Hearing

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There are **three different areas** of hearing difficulties: frequencies, tinnitus, recruitment. After over 41 years of tuning and 67 years of listening, Dave has always been sensitive about his hearing. He always wore ear protection while cabinet making, and still does while tuning.

Dave projected a three-dimensional labeled picture of an **ear interior**. Sound goes in, hits the tympanic membrane, the melbas, and that activates membrane in the inner chamber. Inside of that are cilia. These cilia are at different lengths floating in a liquid for different frequencies. When sound comes in, it knocks them down and they slowly come back in. Once they do not come back, that hearing is permanently lost.

Three-year-olds can hear certain **frequencies**, and as we get older the frequencies change: 5, 7, 9, 11, 13, etc. We start losing our hearing from birth. Older people cannot hear certain sounds that children can hear. To demonstrate, Dave played tones at various frequencies, going increasingly higher until we could no longer hear them. He started at 400, went up to 1200, 2000, 4400 (the top of the piano), 8000 (some people could not hear this), 10,000, 12,000 (the younger members could still hear this but not the older members), 16,000 very few could hear. C8 is 4000+; if you can hear two octaves above this, you are doing well.

The importance of being aware of this is so we can talk to our customers. When Dave was a kid, they had two TVs. Even when they were turned off, he still heard a noise that his parents could not hear. One day Dave was tuning a Steinway D; there was a flat wall at the back. He realized that he was hearing ping-wah off the wall. The wooden sound of the action was traveling slower than the sound of the string. This made him realize that when people complain that the top three notes don't sound right, he will play an octave lower, which they can hear. Then he puts his finger on that string to emphasize the sound of the hammer hitting the wire, so they understand that the whock is happening in every note. Because the higher frequency is different from the whock, it stands out more.

Tinnitus is a whistling sound or pink noise. This could be coming from the nerves between the ear and the brain, the brain making a noise that doesn't exist, a chemical imbalance, or some other reason. One client had a Yamaha C2 that did not sound right after the tuning. Dave returned to make it right; he corrected a few notes in the lower tenor. Then the customer played an F4 and said it didn't sound right. It turned out that the client was a high-altitude pilot and had tinnitus on that note. Dave pointed out that he can't tune to what was in his head. Some tuners have tinnitus right in the middle of the temperament; they must use an electronic tuning device. Some new hearing aids can switch the sound down to a level in the hearing range. Diction happens in the upper range, so most hearing aids over-amplify this register.

We all lose hearing. The third area is called **recruitment.** The cilia on either side of a missing cilia amplify the sound, which is why sometimes one note sounds louder than others.

Attenuation is making less. We don't hear the bubbling of the fish tank when Dave is talking. Our threshold drops. Kawai has the anicode chamber with no reberb on the wall. If you don't make any noise, you start hearing your heart beat and your nerves moving around when your hearing is turned down. As we get older, our attenuation lessens and we can't hear as well: the system is not bringing it down.

Part of the point of hearing protection is protecting attenuation. **Recording studios** do the best to get the sound into the computer. Then the sound is mixed. Then the recording goes to the mastering engineer who uses compression to turn some sound down, listening to the n'th degree at loud levels to fine-tune the balance.

Once in a while, go outside and listen to nothing. Give your ears a **rest**. You come back with fresh ears. When you hear a gun shot, the muscles around the ear bones clamp down so they don't move to prevent the loud sound from entering deeper. After the gun shot, everything sounds muffled, and it takes up to 24 hours for those muscles to relax. Wearing hearing protection raises the bottom threshold of hearing and lowers the volume. When you lower the volume on a piano, your ears open up more and you hear more details, not less. David wears earplugs throughout the entire tuning; he started wearing them in 2005. He has all the details right there. A big advantage of wearing earplugs is that the external sounds of traffic, washing machine, leaf blowers, children and animals, etc., are muted down so much that they do not interfere.

When David is about ¾ of the way through tuning a piano, his watch with a **DB meter** tells him that it is getting loud, and he should do something about his hearing. He demonstrated by banging repeatedly on one note: it was about 100 decibels. If you hear ringing in your ears, that is not good. You should have done something about it earlier. Doing test blows is important for making sure the piano stays where we put it. Some strings will not render going over the friction point without a hard blow.

The new **earplugs** are much improved over the older plugs. If you double your distance from the sound source, that lowers the sound by 3 decibels. Foam is massive over-kill; foam is usually rated at 29 DB, and particularly reduces hearing the higher frequencies. Acoustic filters and musicians' earplugs reduce fewer decibels. Hunters Ear Valves are supposed to close up at certain decibels, but it was too slow. Custom earmolds are effective but pricy. To make them, they squirt epoxy into your ears and are molded to your ears. They have a filter on the outside that provides different decibel cuts. Dave likes 9-15 DB, making things sound about half as loud, which is his comfort zone. You can buy them for different levels of many decibels are cut out. David's are half as loud as without. Eargasm earplugs are silicon and come in small, medium or large, and come on a keychain, so they are always with you. Dave finds them comfortable and can be kept on a key chain. You can buy a packet of silicon ear tips. They stay pretty clean below the tip, and they can be washed. They are $10 for a set of ten, so they can be thrown out when they get dirty, but the filter can be kept. There are other earpieces. Etomotic has one with a longer tip, but it hurt David's ear.

There is also advance **noise cancellation** technology. Sony ear plugs used to be $350, now they are about $270. They cut out the engine noise of an airplane and other exterior sounds. David's wife has to tap him on the shoulder when he is wearing them because he

doesn't hear her. Hunters protection at goAcxel.com have control switches for noise cancellation, protection from the gun, but also amplify the sound of the animal off in the woods. These are almost too quick for tuning because it garbles the initial impact of the note. David showed QR codes to link to various websites for different kinds of ear protection.

Each person's ear is **shaped** differently. He showed slides of various shapes of ears. Some canals go straight in, some bend and go up. Ear microphones, earplugs, and amplifiers might fit in the ear at different angles for better hearing. New earplugs will bug you at first and you will feel that you do not hear anything. It takes a while to get used to it. You don't want to be the guy who is tuning past the ability to hear. The top notes will not sound correct. You can go to an audiologist to have the molds made for custom earplugs. WestTone is what Dave uses. They last for about five years. Kenn Wildes showed a set of plastic and foam adjustable ear clips called SenseGuard from Amazon for about $15. They are light weight, easy to adjust, is his favorite for tuning. Anthony suggested that another cheap option is to chop a regular foam earplug in half and use the tips. Jordan Cook said there is a free app called SoundMeter by ABCapp to check decibel levels.

David sat down at a grand piano with the Cybertuner display on the screen. What does **one cent** difference sound like? He tuned one string perfectly and tuned the adjacent string one cent off. There was clearly a waver. A two-cent difference was even more noticeable. He played a F-A third with the strings that were in tune, then one cent apart, then two cents apart. The beats slowed down. Then he played a fifth with one cent difference. He played an octave in tune. The he tuned an octave one cent narrow. Next, he tuned an octave that was one cent wide. Then he tuned an octave one half cent narrow. We seldom stop to listen to such tiny variations. He tuned an octave one half cent off, and we listened.

Coupling happens when sounds are off. Coupling happens when different beats are off but get closer together and at one point, they are precisely the same. If there is not some degree of coupling, we wouldn't be able to tune anything. We are never smack on to the molecule – tight enough to it. There is just that moment when it was there. Sometimes when fussing with that last half cent, it will work its way into tune: it is coupling.

On his Cybertuner he looked at **partials**. The strongest frequency we hear in F3 is actually not F3, it is F4. One of the frequencies is D#6. He held down the F and struck the D#6 and it rang. Go up high enough in the partials there are quarter tones. A bunch of quarter tones mixed in with chromatics creates a chord. David then switched to Hz. C8 is 4042 cycles per second. The piano he played read 4350.48, which was a bit sharp. Often, Cybertuner wants to tune with the 7^{th} partial in the bass, which mathematically makes the scale more even.

Dave talked about a few **tool tips**. How many people remember Bill Smith? What do you remember about him? He made PTG Golden Hammer Awards, little felt sculptures out of hammers, and giant piano parts for demonstrations. When Bill worked at Sherman and Clay, the man who worked the shop did not believe in power tools. They used bow saws, brace and bit, and hand wood tools.

- Dave showed us a Dewalt cordless screwdriver. Hold the trigger, rotate the drill and it operates on its own, and will even do large screws. It helps to carry a second charger. This tool lives in Dave's kit and is available at Lowe's right now.
- Klein screw shanks are hardened and won't wear out. They are about $70 at Lowe's.

- Ace Hardware has a folding horse for $30. He placed a grand action across two horses. He carries these in his car, and can be set up in almost anybody's house as a work stand.
- Appliance stores use rigid cardboard L beams for protecting furniture. David cut two at 4' and placed one over the hammers and one over the edge of the keys. He wrapped transparent packing tape around the cardboard and the action to hold down the cardboard. Then he took a piece of black cloth from Harbor Freight and covered the action, and then wrapped it with shrink wrap. Everything is protected for transport. To protect an upright action, he covers the hammers with one and the dampers with another cardboard L. He wraps each end with a 1' shrink wrap roll to hold down the cardboard, covers the action with the black cloth, and then shrink-wraps the cloth.

Here is a link to the Zoom video:

https://us02web.zoom.us/rec/play/ioPD167vdWGqe_PwBVmHgzTaGHByW0q92hjeC76XpDQha-8jDCX1HQ_mznhbhQOejumtCag-v0guHp6E.izV4FM5YYDq4_Vxl?startTime=1673925705000&_x_zm_rtaid=rTOPFQuzTTmVYmrQheg_BA.1677359353869.e54df3b69e0598f3fc4ed08f5335e844&_x_zm_rhtaid=299