

Warm-ups: what exactly are we trying to achieve?

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It is universally acknowledged that warming up is essential for all performers using physical skill and dexterity, whether they are musicians, dancers or athletes. There is much information relating to physical performance that we can glean as musicians from the more extensive research findings in sports medicine (Hays 2002). There are numerous published research papers and books concerned with musicians' practice (athletes refer to this as training), these tend to deal with all the preparative processes apart from rehearsal or performance. However, there has been very little quantitative or comparative research into the efficacy of warming up techniques for musicians. Published findings show that vocal warming up increases the functioning of the performer (Elliot, Sundberg et al. 1995), but there is no direct evidence to show what particular activities should comprise an effective warm up, and in which order they should be carried out.

Musical performance as an athletic activity

Musical performance, like athletic performance, involves prolonged, highly controlled and sometimes forceful activity. The demands that this makes on the body can be variable but in all cases they combine speed, strength and duration.

What is a warm-up?

For the sake of definition within this article, the warm-up is purely the preparation undertaken before the musician begins technical or repertoire practice. It is the process by which the individual prepares his or her body for the demands of a practice session, rehearsal or performance. Physically it prepares muscles and joints for heavier and specific use. Mental preparation enables the coordination of the constituent details necessary. The techniques of playing or singing are rehearsed and refreshed in a non-stressful way.

Setting up efficient performing activity: the body as a whole

The warm up period or exercises may offer an opportunity to alter the postural setup to one that is appropriate for performance. This will involve a conscious direction of attention to the technical aspects of singing or playing including the subjective or proprioceptive analysis of what is going on in the body in terms of positioning and tension (Dommerholt 2000). This attention to the body as a whole can help the performer to minimize overall muscular effort; when the forces are reduced to a minimum, then technical control is at its optimum (Watson 2009). Establishing balanced

and effort-reduced posture may utilize techniques such as Feldenkrais, Alexander Technique, Tai-Chi or yoga. This process of postural alignment and proprioceptive awareness relies on working away from the instrument.

Playing a musical instrument or singing on stage will not only make physical demands that are prolonged and repetitive; they nearly always involve unbalanced or asymmetrical body use. If the performer's initial body position is over-tense, during performance one set of postural muscle tensions may be superimposed upon another. Good technique involves the optimization of all constituent actions for creating the sound. If one or more of these elements are deficient, a short-term compensatory behaviour may be adopted. This may lead to bad habits remaining and eventually to a possible misuse injury (Sperryn 1994; Llobet and Odam 2007). Where a playing posture involves either asymmetrical usage or the weight of the instrument must be supported, certain muscles may become over-used. As well as stretching and releasing these muscle groups during and after playing, it is also important to work on strengthening the antagonistic muscles. For example, in supporting the instrument, string or wind players predominantly employ the muscles on the front of the shoulder joint. It is important to work on strengthening the opposing muscles on the back of the shoulder to counter the habitual forward rotation. If this is not done, these over-developed and possibly shortened muscles may cause the player to continue with an unbalanced posture when not playing. The seated orchestral player, pianist or choral singer should be preserving the natural slight inward curve of the lower back (lordosis). With sitting, this can become straight or even kyphotic (curving outwards). The upper back and neck can also slump forwards and down. If left uncorrected, these postures may eventually cause stress to the muscles in the neck and back as well as the vertebral discs.

At the start of warm-up, the principles of postural balance must be addressed. The body as a whole must be in a state of alert poise.

Beginning movement: metabolic processes within muscles

Warming up encompasses many aspects of preparation for practice or performance. The activities will contribute to a rise in temperature of the muscle fibres, enabling a rise in the rate of cellular chemical reactions and increased blood flow delivering oxygen and nutrients; this is necessary to ensure that the muscle activity remains aerobic. The increased activity and the warmth generated will also lower the viscosity of synovial fluid both in the joint capsules and the tendon sheaths as well as the elasticity of tendons and the ligaments that support joints.

Muscles need energy in order to work. This energy comes from the metabolic process of converting substances derived from nutrients, some of which are stored in the cell and some which need to be transported in the blood. The initial few seconds of activity is an anaerobic process – this depends on the cell's glycogen reserves and results in the production of lactic acid. Prolonged anaerobic activity can result in a build-up of lactic

acid, which is effectively a toxin and after some time, will impair performance (Brooks and Fahey 1985). Aerobic activity, which starts after several seconds of gentle activity requires a balance between oxygen availability and its use by the muscle.

The metabolic processes within the muscle cell are complex and interrelated; the byproducts from one process can be utilized by another. These processes are heat-generating and lead to a rise in muscle temperature and results in a reduction in the viscosity of the muscle itself. This is an important consideration when the vibration of a muscle is necessary to produce sound, such as in the lips (for the embouchure) or the vocal folds in singing (Elliot, Sundberg et al. 1995). Raising the temperature in muscles enables oxygen to be liberated from the haemoglobin in the blood more easily, this aids aerobic muscle function. (Martin, Robinson et al. 1975). The rise in temperature increases muscle enzyme activity and enhances blood distribution, dilating capillary beds and dissipating heat from the muscle (Heyward 1991). A rise in temperature of the hand overall will help to moisten the finger pads with a small amount of sweat, this helps with grip, reducing the need for excess muscular work.

It is important that musical performance uses aerobic muscle activity as this increases endurance and reduces discomfort caused by the build-up of lactic acid. Muscles can only work exclusively anaerobically for a couple of minutes; for example in a 100metre sprint. Anaerobic activity will take place if the muscular effort is very high or if a build-up of muscular tension has resulted in a reduction of the blood supply. It would appear likely that an unnecessary build-up of muscular tension in a particular area could lead to an increase in the degree of anaerobic activity within the muscles. This is another reason why it is necessary to perform using the minimum of muscular effort. This can be achieved by encouraging release of the antagonistic muscle pairings and to build in periodic release of all the muscles.

In order to facilitate aerobic muscle function, the warm-up needs to build muscle activity from a slow and gentle start.

Intensity of performance, speed of movement and length of performance can cause muscle fatigue. In simple terms, this means anything loud, high, fast or long. Playing intensely without prior preparation will exhaust nutrient reserves within the muscles and diminish performance. This will result in muscle fatigue, and rest will be needed for recovery. Recovery is most effective with active rest; pursuing a different activity rather than inactivity. This can be incorporated into the warm-up or practice routine. The diverting activity produces a flow of impulses from the non-fatigued parts of the body, this shifts the brain functioning from inhibition to facilitation (Shephard and Astrand 1992).

In order to prevent muscle fatigue, activities need to be varied throughout the warm-up.

Flexibility and stretching

For the musician, flexibility is necessary for the smaller movements which enable fast playing or singing, rapid pitch changes, and a wide range of pitch. Flexibility can only be developed once the muscles and joints are warmed up. Occasionally the musician will need to employ extreme positions of the hand or wrist, for example during repeated movements such as parallel octaves on the piano, large stretches in guitar or cello, and extreme supination and wrist flexion when playing high on the strings in violin or viola. These resemble the extreme demands on the joints made of a dancer, gymnast or hurdler. The other issue for musicians is that complex repeated movements are often made within a limited range of movement. When muscles remain contracted for a long period, they can become shortened and the joints become stiff. In order to prevent this from happening, a stretch in the opposite direction can help to lengthen the muscle, returning balanced use between opposing muscles and enabling a greater range of movement in the joint. This not only applies to the larger postural muscles of the back, neck and shoulder but also to the smaller muscles of the hand and the larynx. Lack of flexibility can often be exacerbated by postural habits and will be improved if the individual allows the opposing muscle groups to relax and stretch periodically during warming up and practice.

The questions here are: how much to stretch, for how long, how frequently and when should the stretches happen in the warm-up, practice, rehearsal and performance timetable. The research literature on the role of stretching for athletes is somewhat inconclusive; the variation in methodology makes comparisons difficult (McHugh and Cosgrave 2010). Whether stretching is beneficial can be determined by comparing the incidence of muscle overuse injury or muscle strain when stretching is included in training with when it is not. Stretching during the warm-up appears to reduce muscle strain injury but not necessarily to affect the incidence of further overuse injury (Pope, Herbert et al. 2000). Static stretches of low intensity are most effective if they are of extended duration and performed for two to four minutes (Ryan, Beck et al. 2008). This is a long time to perform a stretch, especially as the musician may have numerous muscle groups to work on. Certain types of yoga may offer a means of obtaining this type of benefit, however the neural response to stretching can also temporarily reduce effective muscle strength (Avela, Finni et al. 2004). Extended and lengthy stretches immediately prior to muscle use may not therefore be advisable and should be delayed till after the performance.

There is no doubt that trying to force cold muscles and joints will risk injury and strain. Prior to warming-up, stretching need only be a gentle rebalancing of posture; allowing the muscles to lengthen rather than forcibly extending them. This can be achieved by giving attention to the muscles whilst the body is in a state of stillness: releasing and lengthening without any visible activity, in order to achieve a balanced poise.

Never stretch cold muscles. Use small stretches during practice and rehearsal, use longer stretches after performance.

Flexing and extending joints through much or their range of movement is a crucial part of warming-up, but at what point does this movement become potentially damaging? The best guide is to keep below the threshold for discomfort, and to keep the range of movement within 60 – 80% of the maximum. Any stretch which involves a bouncing movement (ballistic stretching) is not recommended for warming-up, neither is anything which encourages breath-holding.

Stretching after warm-up and periodically during practice is helpful. It does not necessarily relieve muscle soreness but will reduce the risk of injury (Herbert and Gabriel 2002). Ballet dancers spend 25% of their practice time on warming-up and stretching exercises, as full range of movement in the joints is essential (Reid, Burnham et al. 1987). Stretching muscles during practice or rehearsal has a different function from the initial warm-up. Here it is to reduce the build-up of specific muscle contraction, which would increase muscle tension and reduce the range of movement. If the finger joints are generally in a state of flexion (curling inwards), they will benefit from some gentle extension stretches. Likewise the back and neck will benefit from an extension stretch to counter-balance a habitual forward curve in a seated posture. The shoulders may benefit from some stretching of the pectoral and deltoid muscles. The muscles of the larynx will benefit from some gentle voicing at low pitches.

Performance-related injury as a result of misuse, overuse or new use

We will first consider overuse injuries. These are muscle fatigue or tension-related. In the singer they may present as muscle tension dysphonia; in the player, there may be pain in the hand, wrist, arm or shoulder. If unnoticed or unattended to, compensatory strategies may lead to secondary disorders such as vocal fold lesions or chronic pain syndrome (Wynn Parry 1998). It is important to point out that these injuries, although common amongst musicians, are not an inevitable consequence of professional music-making. They are, however, often anxiety-related. Sensible practice management as well as a attention to emotional and environmental concerns is of paramount importance.

Common misconceptions about stretching

Many performers believe that a warm-up should start with stretching; however the consensus on this has recently changed (Hackney 1994). From more recent studies we can see that stretching a cold muscle or extending a cold joint can risk causing injury (MacAuley and Best 2002).

There is another belief that stretching will extend the hand-span. Measurements of 69 cellists, 52 guitarists and 83 controls who were all right-handed showed that they *all* had a greater left hand span, regardless of training. This suggests that there is a general trend towards a smaller span for the dominant hand, possibly because it facilitates a stronger grip. Instrumental training cannot be responsible for the individual developing a larger hand-span (Kloepfel 2000).

Psychological preparation and focus

Focusing attention on a task not only improves factual learning but also motor learning, in addition to eliminating distractions that interfere with mindful practice. The warm up might be seen as a part of a change in mental behaviour that could encourage the initiation of a flow state (Williamon 2004).

The musician's brain will have refined numerous sequences of muscle activity that enable complex actions to be carried out automatically (Watson 2009). This happens as a result of years of practice, but these links need to be refreshed regularly in order to be maintained. Repetition of specific activities within a warm-up can help to warm-up the brain as well as the muscles.

Repetition of exercises in a state of alert and deliberate mindfulness will help to develop technical ability.

Sports training principles – how can these apply to musicians?

The basic principles of sports training are: Overload, Specificity, Individuality and Reversibility.

Overload is gradually extending the action and capability of the body. This may involve a progressively faster or longer run. It may involve a greater number of repetitions or application of greater force. This will build on the strength and stamina of the systems. For a musician this applies to anything loud, high, fast or long. The build up to prolonged performances must be gradual and incremental. Although the journey from A to Z may take less and less time with each practice session, the performer must still begin with A each time.

Specificity is working on the precise actions needed for the task. Just as the gymnast rehearses the separate elements of a competition routine, the musician carries out the technical exercises specific to the demands of the instrument including those specific to the demands of the current repertoire. This also relies on a steady build-up of activity.

Individuality refers to the fact that every person has different needs, strengths and weaknesses. These cover physical attributes and limitations, emotional and psychological states and intellectual abilities. The rate of learning varies from person to person, as does their level of commitment. It is crucial that this be taken into consideration when devising an exercise programme, a practice schedule or a lesson plan.

Reversibility describes how training benefits are lost when exercise ceases. Any musician knows that a few days without practice may be occasionally beneficial, but that too long a break will lead to deterioration in performance.

Sports science has also addressed the question of **frequency**. If the individual trains for two days or less per week, there is a very limited benefit. If the training is three days a

week or more, improvements are made. If the training is too intense and too often, then there is the possibility of over-use injury.

Sports training is also of **varied intensity**. Some sessions are endurance-based and require a low-level activity over a long period of time. Some are high-intensity high-speed activities. Some use the Swedish system of 'Fartlek' where the athlete will vary the pace according to their own individual plan. Any burst of high-intensity activity (often using anaerobic muscle metabolism) is better placed nearer the end of the training session as the muscular function will be at its optimum. This would suggest that prolonged practice of demanding passages would be better balanced by interspersing them with gentler activities.

Musicians have been seen to benefit from the 'little and often' system of practice. For athletes, **interval training** tends to be in a ratio of 1:1 for activity and rest, this system will reduce the risk of over-use injury. For the musician, some of the 'rest' time can be used for practice away from the instrument. This can either be internalized visualization of the performance, or it can be study with the score. In balance with the need to prevent over-use injury, the musician does need to learn to pace his or her activity over an extended rehearsal or performance time. Building stamina is essential to enable long performances. The marathon runner will rarely run anything like the full distance in the training for an event. They train with one long run per week (40 – 70% of the target distance), followed by one shorter recovery run (gentle, 20-30% of the distance), one or two shorter runs at a variable pace and one at fast pace. Training for stamina and endurance relies on working at 50 – 60% of the maximum heart rate.

The musician can view a performance in the same way, it is foolish to give 100% effort all of the time, and counter-productive to give too much effort for too long during a performance. Ensemble performance may need to be paced more carefully as this tends to take up more performing hours overall. Solo performances will require greater practice time for the eventual performance and it is the practice that will need to be paced effectively. Staying within an average of 60% is a good guideline. The musician will not necessarily benefit from complete runs of difficult or demanding pieces, preparation will entail varied types of work on shorter sections. The necessary build of physical stamina should be seen to develop in both the playing muscles and also in the postural ones.

Suggested sequence for effective warm-up

All warm-up exercises need to have a direct relationship to the challenges of the instrument/voice, they are not just 'for fun'. In other words, if you don't know exactly what the exercise is achieving, find out or leave it out. When warming-up you should ideally go through each of the following stages. It is important not to skip any of them, although you can choose to spend as long as you like in each one. Establishing a routine

for this helps you to be mindful of the process as well as enabling you to build patterns of good habitual usage.

Set up your mind

Focus on your practice without any other distractions. Practice can become boring and repetitive, so it is important that you remain mindful of your actions. Deliberate practice is goal-directed.

Wake up the body

Some overall body movement will encourage blood flow and warm the larger muscles of the torso. Running on the spot or dancing will do. You could even utilise a brisk walk to the practice studio, or running up the stairs. Overall flexibility exercises are helpful, such as arm circling or back and neck extensions. It is important to be aware that the extent of comfortable movement will be less in the morning after the immobility of sleep, it will also be easier in a warmer ambient temperature.

Align your body

Remember balanced posture, if necessary you can use tension and release methods to achieve this. Eventually it becomes possible to direct the body in a balanced poise with no obvious major adjustments.

Specific flexibility exercises

These may be breathing exercises for singers, wind and brass players. They may be hand or arm movements. Some very gentle stretching may be appropriate here.

Small and gentle movements leading on to extended movements

These are instrument-specific, for example: slow scales (keyboard players), open-string bowing, single notes (wind players), pitch glides (singers). The athletic extremes of performing: loud, high, fast or long, need to each be approached incrementally. Start quietly, at a low pitch, slowly and with shorter phrases or scales. Then gradually increase one element at a time.

Remember to cool down

This is essential at the end of any performance, rehearsal or practice session. It allows the body to return to its pre-exercise levels (Saxon and Schneider 1995).

- Blood supply redistributed
- Metabolic stores replenished
- Tissue temperature lowered
- Hormonal disturbances equalized
- Glycogen stores replenished
- Lactic acid reduced - with complete rest post-exercise, lactic acid will remain in the blood for up to an hour. However, with active cool-down it will have dissipated in 15-20 minutes (Bonen and Belcastro 1976). This could be a

contributing factor to the build-up of muscle fatigue that can be experienced if there is not adequate rest time between playing sessions.

It is crucial to return the posture and body balance to a non-playing state. This is achieved by deliberate stretching of the antagonistic muscle groups. For seated players it may include some back extension stretches, for those supporting instruments, it will include stretching the muscles directly responsible for holding the instrument. For a singer, it will mean returning the voice to comfortable, lower pitches and a release of the laryngeal suspensory muscles.

The most effective way to carry out this cool-down process is to reverse the warm-up routine. Activities must be gradually reduced in intensity and the body stretched and re-balanced.

Conclusion

The parallels between the sports training principles and musical training are evident. It is also important to be aware of the differences between athletic demands and those of the performing musician. From a pedagogical view, the warm up should not be regarded as comprising a brief set of exercises to raise the temperature of muscles in a rather mindless way (which the term almost invites as an interpretation), but to be an important set of inter-related physical and mental activities that if properly carried out will not only contribute to reducing injury, but also increase the efficiency of practice and performance.

References

- Avela, J., T. Finni, et al. (2004). "Neural and mechanical responses of the triceps surae muscle group after one hour of repeated fast passive stretches." *Journal of Applied Physiology* **86**: 1283-1291.
- Bonen, A. and A. Belcastro (1976). "Comparison of self-selected recovery methods on lactic acid removal rates." *Medicine and Science in Sports* **8**: 176-178.
- Brooks, G. A. and T. D. Fahey (1985). *Exercise physiology: Human bioenergetics and its applications*. New York, Macmillan.
- Dommerholt, J. (2000). Posture. *Medical problems of the instrumental musician*. R. Tubiana and P. C. Amadio. London, Martin Dunitz.
- Elliot, N., J. Sundberg, et al. (1995). "What happens during vocal warm-up?" *Journal of Voice* **9**(1): 37-44.
- Hackney, R. (1994). "Nature, prevention and management of injury in sport." *British Medical Journal* **308**: 1356-1359.
- Hays, K. (2002). "The enhancement of performance excellence among performing artists." *Journal of Applied Sports Psychology* **14**: 299-312.
- Herbert, R. D. and M. Gabriel (2002). "Effects of stretching before and after exercising on muscle soreness and risk of injury: systematic review." *British Medical Journal* **325**: 468-470.
- Heyward, V. H. (1991). *Advanced fitness and exercise prescription*. Champaign, IL, Human Kinetics Books.

- Kloeppe, R. (2000). "Do the "spreadability" and finger length of cellists and guitarists change due to practice?" Medical Problems of Performing Artists **15**: 23-30.
- Llobet, J. R. and G. Odam (2007). The Musician's Body, Guildhall School of Music and Drama and Ashgate Publishing Ltd.
- MacAuley, D. and T. M. Best (2002). "Reducing risk of injury due to exercise." British Medical Journal **325**: 451-452.
- Martin, B. J., S. Robinson, et al. (1975). "Effect of warm-up on metabolic responses to strenuous exercise." Medicine in Science and Sports **7**(2): 146-149.
- McHugh, M. and C. Cosgrave (2010). "To stretch or not to stretch: the role of stretching in injury prevention and performance." Scandinavian Journal of Medicine and Science in Sports **20**: 169-181.
- Pope, R., R. Herbert, et al. (2000). "A randomised trial of preexercise stretching for prevention of lower-limb injury." Medicine and Science in Sports and Exercise **32**: 271-277.
- Reid, D., R. Burnham, et al. (1987). "Lower extremity flexibility patterns in classical ballet dancers and their correlation to lateral hip and knee injuries " American Journal of Sports Medicine **4**(347-352).
- Ryan, E., T. Beck, et al. (2008). "The time course of musculotendinous stiffness responses following different durations of passive stretching." Journal of Orthopaedic and Sports Physical Therapy **38**: 632-639.
- Saxon, K. and C. Schneider (1995). Vocal Exercise Physiology. San Diego, Ca., Singular Publishing Group Inc.
- Shephard, R. J. and P.-O. Astrand (1992). Endurance in Sport. Oxford, Blackwell Scientific.
- Sperryn, P. N. (1994). "Overuse injury in sport." British Medical Journal **308**: 1430-1432.
- Watson, A. H. D. (2009). The Biology of Musical Performance. Plymouth, UK, Scarecrow Press.
- Williamson, A., Ed. (2004). Musical Excellence. Oxford, OUP.
- Wynn Parry, C. (1998). Misuse and overuse. The Musicians' Hand: a clinical guide. I. Winspur and C. Wynn Parry. London, Martin Dunitz.