Part I:

The Musician's Hand: An Organ of Exquisite Finesse!

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Introduction:

We all take our hands for granted until the day when we have pain or sustain an injury that prevents us from accomplishing a task that we have done effortlessly a thousand times before. Time and again over three decades as a hand surgeon I heard patients earnestly say to me: "*You know, Doctor, I'm not like everybody else. I **REALLY** need my hands!*" I would usually reply: "*Yes, I know exactly what you mean*" rather than: "*Yes, you really **ARE** like everybody else!*"

If we sit down and think about what we do with our hands we begin to realize that the answer is: *"Just about everything"*. The shorter list would be the things we **don't** do with our hands! Not only do they serve as universal tools that allow us to manipulate every aspect of our environment ("*manipulate*" is from the Latin "*manus*" meaning "*hand")* but they also allow us to touch and feel the many shapes and textures that are so much a part of our daily lives. We have no difficulty reaching into a purse or a pocket and discerning its contents. We can pick up a contact lens and place it gently into the eye yet also swing a sledgehammer with impressive power. We can feel the roughness of sandpaper as well as the smooth soft texture of a baby's skin! We can **even** learn to play a musical instrument!

That said, as a professional or high-level musician **you** have taken these nuances a step further, to a level that goes **far** beyond the skills of the other 99.98% of the population. You have spent thousands of hours developing and maintaining the very unique and demanding skills required to play your instrument with **extreme proficiency, artistry and endurance**. The musician's hand is indeed an organ of exquisite finesse and if anyone needs to take a good long look at their hands and give them some serious thought, it's you!

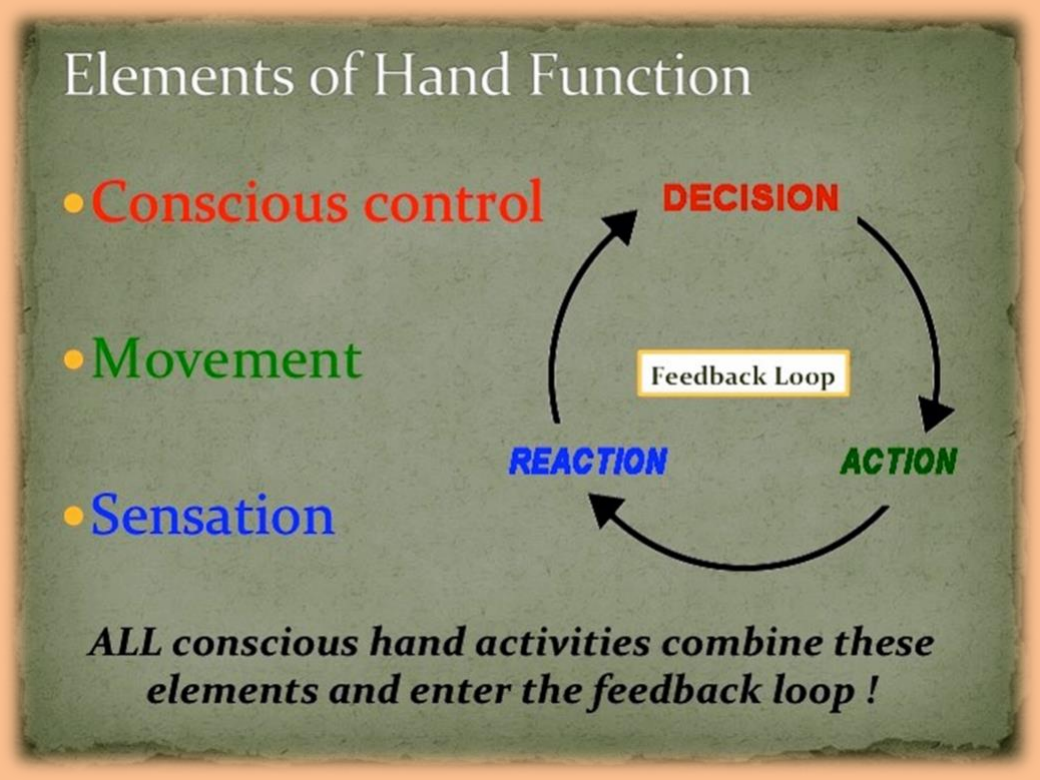
You are part of a very small and thus minimally influential minority and the demands that you place on your hands and wrists are **massively underappreciated**, not only by the general public but also more importantly by the medical practitioners who will evaluate you and treat you in the years to come. **As a professional musician you have very special needs that if ignored, may either bring about or hasten the end of your career!** It is highly unlikely that these needs will be emphasized and taught in the normal curricula of health care trainees in the foreseeable future and most healthcare professionals will either never see or only see a handful of professional musicians in their entire career!

Thus, if you do not personally expend the time and energy necessary to learn about your own physiology and the nature of those special needs, you will not be able to discuss them intelligently and effectively with future providers. This document is not about teaching you to diagnose and treat hand pathologies, for that requires years of study and practice. It's about helping you understand the underlying processes so that you may become an active participant in your future care (If you're thinking: **"Why is this important if I don't currently have pain?"**, you may wish to watch the video on this website or take a look at the introduction to Part III). You are the one who is most highly invested in your career and must therefore take responsibility for its evolution.

In Part I, our goal is to look at some important general concepts that govern the functions of the hand, wrist and forearm and to discuss the **NATURE OF PAIN in order to establish a basis for later discussions in Part II and Part III on how to avoid or manage problems that may interfere with your career in the years to come**. Some of it may seem complicated (it is!) but it isn't necessary to memorize any terms, only to try to understand these basic concepts and their relevance to your own body when you play your instrument. Memorization won't help. Only comprehension will do. If you have never been particularly interested in how things work, you may find this entire website tedious and difficult to read, but it contains physiological principles that are essential to you if you wish to understand the musician's hand, **an organ of exquisite finesse!**

Elements of Hand Function:

Conscious control, movement and sensation



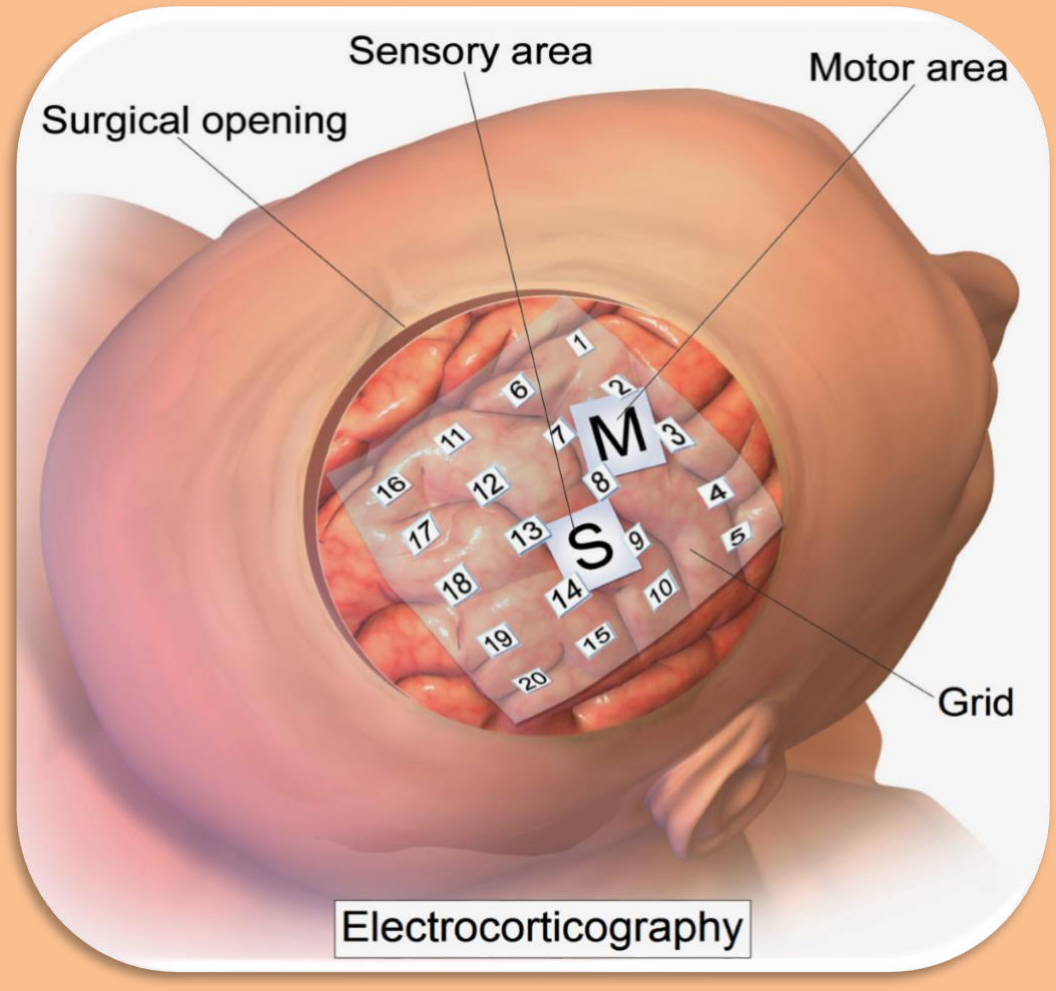
A. Brain and Hands

1. Conscious Control: The intellectual "niche" is our place in the animal kingdom
   a) For millennia early humans were mediocre predators surpassed in individual physical traits by many other animals
   b) Upright posture freed their upper limbs for other uses even when running
   c) Opposable thumbs gave them the potential for very fine manipulation of objects with their hands
   d) Social behavior, especially language, first spoken then written, helped them to pass on knowledge (including music!) to future generations
   e) The basis for all this was their **superior brains** that allowed them to solve problems, become toolmakers and progressively overcome essentially **all** of their physical shortcomings (some of their sophisticated tools were musical instruments for their own diversion!)
   f) Thus, even as mediocre natural predators, we became the masters of the planet with near absolute power over nearly all the other species (we still have some problems with viruses & bacteria!)

2. Brain development

a) An infant's brain is about 25% of its adult size and weight at birth but its whole body is only about 5% of its adult weight – its brain will grow to 75% of its adult size by age 2 and 90% by age 6
b) The brain is a work in progress with basic anatomic modules present even before birth but most of its connections must still be formed (maturation) for normal function, as it learns how to understand and control the body that surrounds it. While brains work in similar ways, **every brain is slightly different**, both genetically and in the development of its own unique connections, accounting for the countless variations seen in how people react to the world they live in
c) The brain grows rapidly until the end of adolescence and continues very slowly until it peaks about age 40 then begins to get smaller ("*atrophy*")
d) Brain maturity is reached around age 25 but varies among individuals
e) The mature human brain, more specifically the cerebral cortex or "*new brain*" (the outer covering of the brain, like the "*bark of a tree*", found only in mammals and a few reptiles) contains over 100 billion neurons that can each make over 1,000 connections with other neurons for an average total of approximately 100 trillion connections (100,000,000,000,000!)
f) The brain can monitor sensations in every organ in the body **except itself**, having no internal sensory nerve endings. Hence, it cannot sense touch, pressure, temperature, local chemical changes etc. and does not feel pain within itself when it is cut, burned, pricked or stimulated during surgery

3. <u>The cerebral cortex</u>: **What are our brain's priorities?**
   a) How did we find out?
      1) Surgical treatment of uncontrollable epilepsy in the 1940's and 50's required detailed mapping of the outer ("*cortical*") surface of the human brain
      2) It could be painlessly stimulated with electrodes in conscious patients awakened during surgery after numbing the scalp with local anesthetic
      3) If motion occurred with stimulation, the body part that moved was noted and the brain location was classified as a "*motor*" area. If sensation was felt by the patient it was localized to a specific region and classified as "*sensory*"
      4) The surface area of the cortex devoted to each specific body region was then mapped showing how much of the brain controlled each particular area



      5) This process (called "*electrocorticography*") was repeated in many different patients and even though minor variations were present, the map was found to be generally consistent and reproducible

b) The results: The "***Homunculus***" – meaning "*little human*"- is a model of a person that depicts the size of **each body part as proportional** to the surface area of the cortex that is devoted to it – the larger the part the more attention it receives from the brain. More recent studies have shown complex and extensive interconnections between these brain areas making this diagram simplistic for most things but still indicative of the brain's priorities

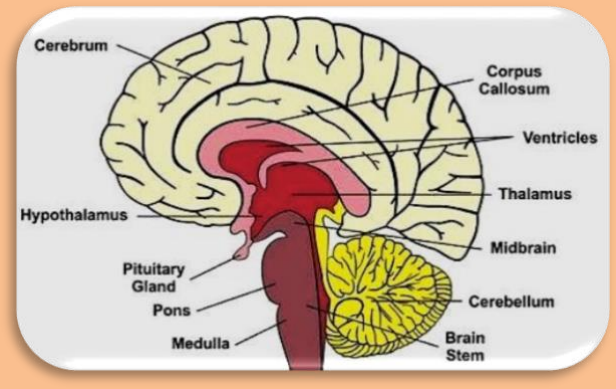
1) Conscious control of the hands and mouth and the face for expressions, especially the eyes and forehead, overshadows **every** other cortical occupation
2) Today we know that as elite musicians **you,** on average, develop the highest level of hand and/or mouth control (finesse) of any humans on the planet!
3) As such, you are the favorite subjects of neurophysiologists! "*Plasticity*" (or adaptability) in neuronal connections even allows you to expropriate adjacent cortical areas making your hand(s) and/or mouth even bigger on **your** homunculus depending on which instrument you play!
4) So, the brain's priorities can be summarized by: ***"hands and mouth"!*** Surprise, surprise - The very things musicians use most! **It's also no coincidence** that they are favored in nearly all other human activities!

It's no surprise that musicians exploit the finesse of their hands and mouths!

The most effective way of getting massive amounts of information into the cortex!

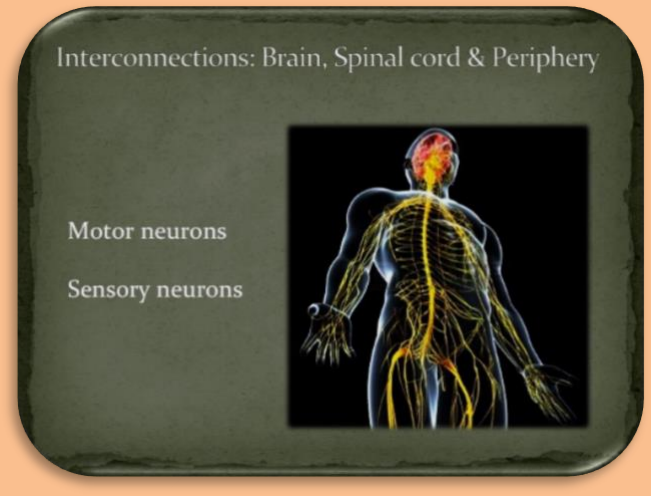
Humans use their hands and mouths to communicate some of their deepest feelings!

4. <u>Unconscious control</u> – **some** hand functions are controlled elsewhere in the brain and spinal cord (the "*old brain*")
    a) Diameter of the blood vessels ("*Vasoconstriction/vasodilatation*")
        a. Skin warmth
        b. Skin coloration
    b) Sweating
    c) Skin oils ("*sebaceous secretions*")
    d) Trembling

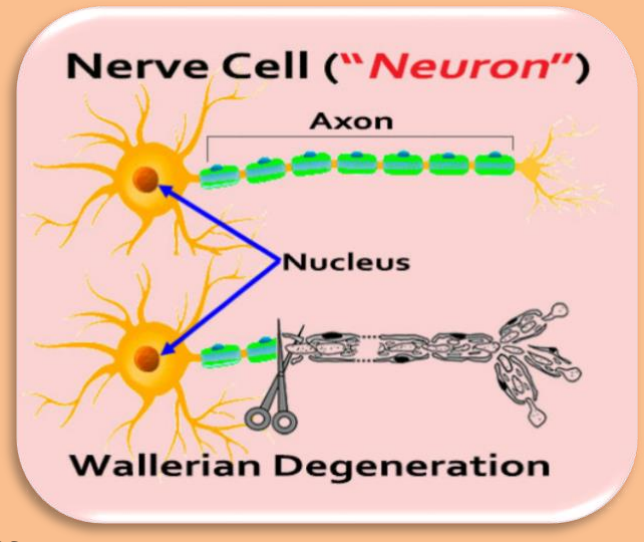


5. <u>Interconnections</u>: getting signals to and from the body – the spinal cord and peripheral nerves
    a) The brain must communicate with the body (the "*periphery*") through nerve fibers ("*neurons*") traveling and sending signals in **both** directions
    b) "*Motor neurons*" mainly travel away from the brain sending signals to the spinal cord and the muscles
    c) "*Sensory neurons*" mainly travel towards the spinal cord and brain sending feedback signals for analysis and comparison to the "*ideal*" outcome

6. The **Nerve Cell** or **Nerve fiber** ("*Neuron*")
    a. The **nucleus** is the director of all the cell's activities and it is located either in the brain itself or in the spinal cord. A cell, or portion of a cell, cannot survive without its nucleus
    b. The "*axon*" is the part of the nerve cell that acts like a wire going to and from the body (the "*periphery*"). It may be several **feet** long in those nerves that go all the way to the fingers and toes!



    c. An injury to the axon separates part of the cell from its nucleus causing the segment beyond the injury site ("*distal*" to it) to die and slowly degenerate (called "*Wallerian degeneration*"). The part closest to the nucleus ("*proximal*" to the injury site) survives and functions normally (see the illustration below)
    d. In a sudden injury that cuts the axons or a severe impact that disrupts them by pulling them apart, the distal segment dies immediately and degeneration begins

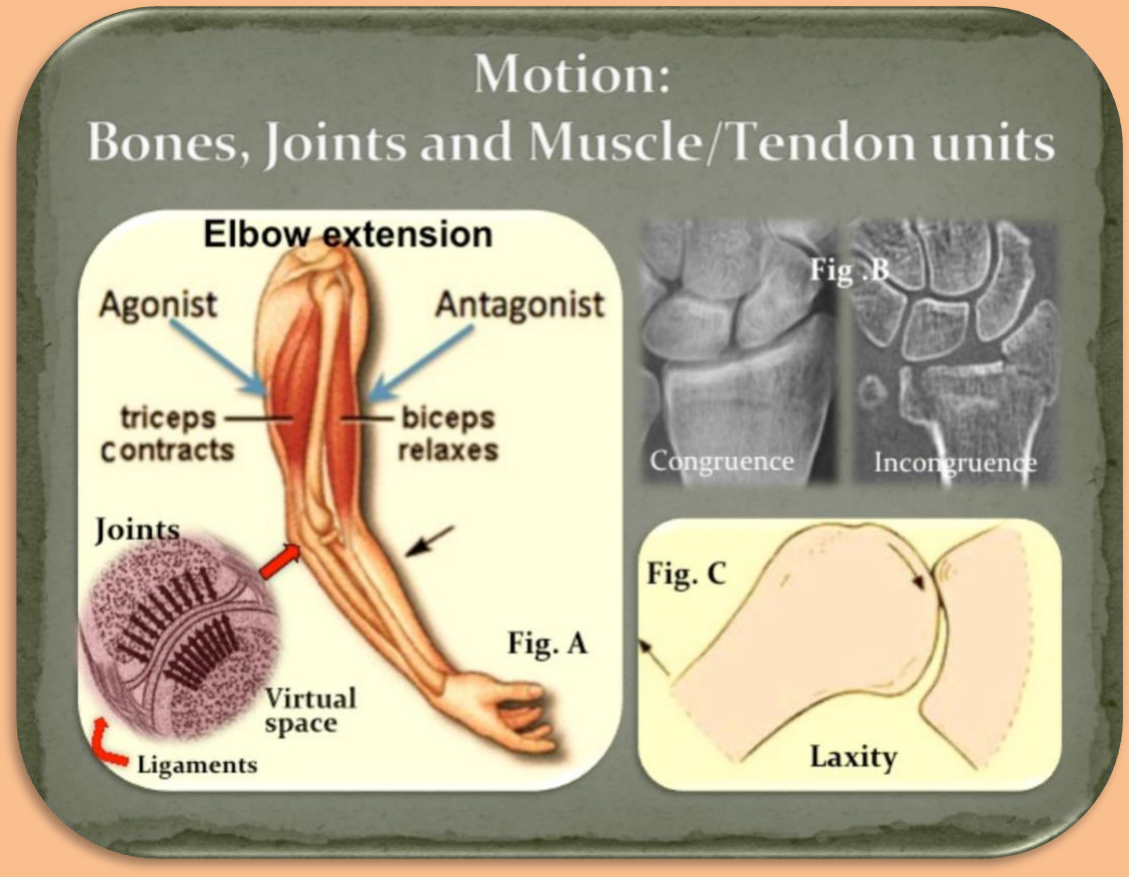


    e. A **nerve** is a large collection of many, many nerve cells travelling together in a single sheath. When a nerve is progressively squeezed ("*compressive neuropathy*") as in "***Carpal Tunnel Syndrome***", "***Digital Nerve Compression***" and several other important conditions that will be discussed in Part III, the distal segment degenerates **slowly** as the individual axons lose their blood supply (become "*ischemic*") and die. The movements and sensations controlled by that nerve are gradually lost
    f. Under certain conditions, damaged nerves can recover ("*regenerate*"), though this both takes longer and is less effective when Wallerian degeneration is advanced
    g. This is a fascinating and complex process and though its details are beyond the scope of our discussion, it is the reason why it takes **so long** for an injured nerve to regenerate and why in some cases more severely damaged nerves **cannot** recover

B. Movement-motor function

1. Bones form a solid base for muscle and other tissue attachments and provide a lever arm for motion. They give your body its form, shape and rigidity. It takes a great deal of force to break ("*fracture*") a bone in young healthy individuals

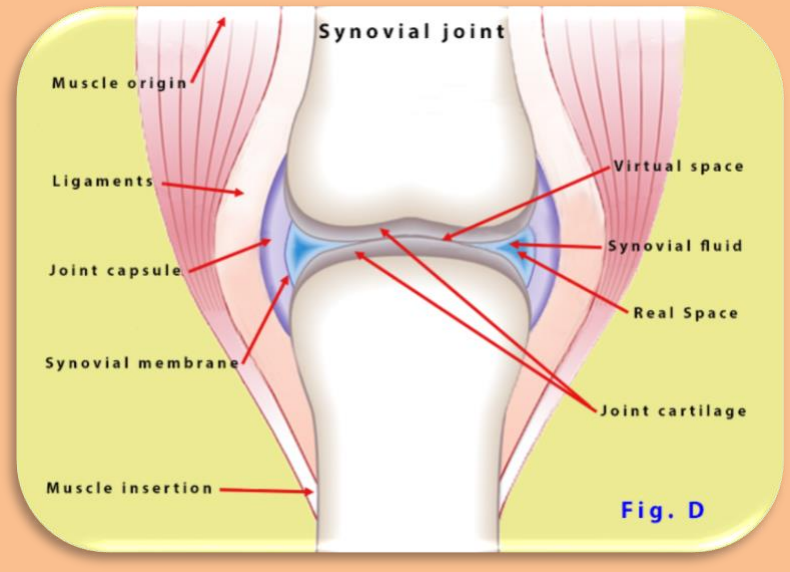
2. Joints between bones have smooth gliding surfaces made of cartilage and are held together by strong ligaments that allow for motion in **specific directions and amounts defined by the individual joint anatomy** (motion of your elbow for example allows you only to bend and straighten but your wrist and shoulder allow you to move in every direction but **only** by a specific amount)
   a) The two cartilage surfaces of a joint match **perfectly** creating a "*congruent*" (smooth) surface (see Fig. A and Fig. D below). This is crucial to prevent wear damage from occurring over time as we will see



   b) They interface so perfectly in fact that they are separated only by a "*virtual*" space. "*Virtual*" just means that there **usually is NO space** between the central portion of the two cartilage surfaces but there **can be** in certain circumstances. When you "*pop*" your knuckles you force open the joint creating a "*real*" space. The loud sound you hear is due to the sudden mechanical shift and is the same as the sound you hear when you pull a suction cup away from a piece of glass. The

surfaces gradually come back into intimate contact reforming the virtual space after a few minutes. No, contrary to what your mother said, popping your knuckles occasionally causes no long-term problems with your hands! In fact, popping joints is what you **pay** the chiropractor to do for you! In normal joints, that little extra stretch of the joint ligaments and the surrounding muscles can feel good! The only time it **may be dangerous** is in **abnormal** joints near nerves and blood vessels

c) Joints are surrounded by a thick membrane called the joint capsule which is lined on the inside by a thin membrane called "*synovium*". It creates a lubricating liquid in the joint (like oil) called "*synovial fluid*"



d) During fetal development, joint motion helps create that precise interface so when a pregnant mother-to-be feels movement inside her uterus, the baby is fine-tuning the formation of the cartilage surfaces of the joints so they will be perfectly congruent at birth

e) It is this "***congruence***" that allows our joints to move smoothly and with minimal resistance by distributing the forces **equally over a large surface area** (Fig. A and Fig. D). This extreme precision allows our joints to last a lifetime

f) Any direct damage to the joint surface (like a fracture - Fig. B above) disrupts this smooth surface and leads to areas of **localized** pressure that cause the cartilage to "*wear out*" and become arthritic over time.

3. <u>Ligaments</u> hold the joints together providing stability and preventing **abnormal** motion. If a ligament is damaged or congenitally "*loose*" the two surfaces are no longer perfectly aligned (see "Laxity" – Fig. C above and the demonstration below) and the congruence is lost, again causing areas of localized pressure and subsequent abrasive damage (wear-damage is called "post-traumatic arthritis")

4. <u>Demonstration:</u> (Joint congruence)

a) Take three spoons from your silverware drawer and align the handles so they fit perfectly inside each other (Fig. 1 & 2)

b) Rotate each spoon slightly relative to its neighbors keeping the handles aligned in exactly the same plane (Fig. 3)

c) Notice how the spoons glide and maintain contact over a large surface area (congruence) – this is similar to joints moving within their **anatomically defined** planes of motion

d) Imagine that a very strong but slightly elastic structure allows this rotating motion but will not allow the handles to change alignment (analogous to ligaments)

e) If you now "tear" or "*stretch*" the "ligaments" and misalign the handle of the top spoon a few degrees (Fig. 4 & 5) you will note that the surfaces are no longer "*congruent*". The top spoon is now elevated above the 2nd spoon and the two surfaces only touch at the edges (**localized** pressure)

f) Compare this to the relationship of the 2nd and 3rd spoons (Fig. 5) that still fit perfectly

g) If we move the spoons with the same motion shown in Fig. 3, the contact surfaces are now much smaller between spoon 1 & 2 and they will rapidly become "scratched" then worn ("*arthritic*")

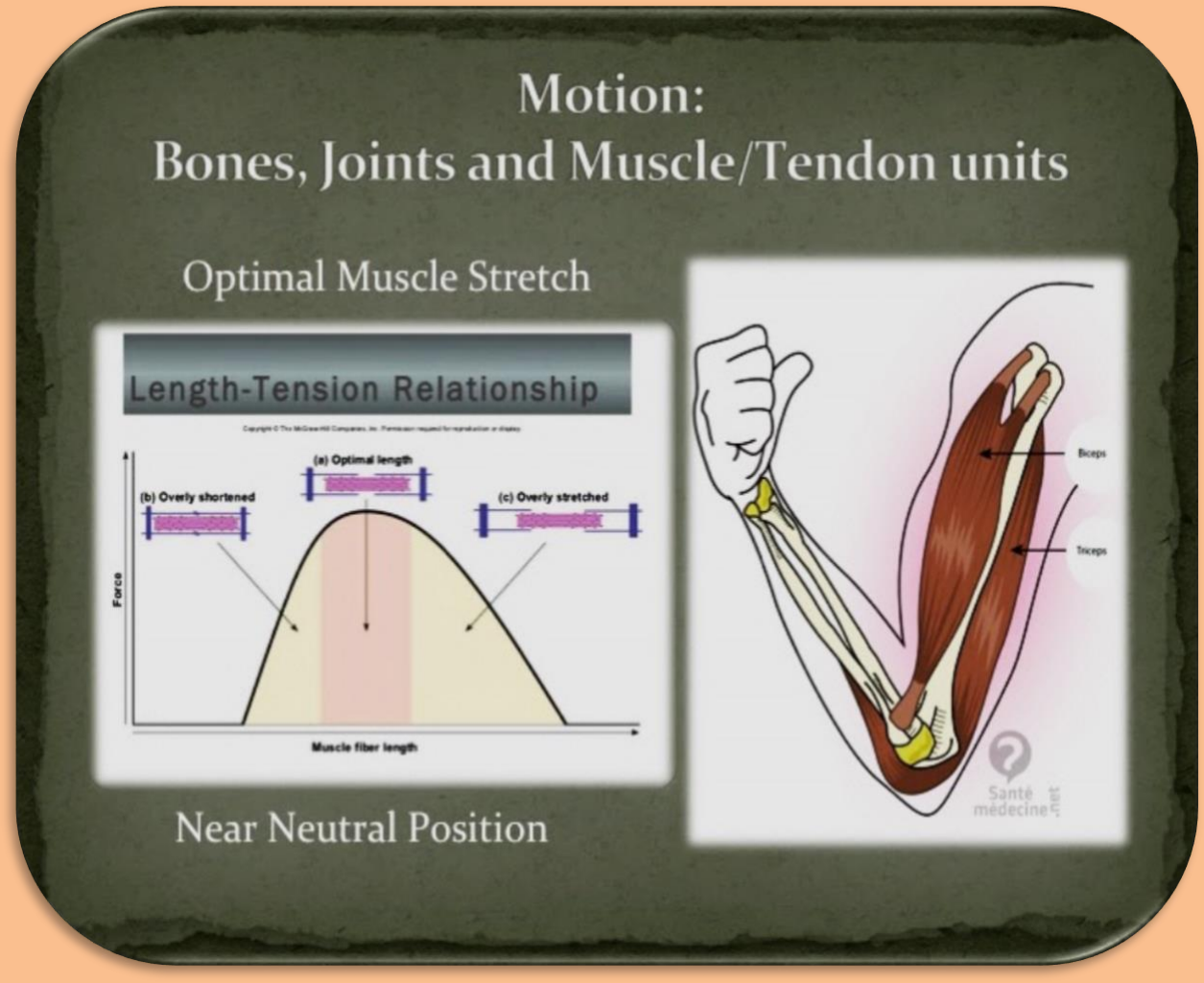
h) This illustrates the basic concept of degenerative arthritis caused by ligament damage or laxity

i) Thus, **ANY** process that damages the congruence of a joint will also cause it to wear out with usage. These "*pathological*" conditions fall into the general category of "arthritis" and they will be discussed in Part III

5. Muscles span joints and when they contract (shorten) they generate motion. Each muscle must originate on one bone and insert on another with a joint in between in order to effectively cause different "*kinds*" of motion in both direction and amount: (these terms below are for reference, and **need not be memorized**!)
    1) Flexion – decreases the angle between the 2 bones
    2) Extension – increases the angle between the 2 bones
    3) Abduction – moves away from the midline of the body
    4) Adduction – moves toward the midline of the body
    5) Rotation – moves around an axis i.e., in the forearm: pronation = rotation with the palm down, supination = rotation with the palm up
    6) Distal – farthest away from the center of the body
    7) Proximal – closest to the center of the body

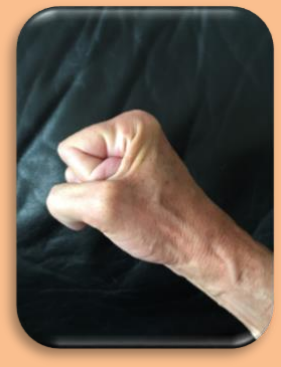
6. **Optimal muscle stretch (THE MUSICIAN'S MOST IMPORTANT CONCEPT!)**
    a) Muscles that cause opposing motions are called **antagonists** – at extremes, one of the pair is contracted and shortened while the other is relaxed and lengthened
    b) They never completely relax however when the limb is suspended in the air because they must **constantly work** to counteract the force of gravity
    c) Smooth **precise** motion requires antagonists to contract simultaneously **against each other** and to coordinate their contractions in a "*give and take*" fashion
        1) This takes more energy (see the demonstration below)
        2) It also uses "*eccentric*" contractions, this means:
            a) Muscle fibers are **forced to lengthen** as they actively contract
            b) Muscles are more easily strained under these conditions
            c) **These motions are routine for musicians**
        3) **Demonstration**: (Precision requires more energy!)
            a) Gently touch the skin at the tip ("*pulp surface*") of your thumb to the same surface of your little finger and separate them again. Repeat this several times paying close attention to the force required in the muscles of the forearm and hand
            b) Now, touch the tip of the fingernail of the thumb to the top surface of the fingernail of your little finger without touching any skin surface together at any point (if you touch skin to skin anywhere, you played the wrong note!) Compare the tension on your muscles and the energy required to accomplish these two gestures. Precision requires more energy to apply the same force. You can mitigate this effect with "*efficiency*" (discussed in Part II)

d) A muscle is strongest, is less prone to injury, uses energy most efficiently **and** has greater **endurance without pain and fatigue** when its fibers are stretched at rest to a **medium** length (**optimal muscle stretch**)



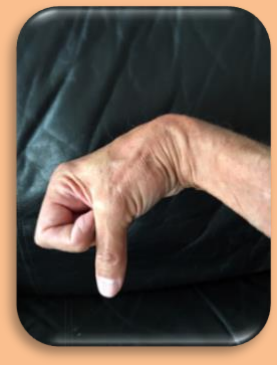
<u>Demonstration</u>: optimal muscle stretch

a) Hold your wrist straight in a comfortable position and make a **very tight** fist as if you were crushing something in your hand or trying to squeeze out every drop of water from a wet sponge (if you have long fingernails, put something soft in your hand so they don't dig into your skin). Hold this fist as forcefully as you can and keep track of how long it takes for you to feel either fatigue or any pain **in the forearm** (if you're still feeling great after 30 seconds, you can stop)



b) Now rest for a minute then bend the same wrist as far as it will go towards your body. Holding it in that

position (use your other hand to help if you need to), and make the same **very forceful fist** as if you were squeezing something and time how long it takes to feel pain or fatigue as you did above. Are you able to generate as much power? Were you able to hold it as long? Probably not. Why not? Did it become painful? Do you **Recognize this pain?**



e) This optimal length is usually attained for both antagonists near the **middle range** of possible joint motion or the "*neutral position*". This range is quite narrow. It can vary somewhat from one individual to another so because your colleague is fine doesn't mean you will be!

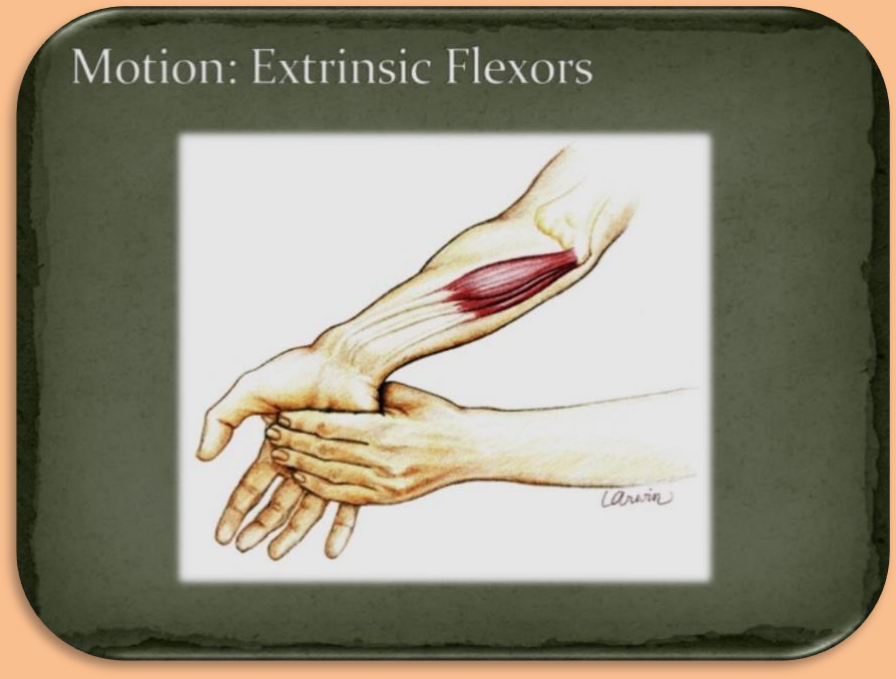
f) Extreme positions (laxity or overstretch) will make the muscle weaker, more prone to strain, rapidly fatigued, and **painful**. **This is normal "*physiological pain*"** (We will discuss this in some detail in Part II) and it can occur in the muscles that control **any joint** in your body (approximately 450 of them!). It becomes most important in **sustained** or **repetitive** activities (musicians!).

g) For a musician, this translates directly into technique and posture. **Failure to achieve near optimal muscle stretch will reliably cause chronic pain** and could end your career prematurely (this is the primary focus of Part II).

h) Modifying muscle stretch until the optimal is reached in **so many** joints is the most subtle and elusive thing that a musician can achieve, yet it is the **single most effective way to prevent, reduce or treat physiological pain!**

7. **"*Extrinsic*"** muscles and tendons:

a) Those whose muscle bellies originate in the forearm, **outside** the hand (thus

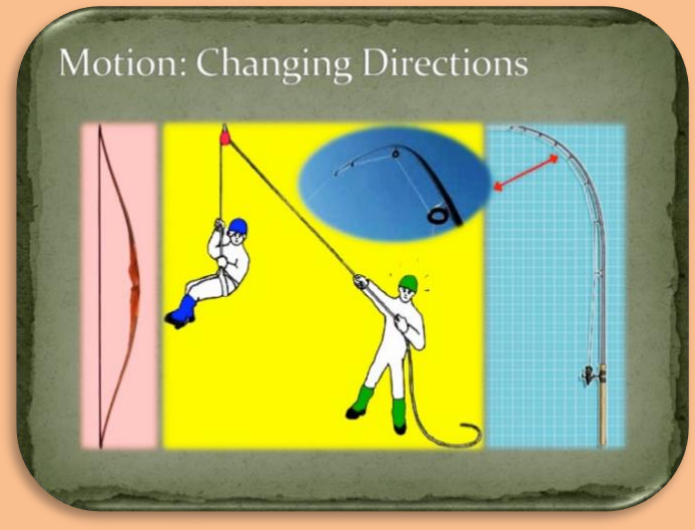


"***ex**trinsic*"), but are connected with fibrous tendons (like ropes) that insert somewhere on the hand or wrist. Thus, they control the hand **from a distance**

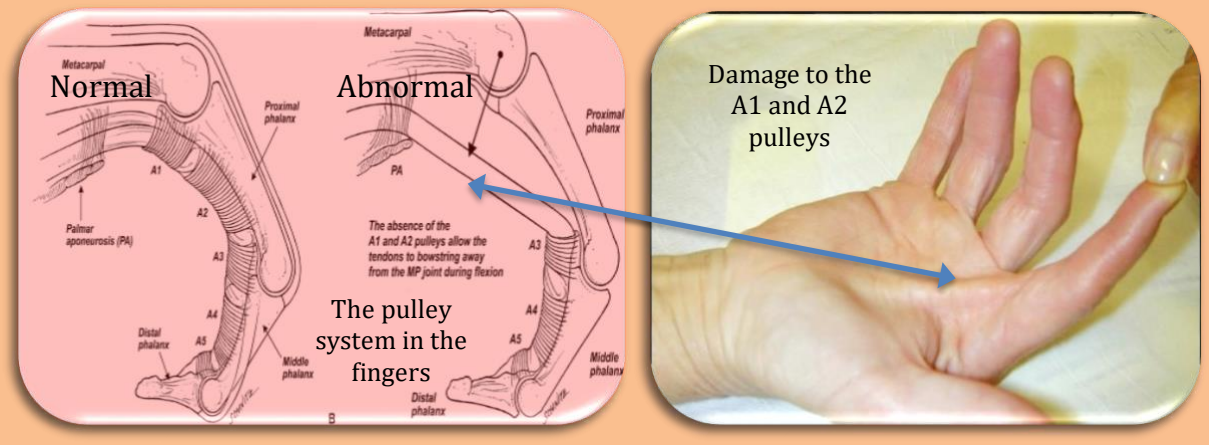
b) The size (volume) of a muscle determines its strength – if we had these large bulky muscles in our hands instead of our forearms, there would be no room left to hold or manipulate objects – **extrinsic** muscle-tendon units allow us to generate tremendous **power without obstructing** our grasp

c) These units are responsible for most movements of flexion and extension of the wrists and fingers

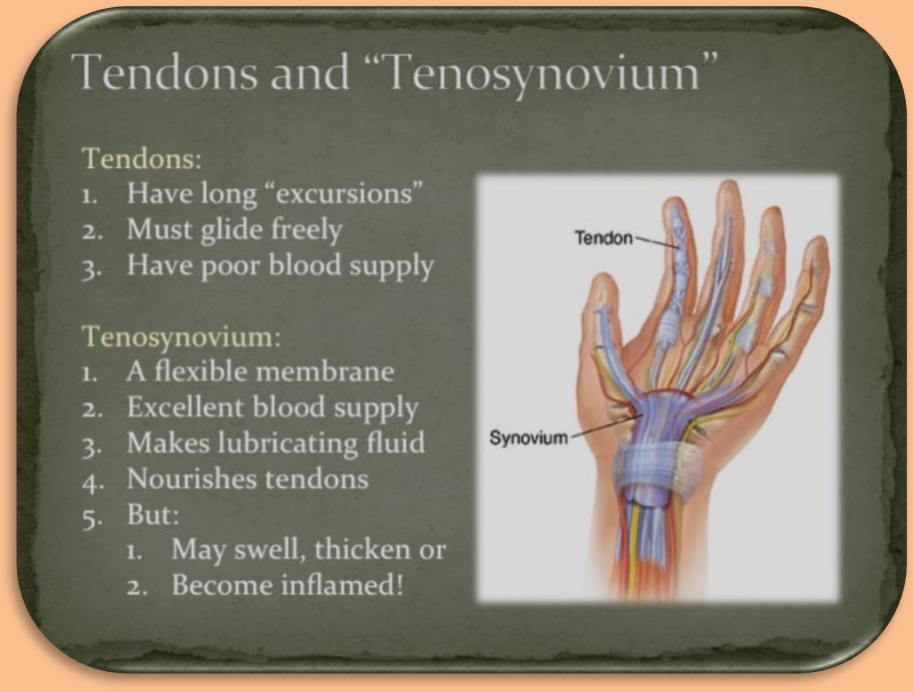
d) Muscles pull (shorten) from fixed locations but their tendons then must **change directions** as the joints move through **different positions**



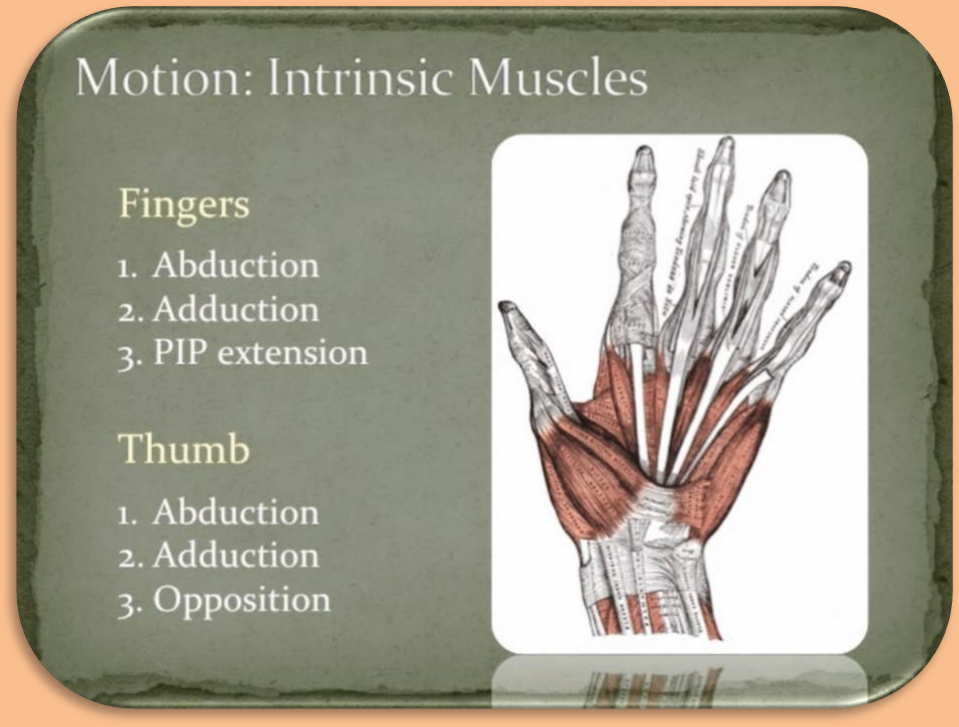
e) A tendon behaves like a rope under stretch and will **always** pull in a straight line "*bowstringing*" away from the flexion side of a joint **unless** there are one or more **pulleys** to hold it in place – compare the archery bow to the fishing rod above where the eyelets ("*pulleys*") hold the line against the pole – bowstringing is now in short segments allowing for a smooth change in directions keeping the tendon close to the bone, again making more space in the hand to hold objects

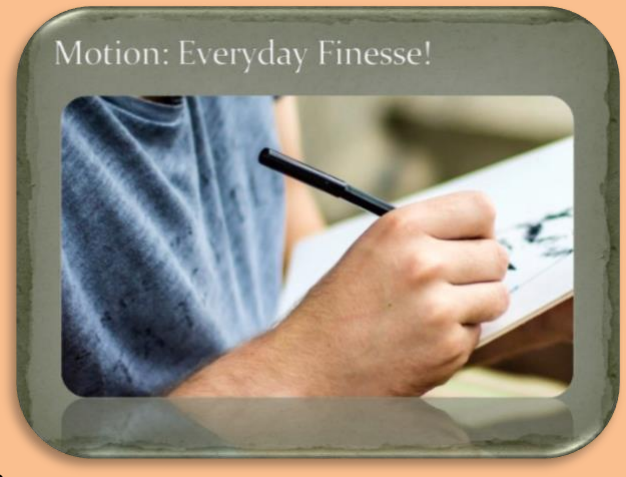


f) Tendons must glide freely through these pulleys
g) Since they have very large "*excursions*" (must glide over long distances) they cannot have blood vessels penetrating directly into them except where they actually attach to bone otherwise, the vessels would be kinked and stretched by the movement. As living tissues however, they must have nourishment
h) A membrane called the **"*tenosynovium*"** (analogous to the synovium in joints) surrounds them and moves short distances with them
i) The tenosynovium has many blood vessels and provides nourishment to the tendons by direct exchange due to its proximity
j) It also creates a lubricant for the tendons, "*synovial fluid*" (just like in the joints!)
k) Understanding **these concepts is necessary if we want to understand why we experience "*tendinitis*"**. This is discussed in Part III
l) In summary:

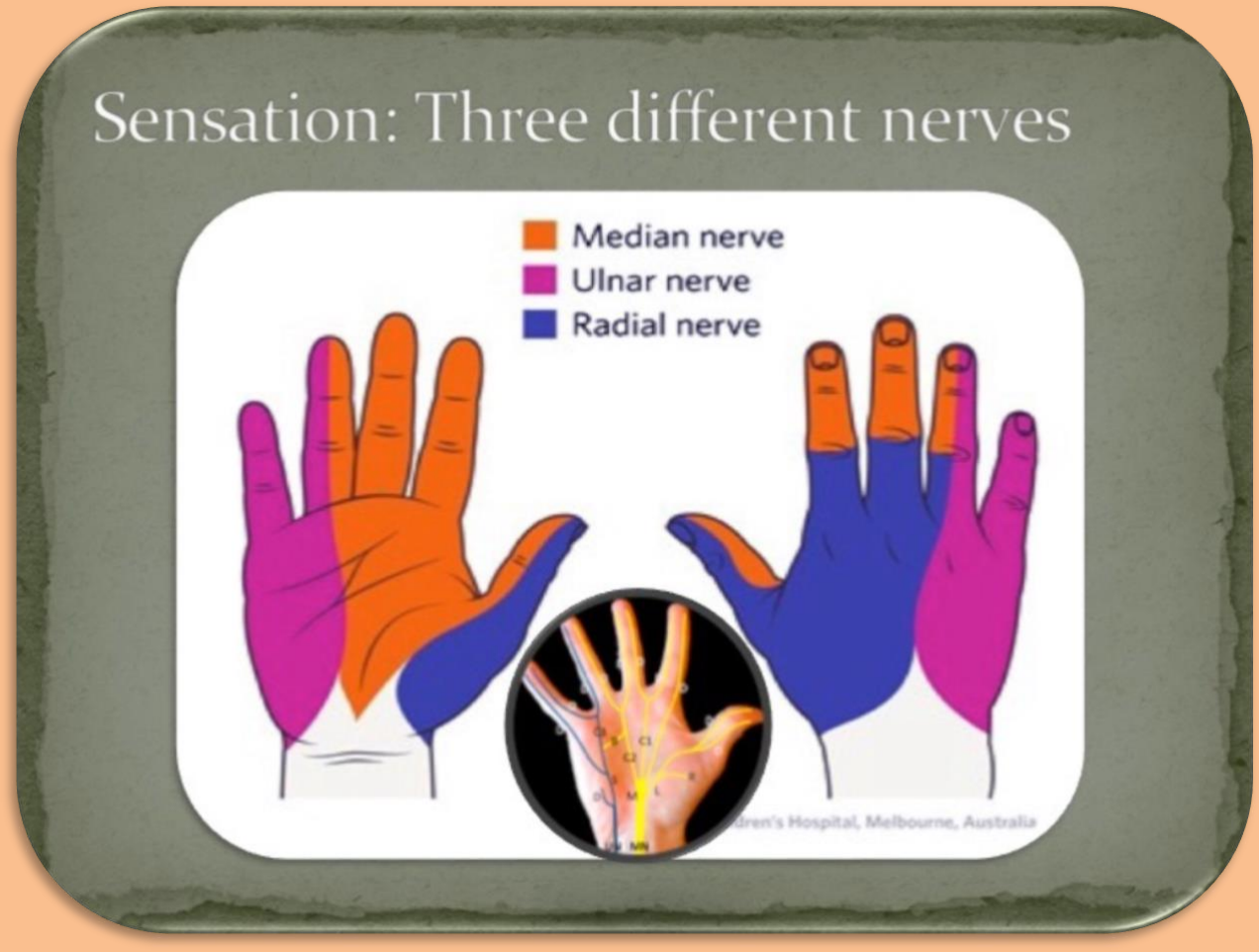


8. **"*Intrinsic*"** muscles:
   a) Those whose muscle bellies are located **inside** ("***in****trinsic*" to) **the hand** itself
   b) Small, much weaker muscles, capable of **incredibly fine, precise motions**
   c) Responsible for spreading the fingers apart (abduction) and pulling them together (adduction) as well as straightening (extending) the middle joint (PIP) of each finger – **these muscles are extremely well developed in most musicians**
   d) Very short tendons with **straight-line pull** and thus **no need for pulleys**
   e) Responsible for our "*opposable thumb*" – opposition means:
      1) Pulling the thumb away from the fingers on the palm side of the hand **and**
      2) Rotating the thumb so the pad ("*pulp*") faces directly the pads of the other digits (in other words, turning the thumb tip toward the fingertips)
      3) Form a big letter "*C*" with your left hand. That's opposition!





C. **<u>Sensation</u> – sensory function creates feedback!**

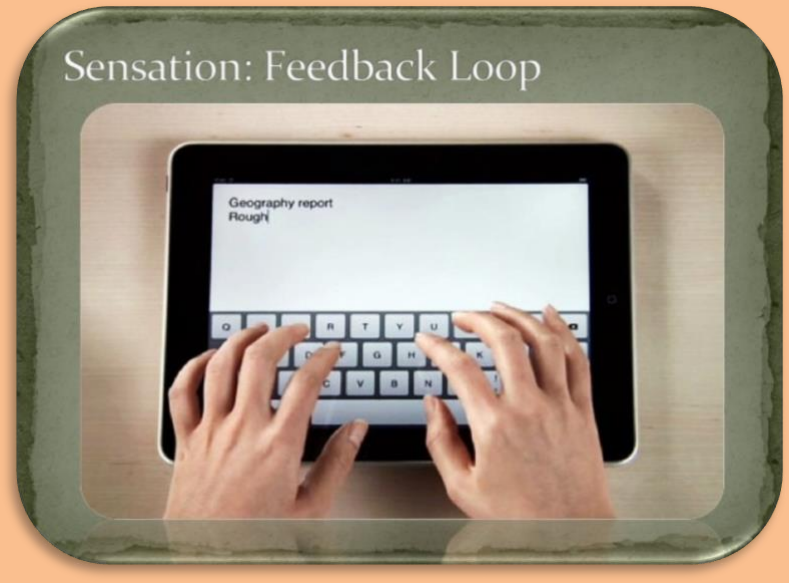


1. Three different nerves give the skin **touch** and **pressure** sensations in the hand. This is called "*tactile*" sensation (they also sense heat, cold etc.)
   a) Median nerve (orange above) – surfaces that are used for fine manipulation – the tips (pulp surfaces) of the thumb, index, long, and ring fingers (**very important for you!**) This is the nerve that is compromised in **carpal tunnel syndrome**
   b) Ulnar nerve (purple above) - border of the hand, little and ring finger side, pulp surfaces of the little finger and half of the ring finger. This sensation is important for most musicians (the same nerve is critical for nearly ALL musicians because it also controls the intrinsic muscles!). This is the nerve that is compromised in **cubital tunnel syndrome** (pathological conditions will be discussed in Part III)
   c) Radial nerve (blue above) – sensation from this nerve is less crucial for most musicians since it does not go to the fingertips. It gives sensation to areas that usually are not in contact with your instruments

2. Common digital nerves (see insert above) control sensation to ½ of 2 fingers rather than 1 whole finger – if injured in the palm not all sensation is lost in an entire finger

3. Signals create a feedback loop of tactile sensation allowing the brain to judge the effects of its motor signals. Imagine what it would be like if you couldn't **feel** the shape, position, motion, resistance etc. of the keys or strings of your instrument!

4. In addition to tactile cues, the brain uses visual and, in your case, detailed auditory information in the feedback cycle to make fine adjustments



Which of these devices do you find more comfortable when writing a long text and why?

The classic keyboard gives you feedback and keeps your hands from drifting. You know when you have made a mistake without constantly having to watch the text!

Musicians and the blind share the most sensory finesse of anyone on the planet!

We usually don't need to see what we are touching to know what it is!

Sensation - <u>The Nature of Pain</u>:

Everyone agrees that acute pain is an unpleasant experience that helps protect us from injury. It has almost certainly been crucial to our survival as a species. Because we evolved in an environment where we were surrounded by dangerous objects and predators, we needed a hair-trigger warning system to protect us from injury, making it appropriate to "*freak out*" at certain stimuli in preparation for rapid "*fight*" or "*flight*". We were **built** to err on the side of **fear**, but **what is the relationship between fear, pain and injury**?

Today, most people live in much safer environments and most of the pain we feel has a more subtle meaning. Our instincts however, are also products of our evolution and we have some difficulty interpreting pain in its more recent context. Pain continues to be a **significant problem** that becomes even more severe, complex and elusive as we witness dramatic improvements in the standard of living and the level of safety in many societies around the world. Why? Shouldn't it be the opposite?

A. **Classical concepts and the vicious circle of pain**:

1. "Nociceptors": In the early 1900's researchers discovered specialized nerve endings that fired **only** when exposed to potentially harmful stimuli (**extreme** pressure, temperature, chemical changes, etc.) and these were very logically thought to be the **origin and source** of our sensations of pain. They were called "*nociceptors*" which means "*harm sensors*" – pain finally had an "***objective***" source and a straight-forward, intuitively satisfying "*explanation*" in the avoidance of injury

2. An "*Obvious*" Conclusion: It seemed logical then to assume that pain was a direct indicator of impending tissue damage and that if it persisted or became chronic that it **must** be associated with some ongoing or continuing **injury** to our bodies

3. The Interjection of Fear: This widespread assumption generated **fear** that untreated or persistent (chronic) pain would necessarily lead to some long-term or irreversible physical damage. This belief, accepted and propagated by the medical community in modern societies, makes it impossible to distinguish between **"*hurt*" and "*harm*"** since by definition in this context, pain indicates harm

4. Sensory Adaptation: Our nervous system however, constantly "***adapts***" our sensitivity to adjust for the intensity of stimuli around us so that when the stimulation level is **low**, we become **more** sensitive and vice versa. Sitting in a dark room for example, we become much more sensitive to light and attentive to its presence. We can see shadows and pinpoints of light we couldn't possibly see when we first entered the dark. Then, when we encounter bright sunlight, we are initially painfully blinded by the intensity of light stimulation, but our eyes and brain **adapt** by gradually decreasing our sensitivity and we can then see details again. This almost exponential "*sensory adaptation*" gives us a much wider and more effective range of perception, markedly improving our ability to protect ourselves and to understand the nuances of our environment. This is an essential part of our **normal physiology** – it involves **all** of our senses, **including those that mediate pain**, and is **inescapable**. In certain circumstances however, this process can work against us

5. Fear of Pain: When we have pain, **if** we are **afraid** that it is an indication of **ongoing or additional injury,** we become highly protective, attempting to **avoid ALL** stimulation. We are even often prescribed complete rest and immobilization (splints and slings) to "***reduce***" our pain but with this decreased stimulation level, sensory adaptation makes us **much more attentive** to and **much more sensitive** to the pain. **Any** motion or touch then causes **even more pain**, more fear and more stress, making us even more protective and less active with no natural end in sight. It

creates a **vicious circle** that is called "*hypersensitivity*" (see also *"Swelling (Edema)"* in Part II). In fearful individuals this can maintain and increase pain dramatically and sometimes cause it to persist indefinitely

a) Let's create a hypothetical situation to illustrate this using the light sensitivity we mentioned above.
   1) You've been sitting in a dark room, say watching an afternoon movie for 2 hours, and you walk out the exit door directly into bright sunlight. It is so bright that it hurts your eyes intensely. Imagine that you learned (and truly believed!) that pain is a direct indicator of tissue damage and you **become afraid** that if you allow the pain to persist you will become blind!
   2) So, you turn quickly around, go back into the dark room and close the door to protect your eyes, thinking: "*I'll wait until the sunlight doesn't hurt my eyes and go out again*". You try it again in 10 minutes but now it seems even worse so you quickly close the door again and wait longer. When will you have waited "*long enough*" in the dark room that bright sunlight will not hurt ("*harm*"!) your eyes? The answer of course is: "Never". The longer you wait in the dark, the more your eyes remain sensitive to the light. This is the vicious circle of hypersensitivity. **Fear of pain** turns it into an **impossible dilemma**
b) We have enough experience with this type of "*pain*" on an almost daily basis that no one could convince us that we are at risk of going blind if we just "*tough it out*" for a while and **adapt** to the bright sunlight. We easily make the distinction between "*hurt*" and "*harm*"
c) In our modern and safe societies however, we have very little personal experience with injury and illness and must rely on prevailing opinions in others and in the medical community for advice and guidance

6. Pain as a Disease: Over time, in some very fearful people, this vicious circle of hypersensitivity can become **so intense** that the **pain itself becomes a "*debilitating disease*"** (called "*Complex Regional Pain Syndrome*" – CRPS) not just a symptom of some process asking for the brain's attention. In this tragic but now common scenario, rest, immobilization and narcotic pain medications are routinely prescribed and are rapidly and deeply addictive. Only mind-altering drugs such as opioids, alcohol and marijuana can give victims temporary relief by reducing their **fear**, but these drugs **only** reduce the fear of pain ("*injury*") **while they are being taken.** Unless the fear itself can be addressed and activity levels ("*stimulation*") can be significantly increased, the cycle continues while the effects of the drugs wear off. Thus, they cannot be stopped, leading to unending drug dependence, chronic fear and stress, and gradual self-destruction. The **injuries themselves heal because**

our physiology will not allow otherwise, but the pain and fear persist causing immense suffering with no end in sight!

This person experiences excruciating, chronic pain in the right hand and has avoided **ALL** usage and stimulation for a prolonged period of many months even though any damage or injury to the hand has **long since healed** (See also "Swelling ("Edema")" in Part II). He is terrified by the **intense** pain he feels with the **slightest** touch. Do you think he's faking it? That his suffering isn't "*real*"? Some people with CRPS beg to have the limb amputated and they must be told that removing the limb would not take away their pain but would leave them with a condition called "*phantom pain*". You will understand why if you read on. (See also the comments below under "*learned Helplessness*")

7. Misplaced Fear: In other animals and in primitive human societies fear is also present but it is **fear of injury and not fear of pain**. Once the threat and the perceived source of injury are gone, other animals and people **stimulate** their wounds by continuing their activities of daily living or they would die of thirst or hunger or would be eaten by predators. They **do not have the option** of complete rest or immobilization or avoidance of contact and so rarely suffer from this vicious circle. Those familiar with domestic animals know that they will often lick their wounds and whimper with pain but appear to have instinctively understood that **stimulation reduces sensitivity**. They often survive devastating injuries without veterinary intervention

8. A Deadly Mistake: This modern **misinterpretation** of the nature of pain has become one of the most pressing problems in our sophisticated societies, especially in the United States where the current "*opioid epidemic*" is now (prior to some brief periods during the COVID-19 pandemic) the **leading cause of death** in people under the age of 50! In some cases, people who don't die from overdosing but whose chronic opioid prescriptions are withdrawn without addressing their fear of pain (for them "*ongoing injury*"), choose suicide as their "*only option"*!

9. <u>Something Must be Wrong:</u> Under this classical interpretation of the nature of pain, **how do we account for the following?**

This woman discovered a healing scratch on her skin but doesn't recall how she injured herself. She experienced no pain and was surprised when someone pointed it out to her. Has this ever happened to you? But this could only occur with minor injuries, right?

***Countless soldiers** during wartime have reported only realizing that they were suddenly and severely injured **after** they looked down **and saw that they were missing an arm or leg.** Their nociceptors should have given them instant and intense pain. Why didn't they?*

*This construction worker jumped down from a ladder landing on a 6" screw protruding from an object on the ground. It pierced his boot just in front of the steel toe pushing all the way through and out the top. He experienced **excruciating pain** and was taken to an emergency room where **he required sedation** to remove the screw and the boot.*

The emergency room staff found that the screw had passed between his toes and was only pressing against his skin. There was no actual injury to his foot. Does this mean that he didn't "really" have pain and was only faking it? Think about it!

B. **Our current understanding of pain**:

1. Background: Pain is the sensation that urgently commands our attention. Consider for a moment that **if impending tissue injury** were truly the **only source** of our pain, it would always occur **too late** to allow us to **avoid** it. It could only allow us to **respond** to injury. It could help us to reduce the severity but, only if we could react quickly enough to remove or escape the source. This is indeed an important mechanism in pre-mammalian species (i.e., before there was a cortex) and is certainly still important in humans in certain circumstances (i.e., stepping on a thorn) but remember that we owe our tremendous success in dominating the Earth to our intellectual abilities. **Only responding** to injury and not avoiding it, does not accurately describe the pain behavior of humans or other mammals. They **prevent** injury, and so **must** be able to **predict** and feel pain **before** any injury actually occurs!

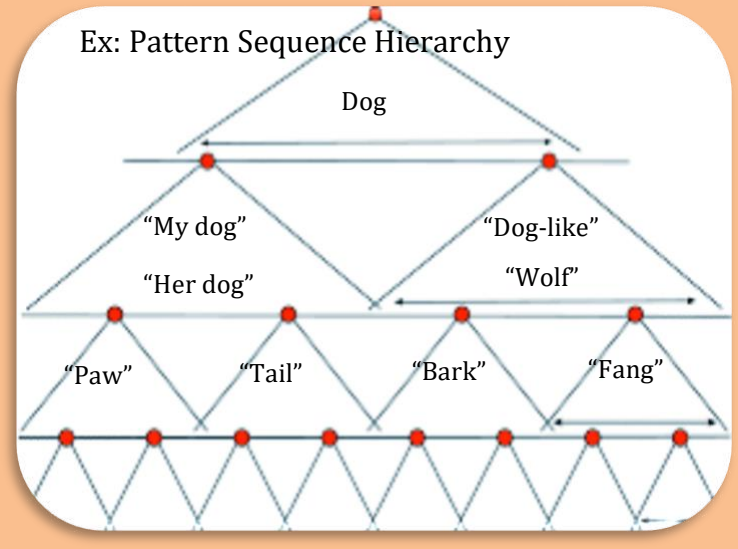
2. Prediction: Our cerebral cortex is a **prediction generator** that learns and creates a hierarchy of recurrent pattern sequences from the world around us which it uses to predict what will happen next, down to the smallest detail in touch, pressure, body position, smell, taste etc., as well as what we will see and hear. As a musician, you can unconsciously predict exactly how much pressure to apply to a key or a string and how quickly it will return to its original position without having to work this out at each repetition, allowing you concentrate on the very slight variations occurring in the moment. This is possible **only** because the laws of physics dictate changes in our world in **highly** reproducible ways (how surprised are you when your prediction was wrong and you inadvertently step off a curb?)
    a) The cortex appears to use a similar algorithm (process) to analyze **all** the signals that can be sent through the nervous system **regardless of the source** i.e., vision, hearing, touch etc. This allows for the adaptability ("*plasticity*") of using different cortical regions depending on our special needs. For example, blind people often use the region of the cortex usually reserved for vision to improve their sense of touch or hearing
    b) When a pattern is recognized and occurs frequently enough, it is given its own "*identity*" and passed up the hierarchy allowing us to "*understand*" it without the need to pay attention to the components that were very important lower in the hierarchy - for **Example**:
        1) Individual letters and sounds are crucial to learning words, which are patterns of these elements in a particular and very specific order ("*temporal sequence*") but once they are learned and passed up the hierarchy, they are recognized **independently** and higher "*contextual*" patterns (phrases, concepts etc.) are formed allowing one to predict the next word with only minor cues making speed reading possible

"Aoccdrnig to rscheearch at Cmabrigde Uinervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are wirtten as lnog as the frist and lsat ltteer are in the rghit pclae. The rset can be a total mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae we do not raed ervey lteter by istlef but the wrod as a wlohe. Amzanig, huh?"

2) Musical phrases are learned in the same way by converting patterns of notes into intervals and sequences allowing you to recognize a melody regardless of the key it is played in, whether it is played by a tuba or a piccolo or hummed by a friend – even if you have never previously heard that rendition

c) **ALL** learning appears to proceed in this way no matter how abstract it is and higher level concepts are formed by patterns of lower level concepts that **occur together** i.e. you can easily recognize a generic "*dog*" even though it may be a different breed from any dog you have ever seen before – you can also as easily recognize concepts such as "*my dog*", "*her dog*", a "*white dog*" and a "*dog-like*" creature, say a wolf, in addition to its patterns lower in the hierarchy such as a "*paw*", a "*tail*", a "*fang*", a "*bark*", the smell of a "*wet dog*" etc.

d) This process of pattern recognition begins in the brain almost certainly before birth and continues progressively throughout our lives with **ever increasing complexity**, allowing the cortex to make templates ("**invariant representations**") of **ALL** the objects, forces, sensations, concepts etc., that make up our daily lives, freeing up our brain to concentrate on and "***fill in***" **ONLY** the missing and unique information in a given context



What does any of this have to do with pain?

3. Twenty-first Century Data: Current research suggests that the sensation of pain is **entirely** constructed in the brain based on nerve signals interpreted within a **context** (that hierarchical series of recognized patterns that allows us to constantly situate ourselves in time, space and the circumstances that surround us) using combined information from our senses (feedback) **but mostly** from our **past experiences** (called "*feed forward*") – if we measure neuron "*traffic volume*", feed forward data outweighs feedback data **10 to 1**!
    a) Signals from the nociceptors are sent **before** any tissue damage actually occurs and several fractions of a second pass before our brain interprets their significance and **tells us** (predicts) what we **should** feel. Thus, when no pain is predicted, the brain may not **initially** interpret nociceptor signals as painful (as in the soldier who didn't realize he had lost a limb). Does this mean our nociceptors don't work? Not at all! It means that their significance must be learned and **interpreted**, the same as all of our other senses! **They are not "*objective*" sources of pain**
    b) Essentially, **any** nerve signals that are unusual enough to command the brain's sudden attention in a particular **context** may generate a full range of responses from pleasure to intense excruciating pain depending on the brain's **expectation** or prediction of pain or danger
    c) The slightest touch to your skin or even to a single hair on your skin, in complete darkness when you believe yourself to be alone, vulnerable and stalked by a mortally dangerous predator **can be** one of the most intense and painful experiences imaginable without the necessity of **any** actual injury. Remember the construction worker who saw the screw sticking through his boot! If you still have doubts about the importance of prediction in the generation of pain, watch this short "*Demonstration Video*"
    d) The element of prediction and anticipation, however brief, is what makes injections SO painful and what makes the threat of torture so uniquely heinous and effective in forcing others to behave against their will. Everything that happens to us in our daily lives occurs within a **context** and that is what largely determines our immediate response. We will discuss the contextual effect in more detail in the paragraphs below
    e) Thus, **ALL pain is REAL pain!** Regardless of the reason or the source, it is as **REAL** as anything we can experience in life, in spite of the **fact** that **ALL pain is subjective and "*in our heads*"!** These concepts have always been deemed contradictory (and generate intense defensive reactions!) but they are not!

C. **What are the implications**?

1. Judgements: Since each of us, by necessity, sees things from a different perspective and from within our own personal context, the amount of pain we experience and how we react to it, is unique to each of us as an individual. Thus, pain can **only** be judged as exaggerated or inappropriate by an observer, **never** by the person experiencing it. So, any judgment on the appropriateness or "*objectiveness*" of another person's pain reflects a misunderstanding of pain itself

2. Reliability: Can the brain be fooled? **Absolutely!** (see also the "*Demonstration Video*" on the previous page)

> ***[Article from: MDedge® Internal Medicine News, April 8, 2021]***
>
> ***"Something's wrong, but I can't put my finger on it"***
>
> *"Mixed martial arts is not a sport for the faint of heart. However, we doubt fans who were watching the Khetag Pliev/Devin Goodale fight on April 1 were prepared for the announcement that a search was commencing for a missing finger. Not broken, in case you think that was a misprint. Completely 100% removed from the rest of the hand".*
>
> *"One would think that pinpointing the exact moment when the finger, belonging to Mr. Pliev, was severed would be easy, but the video evidence is unclear, with the best guess being that a kick in the first round broke the finger and a grapple in the second severed it completely. Mr. Pliev was not helpful in clearing up the matter; not only did he fail to immediately notice the fact that his finger had been broken or severed, he tried to keep the fight going after the second round when the referee noticed some blood where his left ring finger should have been. He thought he was winning. Unfortunately, the doctor on hand, who was clearly a complete drag, felt differently, ending the fight and awarding it to Mr. Goodale in a technical knockout" …*

*("But these things can **only** happen to other people, **never** to me. **Right?"**)*

3. The Placebo Response/Contextual Effect:
    1) "*What is it?"* It is essentially all positive health changes (it is called "*nocebo*" if the effects are negative) that occur as the result of a person receiving an inactive treatment – that is, one that has no known effect on the underlying condition – and it is now often referred to as the "*contextual effect*". "*Placebo*" doesn't refer only to the classical concept of "*sugar pills*" that improve a condition, but in fact to **any** intervention or situation or circumstance that a person **believes** is beneficial even if it is inert.
    2) "*Is it a significant effect*?" In a recent "*meta-analysis*" (a summary of results from multiple studies) the placebo response accounted for approximately 50% of the subjective **and objective improvement** observed across widely varied medical conditions and up to 75% in some osteoarthritis studies, where pain may often be the only symptom felt by the patient. So, at least

half and possibly much more of our recovery following any health-related issue is due to something other than our objective (evidence-based) medical treatment

3) *"What does this mean?"* The word "*placebo*" has a very negative connotation for most people because it suggests to them that if it works, then their pain was not "*real*" but only imagined, believing strongly that there is a difference between the two. If you have understood the subjective nature of pain from the previous paragraphs and are not feeling defensive, it should come as no surprise to you at all that the placebo response is **very real** and **very effective** in dealing with **real pain**! It **is not** a way of "*fooling*" oneself!
   (a) The Context: The "*contextual effect*" is a much better term for this phenomenon because it describes the process much more accurately. Remember that pain (just like it's opposite; a feeling of "*well-being*"!) is generated in the brain in response to a specific moment in time and to **all the factors** that are in play at that moment (the context). Remember also that our brain is a prediction generator and that 9/10ths of its activity comes from our past experiences ("*feed-forward*") rather than from the specific circumstances in which we find ourselves ("*feedback*"). Thus, the context is created by our **perception** of the danger in a given situation and the confidence we feel in our ability to overcome it. What we feel and how we respond can vary as much as the context can vary
   (b) The Extremes:
      (1) "*Learned helplessness*":
         1. Studies from the 1960's and early 1970's looked at the extreme negative ("*nocebo*") side of what would later become known as the contextual effect in both animals and humans. When a situation is perceived as **so** dire and **so** uncontrollable as to be hopeless, animals and people simply give up and accept their fate, making no effort whatsoever to escape or to improve their situation. Remember that this comes about from our perception of the situation and doesn't necessarily reflect our true capabilities
         2. As might be predicted, learned helplessness can sometimes have a positive effect in Complex Regional Pain Syndrome – CRPS (see the image above under "*Pain as a Disease*"). I personally saw 2 or 3 patients over my 30 years of practice whose CRPS resolved when they reached a point of learned helplessness. They became **so** desperate and felt that their lives had become **so** miserable, that they had nothing left to lose by "destroying" (or so they thought) the arm or hand that tortured them by using it, **no matter how much it hurt**! By **giving up** and no longer trying to protect

themselves from what they **were certain** would cause severe injury, they paradoxically broke the vicious circle of pain with stimulation ("*desensitization*" – see below) and gradually returned to normal! Unfortunately, some others who reach the same level of learned helplessness, choose suicide

(2) "*Learned optimism*": A meta-analysis in 2017 looked at 15 studies and concluded that higher levels of optimism were associated with a lower risk of cardiovascular disease, stroke and mortality in general. Of course, correlation is not causation and optimism and motivation alone can't cure cancer or regenerate severely damaged nerves, but these findings again suggest that the contextual effect is far from negligeable and is well worth our attention! All of us have seen examples of people with devastating injuries or disabilities that they have not only overcome, but have developed compensatory skills that go **far** beyond anything we could imagine (Some examples of people with "disabilities"!, More examples!). In a different **context** they may have given up!

(3) The contextual effect is a part of our physiology, **not the supernatural**, and it fits perfectly with our recent discoveries about the nature of pain. The exact mechanisms involved in preventing and fighting disease are not yet well understood but it is postulated that they involve a reduction in **stress** levels. It also remains debatable to what extent optimism and fierce determination can actually be learned or if they require some genetic help, but we gain nothing by assuming that they are beyond our conscious control

(4) *"How can we use this knowledge to our advantage*?": The real question is can we exert some control over the context? There is likely very little we can do to change the instantaneous reaction we have when we are startled, are injured, or have sudden pain. The context is determined by our experience and our instincts. After that however, it is reasonable to consider that the context may be influenced by our deeper understanding of the circumstances but also by our better understanding of the nature of pain! Knowledge is power

4. Current Pain Concepts: Our classical pain concepts are simply **WRONG** yet they continue to be widely accepted, taught and propagated, even in our medical schools! All of the recent research indicates that **pain is not an objective indicator** of impending injury but rather a request for the brain's attention! Until we better understand and spread this knowledge, countless people will continue to suffer needlessly

D. So now what?

1. "*So, you're saying that I should ignore pain because it is unreliable and just my imagination*?" **Absolutely not!** (If this was your reaction, you are feeling defensive and should re-read the above section!)
    a) By our best scientific description, **ALL** pain deserves the brain's attention and you couldn't consciously ignore it any case, even if you wanted to! (If you ignored it, it would have been unconscious and would never have been interpreted as pain in the first place, just like the person with the healing scratch!)
    b) Controlling the panic, paying **closer attention** to pain's nuances **without fear,** and using a more detailed and more objective analysis than the one the brain can accomplish in just a few milliseconds, becomes important exactly **because** it's "*all in our heads*"! If it were objective, it would be outside our control!
    c) We must be **constantly aware** of our natural tendency to initially **overestimate** pain signals in the context of our evolutionary history. Fractions of a second could and can still be the difference between life and death. "*React first – think later*"! That's built into us, but it doesn't mean: "*Just react - don't think*"! (If you didn't watch the short "*Demonstration Video*" a few pages back, watch it now) It is easy and **completely normal** to initially misinterpret the source of and the potential danger posed by any startling or painful stimulus

2. DESENSITZATION**: Once the source of pain is understood**, (or the source of "*danger*" is eliminated), conscious and **deliberate stimulation** of a painful site ("*desensitization*") breaks the cycle and is **BY FAR** the most effective and safest pain treatment available!
    a) It stands to reason that if our interpretation of a stimulus can make it **more painful** (some of you felt pain and distress just **looking at** the image of the screw sticking through the boot!) it can also make it **less painful! (See also *"The Placebo Response/Contextual Effect"* above)**
    b) If we are confident that a stimulus cannot continue to harm us in any way, the signals, **including those from the nociceptors**, that we initially interpreted as a source of extreme pain due to severe tissue damage, can later be re-interpreted as touch, pressure or whatever sensation we consider "*appropriate*" – this is called "*sensory re-education*" and can be used to potentially **modify** our interpretation of pain from **any** source
    c) **Example:** As a hand surgeon, I treated about 300 patients with traumatic fingertip amputations over 30 years (bloody stumps including some degree of bone and fingernail loss - a "*frightening*" injury)
        1) Those who could understand and adopt these modern pain concepts when explained to them in detail, overcame their fear and immediately began

desensitization and working through their pain by using the finger normally. They could be treated with Band-Aids and a light compressive wrap. Their pain resolved **completely** within **days** of their injury. They regenerated excellent quality tissue with normal or near normal sensation, had no "*phantom pain*" (feeling pain in a missing part of your body) and full function. Most returned to their normal work and activities almost immediately and did not feel handicapped by their injury. Obviously, in professional musicians return to work was more complex, depending on their instrument and which hand was involved, but the principles still applied.

2) Those who could not get over their **fear** that the pain they felt would cause additional injury or prevent healing, **avoided contact** with the stump at all costs, developed abnormal hand postures and had to modify **all** of their activities to decrease or avoid stimulation. They suffered terribly, had "*phantom pain*" and poor sensation at the stump. Their pain became chronic and they felt that they had experienced a **"*permanent injury*"** and were now handicapped. Indeed, **all** aspects of their lives were affected. Their suffering was **very real!** (See "*Pain as a Disease*" above)

d) Our brains and our bodies are **extremely** adaptable yet we often do not take advantage of this capacity because of our misinterpretation of the nature of pain or discomfort

1) Another simple example: "*Do you enjoy roller coasters?*" If you do, it is because you are **confident that you are safe, can put aside your fear**, and are therefore able to transform the instinctively terrifying sensation of free fall, normally followed by inevitable severe injury or death, into an exciting and pleasurable experience! Perhaps you dislike roller coasters intensely but then while watching your friends ride, aren't you even more convinced of the brain's **potential** for adaptation?

2) "*Does understanding fear mean that we can change it?*" Maybe not. None of this should be interpreted as suggesting that it is easy to control one's fear, even when we can clearly see it as irrational in a given situation. Our genetic makeup and our individual way of dealing with the world around us is not something we can simply ignore. What I said earlier regarding the contextual effect however, also applies here. We gain nothing by assuming that it is beyond our conscious control. If we don't try to control our fears, we will never know if it is possible

e) If you can bring yourself to actually do it, you can verify the effects of desensitization quite easily the next time you sustain a minor but very painful injury. If you bump your shin, stub your toe, etc.:
   1) **Immediately** massage and stimulate the **most** painful site aggressively and forcefully (fortunately, **many** people do this instinctively – they are **not** usually the ones who suffer from chronic pain!)
   2) The first contact will be **very** painful but if you swallow your fear and stay with it, your pain will subside **within seconds**
   3) It will gradually return when you stop stimulating (local tissue damage and inflammation will occur and be present over the next 7-10 days – **see** Part II), but if you continue to stimulate the site frequently – touch it, massage it and pursue your normal activities, your pain, **initially intense**, will become rapidly tolerable and will quickly subside

3. Stimulation and Healing: ***"But won't all that stimulation prevent me from healing?" Shouldn't I wait for my wounds to heal before I try to get back to my activities?***
   a) **Absolutely NOT!** Your body is made to heal itself **while it continues to function** or your ancestors **could not** have survived and you would not be here! The fatality of an injury was indeed **determined** by the body's ability to continue functioning (self-defense, hydration, nourishment, shelter etc.) **during** the healing process and was favored in our evolution!
   b) **In fact**, our bodies **rely** on our activities to guide the formation of scar tissue
      (a) Our tissues move relative to each other when we move (i.e., muscles shorten, tendons glide, skin slides over tissues beneath it etc.)
      (b) Scar "*heals*" wounds by sticking tissues together and contracting
      (c) It relies on our needs (our activities!) to determine which tissues should be stuck together and which should be allowed to move
      (d) Scar has a long "*maturation*" process (see Part II) that allows us to fine-tune the compromise between stability (stuck in scar) and mobility (gliding motion) but we can only take advantage of this guidance by pursuing the activities that are either necessary or important to us

(e) Once it is mature however, scar tissue is **very** strong and **will no longer allow** gliding tissues to regain their motion. The window of fine-tuning closes permanently

(f) So, if we change our needs completely by "*waiting*" for an injury to heal before we move and use our limbs, we **interfere** with this intricate and valuable process – and **pay the price** with drastically **increased pain and adhesive scarring** (loss of motion)!

E. Conclusions

1. None of this should be interpreted as condemning modern medicine or surgery. They have reduced the fatality of illnesses and injuries dramatically and improved our quality of life

2. Of course, with certain severe injuries, especially those that involve broken bones, **sometimes** rest and immobilization can help us to attain a **better** result, but it is **always** a compromise and the benefits **should outweigh** the **predictable negative effects** that reliably accompany these treatments! Some of the **best results** in modern trauma medicine involve the surgical fixation of broken bones precisely so that early motion can guide the healing of the soft tissues. Long-term rest and immobilization for a professional musician is often a death sentence for their career and should never be used if other options are possible

3. It is not an accident or a coincidence that in recent decades a steadily increasing number of surgeries are done on an outpatient basis. Instead of hospitalizing and keeping patients on bed rest from the day before their surgeries and for days or weeks afterwards, they are now sent home and asked to get up and move around. It has reduced the number of problems and complications dramatically

4. Unfortunately, especially in the upper extremities, older protocols requiring rest and immobilization at home are often still **followed without question** because that is the way we were taught. With our current knowledge however, **these issues should no longer be ignored** and should be actively and aggressively revisited. Specialized hand therapy geared towards progressive but rapid return to playing your instrument should be initiated almost immediately following injury or surgery in professional musicians and unless you discuss this early on with your provider it may not even be considered

5. We as physicians couldn't start by knowing everything up front. We have to learn as we go just like everyone else. Changing established concepts and protocols however,

in this case our notions of the nature of pain and tissue healing, is a long slow process

F. In Summary

1. Finally, in the 21st century, we have the knowledge available to allow us to better understand, manipulate, and control our pain

2. Our instincts however, based on our evolution, naturally generate **fear of injury**

3. Unfortunately, flawed assumptions in the 20th century have turned this tendency into **fear of pain** in modern safe societies, making it impossible for some people to distinguish "*hurt*" from "*harm*"

4. **Pain is not automatically dangerous**. **It is only painful!** Fearfully trying to eliminate pain by avoiding all stimulation has the opposite effect, **increasing pain** by creating a vicious circle of hypersensitivity and adhesive scarring. It can be likened to placing frightened, desperate people in a pitch-black room and telling them to wait until the bright sunlight does not hurt their eyes before they go out and get back to normal life. With injuries it is even worse, since remaining immobile causes tissues to stick together with scar that must then be stretched or torn (generating even more pain and anxiety!) before they can regain normal motion. Until we understand and embrace this new knowledge, countless people will continue to suffer with chronic pain and disability for decades to come – hopefully, **you** will not be one of them

5. Rapid progressive return to one's normal activities as well as progressive direct and deliberate stimulation of the most painful sites ("*desensitization*") is still by far the safest and **most effective** treatment for most minor injuries and has the best chance of preventing chronic pain and disability. It has been practiced successfully by our ancestors for millennia! Unfortunately, our classical misunderstanding and fear of pain have made this treatment option generally untenable except in those who do it instinctively and those who are willing to learn from their mistakes

6. The classic approach to pain is **so fully entrenched** in modern societies that even with mounting evidence of its flaws many physicians will continue to prescribe rest, immobilization and narcotics to treat pain in the foreseeable future in spite of **predictably poor, often disastrous results**. If they prescribed stimulation and rapid return to activity without fully understanding and explaining these concepts

to their patients, they would be branded incompetent by both patients and colleagues!

7. The placebo response/contextual effect is a powerful part of our physiology that is largely ignored, also due to our misunderstanding of the nature of pain. In addition to medical breakthroughs that help improve our ability to create objectively effective treatments, there are many potential interventions that might improve the context of patient care. For example, taking the time to explain patients' conditions to them and share the reasoning for their treatments might help reduce anxiety and stress, create motivation and optimism, and potentially improve overall results dramatically. Understanding the nature of pain allows us to embrace the placebo response and predict its benefits rather than to condemn it as a means of proving to us that our pain is not "*real*"

8. Knowledge is power but a little knowledge is dangerous! **If you believe everything you read on the Internet without making the effort to learn about your own physiology, you will suffer throughout your career**. In today's world of social media, it is all too easy to present our opinions as "*the truth*". While most of us believe that there is an objective reality that exists outside of ourselves, we often forget that **no one** has direct access to it and that we must rely on **evidence** to give us our best **current approximation** of "*the truth*"

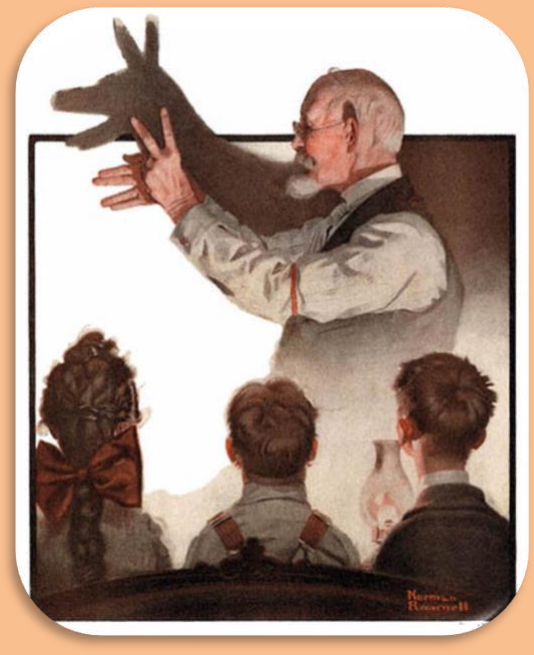
9. Fortunately, today's world also gives us access to scholarly, peer-reviewed articles and now **AI applications** that are available at our fingertips! These applications have the advantage of being "*emotion-free*" and thus can evaluate the actual evidence without applying the confirmation bias! Use them! Verify for yourself the observations made in this document!

10. Learning can allow you to distinguish evidence from speculation, which you can **only** do if you understand the concepts. The "*prevailing opinion*" always lags behind our current knowledge. As a minority with special needs, you as professional musicians will need to know enough about your own physiology to make reasoned judgments about the pain **you will** experience in the years to come

11. Our most objective assessment of any alert signal comes when we are not charged with emotion. If you are already visualizing the end of your career every time you feel pain, you're in trouble! Most pain in musicians is physiological ("*normal pain*" – see Part II) and does not require medical attention though it does **require YOUR careful attention, analysis and activity modifications!**

12. **Musicians take careful note**: If you cannot get past your fears that pain will automatically lead to irreversible injury and you try to be "*extra safe*", you will **paradoxically increase** your likelihood of experiencing a career-ending event

13. **Your understanding and your response to pain are in <u>YOUR</u> hands**!



**This material is intended ONLY as an educational resource for understanding the physiology of the hand and wrist as it applies to high-level and professional musicians in the 21st century. Some of the more recent concepts discussed are not yet part of mainstream medical practice though hopefully they will be in the years to come. It is not intended and should not be used as a substitute for professional medical care or as a justification for ignoring medical advice. Though I AM a retired physician and surgeon, I am not YOUR physician or surgeon and thus cannot be aware of the nuances of your individual circumstances. Once you have a professional that you trust, I STRONGLY recommend following her or his advice to the letter. You may and should however, openly discuss the concepts you glean from this document. D.G*

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