IADMS Studio Teachers' Network (STN) will receive these benefits:

- Three educational posters — this year's posters (described above) focus on the Adolescent Growth Spurt, Pointe Readiness, and Proprioception
- A 10% discount on one registration for Teachers' Day at the IADMS Annual Meeting immediately following joining the STN
- Emails with hyper-links to this publication, the IADMS Bulletin for Teachers
- Email notification of IADMS conferences
- A listing in the IADMS Studio Teachers' Network On-Line Directory

If you are interested in joining the IADMS Studio Teachers' Network, you will find complete information on the IADMS web site at www.iadms.org/displaycommon.cfm?an=1&subarticlenbr=268.

Report on A Day for Teachers 2009

Sonia Rafferty – Program Planning Committee

The theme for A Day for Teachers 2009 in The Hague was **The Reality of Teaching**. The program addressed the need to adapt teaching methodology, moving away from the focus on the "ideal" teacher or dancer to accepting more realistic expectations in the dance class.The beautiful Louis XVI style rooms of the Royal Theatre provided an inspiring environment for the lectures and interactive, experiential and movement-based sessions. Invited presenters from a range of countries, including Australia, UK, Finland, Germany, USA, Canada and The Netherlands, shared their in-depth knowledge and invited comment and discussion from the attending local and visiting teachers.

The day began by looking at training in a psychologically aware environment. Lucinda Sharp explained how behavior could be affected by individuals' thinking patterns and core beliefs. Linda Hamilton described skills that might help teachers, who are often facing multiple stressors and juggling demands, to avoid burnout and keep the passion for dance alive. Later, Jacques Van Rossum discussed ideal teaching behavior, Glenna Batson examined the tendu with emphasis on fundamental postural control, and Javier Torres explored optimizing performance in the ballet class through positive feedback. Dealing with "Real Bodies," Gayanne Grossman and Liane Simmel provided practical solutions on how to deal with hypermobility, scoliosis and dysplastic hips in class, while Marliese Kimmerle approached the challenges of teaching both novice and experienced dancers from a motor learning perspective. Finally, Maggie Morris and Sonia Rafferty introduced the new IADMS/ Trinity College London qualification in *Safe and Effective Dance Practice*, which aims to evidence safe practice in all genres of dance. There was a wealth of possible strategies and relevant take-home information. The annual Day for Teachers is also an excellent opportunity to exchange information and contacts with colleagues who have a common interest and curiosity in developing their practice.

Teaching the Hypermobile Dancer

Moira McCormack, M.Sc., Head of Physiotherapy, The Royal Ballet Company, London, UK

Today we are bombarded with photos of dancers in extreme positions (see for example the advertisements in *Dance Magazine*). Legs are required to be high and spines must bend in every direction. Accomplished dancers themselves admire extremes of flexibility and strive for it. All of this rubs off on the young dance student, who struggles to emulate the seasoned professional. Teachers too can be seduced by the drive for flexibility, without due respect for how it is achieved, or how too much natural hypermobility requires understanding and very careful training.

There is a whole spectrum of inherited flexibility to consider. There is the tightly bound, limited physique (short muscles and bony limitation of joints), which is unsuited to dance and especially ballet, through to the extreme flexibility of the dancer who is weak and uncoordinated but "full of potential." Those dancers with a natural (inherited) global hypermobility are believed to have an abnormality of their connective tissue that allows for joint laxity, with its associated advantages and disadvantages. Many of these physiques are drawn to dance because of the ease with which they achieve extreme positions, the encouragement they are given, and the aesthetic appeal of the hyperextended (swayback) knee and hypermobile ankle. They have connective tissue stretchiness in the joints of the fingers and elbows as well as knees, spine, ankles and feet, indicating how uniquely this physique is held together.

Connective tissue is the living material that binds the body together: ligament, tendon, capsule, cartilage, labra, fat pads, disc, bone and even skin. Generally, connective tissue is composed of cells and fibers suspended in a matrix. In ligaments the fibroblast cells produce dense, parallel-arranged masses of collagen and elastin fibers. These proteins, aligned along the lines of stress, give ligaments and tendons their powerful resistance to axially loaded tension forces, but allow some stretch.

In inherited joint laxity there is a problem with how collagen is made. This is a genetic disorder affecting those genes that encode the various connective tissue proteins, including collagen and elastin. Genetic defects distort the biochemical structure of these proteins and impair their tensile properties, resulting in tissue laxity, or hypermobility. Unfortunately, this is accompanied by tissue fragility, weakness, and a tendency to mechanical failure. Some dancers may present with abnormal flexibility but develop strength early on and do not injure easily. Others fall into the Joint Hypermobility Syndrome: they have generalized flexibility but accumulate joint pain and injury that results in deselection.[1]

In 1973 Beighton et al. devised a quick 5-maneuver test to score hypermobility (see photos 1-5). The 9-point score is not an accurate measure, but it does provide an interesting initial observation and means of recognition.

As another indicator, the skin in hypermobile tissues tends to be stretchy, especially on the back of the hands and elbows and on the front of the knees. Further evidence of skin involvement is the presence of stretch marks over the lumbar spine and thighs in adolescents. When scars heal they tend to be thickened and white.[2]

Testing the "untrained joints" – wrist, fingers and elbows – gives an indication of the stretchiness of the ligaments involved, reflecting a general type. However, the hip and spine are tested uni-directionally with foot and ankle not included, whereas these are very much the teacher's concern (see photos 6, 7 and 8).

A hypermobile joint has a lax capsule and ligaments guarding its range. It is less stable, weaker, and more susceptible to injury than a normal joint. Knees and elbows can hyperextend more than 15°. The foot and ankle can plantar flex (point) far more than the norm (photo 7). The spine flexes and extends significantly more than normal, indicating that the ligaments stabilizing the spine allow increased motion between vertebrae. Therefore, joint stability is reliant on muscular support and neural control for its integrity.

Hypermobile individuals have decreased proprioception;[3] hence, posture, balance and coordination are affected. Embedded in joint capsules and ligament are sensory nerve endings that constantly inform the Central Nervous Sys-

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Figure 1 Thumb touches forearm.

Figure 2 Hyperextension of fifth finger.

Figure 3 Hyperextension of the elbow.

Figure 4 Hyperextension of the knees.

Figure 5 Hands flat on floor.

Figure 6 Pronating foot.

Figure 7 Hypermobile legs and feet.

Figure 8 Hypermobile spine.

tem of position, movement, and rate of movement. The stretchiness of hypermobile tissue is thought to render this proprioceptive feedback system less efficient. Young dancers tend to need more training that is paced slowly, to instil good posture and alignment throughout the body. Attention needs to be paid to the deeper stabilizing muscles that support the joints of the spine, shoulders, hips and feet. They need longer warm ups too, indicative of a slower proprioceptive system.

It is the sensory part of the nervous system that allows us to appreciate acutely the position of our limbs in space, be it joint position or muscular activity. The motor part of the nervous system then responds to received information, and the result is fine control throughout the range of movement and coordination of complex moves. However, it is here, as already noted, that the hypermobile physique

has a deficit.

At the Royal Ballet Company and School we investigated the incidence of hypermobility and the incidence of Joint Hypermobility Syndrome, using the Brighton Criteria in both cases. The Brighton Criteria for inclusion in the syndrome takes into account the 9-point Beighton test and history of injury. We found that 74% of girls and 82% of boys in the lower school (11–16 yrs) were hypermobile. The incidence in the 16–18 year olds was 94% of females and 83% of males. In the professional company the incidence was 95% of females and 82% of males. These figures suggest that a physical type is most definitely selected. Interestingly, the incidence of Joint Hypermobility Syndrome in the Lower School was 47% in girls and 45% in boys. In the 16–18 yrs it was 46% in females and 35% in males. However, in the professionals it was 26% in females and 36% in males. The decrease in numbers in the company suggests that hypermobile dancers who have also been injured are less likely to progress into the profession. We also found that none of the principals had the syndrome, implying that professional development is jeopardized by it. These observations suggest that a clear understanding of the vulnerable physique is required of dancers and those who train them, with prevention strategies in place.

The principles of teaching do not change with the hypermobile dancer, but they are harder to instil. Stability and placement emanate from the core to the periphery. When the placement of the pelvis is correct and well understood, turnout at the hip can be trained, hyperextended knee controlled, and good biomechanics of the foot applied. In the upper body, the lumbar spine can be stabilized in neutral, guiding the rest of the spine and shoulder girdle into alignment over the pelvis and legs.

The "swayback knee" is always a challenge. Although attractive, if the joint extends 15° or more past neutral it is hard to teach and strengthen. If allowed to lock back into its full extension when weight bearing, the muscles that control it relax, the control of turnout is lost, and the student "sinks into the hip." This is often accompanied by a tucking under (posterior tilt) of the pelvis and loss of the neutral lumbar spine. End of range extension of the knee can be curbed by activating the adductor muscles, the hamstrings, and the vastus medialis part of the quadriceps, just above the patella. This in turn allows better use of the calf muscles and brings the weight further forward over the center of the foot. Students should be discouraged from resting in extreme positions – relaxing in the sway back posture, which overstretches the front of the hips and the backs of the knees.

The foot in all dancers bears the stress of incorrect alignment above it. In the excessively flexible foot and ankle the many small joints of the midfoot, composing longitudinal and transverse arches, are easily compromised. Each joint is bound by ligament and capsule, and further supported by intrinsic muscles of the foot. If the arches are stressed in the "rolling" pronated foot, the medial longitudinal arch flattens and the foot may never recover. Working the foot in alignment is all important; strengthening the intrinsic muscles with a regimen of exercises should start as early as seven years of age. Outdoor footwear should be inspected; supportive and carefully fitted shoes ensure a good foot position outside of the studio too.

The hip is different in its makeup. The flexibility of this ball-and-socket joint relies not only on the extensibility of soft tissues but also on bone shape. The bony architecture of acetabulum and femur can restrict the range of external rotation in the hip joint. If this type of restriction is present, use of knee and foot in turnout should correspond accordingly. Having said that, the amount of turnout used in all physiques should correspond to maintenance of balance in one-legged stance with no postural compensation.

Hypermobile dancers appear to need and want to stretch constantly, often relaxing into extreme positions for long periods of time. They do appear to have an altered kinaesthetic sense; therefore, this is not something to ban, as long as they are not sitting in box splits instead of warming up and going through their stability exercises before class. Ballistic movements into end of range should be choreographed with care. Control of each part of the range is more important in the young dancer. Weird positions and party tricks should be discouraged.

While the hypermobile physique is drawn to dance, the vulnerable skeleton is easily injured. This is the down side of having extra flexibility. A child who complains of joint pain and suffers transient joint swelling should be referred to a specialist for further diagnosis. Hypermobile tissues bruise easily (fragile blood vessels) and heal at a slower than normal rate.[4] Allowance needs to be made for this after acute injuries, such as an ankle sprain. It is important, however, not to label a dancer, with all things negative blamed on his or her hypermobility. Microtrauma to tissues from misuse of lax joints is managed by strengthening around them to improve function and prevent injury; thus we find that dance training can also be protective of the hypermobile physique, improving fitness and stability.

Hypermobile children are initially attractive in the audition process of vocational dance schools. However, they frequently struggle to keep up with the rest of the class. Often the pace of learning is set with no allowance for those who need more time and whose physiques take longer to adapt. They have to work harder throughout a dance career to hold on to technique, and without an understanding of their physiques and the drive to work hard, they rarely succeed. It is the teacher's knowledge and understanding that recognizes artistic talent and physical hurdles. Through determination, encouragement, patience and demand for meticulous work, this type of physique can be equipped with the stability and strength required for a professional career.

Acknowledgment

A portion of this article was generated from McCormack M, Briggs J, Hakim A, Grahame R. Joint Laxity and the Benign Joint Hypermobility Syndrome in Student and

Professional Ballet Dancers. The Journal of Rheumatology. 2004;31(1):173-178.

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Stretching for Dance

Matthew Wyon, Ph.D., Research Centre for Sport, Exercise and Performance, University of Wolverhampton, Jerwood Centre for the Prevention and Treatment of Dance Injuries, and Birmingham Royal Ballet, Birmingham, UK

Flexibility is an important part of fitness for dancers, as high levels of flexibility are required to meet the choreographic demands placed on performers today.[1, 2] Flexibility can be defined as the ability of a joint to move through its full range of motion (ROM). It can increase within a specific program and decrease after a period of inactivity.[3] Dancers are often associated with large ranges of motion, but these are normally very joint specific. For example, Spanish dancers require good ROM in the shoulders while having hip ROM similar to that of the non-dancing population; classical ballet dancers, on the other hand, require extensive ROM around the hips and normal levels at the shoulder. In recent years the ROM that dancers need has increased drastically; this is especially seen in classical ballet, where the height of the développé in Les Sylphides has increased from 60° to nearly 180°. There are two types of ROM, passive and active. The former describes ROM when an external force (another person, for instance) moves the limb as far as it can go, while active ROM relies on muscular strength to move the limb (e.g., use of the hip flexors in a développé devant).

It has been reported that up to 17 factors can affect flexibility, including age, body morphology, genetics, gender, bones, nerves, muscle, ligaments, and connective tissue.[1] Koutedakis and Sharp[4] found that 85% of factors limiting flexibility are related to the joints, such as articulating bone and cartilage surfaces and ligaments. The main structure whose length can be altered is the muscle unit. Short of any genetic disposition to passive flexibility, the most effective way of achieving any measure of flexibility is through some form of stretching. The aim of this article is to look at the different stretching techniques available to dancers, our research comparing two of these stretching techniques, and how stretching is best integrated into dance training. The article will not cover specific stretches for dancers, as dance is not generic enough to allow us to prescribe stretches that are ideal for all dancers. However, the principles discussed in the following sections can be applied to any form of dance and any muscle.

Physiology of Stretching

There are a variety of adaptive mechanisms that occur as a result of stretching. The potential links between the observed effects, their causes and consequences still remain elusive. The mechanisms most researched in humans are structural and neurological. Brooks, Fahey and Baldwin[3] note that of all the factors involved, the connective tissue adaptations can show the greatest improvements in ROM due to their potential to increase permanently in length. Since a permanent increase in ROM is the main goal of any dancer's stretching program, effort should be aimed at using stretches that permanently increase a muscle's length. However, as some muscles provide postural stability and need to be stiff,[5] caution must be taken as to which muscles are being stretched. Neural adaptations can be two-fold. First, the myelin sheath that surrounds the nerves needs to be stressed gently (aggressive stress can cause "tethering," which results in muscle spasm, pain, and tingling along the path of the nerve).[6] Secondly, neuromuscular monitoring of the muscle's status is initiated by nerve endings, such as the nerves of the muscle spindles. These nerves monitor muscle length and need to adapt to the increased ROM so that it continues to provide relevant information about its length. Rapid increases in length, such as occurs in an ankle sprain, result in incorrect information being relayed back to the brain, causing increased instability and reduced proprioception.[7] The Golgi Tendon Organ (GTO), found in the muscle tendon, adapts by reducing its autogenic inhibition reflex, thereby allowing more force to occur within the muscle before its protective mechanism causes it to contract. That said, as with mechanical adaptations, there is no current consensus on a singular mechanical adaptation due to stretching.[6, 8]

Review of Stretching Techniques

There are five main methods of flexibility training: static, active, dynamic, and two forms of proprioceptive neu-

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romuscular facilitation (PNF).[9] **Static stretching** involves taking the limb to a position where tightness is felt, and then holding that position. As the position is held, the mechanical structures gradually elongate, and over a period of time the plasticity (permanent deformation) of those structures increases, thereby increasing the ROM. Research provides varying information on the optimal length of time the stretches should be held, varying between 15-60 seconds for a single or multiple repetitions.[10] The intensity at which the stretch is held is usually reported at 8/10 intensity which is just below the point when the muscle starts shaking (this is when the autogenic inhibition reflex starts to protect the muscle by causing it to contract).[11]

Active stretching involves contraction of the agonist muscle, the muscle doing the work, to allow the antagonist, the opposite muscle, to stretch (e.g., contracting the quadriceps allows the hamstrings to stretch). This type of stretching replicates most dance movement and develops flexibility and strength at the same time, though it is often the most under-utilized method by the dance community. The intensity and duration of the stretch are usually determined by the strength of the agonist muscle, and the achieved ROM is much less than that seen in passive methods.[9]

Dynamic stretching is unlike other techniques in that the limb is never held in a specific position for a prolonged period of time. Here the limb is taken through its ROM, from full contraction to full extension, at a controlled, slow to moderate speed, as in performing a fondue or plié.[9]

PNF methods have been adapted from physiotherapy techniques.[12,13] One is contract-relax (CR), in which the muscle to be stretched is first isometrically contracted (muscle length remains the same) for up to 10-15 seconds prior to being stretched[14.] This initial contraction causes the nerve endings to prevent the muscle from contracting, thereby allowing for greater ROM to be achieved during the subsequent stretch phase. The next PNF method (contract-relax-agonist-contract, or CRAC) is a progression from the first, but during the stretch phase the opposite muscle is contracted to move the limb into greater ROM, causing the muscle being stretched to relax. For example, first you employ CR on the hamstrings and then, during the stretch phase, contract the quadriceps to move the leg, allowing the hamstrings to relax and stretch a little more.

There are several lesser used techniques, of which **ballistic stretching** is the most controversial, but also the one that most closely replicates dance movement[1] (e.g., grande battement and a split jump). It is important to remember that it isn't the technique that is contra-indicated, but how the stretch is executed. To carry out ballistic stretching safely the muscle needs to be conditioned/trained, have a good ROM, and be introduced gradually. Initially mid-range movements should be used at a controlled, moderate speed, and then the speed and the ROM are gradually increased.[9] This technique is beneficial in preparing the muscle for rapid movements, and is often seen being used by sprint athletes just prior to entering the blocks. Dancers can use this technique to prepare for jump sequences.

Micro-stretching© is a technique developed by Apostolopoulos.[15] The underlying theory promotes very low intensity stretching (3/10), as he suggests that higher intensity stretching causes the muscle to contract (muscle shaking/spasm). He feels this can cause damage to the muscle fibers, with the formation of fibrous tissue that further limits ROM. A lower intensity stretch doesn't stimulate this reaction, thereby allowing for lengthening and adaptation in the myofilaments and muscle fibers. Apoulopous also states that the position the person is in is important, as too often the muscle being stretched is not totally relaxed but rather is under tension. For example, if the muscle is involved in balancing, as in a standing hamstring stretch, it cannot simultaneously relax. He suggests that this technique should be carried out two hours post-exercise, when the muscle has returned to a more normal temperature.

Fast stretching is a technique developed by this author, the aim of which is to reset the muscle's length post-exercise. Often during exercise muscles are not used through their full ROM, and afterwards they feel tight and shortened. This is especially seen after high intensity exercise and weight training. The muscle needs to be taken through its full ROM so that its resting length is restored. The technique takes a muscle to its full ROM, but unlike the static method each stretch is held for just 5-6 seconds.

Choosing the Right Stretching Technique

All techniques are not equal, and the correct method needs to be chosen for each situation. There is still a lot of controversy over the effects of stretching, especially pre-exercise. A number of studies have shown that acute static stretching has a short-term negative effect on power,[11, 16, 17] but research hasn't shown whether subsequent exercise negates this effect.[18] Based on a review of the literature and the author's own experience and research, the following techniques are recommended.

Warm-up

The main focus of warm-up is to prepare the body for subsequent exercise.[19] This must include priming the appropriate muscles to move through the required ROM and speed. Rather than stretching every muscle, focus should be on preparing the limbs to be able to move through the ROM demands of the anticipated movement. This probably needs to be achieved through static stretching, with stretches held for approximately 15 seconds. Stretching stabilizing muscles (such as the peroneus longus and brevis in the ankle) could potentially increase instability of joints, and unless the ROM is required, as in turn-out, the author recommends these muscles be left alone. The muscle then needs to be prepared to move at the required speed, and this is achieved initially through dynamic stretching and possibly ballistic stretching when the muscle is very warm if the subsequent movements require high limb speed (e.g., grande battements). It must be emphasized that stretching

is only one component of a warm-up, and should never be the sole aspect.

Immediately Post-Exercise

What is required immediately post-exercise is another area of concern and controversy. Initially it was thought that this was the ideal time to develop and increase a muscle's ROM, but more recent research has suggested that the muscle is too pliable at this time to affect permanent increase in ROM. This author finds the fast stretch technique to be especially useful between classes/rehearsals or after a performance when dancers are expected to leave the theater quickly and there isn't time for a complete warm-down and long stretch.

Recovery Stretching and Development of Passive ROM

As previously stated by this author,[20] the physiological theory behind Micro-stretching© seems beneficial for increasing passive ROM. We exposed 24 dancers to two different stretch conditions over a six-week intervention period. Both groups carried out the same set of stretches, but the intensity of the stretches varied, with one group performing low intensity stretches (Micro-stretching) and the other more intense stretches (8/10). Both groups increased their active and passive ROM, but the Micro-stretching group improved significantly more in both respects. Apostolopoulos[15] also claimed that Micro-stretching promotes healing within the muscles, but this has not yet been proven scientifically. Anecdotally, this author has seen dancers reduce muscle tightness and delayed onset muscle soreness (DOMS) very quickly using this technique. Because the technique is at a much lower stretch intensity it is less stressful mentally and physically, and helps with relaxation at the end of the day.

Developing Functional ROM

There is often too much focus on increasing passive ROM without developing the muscular strength needed to utilize this enhanced range. Active stretching and strength training should be incorporated into a dancer's program. Grossman and Wilmerding[21] demonstrated the benefits of some simple floor exercises for increasing développé height; this author would develop those exercises further by adding exercises standing unsupported in center. It is often beneficial to do these exercises with a partner, as they can provide resistance and recovery (when you exchange roles). An example of this type of exercise is lifting a straight leg as high as possible to the side (développé à la seconde) with the partner cupping their hands underneath the heel. The exerciser can then relax the foot and leg into the partner's hands. It is important for the exerciser to maintain a correct body position during the exercises – spine straight, pelvis properly aligned, and support leg straight. Finally, the exerciser attempts to lift her/his foot out of the partner's hands, without affecting posture. Each repetition should be held for 2-3 seconds before returning the foot to the partner's hands, and 6-8 repetitions are carried out per position. As the height of the développé increases, so do the partner's hand positions, so that the exerciser is working the far range of movement. This can be painful, and the muscles can become fatigued very quickly; therefore, technique and maintenance of correct posture are all-important. Once these have been compromised, rest is required and the partner can become the exerciser.

Summary

Stretching is a vital aspect of dance to provide the dancer with the ROM necessary for artistic expression. This review has shown that stretching alone is not enough, and more thought is often required to select the correct technique to prepare, develop, or recover the muscle. It is also a good idea to start each stretch session with a different muscle, as otherwise some muscles will always be over-looked, which could limit or compromise movement. Every few months review what you are doing or prescribing, according to the developments achieved.

Acknowledgment

This article was generated from Wyon M, Felton L, Galloway S.A comparison of two stretching modalities on lower limb range of motion measurements in recreational dancers. J Strength Cond Res. 2009;23(7):2144–8.

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IADMS Education Committee

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Recommendations for Stretching

- Make sure your muscles are warm first.
- Don't force stretches but "listen" to your body. If the muscle starts shaking then you have gone too far.
- Always make sure that the muscle being stretched is totally relaxed and not under any tension.
- Don't just work on your good areas but start each session with a new muscle group.
- Adaptations take time.
- Don't just stretch but choose how you stretch carefully.
- Within a warm-up you should incorporate short static stretches before stretching the muscles dynamically. The limb should be taken through the range of motion about to be experienced in the subsequent movement.
- During the warm-down, short static stretching should be used to help return the muscle back to its normal length
- Developmental stretching should occur away from the dance class with stretches being held up to 60 seconds and at a low (3/10) intensity. Remember to strengthen the muscles as well to increase the active range of movement.

Courtesy of English National Ballet Company Photographer Asya Verzbinsky

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Understanding Balance
Applying Science to Dance Training

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Watching a ballet pas de deux or the gymnastic gyrations in a ballroom dance competition suggests that dancers possess supra-normal balance. By the same token, daily balance itself is a miracle. We can dash down a flight of stairs while maintaining a lively conversation on a cell phone, nursing a full cup of coffee, or fumbling for our car keys at the bottom of a large handbag – a testimony to our brain's ability to stay upright and stable in a world of constant motion. Balance is, simply put, the ability to stay stable and not fall as we move within and beyond our base of support (normally our feet in everyday navigation). In dance, this base of support changes constantly – such as when the dancer piqués from two feet to one foot, and even to no feet when airborne. The dancer's base of support also can shift to the pelvis when rolling, the arms during handstands, and the head when break dancing.

Balance is a lifetime achievement, a process of learning to navigate in the world that begins in infancy and continues into old age.[1] We are upright skeletons with many joints and muscles, tottering over a small base of support (our 52 foot bones). Add our high center of gravity, and we oscillate like an inverted pendulum. At the same time, balance is much more than a mechanical phenomenon. Even from the perspective of neuroscience there is no one balance "center" in the brain. Rather, balance emerges from the interplay of many body systems and the task at hand (Figure 1).[2,3] The brain stays busy, constantly updating the status of our body and solving three balance problems: 1) "Where am I now?" 2) "Where am I going?" and 3) "What am I going to do next?"[3]

Our brains are in essence "embodied," processing online

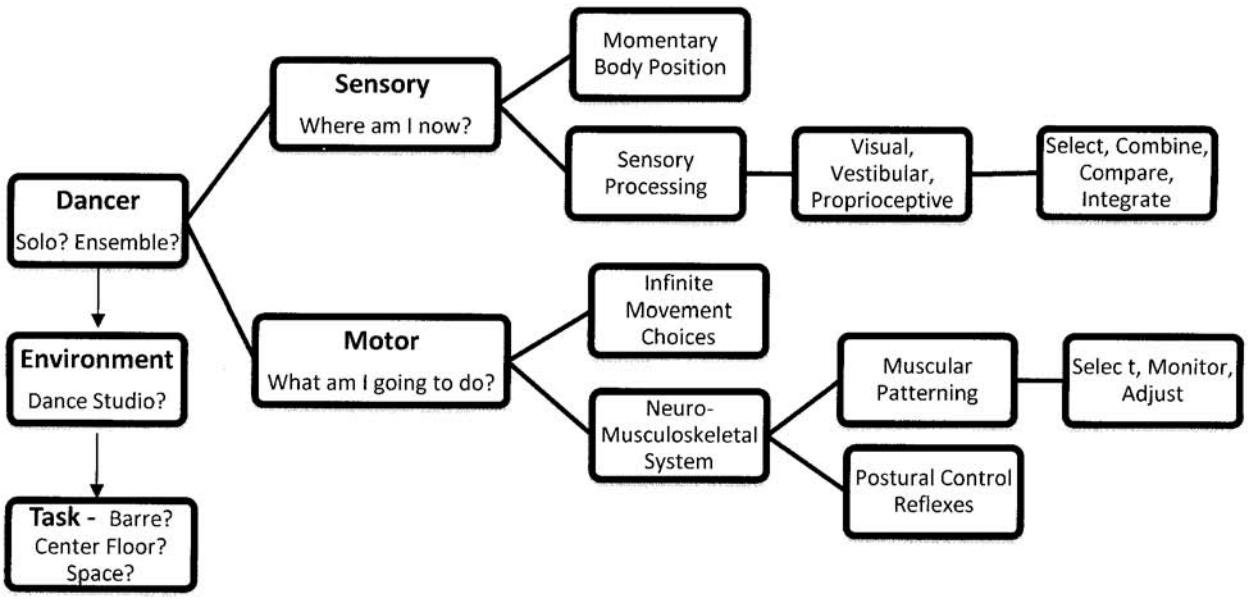

Figure 1 "Balance" – A Complex System of Support Combining Person, Place & Movement Task. (Batson G, derived from *Resources on Balance*, http://resourcesonbalance.com/clinical_info/BalanceControl.aspx.)

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information moment-by-moment from the body senses and the world. Brain processes for balance are constantly working, attuning to bodily needs for stability as environmental and task conditions change. Whether practicing alone in a studio or on stage performing with a large corps of dancers, the dancer's brain is busy processing a lot of input. The brain integrates multiple mechanical forces coming from our moving body, the ground, and any other objects we are carrying or touching, as well as our perceptions, thoughts, intentions, and emotions. In addition to handling sheer volume of input, we also need for our complex balance system to handle prediction and the actual outcome of our experience. Our intentions influence our current balance status, but may be altered at any moment by spontaneous, unanticipated changes in the original plan. Our ability to perceive *in action* helps the brain process both anticipated movement and the actual outcome, especially when dancing. Perceiving in action involves the integration of a wealth of cutaneous, proprioceptive, visual, and vestibular inputs with our conscious intentions, as well as many other non-conscious neurological and mechanical inputs. To accomplish this extraordinary task our brains use a flexible "map" of our body,[4] which functions as a unified program linking body to space and context. Dance training ideally expands our body map's capabilities, promoting clarity and differentiation of body part relationships for skillful balance and coordination.

Balance Within the Dance Context

To handle the complexity of balance, our nervous systems must act fast. For this we have evolved "postural responses."[5] Postural responses are whole body neuromuscular reflex patterns that activate quickly, either in response to our decision to move or when we are inadvertently thrown off balance. In ballet, for example, balance reactions often are anticipatory, coming mainly from the dancer's own body. When dancers "prepare" for a port de bras while standing center floor in first position, the anticipated movement of the arms disturbs the static standing body. The brain "senses" this intent to move and activates the muscles of the trunk and legs shortly before the onset of arm movement to prevent falling. Similarly, when preparing to tendu, the reflex muscle synergies in the trunk and standing leg activate to maintain balance milliseconds before the gesture leg moves forward. These quick, whole body reactions are necessary to support limb movements without excessive disturbance to the center. Without these anticipatory control signals to the muscles to stabilize the trunk, the dancer might sway excessively or even fall while shifting weight onto the standing leg. The dancer's brain must be able to modulate changing and multitasking demands –stabilizing the trunk while facilitating movement of the arms and legs–for expressivity and mastery of technique. How different this example of anticipated postural response is from the unexpected postural disturbances seen in contact improvisation, when a dancer suddenly flies spontaneously into another dancer's unsuspecting arms!

Implications for Teaching

Postural responses are evident in infants, implying that balance is something innate and hardwired in the nervous system. These responses are far from universal, however, even in infants and children. Rather, postural responses are highly variable and flexible throughout growth and development, influenced not only by genetics but also by experience and training.[5] They are not at all mastered in children or adolescents,[6] the ages when many children start dancing. Poorly coordinated or under-developed postural control responses are characterized by excessive muscular "holding" and fixation. Evidence of signs that balance is in jeopardy include awkward transitions, lack of differentiated movement between trunk and limbs, excessive mini-hopping or weight shifting on one leg, flailing arms, and finally, falling.

One challenge facing dance educators is to provide an environment for learning that facilitates optimal growth and development of any aspect of motor skill. The main take home message for balance is that it is not so important for novice dancers to learn the "right" postural control strategy, but rather to build a repertoire of postural strategies throughout their dancing lives. Since dance requires a multiplicity of strategies to handle changing space, time, and effort dynamics, the key to teaching balance is to facilitate adaptive readiness and responsiveness. In this vein, the range of possibilities in dance for exploration and discovery of balance is infinite. Virtually any dance style challenges balance. Dancers can and do routinely face different types of balance challenges that test sustained static balance, such as dynamic quick weight shifts and changes of direction at center floor, and changes in whole body base of support. Examples of each of these include, respectively: one legged stance with eyes moving or closed at the ballet barre; leaping with quick directional or level changes with arms opposing legs in modern; and falling or rolling in contact improvisation or other dance forms. Again, the key is to explore a variety of unexpected and unfamiliar balance challenges within the style.

Since dance teachers already have available a range of good options for learning balance, the best advice for teaching balance is not *what to do*, but rather *what not to do*. One main pitfall in teaching is to interfere with automatic balance processes. Finding balance is an ongoing, exploratory process in which trial and error is a function of learning. The art is in finding the (metaphorical) balance between allowing movement exploration to activate automatic processes and providing instructional guidance that eliminates excessive error. Striving for balance mastery too soon can interfere with the nervous system's automatic processes. Using a one legged balance on demi-pointe center floor as an example, repetitive, redundant exercises and cues to achieve the "right" point of balance can make the dancer anxious and self-conscious as he or she searches for the elusive anatomical element that will make this possible. To paraphrase Martha Graham on the variability of the plié, every act of balance is "a different song." The goal in

learning to balance is not to become "self" conscious, but to refine sensory capabilities that help calibrate and control forces both within the body and in space.

A related way that automatic balance mechanisms can be disrupted is by emphasizing cues focusing on one body part isolated from the total action of the body in space. Motor learning experts refer to attending to these body-based cues as "internal focus of attention," as opposed to attending to cues that connect the body to space, called "external focus of attention."[7] Examples of poor cueing choices might include emphasizing a single body part while balancing on one leg: "Pull up on the knee caps!" or "Rotate, rotate, rotate the hip!" Dissonant cues such as "pulling up" while simultaneously attempting to "drop the weight through the tail to the floor" can also create conflict between stylistic demands and the body's need as a whole to explore gravity and ground reaction force. Such singular body-focused cueing removes the dancer from the spatial context, interrupts the complex neuromuscular coordination needed for integrating the entire limb, and in the end interferes with automatic balance mechanisms.[7]

In summary, when it comes to balance we are training the dancer to become a creative problem solver within the moment, rather than chasing the elusive perfect placement. Creating an environment of exploration where dancers can practice "error" to find their way to balance before adding stylistic flourish might be a smart option toward the growth and development of the autonomous dancer.

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Abstracts from the Current Literature

Gayanne Grossman, P.T., Ed.M., and Marliese Kimmerle, Ph.D.

Twitchett E, Angioi M, Koutedakis Y, Wyon M. Video analysis of classical ballet performance. J Dance Med Sci. 2009;13(4):124-8.

This study evaluated the physiological demands of classical ballet performances. Using video analysis of 48 performances the authors were able to examine differences between the demands placed on artists, soloists and principal dancers. In order to evaluate the physiological demands the authors selected the following items to record in 30-second intervals: work intensity, body movement, partner work, and transitory movements. This provided data on the number of jumps, falls, lifts, pliés and direction changes performed, the mean time spent at various intensities, and work-to-rest ratios compared by gender and type of performer. The results showed that varying demands are made of the different members of a company, which is reflected in past physiological assessments. For example, principals had the least amount of rest and performed at higher intensities, while soloists had the greatest rest time but performed more jumps per minute than artists or principals. Comparisons of the same variables were also provided for male and female dancers. This highlights the need to differentiate between rank and gender for supplementary training, and also suggests that the performances themselves will have a different training effect on the dancers depending on their roles. These performance data, particularly the type of repeated actions per minute and the work-rest ratio, are also useful for identifying the forces and stressors on joints and consequent risk of injury, as well as the need for specific strength or agility work. Data regarding the demands of a specific repertoire may aid in the development of a training program appropriate to the demands of the specific roles.

Chatfield S. A test for evaluating proficiency in dance. J Dance Med Sci. 2009;13(4):108-14.

Both in dance science research and in dance education one commonly has to assess performance proficiency. This could be done for the purposes of entrance screening, evaluating the effectiveness of some teaching/training intervention, giving a grade in an academic setting, moving students to different levels or providing individual feedback, etc. There are some aspects of technical performance that can be evaluated using quantitative measures, such as degrees of turnout or height of a vertical jump, but others require qualitative approaches, that is, subjective judgments made about performance competency. This requires developing specific criteria for what components of 'technique' are being evaluated, and achieving a high degree of agreement between judges in scoring those criteria. This study identifies some of the challenges inherent in this process. It involved 41 participants who were videotaped performing compulsory and improvisational segments of movement. Three judges were trained to use a set of progressive scoring criteria that included evaluation of technique, space, time and energy, phrasing and presence, with a score between 1 and 5 given in each area. Results showed that using this system produced a high degree of inter-judge agreement and also high intra-judge reliability; that is, judges were highly consistent in their own repeated scorings. The assessment was also able to place the dancers correctly in their dance experience level, which indicates that the assessment tool has sensitivity and specificity. The author provides the following helpful recommendations for future development and use of qualitative evaluation tools: 1. rigorous preliminary training with the judges; 2. pilot testing; 3. more than one judge and/or repeat test administration; and 4. inclusion of an improvisational component in addition to a compulsory component.

Sidaway B, Trzaska A. Can mental practice increase ankle dorsiflexor torque? Phys Ther. 2005 Oct; 85(10):1054-60.

A team of researchers asked if mental practice can increase strength in the ankle dorsiflexor (ankle flexor) muscles. They defined mental practice as the cognitive rehearsal of a task in the absence of movement. They recruited 24 healthy students between the ages of 19 and 24 who were not engaged in any exercise program. These participants were randomly assigned to one of three groups: a mental practice group, an exercise group, and a control group (one that did not exercise). The students' baseline isometric dorsiflexor strength was tested on a Biodex System 3.0 isokinetic dynamometer. Then, three times per week for four weeks, the mental practice group was instructed to close their eyes, take a deep breath, focus on a white screen, and imagine the feel of the exercise they engaged in during baseline testing. They imagined the exercise for five seconds, repeated ten times. The students were monitored to ensure that muscle contraction was not occurring. The exercise group performed the exercises on the Biodex system using the same frequency. The control group

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did not exercise. After four weeks all of the groups were retested for strength. The exercise and mental practice groups' strength improved by 25.28% and 17.13% respectively. The control group did not improve. Other researchers have similarly shown strength or performance improvements through the use of mental practice, although the mechanism is not completely understood. Some suggest the improvement may be the result of better preparation and anticipatory movements. Other researchers have shown that minute impulses from the nerves provide kinesthetic feedback, facilitating corrections in the motor program and neuromuscular coordination. This study indicates that mental practice has useful implications for improving muscular strength in many muscle groups and for facilitating improvements in coordination. Dance teachers may find this technique helpful when training students.

Akuthota V, Nadler S. Core strengthening: focused review. Arch Phys Med Rehabil. 2004;85(3 Supp1):S86-92.

These authors reviewed the literature on core strengthening. They defined the "core" as the muscular corset around the lumbar spine that is used to stabilize it. The core can also be visualized as a box, with the abdominals and spinal muscles in the front and back, the diaphragm on the top, and the pelvic floor as the bottom. Passive bone, fascial and ligamentous structures, and muscles serve as stabilizing forces. The article describes the specific function of each passive structure: the paraspinals, the quadratus lumborum, the abdominals, the hip girdle musculature including the gluteals and the psoas, the diaphragm, and the pelvic floor. The authors provide a detailed strengthening program, including recommendations for functional progression, activation patterns, and time of day. The focus is not just on strengthening, but includes endurance training. It also addresses motor re-learning when the muscles are inhibited (do not fully contract) or less active than normal. The authors explain that transverse or rotational movements are often overlooked, which is a problem because sport activities occur on three planes. They discuss the benefits of enhanced neuromuscular control and methods to facilitate it. Recommended exercises include utilizing co-contraction, plyometrics (which are jump exercises that allow a muscle to achieve maximum force in the least time), protocols for balance work, perturbation challenges (these train reaction to unexpected forces such as balancing on an unstable surface or quick direction changes), and sport-specific skills. Injury prevention and improved performance are the goals of this comprehensive program. The article includes photos and descriptions of useful exercises.

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