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# Deconstructing Chaos: The Role of Pitch Hierarchy in Music Perception



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## Introduction:

During the early twentieth century, art music composers pushed Western tonality to the limits and eventually abandoned tonality altogether, creating a system of composition that treated every pitch equally. This atonal system broke down all keys and harmonic progressions that are cornerstones of Western musical pitch hierarchy<sup>14</sup>. Pitch hierarchy is defined as the preferential treatment of certain notes over others in the context of the octave<sup>3</sup> and atonality is defined as any musical style that seeks to deny pitch hierarchy or the presence of a tonal center<sup>3</sup>.

Composers of this new atonal style, specifically Arnold Schoenberg, believed this evolution of pitch treatment mirrored the evolution of society and that "the extreme chromaticisms of twentieth-century harmony [were] evidence of European civilization having progressed up the scale of aural discrimination to higher reaches of the harmonic series, beyond the quasi-diatonic scale of harmonics 8-16 and into more subtle regions of pitch and interval nuance"<sup>8</sup>. This project will investigate the legitimacy of this claim from a physical, mathematical, ethnomusicological and biological basis.



## Objectives:

This project, done as a review of current literature, will seek to answer the following questions through an integration of scientific understanding applied to musical phenomena:

- How can we identify tonal and atonal musical structures even without musical training?
- How do our brains process tonal hierarchy?
- Is this perception of tonality an innate process or is it learned over time and repetition?
- With this analysis, is Schoenberg's theory that humans have evolved to perceive the upper regions of the overtone series a plausible claim?

## Ethnomusicology:

- All musical cultures of the world (with the exception of Aboriginal Australians) base musical pitch hierarchy on the interval of the octave, which is exceptional when considering differing cultural styles have little else in common<sup>14</sup>.

## Physics:

- Sound travels as a wave, with a specific frequency that is directly translated into pitch recognition by the brain<sup>5</sup>.

- Consonant and dissonant intervals can be described by the ratios of the frequencies of sound waves produced and perceived<sup>13</sup>.

- When a sound wave is produced from a natural source, there are also overtones produced by the vibrations of standing waves in the air. The first overtone produced is the interval of the octave<sup>13</sup>.

- The overtone series is the physical basis for the octave as the fundamental interval or musical structure. Other consonant intervals preferred in Western tonal hierarchy (the perfect fourth and perfect fifth) also appear early in the overtone series<sup>14</sup>.

- The contrast of consonance and dissonance is most often used to create sense of expectation in music<sup>5</sup>.

- Dissonant intervals contain beat frequencies that are too close together to be resolved, cause coarse fluctuations in the firing of auditory neurons and give the perception of roughness<sup>7</sup>.

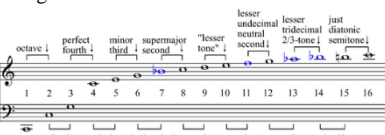


Figure 1: Harmonic series as musical notation with intervals between harmonics labeled. Blue notes differ most significantly from equal temperament

## Physiology:

- Sound waves enter our ears and are picked up by tiny hairs in our inner ears.

- The basilar membrane of the inner ear contains hair cells that are frequency selective, firing only response to a certain band of frequencies<sup>10</sup>.

- For progressively dissonant music, blood flow to the right amygdala (fear center of the brain) increases. Blood flow to the orbitofrontal cortex and subcallosal cingulate decreases<sup>7</sup>.

- For "pleasurable" music blood flow in a network of cognitive, emotive and autonomic areas increase and blood flow to limbic structures, especially the amygdalae, decreases<sup>7</sup>.

- The brain stem and the dorsal cochlear nucleus (structures that are so primitive that all vertebrates have them) can distinguish between consonant and dissonant intervals; this distinction happens before the higher level, human brain region - the cortex - is involved<sup>6</sup>.

## Neurobiology:

- Consonance in the vertical direction is a positive phenomena in itself, not simply caused by the absence of dissonance<sup>9</sup>.

- When a consonant interval is perceived, the fine timing of the auditory nerve contains strong representations of harmonically related pitches implied by the interval in addition to the pitches of notes actually present in the interval<sup>7</sup>.

- Contrastingly, dissonant intervals evoke auditory nerves that do not imply harmonically related pitches<sup>7</sup>.

- The structural processing (musical syntax) has been localized to the frontal lobes of both hemispheres in areas adjacent to and overlapping with those regions that process speech syntax, such as Broca's area, and shows up regardless of whether listeners have musical training<sup>6</sup>.

## Conclusion:

The octave can be assumed to be the basis of all musical systems. The significance of this interval creates an inherent structure for pitch hierarchy as a central tenant of musical cognition. Though the preference for other intervals may be learned through socialization, our preference for the octave is both an innate, biological phenomena, and also a product of constant exposure to this interval throughout our lives from the overtone series.

The preference for consonant intervals, often found at cadence points in tonal music, is also an innate process. The physiological and biological changes associated and observed with the perception of consonant intervals implies neurological basis for cognition. This physiological response that precedes higher brain function explains why advanced musical training is not necessary for the perception of tonal and atonal structures. In light of these observations, it seems unlikely that, as Schoenberg predicted, Western society would begin to discriminate and preference the upper, non-diatonic region of the overtone series.

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