Ergonomics for Fine Arts

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Early assessment of working conditions and early training will prevent or reduce injuries that can last for a lifetime.

Artists and staff who work in fine arts departments have particular ergonomic needs that often require specialized approaches. They experience a range of movement, voice, and repetitive strain issues that are different from typical ergonomic stressors experienced by other academic staff.

CAUT has worked closely with academic staff in fine arts programs to determine the types of injuries they experience and to identify ways to prevent such injuries.

The Occupational Health Clinics for Ontario Workers (OHCOW) has been instrumental in developing the attached technical document. This document, drawing upon the ergonomic expertise of the OHCOW, provides clear instructions on how fine arts staff can work safer.

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The most important concept to remember is what fires together gets wired together so if you override pain signals the pain becomes chronic and extremely difficult to treat.

Dr. John Chong from the Faculty of Health Sciences at McMaster University and Medical Director of the Musician's Clinics of Canada, who has also contributed to this document, alerts fine arts staff to the following: "The prevention of overuse is the control of use. This simple checklist goes a long way to preventing impairment and disability: A = alignment B = breathing C = coordination D = diet E = exercise F = focus G = goals. The most important concept to remember is 'what fires together gets wired together" so if you override pain signals the pain becomes chronic and extremely difficult to treat.'"

It is important that fine arts staff identify those stressors that may lead to ergonomic issues before they cause damage. Early assessment of working conditions and early training will prevent or reduce injuries that can last for a lifetime.

Please work with your association's and institution's Joint Health and Safety Committee to assist with providing safer workspaces, and consult resources like the Musician's Clinics of Canada for advice on care and prevention of ergonomic injuries. It is also important that you let your healthcare providers know and understand exactly what your "work" processes are in the case of an injury so that accurate diagnoses and effective treatment can be given.

Please contact CAUT's Health and Safety Officer for further assistance.

Resources

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Musician's Clinics of Canada
www.musiciansclinics.com

Occupational Health Clinics for Ontario Workers
www.ohcow.on.ca

Performing Arts Medicine Association
www.artsmed.org/

Worker's Health and Safety Centre
www.whsc.on.ca

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Occupational Health Clinics for Ontario Workers Inc.

Centres de santé des travailleurs (ses) de l'Ontario Inc.

Ergonomics for the Fine-Arts

Prevention Through Intervention

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In May of 2011, 136,600 artists spent more time performing their art than any other occupation in Canada[1]. This occupation represents 0.78% of the overall Canadian labor force, which translates to about one in every 129 Canadian working as artists[2]. This is comparable to the number of workers in the automotive manufacturing, utilities, and telecommunications sectors.

The term "artist" comprises various areas of occupations[3]. In fact, musicians and singers are the largest of nine occupations included as artists as they comprise 25% of all 136,600 artists. Not only are artists unique in their levels of creativity, but they are also much more likely than any other workers to hold multiple jobs[4]. An alarming 11% of artists reported having a minimum of two jobs, which is a stark contrast to the 5% of the overall labor force who did so. This may place them at a higher risk of developing a musculoskeletal disorder for multiple reasons including: lack of rest and recovery, fast paced lifestyle, lack of time to engage in health and safety training. As a result, topics relating to ergonomics should be emphasized for workers in the fine arts sector. Not only are they susceptible to injury as a result of multiple jobs, but the awkward postures, repetition, and force they are exposed to subjects them to additional risk factors.

1.0 Musculoskeletal Disorders

MSDs are injuries and disorders of the musculoskeletal system. The musculoskeletal system includes muscles, tendons, tendon sheathes, nerves, bursa, blood vessels, joints/spinal discs, and ligaments. MSDs may be caused or aggravated by the presence of one or any combination of the following risk factors: repetition, awkward or static postures, high forces, and contact stress. When these factors exist simultaneously, the risk of developing a MSD is significantly increased. Although some musculoskeletal injuries occur at one specific moment, many more injuries result from repeated strength demands coupled with lack of significant rest periods that together, exceed the tissue tolerance of an individual. Since an injury lowers one's capacity and overall tissue tolerance of that area, returning to pre-injury duties before adequate rehabilitation could result in increased risk of developing a more severe or permanent injury or overusing another body part to compensate for the current injury.

2.0 Health Consequences of Poor Ergonomics

2.1 Wrists

The risk factors associated with the fine-arts that most commonly affect the wrists are chronic repetitive movements, awkward and static positions, mechanical stresses to digital nerves such as sustained grasps on instrument handles, extended use of instruments and inadequate work breaks. The wrist is in constant demand, often sustaining excessive and repeated stresses and strains. The safest position for the wrist

[1] National Household Survey and the Labour Force Survey (2014). A Statistical Profile of Artists and Cultural Workers in Canada. Retrieved on July 14th 2016 from http://www.hillstrategies.com/content/statistical-profile-artists-and-cultural-workers-canada

[2] Ibid

[3] Ibid

[4] Ibid

is a straight or neutral position. Special care should be used to avoid bending the wrist downwards (flexion) or outwards (ulnar deviation).

2.1.1 Carpal Tunnel Syndrome (CTS)

CTS is one of the most common problems that affect the hand and wrist. CTS occurs when the median nerve, which runs from the forearm into the hand, becomes pressed or squeezed at the wrist. The median nerve controls sensations to the palm side of the thumb and fingers (although not the little finger), as well as impulses to some small muscles in the hand that allow the fingers and thumb to move.

The carpal tunnel is a narrow, rigid passageway of ligament and bones at the base of the hand. It houses the median nerve and tendons. Thickening from irritated tendons or other swelling narrows the tunnel and causes the median nerve to be compressed. The result may be pain, weakness, or numbness in the hand and wrist, radiating up the arm.

Repetitive wrist motions, especially while a pinch pressure is exerted by the fingers, have been linked to an increased incidence in developing CTS (Huntley, 1988).

2.1.2 Tendonitis of the Wrist

Tendonitis is an inflammation of tendons, which are the structures that attach muscle to bone. Tendonitis of the wrist is accompanied by pain, swelling and inflammation on the thumb side of the wrist, and is made worse with grasping and twisting activities (e.g. polishing and scaling). People with this disorder have often noted an occasional “catching” or snapping when moving their thumb.

2.1.3 Guyon’s Syndrome

Guyon's canal is a space at the wrist between the pisiform bone and the hamate bone through which the ulnar artery and the ulnar nerve travel into the hand. Compression of ulnar nerve occurs in this space at the base of the palm. It is commonly caused by repetitive wrist flexing or excessive pressure on palm/base of hand. It is characterized by pain, weakness, numbness, tingling, burning in the little finger and part of the ring finger.

2.2 Fingers

Grasping or pinching light objects becomes a problem when the item is held for long periods. The pressure can reduce blood flow and strain tendons, leading to hand symptoms. Repetitive motion, such as prolonged grasping, can lead to tendonitis (inflammation of the tendons).

2.2.1 DeQuervain’s Tenosynovitis

This disorder is characterized by pain and swelling in the thumb and wrist area when grasping, pinching, twisting, and a decreased range of motion of thumb with pain. Possible causes include synovial sheath swelling, thickening of tendons at base of thumb, and repeated trauma or twisting hand/wrist motions.

2.2.2 Trigger Finger
Trigger Finger often results from sustained forceful gripping and repetitive motions, which irritate the tendon and tendon sheath (tenosynovium). Nodules form in tendons, causing warmth, swelling, and tenderness of the tendon. Pain occurs during movement that place tendons in tension. The fingers lock in the "Trigger Position".

2.3 Elbow
The elbow should generally be held at a right angle or ninety degrees. Because blood vessels and nerves supplying the forearm and hand travel along the elbow joint, repeated or prolonged bending can cause compression, leading to forearm and hand symptoms.

2.3.1 Epicondylitis
Injuries at the elbow typically occur at either the inside of the elbow, referred to as Medial Epicondylitis (golfer's elbow), or outside of the elbow, known as Lateral Epicondylitis (tennis elbow). The forearm flexors, used to make a fist, attach at the inside portion of the elbow. Whereas the forearm extensors, used to open the hand, attach at the outside of the elbow.

2.3.2 Cubital Tunnel Syndrome
Cubital Tunnel Syndrome is often caused by prolonged use of the elbow while flexed, resting the elbow on an armrest, or trauma from overuse can compress the ulnar nerve. It is characterized by pain, numbness, tingling and impaired sensation in the little and ring fingers, side and back of hand, loss of fine control, and reduced grip strength.

2.4 Shoulders
Shoulder disorders are often caused by compressed nerves, arteries, and veins that supply the arm and hand, leading to upper extremity symptoms. Poor thoracic alignment also limits oxygen intake. When oxygen intake is diminished, the body experiences fatigue, which can lead to a loss of concentration.

2.4.1 Bursitis
The term bursitis means that the part of the shoulder called the bursa is inflamed. There are many different problems that can lead to symptoms from inflammation of the bursa, one of those being impingement.

2.4.2 Thoracic Outlet Syndrome (TOS)
TOS is a condition resulting from compression of the nerves, arteries, and veins as they pass through from the neck to the arm (thoracic outlet). Possible causes include tight scalenes and pectoralis muscles, extra cervical rib, and prolonged durations of working with elevated elbows. This disorder is characterized by pain in the neck, shoulder, arm or hand, numbness and tingling of fingers, muscle weakness/fatigue, and cold sensation in the arm, hand or fingers.

2.4.3 Rotator Cuff Tear
The rotator cuff (RC) is a group of 4 muscles; supraspinatus, infraspinatus, teres minor and subscapularis. The RC assists with both gross and fine motor control of the arm. RC injury tends to occur where the muscle's tendon attaches to the bone.

2.4.4 Rotator Cuff Tendonitis
This disorder is characterized with pain and stiffness in the shoulder associated with backward and upward arm movements, and weakness of rotator cuff muscles. Possible causes include swelling or tearing of rotator cuff soft tissue, shoulder joint bone spurs/abnormalities, and poor shoulder posture.

2.5 Neck
It is common for pain in the arm and hand to stem from problems in the neck. Neck and arm strain can be prevented by keeping the head and neck in proper alignment. The slight inward curve of the neck balances the head on the spine. Holding the head forward disturbs this balance, straining the joints and the muscles of the neck and upper back. This posture also causes compression of the nerves and blood vessels as they exit the neck, leading to symptoms in the arm and hand.

Neck problems generally arise from prolonged static neck flexion and shoulder abduction or flexion, lack of upper-extremity support, and inadequate work breaks. Awkward postures are often adopted to obtain better views of the intraoral cavity, provide a more comfortable position for the patient and to coordinate their position relative to the canvas/easel/music notes.

2.5.1 Myofascial Pain Disorder (MPD)
MPD is characterized by pain and tenderness in the neck, shoulder, arm muscles, and a restricted range of motion. Possible causes include overloaded neck/shoulder muscles.

2.5.2 Cervical Spondylosis
This disorder is characterized by intermittent/chronic neck and shoulder pain or stiffness, headaches, hand and arm pain, numbness, tingling, and clumsiness. Possible causes include age-related spinal disc degeneration leading to nerve compression and spinal cord damage, arthritis, and time spent with the neck in sustained awkward postures.

2.6 Back
The main risk factors associated fine-arts are the sustained awkward postures and poor seating. Most individuals with low back pain do not simply injure their back in one incident but rather gradually over time. Repeated stresses from over the years begin to add up and slowly cause degeneration of various parts of the spine, resulting in low back pain.

2.6.1 Disc Problems
In a seated posture the pressure in the lumbar discs increases by 50**%** as compared to standing. Additionally, sitting in an unsupported posture can cause twice the amount of stress as compared to standing. During bending (forward flexion) and twisting (rotation) motions of the spine, the pressure on the lumbar discs increases by 200% (Fisk, 1987).

This type of pressure on the disc can lead to a bulge or herniation, causing compression on a spinal nerve.

2.6.2 Sciatica

Sciatica is characterized by pain in the lower back or hip radiating to the buttocks and legs, causing leg weakness, numbness, or tingling. It is commonly caused by bulging, prolapsed or herniated discs compressing a spinal nerve root and is worsened with prolonged sitting or excessive bending and lifting.

3.0 The Seated Position

In the fine-arts department, it is not unusual to spend prolonged periods of time in a seated position. Artists can spend significant periods painting, practicing an instrument, or rehearsing scripts. This is concerning because while in a seated position, the pressure on the vertebral disks is equivalent to 150% body weight which is a stark contrast to the 100% of body weight applied to the back while standing (figure 1). Many musculoskeletal disorders (MSD) arise from prolonged seating[5]. These include low-back pain, neck and shoulder fatigue, lower-leg numbness, swelling and discomfort, and development of pressure sores. These types of MSD's account for approximately 50% of all workplace injury claims[6]. Seated tasks represent a significant health and productivity concern when performed for prolonged periods. As a result, it is imperative to consider task performance and comfort in a seat design.

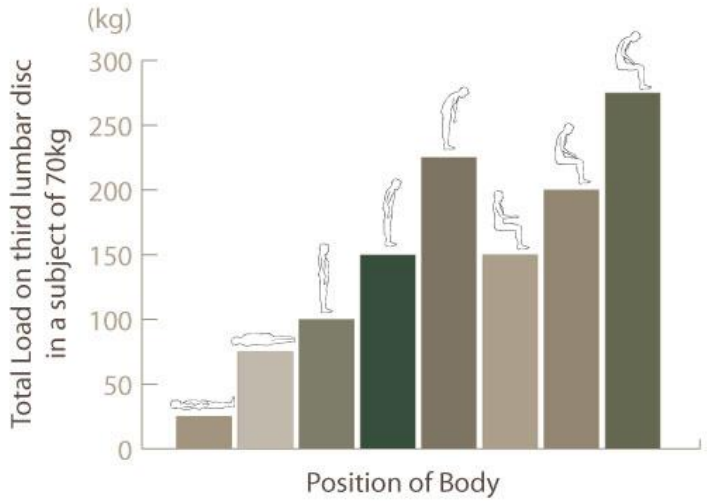

Figure 1: Load on lumbar disks for various positions.

3.1 Sitting and Low-Back Pain (LBP)

When an individual sits, the natural curvature of the back is distorted and adopts a C curve rather than an S curve (figure 2). This is especially the case when there is insufficient lumbar support in a chair.

[5] Hansen, D.J. (1994). The Work Environment. Boca Raton, FL: Lewis Publications.
[6] Ibid

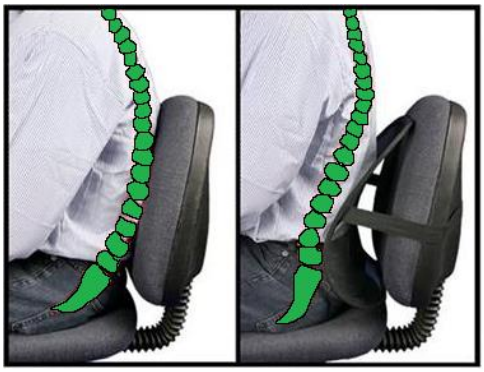

Figure 2: Lumbar spine with and without lumbar support.

In that case, the back is under excessive mechanical stress which increases the onset and severity of muscle fatigue and discomfort in the lower back. It also increases the risk of developing a musculoskeletal disorder.

3.2 Sitting and the Lower Extremities

Sitting for a prolonged period of time can reduce blood flow to the lower extremities. This is especially true when the seat pan is not at the correct height or when the seat pan is too deep. This increases the pressure at the back of the thighs and reduces blood supply to the lower limbs. This can produce swelling, edema, and can irritate the nerves[7].

3.3 Sitting and the Upper Extremities

The upper back, neck, shoulders and arms are comprised of a complex organization of tissues[8]. When a workspace design is ergonomically poor, it can cause the head to fall forward or the shoulder to flex. This results in significant muscle activity and tissue strain. If a poor seating design is combined with a task that promotes awkward postures (such as playing an instrument), then significant fatigue, discomfort, and stiffness may occur.

4.0 Adjusting your Chair

Since many artists perform while sitting down, the question of seating is an important one[9]. Painters and musicians are often practicing on stools or on non-adjustable stackable chairs. An artist that is 5 foot tall, will not be able to sit at the same height at an artist that is 6 feet tall. If a shorter individual cannot place the soles of the feel directly on the ground, there is significant pressure on the back and the thighs[10]. Conversely, if a tall individual is sitting on a chair that is too high, lordosis (an accentuated C-curvature) in the back persists[11]. An ideal chair should be fully-adjustable with an adjustable seat pan, height, lumbar support, and tilt. This is the typical chair used by

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[7] Ibid
[8] Ibid
[9] Watson, A.H.D (2009). *The Biology of Musical Performance and Performance-Related Injury*. The Scarecrow Press Inc: Plymouth, UK.
[10] ibid
[11] Ibid

office workers and it can easily be adopted to fit the fine-arts as they can be ordered without wheels or armrests. An office chair without armrests would provide adjustable parameters all while ensuring comfort without restricting instrument use.

4.1 Seat Height

When seated, the feet should lay flat on the floor and the knees should be in a 90º angle. A guideline to achieve this is to raise or lower the chair until the edge of the seat pan is just below the kneecap (figure 3).

Figure 3: how to adjust height of chair

4.2 Seat Pan

The importance of a proper seat pan depth is one of the most common misconceptions in the world of seat ergonomics. The seat pan refers to the area of the chair that the user sits on (figure 4). Pressure in the popliteal fold or the back of the knee caused by a seat pan that is too deep can have immediate and long-term consequences[12]. Since many major blood vessels and nerves flow to the lower leg by means of the knee area, such pressure can restrict blood flow. In the short term, swelling of the lower extremities, coldness, numbness, and discomfort can arise[13]. In the long term, chronic edema can result which can cause circulatory issues such as varicose veins. An adequate seat pan should allow enough space for a closed fist between the edge of the seat pan and the back of the legs.

[12]Hansen, D.J. (1994). The Work Environment. Boca Raton, FL: Lewis Publications.
[13] Ibid

Figure 4: Seat pan depth and fist test examples

Chairs can be purchased with seat pans ranging from 15 to 21 inches. In order to ensure an adequate seat pan depth, the length from buttock to behind the knee (known as buttock to popliteal length) of the user can be measured using a standard measuring tape (figure 5). The seat pan should be at least 3 cm shorter than the buttock to popliteal length measurement.

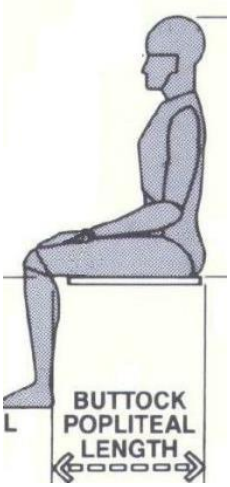

Figure 5: example of the buttock to popliteal length.

To further reduce the stress placed on the back while in a seated position, the seat pan should have a 4-8º backward slant[14]. This prevents users from sliding forward and encourages the use of the backrest.

4.3 Backrest

Since many musicians and artists have a tendency to use a stool rather than an ergonomic chair, the importance of a backrest will be identified in the following. Sitting erect without the use of a backrest can decrease spinal stress because it promoted

[14] Hansen, D.J. (1994). The Work Environment. Boca Raton, FL: Lewis Publications.

normal curvature of the spine[15]. However, maintaining an erect posture causes continuous contraction of the back muscles. This causes fatigue and discomfort so the user has a tendency to adopt a slumped posture. As seen in figure 2, the slumped posture causes the back to adopt a C curve. It reduces postural demands upon torso musculature, but does so at the expense of increased mechanical stress in the lower back. The purpose of the back rest is to maintain the normal curvature in the lumbar spine. It also supports the shoulders and bears the weight of the torso, which minimises the stress and activity in the surrounding musculature. The backrest should be slightly angled (110º), which will permit the user to maintain an upright posture. The height of the backrest should be at least 21cm to provide adequate support to the lumbar spine.

5.0 Musicians

For most musicians, a large proportion of playing time is devoted in their daily routine for individual practice, which is needed to maintain satisfactory levels of performance and to learn new material[16]. Many instrumentalists suffer from overuse syndrome due to repetitive and sustained motions MSD's are prevalent amongst musicians[17,18,19]. In fact, the demands of playing an instrument are comparable to certain athletic pursuits[20]. The difference is that musical instruments require the recruitment of smaller muscles whereas sports require the use of larger muscles[21]. The recognition of ergonomics, exercises, and physiotherapy is commonly referred to in sports, yet it is not as relevant for the fine-arts. Risk identification and prevention strategies are seldom taught to musicians in their studies[22]. Ergonomic strategies for musicians are lacking, which drove the current literature review.

5.1 Warm up & Stretching

The first step in preventing injuries for musicians is to warm up the muscles that will be used. It is most beneficial to warm up in the morning since muscles are tighter and stiffer after inactivity spent in sleep. In addition, prolonged period of practice should be separated into 35 to 45 minute intervals. After this time period, the musician should spend at least 5 minutes performing stretching exercises for the playing and postural muscles. Stretching is also important once practice is completed to prevent the carry-

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[15] Andersson, G.B.J., Ortengren, R. (1974) Myoelectric back muscle activity during sitting. *Scandinavian Journal or Rehabilitative Medicine*, 3: 73-90

[16] Watson, A.H.D (2009). *The Biology of Musical Performance and Performance-Related Injury*. The Scarecrow Press Inc: Plymouth, UK.

[17] Bragge, P., Bialocerkowski, A., & McMeeken, J. (2006). A systematic review of prevalence and risk factors associated with playing-related musculoskeletal disorders in pianists. *Occupational Medicine (London)*, 56, 28–38. http://dx.doi.org/10.1093/occmed/kqi177.

[18] Belmarsh, K., Jardin, G. (1996). An overview of upper extremity cumulative trauma disorders in pianists. *Work, 7(2)*: 121-127

[19] Stanhope, J. (2016). Physical performance and musculoskeletal disorders: Are musicians and sportspeople on a level playing field? *Performance Enhancement & Health*, 4: 18–26. http://dx.doi.org/10.1016/j.peh.2015.11.004

[20] Watson, A.H.D (2009). *The Biology of Musical Performance and Performance-Related Injury*. The Scarecrow Press Inc: Plymouth, UK.

[21] Ibid

[22] Stanhope, J. (2016). Physical performance and musculoskeletal disorders: Are musicians and sportspeople on a level playing field? *Performance Enhancement & Health*, 4: 18–26. http://dx.doi.org/10.1016/j.peh.2015.11.004

over of asymmetries into daily life. Musicians often adopt awkward postures and stretching can help ease into a neutral posture following practice.

5.2 Musical Instruments

For musicians, ergonomics is an area of concern. This was demonstrated by surveys sent out by the Canadian Associating for University Teachers. Results generally demonstrate that ergonomics is part of the curriculum, but that many components of ergonomics are overlooked.

The use of many instruments require what we refer to as awkward postures (figure 3). We especially see awkward postures of the fingers, wrists, neck, and back. Considering that musicians spend hours practicing in these positions, it is not surprising that many musicians suffer from the same types of musculoskeletal disorders (MSDs) that are seen in workers on assembly lines[23]. Sadly, these injuries have forced some very talented people to stop playing instruments.

The problem with awkward postures in musicians is that often the postures are a result of the instrument design. In this case, it is often a matter of technique and training that may help keep musicians playing

Instruments often require repetitive and awkward wrist postures including flexion, extension, ulnar deviation, radial deviation, and pinch grips (figure 6). These postures can increase the risk of MSD's such as carpal tunnel syndrome and strain injuries due to compression of the nerves going through the wrists.

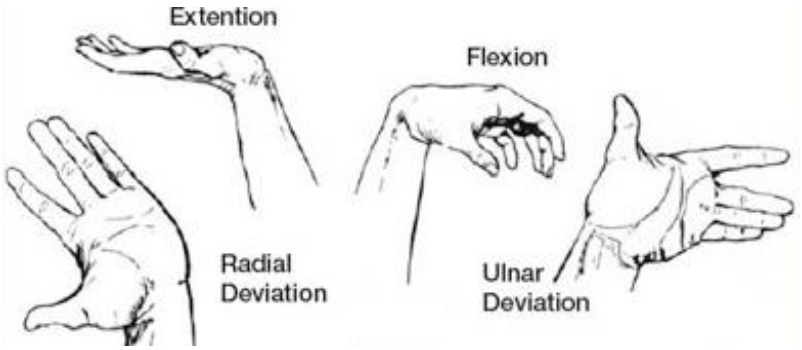

Figure 6: Awkward wrist postures.

Good techniques involve reducing these awkward postures by being conscious of the positions adopted[24]. When developing good technique, emphasis should be placed on eliminating any unnecessary muscle activity while playing (figure 7).

[23] Michael, R. (2001). Ergonomics Resources for Musicians. Retrieved on May 16th 2016 from https://ergoweb.com/ergonomics-resources-for-musicians/

[24] Watson, A.H.D (2009). *The Biology of Musical Performance and Performance-Related Injury*. The Scarecrow Press Inc: Plymouth, UK.

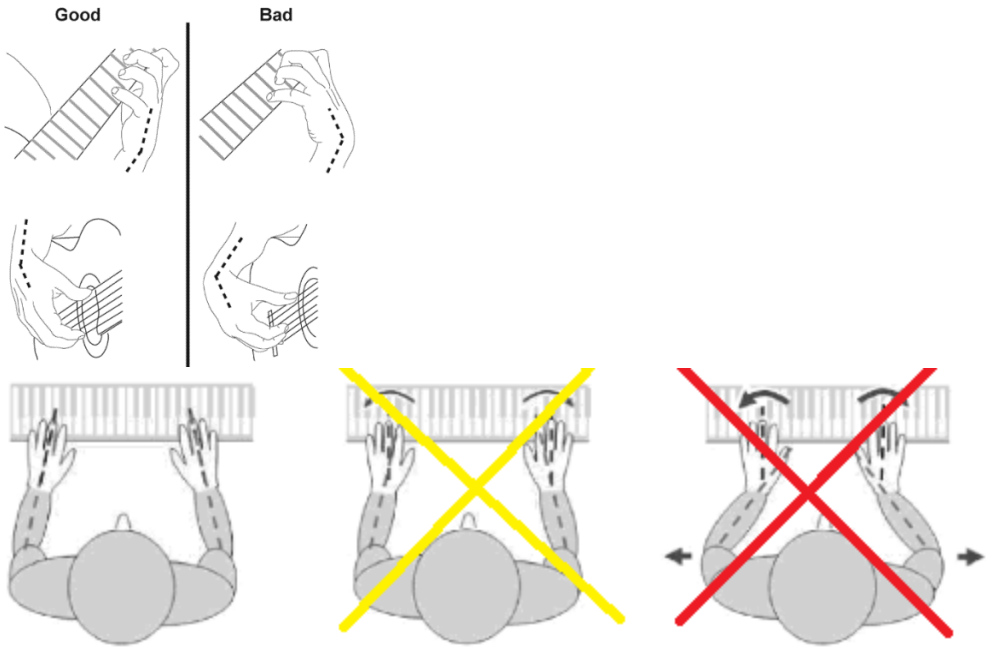

Figure 7: Examples of good and bad hand and wrist postures when using a guitar and a piano

When wrist flexion is present, compression of the tendons and median nerve results. Similarly, ulnar deviation can restrict the movements of finger tendons in the carpal tunnel[25]. It is crucial to achieve independent control of the fingers. Adopting a good posture should become instinctual, which can be accomplished through practice. Using less force in the fingers is also possible with years of practice. The force acting on the joints are affected by the posture of the hands. The force is at a maximum when the wrists are flat and the fingers are extended. Force is minimized when the fingers are curved.

5.3 Recommendations for Musicians

1) Many instruments can be played either standing or sitting. As we have seen, the pressure on the spine is lower during standing. Musicians should make an effort to play while in a standing position.

2) Change your position often. There is no single position that can be held comfortably for a prolonged period of time.

3) Be conscious of your posture. There is often a tendency to lean forward, which places additional strain on the back. While seated, the backrest should be used.

4) Ensure that the grip on your instruments are firm but still flexible. This will help reduce the tension and muscle fatigue.

[25] Ibid

5) Ensure that your weight is distributed evenly on both feet. You should rotate between an upright position, placing weight mainly on your right foot, and placing weight mainly on your left food. Change it up!

6) Ensure that micro-breaks are taken after 35-45 minutes of practice. During this time, stretching exercises should be performed.

7) Reduce awkward postures. It's important to be aware of your position during practice and to aim at adopting neutral postures while playing.

8) Reduce force in the fingers. Do not aggressively strike your keys.

6.0 Painting and Drawing

Painting requires extensive use of shoulder muscles. As a result, they commonly develop musculoskeletal disorders in the shoulders[26,27]. Scientific literature on shoulder loading in artists during painting is scarce. Even less information is available on the benefits of using different paint roller styles or the consequences of painting at different heights[28]. However, some ergonomic interventions can be suggested based on the typical posture adopted while painting.

6.1 Canvas and Easel Adjustability

A neutral posture consist of having the elbows in a 90º angle. As a result, it is important to ensure that the artwork is placed on a height-adjustable stand. An effort should be made to sure that this position is achieved. Painters have a tendency of adjusting the artwork based on the visual demands. This means that the artwork is positioned parallel to the eye, which requires elevation of the shoulder. Maintaining a static posture in the shoulders all while exhibiting an awkward posture is a significant risk factor for musculoskeletal disorders. Previous research has documented that prolonged static elevated arm tasks can cause muscular fatigue, including for repetitive arm movements[29].

6.2 Correcting Neck Posture

Painters can spend a lot of time hunched over, as required when working on a piece of art from a horizontal surface (desk, table). An improperly adjusted painting easel can also cause awkward postures of the neck as a result of looking up or down too frequently.

Unfortunately, poor postures of the neck can have some serious health consequences. Studies determined that when your head is tilted forward, additional strain is placed on

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[26] Stenlund, B., Lindbeck, L. and Karlsson, D. (2002) Significance of house painter's work techniques on shoulder muscle strain during overhead work. *Ergonomics*. 45, 455-468

[27] Rosati, P.M., Dickerson, C.R. (2009). The influence of wall painting on shoulder muscle activity and horizontal push force. Retrieved online on May 24th 2016 from http://www.oiweb.com/data/PaintRollerStudyJan09.pdf

[28] Ibid

[29] Ibid

the neck[30]. This can translate to chronic neck pain that can range from mild to debilitating, depending on the degree of forward head posture.

The use of a drafting table can reduce the amount of strain placed on the neck musculature. They permit 90º elbow angles and the angled surface reduces the amount of neck flexion required.

6.3 Recommendations for Painters

1) Sit on an office chair and ensure it is properly adjusted

2) Alternate from a seated to standing position

3) Ensure that the artwork is on a height adjustable stand.

4) Limit awkward postures of the wrist and shoulders by adjusting the position of the artwork.

5) Reduce fine wrist movements by moving the entire arm rather than just the wrist.

6) Make use of a drafting table, when applicable

7) Ensure that micro-breaks are taken after 35-45 minutes of painting/drawing. During this time, stretching exercises should be performed.

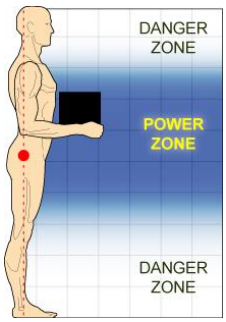
7.0 Theatre Setup

The role of a theatre setup worker is a varying one. Many duties and responsibilities are required to successfully deliver a spectacle. The most hazardous aspect of this type of work is lifting. They are often lifting sound or lighting equipment, assembling props, and ensuring proper assembly of the stage. While doing so, there is risk for back injury, which is most prevalent when lifting. As a result, understanding proper lifting techniques is a vital aspect of the job from an ergonomics standpoint. The following outlines important recommendations that will allow safe performance of these duties.

7.1 Lifting

Prior to a lifting task, it's important to warm up the body. This will help to prevent muscle strains and pulls. It is important that you stretch your back and leg muscles. DO NOT OVERSTRETCH. One should also pay special attention to the size, weight, physical characteristics, and the location of the object being lifted. All of these factors will affect the lifting technique.

[30] Yip, C.H., Chiu, T.T., Poon, A.T. (2008). The relationship between head posture and severity and disability of patients with neck pain. *Journal of Manual Therapy*, 13(2): 148-154.

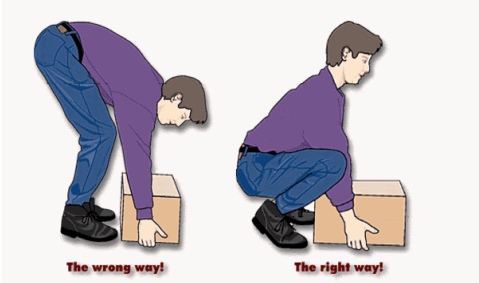


As a general rule, if an object is heavier than 40 pounds for females or 50 pounds for males, it should be considered a two-person lift.

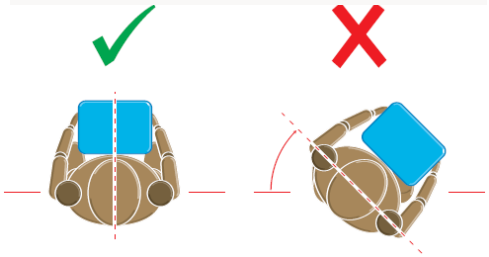
Keep the weight in the power zone. This is the optimal area to be lifting objects, particularly heavier loads. When lifting in the danger zone, the risk of injury is increased.

7.2 Principle of Lifting

The **B.A.C.K.** principle should be used when lifting. This technique will help you remember how to lift safely. Below there are descriptions on how to use this principle and how to lift safely.



Back Straight – The back should be kept in a naturally straight position when lifting. The intervertebral discs are designed to tolerate more load when the back is straight. Lifting from a flexed position unequally loads the spine, putting you at risk for injury.



Avoid Twisting – The back is more likely to be injured if twisted when lifting. Twisting causes the intervertebral discs to load unevenly. Twisting can also irritate the facet joints and cause swelling and pain. The facet joints are designed to prevent the vertebrae from rotating, so injury to the surrounding soft tissues can occur if a twisted posture is used when lifting.

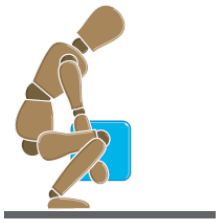
Close to the Body – It is important to keep the load as close to the body as possible when lifting. The back is like a “pivot joint”. In order to stop from falling forward, the muscles, ligaments, and other soft tissues have to generate a force equal to the force of the load and the body. The further a load is held away from the body, the greater the muscle force needed to “balance” the load.

Keep Smooth – It is important to lift under control. The lifting motion should be smooth and fluid. Not only does jerking increase the load on the spine but it also increases the risk of a slip, trip, or fall injury.

7.3 Lifting Tips

1. Make Sure You Have Firm Footing **-** Keep your feet apart (about shoulder width) for a stable base. Place one foot to the rear of the object and the other foot slightly ahead of the other and to the side of the object.

2. Bend Your Knees - Bend at the knees, not at the waist. This keeps you from slouching or rounding your back. This would place additional pressure on your back, putting your back at risk for injury. Let your powerful leg muscles do the work, not the weaker back muscles. Maintain your upper body in its vertical position. With the arms, slide the object toward the body to give it motion. At the same time, use the legs to lift the object and bring the back to a vertical position. Be sure to keep the load close to the body as you lift.

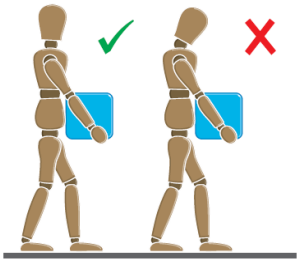

Start in a good posture

3. Test the Weight – Tip the load slightly to see if it's light enough to carry. If not, get help or use special equipment.

4. Get a Good Grip – Using your palms, not just your fingers, keeps the load from slipping and jarring your back.

5. Keep the Load Close to the Body – This puts less pressure on your back than holding it far away. Tighten your abdominal muscles to support your spine. This helps offset the force of the load on your spine. Keep your head upright. This helps to maintain a good standing/walking posture.

6. Align Your Spine – To reduce strain, align your spine. Keep your ears, shoulders, and hips in a straight line. **DO NOT TWIST**. It may not always be possible to keep the back in a vertical plane, but avoid arching the back. Bend from the hips, not the back. Bending the back over the load adds some of your body weight to the load.


Keep the head up when handling

7. Place Before Moving – Place the weight down first and then push it into place. Do not bend too far forward or to the side in order to place a weight.

7.4 Additional Considerations

1. Use a dolly or cart whenever possible to move boxes. Push the dolly rather than pulling it. Keep the back straight and the knees slightly bent. When going through a doorway, stop, turn around, and pull the dolly through. Do not over load the dolly and ensure that the objects are not falling over the edge.

2. When carrying objects up and down stairs, ensure the steps can be seen and if possible, keep one hand free to hold the hand rail. Use a two person lift and carry if necessary.

3. Stack materials safely and in a sturdy manner. Weak boxes or surfaces won't be able to hold as much weight. Dispose of packaging materials and keep aisles clear.

4. Use wider and shorter steps when walking on uneven surfaces.

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