Research Proposal
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Spatial Metaphors in Pitch Perception

The proposed research project examines spatial *metaphors* used to describe aspects of pitch perception. The question to be answered is: How seriously should we take these spatial metaphors – in what sense do they capture aspects of spatial perception that are truly akin to genuine spatial perception? By extension the project illuminates the nature of genuine spatial perception. The project unfolds in three phases.

Phase 1

The project will focus on two persistent and cross-culturally robust spatial metaphors. The first is the familiar 'pitch height' metaphor: the greater the frequency of the sound, the 'higher' its pitch. The second,'harmonic space', represents the fact that, e.g., two adjacent keys on the piano will produce tones that are more dissonant when sounded together than two keys separated by an octave, despite being closer in pitch height, by plotting more dissonant pitches at more distant points (relative to one another) on a lattice.[1]

These spatial metaphors have been given precise mathematical descriptions by psychoacousticians and music theorists. However, we lack an integrated model of them, despite the fact that the perception of pitch height and harmonicity interact. For instance, slight changes in the harmonic relations among constituents of a complex sound can alter the perceived pitch of the sound. Therefore, a complete description of either aspect of pitch perception must integrate the two 'spaces'. In Phase 1, I will develop a mathematical description of a pitch space that does just this. The model will be designed with an eye toward the operations of the neural mechanisms responsible for pitch perception – in particular, those responsible for the interactions between pitch height and harmonic perception.[2]

Phase 2

Phase 2 will examine the mutual constraints that the phenomenal character and representational contents of pitch experience impose upon one another. The approach takes the pitch space model of Phase 1 as its basis, noting that this model describes the structure of the qualitative character of pitch experience. This provides a locus for the analysis of phenomenal character and content – namely, their structural similarity. Particular attention will be paid to the physical attributes of sound waves (especially frequency and wavelength), how these interact with one another in composite sounds (sounds with many frequencies), and how these relationships relate to the structure of pitch space.

This discussion should hold generalizable lessons pertaining to the debate over the relation between phenomenal character and representational content in the philosophy of perception: By examining the structure of phenomenal character (as revealed in spatial metaphors accurately describing them), we will be able to offer a more nuanced exploration of the interaction of representational contents and phenomenal character than has heretofore been offered. Existing discussions rarely appeal to the

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[1] This metaphorical space was first developed by the mathematician Leonhard Euler (1739); Euler called it the 'Tonnetz', i.e., 'tone-network'.

[2] Insofar as these are known; insofar as they are not known, this will suggest an area for fruitful collaboration with researchers on audition in the empirical sciences.

structure of phenomenal character. Rather, they trade in general arguments for (or against) the claim that representational content determines phenomenology (and/or vice versa).[3]

Phase 3

Phase 3 will examine what – other than being describable as a mathematical space – is necessary for genuine spatial perception. One straightforward thought is that genuine spatial experience represents genuinely spatial properties, whereas experiences that are described using (mere) spatial metaphors do not. However, it is not obvious what counts as a 'genuine spatial property'. After all, pitch is primarily determined by the frequency of a sound wave, and sound waves are spatially extended – frequency is intimately related to wave*length*. If a line is to be drawn between spatial metaphors and genuine space in perception, it will need to appeal to other features of perceptual experience. For instance, paradigmatic instances of spatial perception (e.g., visual experience) are anchored to a vantage point while pitch perception is not – we don't occupy a position in pitch-height space from which we hear sounds.

To address this issue, I will introduce a way to represent a hypothetical vantage point in pitch space by treating experienced intensity as vantage point-dependent: Given a vantage point in pitch space, the perceived intensity of a frequency is a function of its 'intrinsic' intensity and its pitch height and harmonic distance from the vantage point.[4] This will allow us to model hypothetical movements of a perceiver through a pitch space populated with auditory objects in light of the resulting alterations of the perceiver's experience of those auditory objects.[5]

I will present scenarios describing such movements under different conditions (e.g., whether or not the vantage point/multiple auditory objects can occupy the same point in pitch space, how closely the structure of pitch space matches the structure of the space it represents) and test these against intuitions as to whether or not the scenarios described amount to genuine spatial perception. This will open onto a discussion of the extent to which our intuitions concerning the perception of space are governed by our intuitions concerning the ontology of space, and vice versa.[6]

I will share my results in three separate papers, corresponding to the phases of the project. The first will present my integrated pitch space model from Phase 1 and will be aimed at an interdisciplinary audience of philosophers of perception, psychoacousticians, perceptual psychologists/cognitive neuroscientists, and researchers in music theory and cognition. The remaining papers, presenting the results of Phases 2 and 3, will be written for a primarily philosophical audience – particularly for philosophers specializing in perception and cognitive science. I also plan on writing a paper that compares the results generated with respect to pitch perception to borderline cases spatial perception in other sensory modalities, such as the perception of depth in pictorial space.

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[3] Austin Clark's work on the structure of visual phenomenology is a notable exception. However, no work in this vein has been done on auditory perception. Phase 2 will also fruitfully intersect with theories of mental content that point to isomorphism/homomorphism as content-determining. These theories tend to focus on relatively complex phenomenal structures (when they focus on phenomenology), such as those implicated in object recognition or pictorial representation. My work focuses on the structure of quality spaces (e.g., pitch and less directly, color) – that is, at the fundamental building blocks of phenomenal character.

[4] The idea is that intensity decays as a sound traverses pitch space. So the 'intrinsic' intensity can be calculated from the perceived intensity and the overall distance from the vantage point in pitch space.

[5] These 'auditory objects' have a spatial structure in pitch space which becomes apparent to our hypothetical listener by the sounding of the pitches corresponding to the locations the object occupies. The principles for grouping pitches into a composite sound will be the same as those governing our own groupings of pitch components into composite sounds – see Bregman (1990), *Auditory Scene Analysis*.

[6] The approach taken in Phase 3 is inspired by Strawson (1959), *Individuals*, chapter 2, though my aims are different and my analysis of auditory experience is more sophisticated.