The term “tonal color” relates to a multidimensional quantity which we are capable of perceiving. Science has not yet managed to fully explain the different elements of tonal color. Nevertheless, we can say that tonal color is a complex attribute by means of which we can distinguish between sounds with the same pitch, loudness, subjective duration and angle of incidence.

Any violinmaker who is experienced in the area of tonal adjustment will have an intuitive understanding of the various possible tonal colors and other nuances of sound. His or her professionalism is based on the ability to obtain desired tonal colors by modifying the construction and adjustment of an instrument.

However, this article will not discuss why we perceive tonal color as we do. Instead, it will consider certain tonal colors and describe instrument- and resonance-related reasons for the differences that result.

Why do different violins have different tonal colors? One main source of the tonal color we perceive is the spectral distribution of the radiated sound power. In other words: “How much sound is being radiated and in what frequency ranges?” The sound has different levels in different frequency bands due to the resonance properties of the violin. Typical strong resonance ranges (resonance regions) in violins are as follows:

- Helmholtz resonance around 270 Hz
- Corpus resonances around 450 to 550 Hz
- The “a formant” around 700 to 1000 Hz
- Higher frequency plate resonances around 2000 to 3500 Hz

If we analyze the sound radiated by violins that have been subjectively rated as having a “good” sound, then we will tend to ascertain a certain balance between these four ranges: The envelope curves over the resonance peaks of these four resonance regions will have relatively high levels. By way of example, we have identified these resonance regions in the resonance profile of a violin by Joseph Guarneri del Gesu:

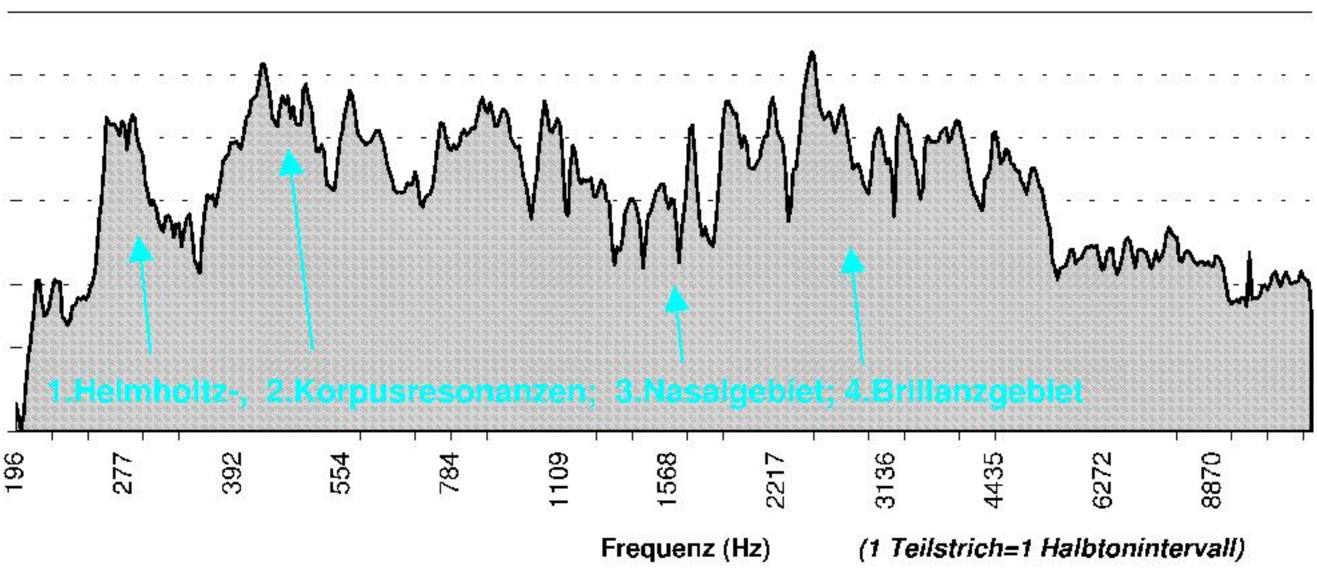

Fig.: Sound energy radiated in all spatial directions by a Guarneri del Gesu violin as a function of frequency. The typical resonance regions are clearly recognizable.
The resonance profile shown here was produced by measuring the ratio of the sound pressure to the exciting force. This ratio is graphed vs. frequency.

It is also typical to see lower levels between each of the different regions with strong resonance. This dropoff should have the widest bandwidth in what is known as the “nasal range”. Since our hearing is very sensitive in the nasal range, the level in this range compared to the levels in the other “strong” resonance regions is extremely important in terms of the aesthetic qualities of the perceived tonal color. Accordingly, we can define the nasal range as a fifth resonance range (from 1000 to 1800 Hz).
The level in the nasal range can be lower by up to 10 dB for good quality violins compared to the levels in the four other ranges mentioned above. If the nasal range is too dominant in the radiated sound, then the instrument will have a sound that is “nasal”, “tight”, “vulgar” and thus immediately “transparent”. In terms of the aesthetics of tonal color, the relative levels of the different resonance regions with respect to one another is very important. “Too much” can be as much of a problem as “too little”.

The influence of these resonance regions on the sound can be clearly demonstrated by taking a short musical phrase that was recorded by a solo violinist and using a parametric filter bank to artificially raise or lower the levels of the different resonance regions. The following playlist contains the original recording along with recordings in which the different resonance regions have been increased by 10 dB and decreased by 10 dB.

Your flash plugin version does not match the required version 9.0.0 for this website. Please go to http://www.adobe.com/shockwave/download/
>Javascript has to be enabled in your browser to view the content.

Click on the following link to see a full-page version of the graph and listen to the audio examples. Then, click on the blue arrow to hear the original version and on the red or green arrow to hear what happens when the selected resonance region is boosted or lowered:
www.schleske.de/hoerbeispiele/playlist10.html

If the audio quality of your computer’s sound system is adequate, you will be able to hear just how important the level balance of the different resonance regions is. We can formulate some impressions of what we hear as follows:

Helmholtz resonance too strong:

- Dull, hollow sound

Helmholtz resonance too weak:

- Thin, chirpy sound

Corpus resonance too strong:

- Hollow sound (like trying to talk with hot potatoes in your mouth) with a tendency towards wolf tones

Corpus resonance too weak:

- Flat, weak sound

Nasal resonance too strong:

- Vulgar, nasally sound

Nasal resonance too weak:

- Powerless, covered sound that does not carry

Brilliance region too strong:

- Harsh, vulgar sound

Brilliance region too weak:

- Dull, covered sound

The attributes listed above are intended as examples and will vary widely from listener to listener. What is most important is that the violinmaker needs to be able to develop common terminology with the client. As we mentioned above, it is also important to recall that in each of these ranges, “too much” can be as much of a problem as “too little”. For example, even “too little” of the nasal sound components will have a negative effect on the overall sound. An instrument that is not sufficiently nasal will have trouble being heard and cutting through, while an instrument that is too nasal will be limited to a single tonal color that is one-dimensional and vulgar due to the dominance of the nasal resonance.

Please note the following about the artificial manipulations of the resonance regions that are provided here as examples: When constructing new violins or making sound adjustments on existing instruments, entirely real attributes (such as the design of the arching, the thickness graduation or the soundpost position) are responsible for the fact that when the instrument is played, individual frequency components (harmonics) are “amplified” to varying degrees and are thus contained to a greater or lesser degree in the instrument’s overall sound. These artificial manipulations are intended only to allow you to “hear” the different resonance regions. They should help you to become more sensitive when it comes to hearing specific tonal colors and understanding what types of resonance produce them.

Additional material:

List of all of the audio comparisons:
www.schleske.de/hoerbeispiele/playlist00.html

General information about how the instruments were recorded:
www.schleske.de/hoerbeispiele/hoerbeispieleinfo.html

Information about the measurement technique:
www.schleske.de/index.php?http://www.schleske.de/06geigenbauer/akustik3schall3messmeth.shtml