The Essentials of Healthful Biomechanics for the Pianist

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This PowerPoint presentation and workshop were both informational and experiential as teachers learned why a foundational knowledge and understanding of biomechanics could be helpful in teaching students healthful piano technique, and how that knowledge might be applied in the teaching studio.

Introduction

It is important for me to share my own background briefly because you may ask why a pianist is speaking about a scientific field. Although I am not a licensed healthcare professional, I have studied biomechanics and anatomy autodidactically since experiencing a debilitating injury in 1963 at the age of sixteen while preparing Beethoven's Concerto No. 3. I also grew up in a family of athletes, and from an early age viewed playing the piano as a complex athletic, coordinative activity, as well as a means of making music. I realized early on that we were both artists and athletes. My interest and research led me to produce the video *Freeing the Caged Bird: Developing Well-Coordinated, Injury-Preventive Piano Technique* in 1996, and to become involved in the field of performing arts medicine.

But a growing reputation as a "specialist" in the field of injury-preventive keyboard technique, and my development of a Professional Certificate in Injury-Preventive Keyboard Technique at Salem College, led to further study of movement and exercise science, and the related field of neuroscience, while earning a doctorate from Columbia University during the past four years. Through rigorous graduate study and research in these fields, added on to decades of self-training and working with injured pianists and organists, I hoped to enhance my own knowledge and ability to help pianists prevent or recover from playing-related injury. The principles that I will outline today echo a set of core principles of biomechanics that were corroborated by experts from the fields of performing arts medicine, sports pedagogy, piano technique history, cognitive embodiment, and applied technology during a panel discussion—"Enlightened Keyboard

Technique: A Definitive Model for the Twenty-First Century"—at the 2008 MTNA Conference in Denver, CO.

What is (are!) Biomechanics and Why Should We Know Something about Them?

It is the study of how forces—external and internal—act on the body. It is a core element of the general field of kinesiology that is the study of the body in motion. In other words, biomechanics is physics applied to the body. It includes the fields of kinematics and kinetics. Generally speaking, it involves the application of, among others, Newton's Laws and the Laws of Motion. These laws include the laws of gravitation, inertia, momentum, action-reaction, and conservation of energy.

Who studies biomechanics? Among others, athletes, coaches, physical therapists, occupational therapists, scientists, researchers, sports medicine physicians, and performing arts medicine physicians, including osteopaths and orthopaedists. [Illustrations of the application of biomechanical analyses in sports, orthopaedics, ergonomics, etc. were shown.]

Why do piano students not *study biomechanics!?* Because most teachers and piano students believe the topic is too complicated and not really relevant to their piano studies and music making. [At this point, both historic and modern illustrations of complex biomechanical analyses of the human body were shown.]

But why should pianists study basic anatomy and biomechanics? To paraphrase the great twentieth-century music teacher Nadia Boulanger, we cannot be truly free musically if we do not master technique. Knowing core principles of efficient biomechanics 1) gives us a rational understanding of how we are structured to be active beings, 2) helps us understand what is functionally healthful and what is not at the piano, 3) empowers us to recognize risk factors for playing-related injuries, and 4) helps us avoid or prevent the recurrence of playing-related injury. Most of all, it helps us remove physical impediments and realize our potential as artists.

As the American physiologist Homer W. Smith wrote in *From Fish to Philosopher* (1953/1961),

> the most intricately and perfectly coordinated of all voluntary movements in the animal kingdom are those of the human hand and fingers, and perhaps in no other human activity do memory, complex integration, and muscular coordination surpass the achievements of the skilled pianist (p. 205).

Results of Research

- Advanced piano playing is one of the most demanding activities known to humankind—a complex interaction of the musculoskeletal, neuromuscular, and sensorimotor systems (Altenmueller & McPherson, 2008; Pascual-Leone, 2001).
- Advanced pianists are like dancers and "artistic" athletes, combining subtle, complex motor skills with high artistic demands (Manchester, 2011).
- Pianists who play advanced music repertory must practice at least 10,000 hours over ten years to achieve a high professional level (Sloboda, 2005).
- Risk of injury and presence of pain do not diminish musicians' motivation to practice and perform (Guptill, Park, & Sumsion, 2007).
- Rate of playing-related neuromusculoskeletal disorders and injuries in pianists remains high worldwide, limiting or halting study and playing careers (Ackland & Allsop, 2010; Aoki, Furuya, Kinoshita, & Nakahara, 2006; Bialocerkowski, Bragge, & McMeeken, 2006).

One reason it is so urgently important that we define and understand these core principles of efficient biomechanics is to help prevent the tragic waste of talent, time, energy, and careers that result from playing-related injury. One of my own adult students so poignantly described the effects of being injured:

> I felt as if I were being punished for pursuing my love and passion. I felt imprisoned in my own body, not being able to express myself. I was envious of others practicing and playing in concerts while I was unable to play. . . . Since music is the core of my soul, I felt that there was no purpose for me to live any longer.

As Reginald Gerig (2007), the noted author of *Famous Pianists and Their Technique*, believed that the great pianists throughout history strived to

discover basic technical truths (Gerig, 2007). And Gerig further states in an article on Franz Liszt,

> The well-coordinated pianist will possess an overall flexibility and ease, a balanced state of lightness, buoyancy, and weightlessness; a condition in which *every detail functions in the context of the whole living being and is thoroughly integrated*. . . . [Healthful piano technique] *operates in harmony with the laws of nature* [emphasis added]—with a special regard for those laws concerned with physiological movement and muscular coordination [biomechanics] (Gerig, 1997),

Another way of expressing the importance of pianists' understanding of good biomechanics comes from an exercise science principle: Any technique that is formed according to the laws of physics produces the best results with the least expenditure of energy. For the pianist, this translates to minimizing effort in order to maximize artistry, and reducing physiological obstacles to making compelling music.

According to Chopin's students, "Suppleness was his great object. He repeated, without ceasing, during the lessons: 'easily, easily' [facilement, facilement]. Stiffness exasperated him." (Eigeldinger, 1988, p. 29).

Core Principles of Biomechanics for the Pianist

At the risk of oversimplifying, we will reduce these core principles of biomechanics to two relevant goals in piano playing: First, optimal, dynamic skeletal alignment of the entire body—not only the arm, hands, and fingers—as we play. Second, efficient muscle use. Optimal alignment allows for efficient transmittal of force/energy from the body into the key, without wasted effort. Muscle efficiency means using the appropriate muscles at the right time and at the appropriate degree of contraction and release to get the musical result desired. In this way, we also develop a means of releasing muscle contraction in an ongoing manner to prevent accumulation of tension and stress on tendons, ligaments, joints, and nerves. The goal is both physical and musical: Physically, we need to use our energy in the most economical, efficient way to place the least stress on the neuromusculoskeletal system. Musically, we need to ensure that we are using our bodies to achieve a compelling musical result. Though many pianists have historically disagreed, efficient biomechanics and compelling music making are not mutually exclusive. They can and should be used synergistically, in collaboration, to help the pianist feel that with the least amount of physical effort, she is gaining a maximum artistic result.

"Breaking" the Laws of Biomechanics Increases Risk Factors for Playing-Related Injury

The following are examples of the results of not following core principles of healthful biomechanics for the pianist:

- Overuse or misuse of muscles.
- Alignment of various bones and joints that extend beyond the healthy range of motion.
- Any excessive force or pressure on joints, muscles, ligaments, tendons, and bones.
- Sustained accumulation of muscle tension or contraction.
- Failure to release muscle tension/contraction.
- Physical mismatch between the pianist's size and the piano keyboard's size.

More specific body use patterns that can lead to fatigue, pain, and injury are as follows:

- Unnecessary raising and tightening of trapezius (shoulder) muscles.
- Unnecessary and continuous contraction of triceps (upper back arm).
- Continuous holding out of upper arms while playing instead of letting them hang more freely.
- Jutting head forward, tightening jaw.
- Continuous tightening of wrist and hand while playing.
- Hyperextension of hand (excessively lowered wrist) while playing.
- Sustained use of muscle groups in opposition.
- Unnecessary lifting of fingers or holding fingers up while playing.
- Slumping torso resulting in compressed spine, loss of support, and inadequate breathing.
- Poor postural alignment and imbalance throughout the body.
- Continuous fixation of joints of fingers, wrists, elbows, and shoulders resulting in muscle fatigue and loss of mobility, power, and inflexibility.

Remember, stress on joints and accumulation of muscle tension are two of the most common causes of physical discomfort and eventual injury.

Experiential Exercises for Sensing Optimal Alignment and Efficient Muscle Use

Now let's apply some of the core principles of efficient biomechanics to the simple act of sitting at the piano. But first, we need to be aware of a condition that Moshe Feldenkrais and his student Thomas Hanna in the field of somatics brought to light: sensory-motor amnesia. Hanna defined it as the loss of the memory of how muscles feel and how to control them (Hanna, 2004). He felt that we respond to environmental stressors with muscular reflexes that can create ongoing muscle contraction. Sensory-motor amnesia is the condition of being unaware we are carrying so much muscle contraction. Cultivating our *kinesthetic awareness*—our ability to sense our alignment and the state of our muscles—is the key to gaining control and biomechanical efficiency.

[Participants were then guided through a series of instructions for experiencing natural breathing, efficient postural alignment while sitting, and selective control of muscles used in playing.]

Sitting at the Piano *before* Playing

- Notice the natural flow of your breathing.
- Balance on your sitting bones.
- Allow your spine to decompress and lengthen into its four natural curves.
- Allow your shoulders to be released.
- Allow your neck to be released of *unnecessary* contraction or tension.
- Allow your head to balance on top of your spine (like a helium balloon!).
- Allow your upper arms to hang pendulously from the shoulders (supported by the torso).
- Allow your forearms and hands to rest lightly on your thighs.
- Allow your legs to fall gently apart.
- Feel the floor supporting your feet.
- Notice the natural flow of your breathing.

Ways to Minimize Unnecessary Effort While Playing

- Maintain kinesthetic awareness.
- Release the medial deltoid regularly by letting the upper arm hang into gravity.
- Release extensor muscles (top of forearm) regularly by periodic slight lifting of the forearm to allow the hand and fingers to hang into gravity.
- Free the wrist joints regularly when moving side to side or up and down.
- Allow non-playing fingers just to rest on keys.
- Be aware of your breathing.

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