Origins of Western Tonal Expectation and its Compositional Utility

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One of my earliest yet clearest musical memories took place in front of my mother's laptop when I was ten years old. I had no musical training at the time but found myself deeply attracted to classical music and often spent my free time browsing the internet, forcing the youtube recommendation algorithm to show me as many pieces as possible. That day I stumbled across a piece I hadn't seen before, a symphony by a man whose name I didn't recognize at the time: Pyotr Tchaikovsky. The title told me it was the second movement of his fifth symphony. Curious, I clicked on the video and turned up my headphones. Around two minutes in, as the french horn and the clarinet finished their duet, the music wound down to a point where I thought we'd be returning "home," so to speak. However, the harmony resolved to a completely different, and what seemed to me at the time random tonic. While I know today that Tchaikovsky uses a clever dominant voicing to modulate from D major to the distant F# major, at the time I was surprised and confused as to what had happened. I had expected something to happen harmonically and anticipated an entirely different resolution to the one Tchaikovsky had provided. Years later this concept fascinated me: if children seem to have harmonic expectations without any musical exposure or training, what are the apparently innate psychological and cognitive mechanisms behind this tonal expectation? And how do external social factors influence these mechanisms over time? Many composers in the past have used delayed resolution, dissonance, and various other harmonic techniques to add to the passion and intensity of their work, but why do these means work so well? The answer may lie within our own psychobiology. By understanding the hows and whys of these concepts, one can exercise more

expertise in compositional choices and perhaps even come closer to solving one of the mysteries of music: why does music make us feel?

Psychobiological Factors

At the forefront of tonal expectation, it is inherent that there is a pre-conceived inclination to consonant intervals and chords among infants, notably before any cultural or environmental factors can alter musical preferences. Studies utilizing looking-time paradigms have shown that babies two-months old will look at an object for longer when a consonant chord or interval is playing, such as a perfect octave or major chord, as opposed to a dissonant one, such as a tritone (Trainor, Tsang, & Cheung, 2002). Additional trials with four and six year old children solidify this pattern (Will, Roeske, & Degé, 2024) and suggest that humans are born with pre-programmed harmonic preferences. The reasoning behind this is both biological and evolutionary in nature. Physiologically, the cochlea, an organ within the ear that processes sound into frequency, and the auditory nerve, the nerve connecting the cochlea to the brain stem, encode consonant acoustic information more smoothly than dissonant.

Why these sound-processing hubs prefer consonance is due to the harmonic series of all pitched sounds. When any tone sounds, sounding also above the fundamental, or root note, are overtones. These overtones are multiples of the fundamental frequency. Consonant intervals, such as a fifth from C to G, are easily encoded by the cochlea since C and G share many overtone frequencies, making the interval easy to recognize and simple for the cochlea to encode, firing dopamine systems as it processes (Plomp & Levelt, 1965). Dissonant intervals, such as a tritone (C to F#), are less pleasant for the cochlea since C and F# share far less overtones within the harmonic series, making the interval harsh and rough to process as it irritates the same

cochlear band during the encoding process. Dopamine systems are activated to a lesser extent with dissonant chords and intervals. It is a similar concept in terms of the auditory nerve as well. Intervals and chords where the pitches have overlapping overtones engage the auditory nerve in more phase-locked, synchronized firing and hence are smoother for the brain to process (Tramo et al., 2001). This is the biological basis as to why many people have similar tonal expectations and preferences towards consonance regardless of heritage, environment, or lack-of musical training.

Different cultures share the use of consonant intervals as a foundation, despite having diverse differences in many other aspects. It is telling that octaves, perfect fifths, and perfect fourths are seen as stable and preferable intervals in Chinese traditional, Indian raga, Middle Eastern maqam, and western classical music, completely different musical cultures unified by a seemingly universal structure around these stable consonants. The anatomy and function of the inner ear and brain steer towards consonance prior to any musical exposure.

Why this mechanism exists is likely due to the evolution of hearing as humans developed speech and communication. The human voice, specifically speech and other vocalizations, follow the harmonic series pattern (Boersma, 1993) and share many similarities with the frequency ratios of consonant intervals and chords. Human hearing has evolved to receive and seamlessly encode language, as seen by the functionality of the cochlea and auditory nerve, and hence also easily encode and prefer musical intervals and sounds that share similarities or mimic the same harmonic patterns as the human voice. This inherent relationship of consonance and dissonance is why resolution in music is satisfying. When a dissonant interval, such as a tritone, is sounded, the cochlea anticipates where the overtones “should” overlap, creating the listener’s desire and expectation for resolution to a consonant sound, such as a major chord. During

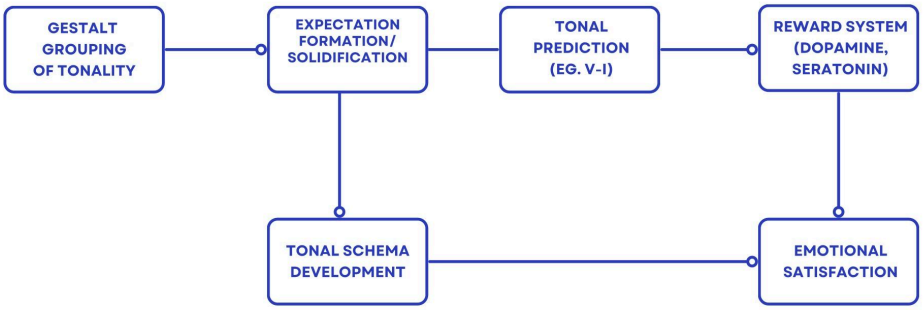
tension, such as the sounding of a tritone, chemicals such as cortisol release in the brain. But if the expected resolution is achieved, such as a dominant to tonic movement, dopamine and serotonin are found to release within the brain (Salimpoor et al., 2011).

One of the most apparent reasons behind the serenity and beauty found in Arvo Pärt's "Spiegel im Spiegel" (see notable works pg.11) is Pärt's use of stable, consonant harmony and the constant return to F major. All dissonances resolve to their respective tonics, fulfilling the tension created by the anatomical mechanisms within the ear, and rewarding the listener with dopamine. Due to hundreds of thousands of years of evolution and inclination towards language, the human brain and ear are designed to easily encode, and hence enjoy, these consonant harmonies and resolutions Pärt writes. In contrast, Anton Webern's revolutionary "6 Bagatelles for String Quartet," for example, defy the tonal expectations and preferences humans are born with, creating an unpredictable and harsher, while still musically engaging, atmosphere that non-musically trained audiences are less likely to engage with compared to the work of Pärt, Mozart, Beethoven, or any other of the more tonal composers. While there are many exceptions to this rule, and musical preference is further molded due to external factors, the first foundations of tonality and expectation are hardwired into humans' very anatomy and fortified by psychochemical motivation schemes within the brain.

Gestalt Learning and Reward Systems

These reward systems continue their moulding of musical expectation and preference as childhood development progresses, being highly influenced by the music heard during these formative years. During childhood, specifically infancy to around seven years old, the brain is the most plastic and the auditory cortex is most adaptable to incorporate language learning, and

in turn musical preferences (Lenneberg, 1967). A child who grows up listening and playing Indian ragas will develop tonal expectation and recognition for more microtonal motions over drone pitches and resolutions to Sa (tonic) that adhere to raga rules and scales. The same logic applies to a child who is surrounded by Javenese gamelan music, who will in turn learn to expect the gong strike as closure, rather than a resolution to a tonic via harmony. For individuals growing up playing and listening to classical, tonal expectation will likely center around functional harmony, tonic-dominant relationships, and western classical music forms (Trainor & Trehub, 1992). In all three of these examples, these musical preferences are moulded by gestalt-grouping learning, reward systems, particularly the mesolimbic dopamine system, and above all the music a child is exposed to during these early years (Peery & Peery, 1986). Gestalt psychology revolves around the concept that the brain organizes pieces of information into a structured whole. As one listens to a piece of classical music, the first movement to Wolfgang Mozart's K. 545 piano sonata for example, the brain organizes the acoustic information into chords, phrases, and overall structure. Cadences and resolutions, such as the strong V-I movement found at the end of the exposition of the sonata-allegro form movement, activate the mesolimbic dopamine system and reward the listener for correctly expecting said progressions, creating a sense of satisfaction. This satisfaction overtime creates and adds to tonal schemas (mental frameworks of how music should progress or resolve) that are developed in childhood. The overall process can be represented in the following diagram:



This being said, individuals who grow up with exposure to predominantly one type of music, say western classical, can very much still enjoy and learn from the music of other cultures and eras. A diverse listening and basic understanding of all music available is likely to increase overall enjoyment of music as a whole. However, the most fundamental musical expectations people hold are sculpted from the music heard and enjoyed in those formative childhood years.

Maximizing Emotional Intensity

As one listens to more classical music, particularly pre-twentieth century works, these tonal schemas that feed the reward systems within the brain become more and more solidified. Common progressions such as a circle of fifths sequence, a dominant to tonic motion, or a suspension resolving to its designated note within a chord become expectation. Fulfilled expectations are satisfying to the brain, but delayed fulfillment has been shown to increase emotional intensity associated with the music and heighten overall dopamine rewards while listening. Meyer proposed in his *Emotion and Meaning in Music* (1956) that musical emotion

and intensity comes from “frustrated expectations.” That is, refusing the brain of tonal closure and utilizing harmonic wandering is one of the keys to creating a sense of intensity, longing, and emotional depth. Pieces that have constant resolutions and expected harmonic motions, such as Wolfgang Mozart’s K.545, create a sense of satisfaction and stability. Stretching the limits of tonality and delaying harmonic resolutions, however, challenges the tonal schemas in the brain and intensifies dopamine anticipation, creating resolutions far more emotionally impactful. Individuals exposed to music with delayed cadences and greater harmonic complexity, traits often associated with Romantic and 20th-century era music, reportedly experienced more “chills” and heightened emotional moments compared to music that resolves often and has expected harmonic progressions (Salimpoor et al., 2011). Post-tonal and atonal music have a similar yet distinct effect. Individuals exposed to these types of music showed increased activity in the amygdala, the part of the brain most associated with fear and dread (Koelsch, Fritz, Müller, & Friederici, 2006). This would explain why the pieces most associated with any kind of emotional intensity, whether it be emotional chills or anxiety, utilize more dissonance, further the extension of musical phrase, and delay resolution (or do not use tonality in the first place).

Samuel Barber’s “Adagio for Strings,” voted “saddest music in the world” in 2004 by listeners of BBC’s Classic FM, is filled with delayed resolutions, deceptive cadences, intense dissonance, unresolved suspensions, and complex harmonic motions throughout the entire piece, creating a profoundly emotional experience built on withholding fulfillment of expectation from the brain. The famous climax of the work reaches to a piercing Fb major chord, an unexpected choice considering the original tonic of Bb minor, and the ending of the work hangs on an F major chord, the dominant of the home key. Barber’s work is built around never truly supplying what the brain expects, which is in part why the work is considered by so many to be full of

longing, tragedy, and emotional depth. Similar logic can be applied to Richard Wagner's Prelude to "Tristan and Isolde," the prelude to an opera following two lovers who can never truly be together. The work is famously built around the harmonically ambiguous "Tristan chord" and wanders to an intense climax that never truly resolves, symbolic of the predicament Tristan and Isolde find themselves in. Often it is the build up to what one expects to be a resolution or motion but denial of said expectation that gives many pieces their emotional intensity in western classical music.

Compositional Utility

A basic knowledge and understanding of these musical psychological and biological mechanisms are crucial to a composer's craft, especially in the realm of commission and orchestration work. When hired to arrange or compose a piece for an event, corporation, film, or any other medium, it is imperative to understand which emotional quality, and hence which music-type, is needed. If an organization asks a composer to write an anthem for an important annual meeting or gala, for example, the music written should be appropriate and listenable to the attendees of the event. Therefore, a composer should create music that, to some extent, plays into and utilizes the pre-conceived tonal and harmonic expectations of the brain. A grand anthem that has a strong tonal center, familiar functional chord progressions, and follows the expectations created by the brains of the listeners, while still throwing in some harmonic surprises and innovations to keep engagement and maximize satisfaction at eventual resolution points, would be highly appropriate and likely successful. John William's "Olympic Fanfare and Theme" is a notable example of a fully tonal, consonant work that follows functional harmony motions and limits dissonance and harmonic exploration. These attributes are entirely

appropriate and effective when one considers that the piece is intended as a prelude to the Olympics, an event watched by millions of people across the globe. Fulfilling the harmonic expectations of the millions of listeners with such a grand orchestration creates a welcome and noble atmosphere to set up the international event that is the Olympics.

If one wrote a work for the Olympics that has large portions of atonality, for example, listeners would likely struggle to connect with the work in the manner presented as it would go against the tonal expectations they likely developed in childhood. Intense dissonance and atonality would create an atmosphere not in line with the energy of the Olympics. Said atonal or post-tonal techniques would be appropriate for film scenes that aim to maximize tension, for example, or for a work that represents an emotionally profound and dark concept. In these instances, tonal harmony that plays into every expectation of the mind would fall short of the intensity required. A famous example of this is the appearance of Béla Bartók's "Music for Strings, Percussion, and Celesta" at the beginning of the 1980 horror film, "The Shining." The dissonance and tonal ambiguity that never truly resolve within the work goes against the expectations of the ear, activating the amygdala and creating a sense of tension, fear, and forebodingness that sets up the mood for the rest of the film.

Realistically, a composer needs a combination of tonal, atonal, and post-tonal harmonic techniques to provide the best work for any commission or event. Benjamin Britten's "War Requiem," composed for the consecration of the Coventry Cathedral in 1962, is a notable example of a work that utilizes tonal idioms while also adding quasi-atonal sections to maximize the emotional impact for the listener. The sections that use Latin liturgical text are mostly modal and quasi-tonal in nature. The Wilfred Owen war poem passages, however, have intense atonal qualities and emphasize harsh dissonances that highlight the brutality of war. This toolbox of

expanded tonality was essential for creating a work appropriate for both the consecration of a cathedral and to represent the horrors of war that lingered at the time. Composers in this modern age must strive to understand and artistically appreciate the entire harmonic spectrum of classical music available in order to confidently write for any commission, or simply to write for their own best self.

On the point of personal composition (to write for one's private, non-commercial portfolio), knowledge of how to fulfill or violate existing tonal expectations among listeners remains a crucial skill. Within a singular piece, one may want one section to be relaxing and serene, immediately jump to an anxiety-inducing whirl of notes, and then close with a passage eliciting intense longing. Study of the psychobiology that makes up tonal schemas would allow a composer to know what harmonic devices to employ for each section to successfully invoke each intended emotion. The composer’s process would be rendered more precise and replicable with less guessing.

Tonality, cadences, and chord progressions are not the end-all-be-all of why different types of classical music convey different emotions and intensities. When the brain is developing its tonal expectations during childhood, it is also creating musical schemas for rhythm, timbre, tempo, pitch range, and a myriad of other factors. Similar to how a composer can employ a sudden change to more complex or dissonant harmony or extend a phrase for emotional impact, they could also fulfill or go against the brain’s expectation of rhythm, timbre, or tempo, for a desired emotional effect. Edward Gregson creates a sense of urgency in the first movement of his “Concerto for Euphonium and Orchestra” by constantly playing with varying time signatures and placement of accents, often tricking the brain into a false sense of expectation-fulfillment before completely changing directions. In terms of orchestration as a tool to invoke emotion and defy

expectations, Aaron Copland's "El Salón México" will settle into a set instrumental timbre before suddenly adding or dropping out the majority of the orchestra, creating an atmosphere of excitement and anticipation. Harmony and different approaches to tonality are but one important piece of the compositional toolbox a dedicated composer must build. A composer can acknowledge and utilize the psychological and physiological factors that influence tonal expectation to their advantage. Tonal palettes are developed over years of musical exposure, molded by gestalt grouping and expectation-fulfillment dopamine reward systems. Knowledge of how the brain forms these expectations and their impact on musical enjoyment can allow a composer to more easily choose appropriate types of tonality for a musical work based on the context at hand. Such understanding doesn't just give the composer knowledge, but also a strategy to make a listener truly feel.

Notable Works to Listen to and Their Relevance

I: Pyotr Tchaikovsky's "Symphony in E Minor," second movement (1888)

- Employs an unexpected turn from the movement tonic D major to the distant F# major via a clever dominant voicing, defying expectations and regrouping listeners' attention.

II: Arvo Pärt's "Spiegel im Spiegel" (1978)

- Use of consonance and simple harmony that allows for smooth cochlear encoding, creating a sense of calmness and serenity.

III: Anton Webern's "6 Bagatelles for String Quartet" (1913)

- Heavy use of dissonance and atonality that goes against the consonant expectations of the cochlea and brain, creating an intense and dark atmosphere.

IV: Wolfgang Mozart's "Piano Sonata No. 16," first movement (1788)

- Strong dominant to tonic cadences and clear functional harmony reward the brain for correctly anticipating their arrival and progression, creating an immediate sense of satisfaction.

V: Samuel Barber's "Adagio for Strings" (1938)

- Denies automatic fulfillment of tonal expectations via delayed harmonic resolutions, impactful dissonances, and extensions of phrases to create a deep sense of longing, tragedy, and at times, pain.

VI: Richard Wagner's Prelude to "Tristan and Isolde" (1859)

- Full of longing and desire that is achieved via tonal ambiguity (the Tristan chord), chromatic voice leading, and refusal to resolve to a stable tonic even at the climax of the work.

VII: John William's "Olympic Fanfare and Theme" (1984)

- Strong use of consonance and functional harmony that fulfills pre-conceived tonal expectations for the listener, creating a satisfying sense of grandeur.

VIII: Béla Bartók's "Music for Strings, Percussion, and Celesta" (1936)

- Heavy use of dissonance and tonal ambiguity that leaves the brain's search for consonance unfulfilled, creating a feeling of foreboding or anxiety.

IX: Benjamin Britten's "War Requiem" (1962)

- Employs different harmonic approaches to different sections of text. Latin text passages use modal and more consonant harmony, symbolizing hope and the consecration of the cathedral, while the Wilfred Owen war poem passages have intense dissonant and quasi-atonal harmony, symbolic of the horrors of war.

X: Edward Gregson "Concerto for Euphonium and Orchestra," first movement (2018)

- In addition to being full of innovative harmony and counterpoint, the work further plays with the expectation of the ear by shifting time signatures and accent placement, creating a sense of urgency in the rhythm.

XI: Aaron Copland's "El Salón México" (1936)

- Utilizes changes in orchestral timbre to keep engagement and amplify or diminish intensity throughout the work.

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