Johann Sebastian Bach: his science and his faith, Doug Hayhoe, May 2023
Bach had a unique way of combining science and Christian faith in his music.

Introduction

When my siblings and I were young, our grandmother paid for us all to take piano lessons. The last piece I learned to play was a prelude and fugue by the baroque composer, Johann Sebastian Bach. I didn't appreciate his music then, nor for most of my life, preferring to listen to the classical symphonies of Beethoven or the romantic waltzes of Chopin (Table 1).

Musical periods		**Well-known musicians**
Baroque	1600-1750	Bach (1685-1750), Handel (1685-1759), Vivaldi (1678-1741)
Classical	1750-1830	Beethoven (1770-1827), Haydn (1732-1809), Mozart (1756-1791)
Romantic	1830-1900	Chopin (1810-1849), Liszt (1811-1886), Tchaikovsky (1840-1893)
20th century	1900-2000	Bernstein (1918-1990), Gershwin (1898-1937), Stravinsky (1882-1971)

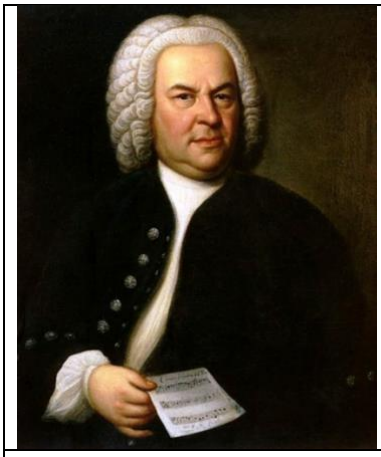
Table 1 Musical periods of Western music

Recently a friend encouraged us to go to Bach's *St John Passion*. The way Bach captured the emotions of Christ, of his disciples, and of the opposing crowd, during the first Easter week, reminded us of his unique contribution to music. He was the "master of counterpoint," a style that involves different melodies that interact, creating melody and harmony at the same time. I then read up on his faith, and began to appreciate his deep respect and belief in God's Word.

A brief biography

Bach was born in 1685, and grew up in a German family where almost everyone was a musician, including his ancestors back five generations and most of his children and grandchildren, not to mention cousins and nephews. As a toddler, he no doubt crawled behind the organs and harpsichords his relatives were constantly repairing. A few years later he repaired them himself.

He learned to perform from a young age. His father taught him violin, an uncle the organ, and a brother the clavichord (precursor to the piano). When he was fifteen, he went to Saint Michael's school, to study music, as well as Latin, Greek, and theology. When he graduated, he got a job as a teenage church organist. It wasn't long after this that Bach wrote his first prelude and fugue.



Johann Sebastian Bach
(by Ellias Gottlob Haussmann)

Bach composed all kinds of music: violin solos, orchestral music, choral music, and popular secular tunes. When he was music director in a church in Leipzig, he began each week by composing a new piece, then spent the week training the musicians and singers, so they could play it that Sunday. He also prepared for many religious holidays and royal performances.

Bach's first wife, a cousin, was also a musician. After she passed away, he married a soprano singer, who helped him with his compositions. Altogether, he had 20 children, though only half lived to adulthood. Four of these were musicians. Bach died from a bad infection in 1750.

The science of harmony

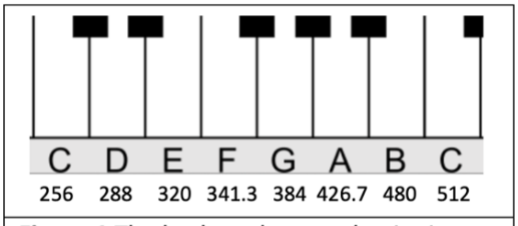


Figure 1 The keyboard octave beginning at Middle C, with frequencies listed below.

The ancient Greek philosopher Pythagoras noticed that the frequencies of notes that sound pleasant together form a simple ratio. An example is when the C an octave above is played with middle C. In the Pythagorean or harmonic system the frequencies are 512 and 256 (Figure 1). These frequencies form a ratio of 2/1. (You can hear these two C's and additional octaves above played here.)

Another pleasant-sounding combination is C and G, a "perfect fifth." The frequencies of G and C form a ratio of 384/256, which is 6/4. Yet another pleasant-sounding combination is the "major third," C and E. Their frequencies form a ratio of 320/256, which is 5/4. So, the frequencies of C, E, and G, which form a major chord, are multiples of 4, 5, and 6.

[In the Appendix, I explain why frequencies that form a simple ratio sound pleasant when sounded together. It involves the science of multiple standing waves simultaneously being set up on the strings of the musical instruments. Musicians such as Bach, of course, knew this.]

There's a big problem, however, with harmonically tuned keyboards, like the one shown in Figure 1. Major chords in other keys except C and G don't sound as nice. In the key of D, for example, the major chord involves these three notes: D (288), F# (363), and A (426.7). These frequencies aren't multiples of 4, 5, and 6, but rather 4, 5.04, and 5.9. So, the major chord doesn't sound quite as pleasant. You get the same problem in almost all the keys except C and G. This problem had been known for centuries, and many attempts were made to adjust frequencies to give a keyboard of "equal temperament," but none really caught on until Bach's day.

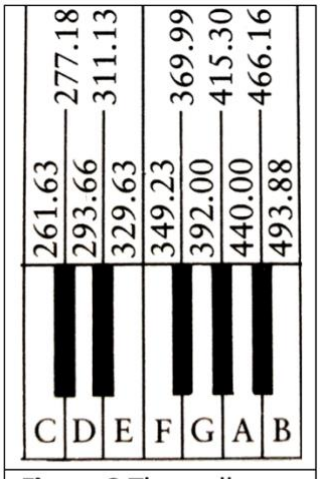


Figure 2 The well-tempered keyboard

Bach's scientific use of the well-tempered keyboard

When Bach started composing, the German organist Werckmeister had just devised a "well-tempered" keyboard. He adjusted the frequency of the twelve notes so that the full octave ratio (2/1) as well as the perfect fifth ratio (6/4) were still the same no matter what key you were in. But the compromise was that the major third ratio, which harmonically was 5/4, became a little sharper, at 5.04/4. Both Werckmeister and Bach decided that people could live with this, and thus enjoy all the keys.

Werckmeister was the theorist; Bach was the practician who quickly went to work composing both a major and minor prelude and fugue for each of the 12 keys. He also used the complex counterpoint strategy throughout. One hand plays one tune, the other hand plays another, but they respond to each other. Of course, this doesn't appeal to everyone. Perhaps that's why I preferred Chopin, in my early years!

Prelude – *a brief introduction to another longer piece or to a religious ceremony*

Fugue – *a musical composition in which a theme is repeated by successive tunes in counterpoint*.)

When Bach had finished this amazing burst of energy, the set of 24 prelude and fugues became known as *The Well-Tempered Clavier* (i.e., keyboard). It may be the most important work of music ever composed. (Here is #6 played by Paul Baron in 4 min.) Although Bach was technically still part of the Baroque era of music, "Classical and romantic composers such as Mozart, Beethoven, Schumann, and Chopin played Bach's preludes and fugues every day" (*BBC's Greatest Composers: Bach*). He became known as the father of classical music (Table 1).

Bach's Faith

Bach always signed his music "to the glory of God." And he expressed the goal of music in these words: "The final aim and reason of all music is nothing other than the glorification of God and the refreshment of the spirit." Yet, some scholars have argued that Bach was really a modernist, that his religious work was a necessary part of his job, in Lutheran Germany where he lived.

An important discovery in 1933, however, revealed Bach's true respect for God's Word. His three-volume family Bible, called the *Calov Bible,* with the date of 1732 written on its cover, was found in an American collection. It contained the text of the Lutheran translation of the Bible along with a commentary taken from Luther's writings and sermons, and organized by the Lutheran theologian Calov. It was subsequently donated to the Concordia Seminary in St. Louis.

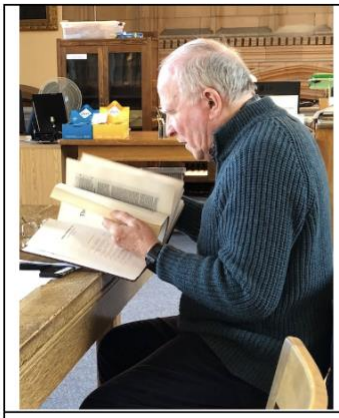


Figure 3 The author looking at Bach's Calov Bible.

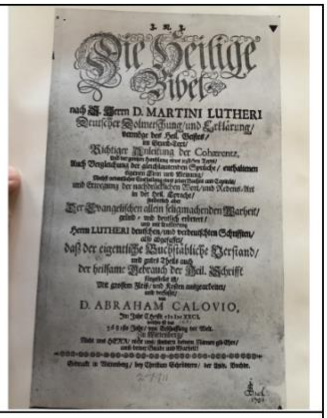


Figure 4 Bach's signature and date at bottom right

In 1985, the seminary had it scientifically examined, using advanced technology. Most of the comments and notes in it were identified as likely written by Bach himself. Copies of the Bible were then made and sold to university libraries, such as the University of Toronto. I was able to examine it this past year and see Bach's underlining, emphases (i.e., *N.B., which means "note well."),* and occasional handwritten comments. (English translations of the text and his own comments, are included in the copy.)

Commentators of Bach's Calov Bible refer mainly to his comments about the arrangement of music for the temple, in 1 Chronicles 25 and 2 Chronicles 5. In the margin beside the first, Bach had written, "This chapter is the true foundation of all sacred music." And beside the second, he had noted: "In devout music God is at all times present with his grace." Since these were written for Bach's view alone, we see here his personal faith in the Scriptures as God's revelation to us.

Two other sections of the Bible, however, intrigued me more. When Jesus teaches the priority of of peacemaking, in Matthew 5:9, and the danger of letting your anger affect relationships with others, in Matthew 5:22, Bach had written "NB" beside each. He had also marked off Luther's commentary on these verses. This was noteworthy, as Bach in his earlier years had trouble dealing with his anger, letting it rupture some relationships, according to his biographer Christoff Wolff. I couldn't help thinking that here he was submitting his conscience to God's Word.

The other intriguing section was near the end. After the well-known verse, "The blood of Jesus Christ, his Son, cleanses us from all sin" (1 John 1:7 KJV), the Calov Bible had included a long commentary by Luther on the value of the blood of Jesus. Of all the sections in the Bible that Bach had marked out, this was the longest. Anyone reading this commentary as seriously as Bach did, as indicated by his marks, would have no doubt about his deep evangelical faith in Christ and his work on the cross. (Luther's full commentary on 1 John 1:7 is in Appendix 2.)

Of course, long before the discovery of the Calov Bible, anyone who had listened to Bach's *St. Matthew* or *St. John Passion*, portraying the solemn events of the last week in Jerusalem through music and chorus, would have realized that Bach must have been deeply touched by Christ's great love and sacrifice for all of us. The wonder is that so many musicians and music critics today can be enthralled by these great passion oratorios, and yet be untouched by Christ's love.

Conclusion

There is no doubt that Bach was one of the greatest musicians ever. And part of this greatness was his ability to understand how the ear hears music. Philip Kennicott, in his 250th anniversary article in the Washington Post, concludes, "Bach, the scientific composer, would be heard as a scientist who observed how we hear, rather than dictated how we should listen." At the same time, as Christianity Today has pointed out, "Bach the musician was indeed a Christian who lived with the Bible." In fact, he was truly a person of God's two books, nature and Scripture.

Bach respected and worked with what had been discovered about how the human ear hears music, along with equally respecting and working with what God revealed about music in the Scripture. No other musician has combined such a high level of scientific skill and passion for music making, and at the same time such a deep respect for Scripture, as Johann Sebastian Bach.

Appendix 1 The science of frequency ratios and harmonics on a string

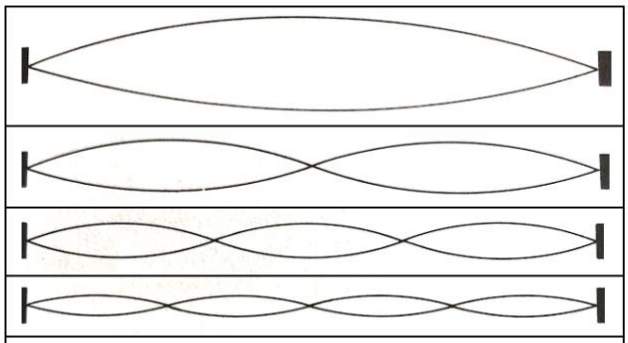


Figure 4 Standing waves on a string showing the base wave, and three overtones.

When a violin bow is drawn across a violin string, a piano string is hit by a hammer, or a guitar string is plucked by a finger, standing waves are set up on the string. The first standing wave fits only half of its wavelength onto the string (Figure 4 top). The second standing wave, the first harmonic, fits one wavelength between the two ends; the third standing wave, the second harmonic, fits one and a half wavelengths on the string, and the fourth fits two wavelengths on the string.

As the wavelength decreases, the frequency of the sound produced increases. The first harmonic, with half the wavelength of the base sound, has twice the frequency. It is an octave higher. The second harmonic has one third the wavelength and three times the frequency. It is an octave and a fifth higher. And the third harmonic, with one quarter the wavelength, has four times the frequency. It's two octaves higher. (Wavelength and frequency have an inverse relationship.)

Now we can see why the perfect fifth, C and G played together, is pleasing to the ear. The frequency of C is 256 (Figure 1). The frequency of its overtones or harmonics, which are simultaneously sounding on the string, have one, two, three, four, or five times the frequency: 512, **768**, 1024, 1280, and **1536**. So, when C is sounded, the ear hears all these frequencies. The frequency of G is 384, and the frequencies of its harmonics are **768**, 1152, **1536**, 1929, and 2304. If you compare these lists of harmonics, you see that two are shared. This duplication of harmonics, when C and G are sounded together, makes the perfect fifth sound "pleasant."

Appendix 2 The final marking in Bach's Bible, on the value of the blood of Christ

Columns 1092–1093 (fac. 266). (. . . The same blood, says Luther in Vol. IV of Altenburg p. 689, that flows from the side of Jesus Christ is the treasure of our salvation, the compensation and reparation for our sin. For through His innocent suffering and death and through His dear sacred blood spilled on the cross did Lord Jesus Christ pay for all our guilt, eternal death, and damnation in which we had been mired through sin. The same blood of Christ represents us before God and cries out for us without pause unto God: grace! grace! pardon! pardon! remission! remission! Father! Father! and gains for us God's grace, forgiveness of sin, righteousness, and blessedness. Thus cries out the blood of Jesus Christ, our only mediator and supplicant, without end, forever and ever, that God the Father attends such pleas of His dear son on our behalf and is merciful to us poor miserable sinners. For He cannot see any sin on us, even if we are covered with sin, indeed being nothing but sin, inside and out, in body and soul from head to toe, for he sees alone the precious blood of his dear Son our Lord Jesus Christ with which we are sprinkled. For this same blood is the golden cloak of grace with which we are clothed and come before God that He cannot, nor will not, see us any other way but as if we were the dear Son Himself, full of righteousness, holiness, and innocence. On the other hand the innocent blood of Christ also has such virtue and power that it absolves, frees, washes, and purifies us from all sin and misdeed; therefore, whoever is sprinkled and clothed with this blood may come before God securely and joyfully, call unto Him and hope confidently and without doubt that he will be heard, as Saint Paul says in Ephesians III. Through Jesus Christ we have joyfulness and entry with all assurance through faith in Him.)

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