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## **AUDITORY ILLUSIONS IN MODERN FILM INDUSTRY AND MUSIC**

Auditory illusions are one of the most entertaining phenomena, based on the peculiarities of the structure of our brain. Unlike optical illusions, they are not so easy to recognize. The listener hears either sounds which are not present in the stimulus, or "impossible" sounds. Auditory illusions highlight areas where the human ear and brain, as organic survival tools, differ from perfect audio receptors (for better or for worse).

Pitch is a perceptual property of sounds that allows their ordering on a frequency-related scale, or more commonly, pitch is the quality which makes it possible to judge sounds as "higher" and "lower" in the sense associated with musical melodies.

However, one cannot model pitch as a one-dimensional phenomenon. A problem with such a model is that it cannot account for perceived similarities between pitches that are not next to each other on a one-dimensional scale. An octave is the interval between two pitches when the frequency of one equals twice the frequency of the other. All notes of a certain type coincide if one views the helix from above. The helix becomes a circle, specifically, the chroma circle.

In 1964 Roger Shepard surmised that if one could take pitch height out of the equation, listeners would hear only chroma. He created what have come to be known as Shepard tones — tones that have specific chroma (C, B-flat, etc.) but no specific

height. When listeners hear an ascending chromatic scale using Shepard tones, they hear the scale constantly rising, but never getting any higher in reality.

As a side effect the Shepard tone by its nature builds tension and suspense, hence it is used in music, movies, video games etc. For example it is very commonly used in electronic dance music. As the so called 'build-up' in progressive dance music is a very important aspect of the musical structure, the Shepard tone can be used as an effect to raise the song's energy to a certain level.

It was used in the ending of the song "Echoes" from the album *Meddle* (1971) by English rock band Pink Floyd. There a Shepard tone fades out to a wind sound, which creates special mood. Also, the Austrian composer Georg Friedrich Haas uses a Shepard tone effect towards the end of his orchestral piece *in vain* (2000/02).

In the film *The Dark Knight* and its follow-up *The Dark Knight Rises*, a Shepard tone was used to create the sound of the Batpod, a motorcycle which the filmmakers didn't want to change gear and tone abruptly but to constantly accelerate. Richard King, the sound designer behind *The Dark Knight*, said that "Chris [Nolan] had the idea that it should never shift, that it should keep ascending in pitch like an unstoppable force, we had an idea to use a concept called The Shepard Tone." The team later captured the sounds from electric race cars and Tesla models to find the base pitch to create the Bat-Pod's Shepard Tone.

It is being used a lot in Hans Zimmer productions (*Interstellar*, *Dunkirk*). For example, in the *Dunkirk*, a Shepard tone is used to create the illusion of an ever increasing moment of intensity across intertwined storylines.

## References

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