Sounds

Casey O'Callaghan (Bates College)

Oxford Companion to Consciousness
Editors Timothy Bayne, Axel Cleeremans, and Patrick Wilken

Philosophical work on perceptual consciousness traditionally has focused upon vision and visual experience. Considering other varieties of experience, however, reflects the diversity among things and features of which we are conscious. Attention to audition, in particular, has much to contribute to a more comprehensive understanding of perception and sensory awareness. Because they differ in several important respects from visual experiences and their objects, auditory experiences and the nature of sounds hold particular significance for investigating perceptual consciousness.

What do we hear? Sounds are, in the first instance, what we hear. They are the immediate objects of auditory experience in the following sense: whatever else we might hear, such as ordinary objects (bells, trumpets) and events (collisions, typing), we hear it in virtue of hearing a sound. Sounds are not, however, experienced as private items or sensations akin to pains or nausea. Sounds audibly appear to populate the world beyond our ears. Sounds are, in Moore's sense, "things to be met with in space."

What sort of thing is a sound? Science has taught that sounds are waves. Waves, then, are what we hear according to the predominant view of sounds. Philosophers, however, often have grouped sounds, along with colors and tastes, with the sensible or secondary qualities. According to this traditional line of thought, sounds are either dispositions to produce experiences, categorical bases of such dispositions, physical properties, or simple primitive features revealed in experience. The choice depends on one's view of the natures of sensible qualities. According to a third line of thought, it has recently been suggested that sounds are a certain kind of audible event. This view is motivated by several arguments grounded in the phenomenology of auditory experience which indicate that sounds might be neither waves nor sensible qualities.

Where do we hear sounds to be? Hearing, like vision and probably unlike taste, is a spatial modality. We learn through audition not just about whether a sound is high-pitched or loud, but also something about the location of its source. We learn through auditory experience not just the source's direction, but also that it occupies a certain location in egocentric space. Cues to spatial hearing include interaural time and level differences, head and pinnae-related signal transformations, secondary reflections, and motion-related changes. Sounds furnish information about source locations because sounds audibly seem to be located outside the head in some direction, or *externalized*. Externalization is the sense in which the sound seems in auditory experience to come from or to be located beyond one's ears. Notice, however, that sounds do not ordinarily seem to travel through the surrounding medium. They do not appear to move at all unless their sources do. The spatial experience of a sound is notably unlike the auditory analog of experiencing an incoming snowball. So, sounds seem to *come from* sources only in the sense that sounds seem *generated* or *caused* by their sources.

Are sounds waves? Given the apparent distal locations of sounds, some have argued that the traveling wave view of sounds implies a systematic illusion concerning the experienced locations of sounds. Since the wave travels through the medium, but

the sound seems to be located at a distance, we misperceive the spatial locations of sounds if sounds are identical with waves. On the other hand, if location perception is not systematically illusory, then sounds are not waves.

Do sounds have spatial boundaries? Though spatial auditory experience shapes our understanding of the place of sounds in the world, spatial features play a different role in the perceptual individuation of sounds than in the visual individuation of objects. In particular, the spatial boundaries so critical for visual objecthood play a far less important role in audition. For example, spatially distinct sources might seem to make a single sound if they share pitch, and a single source might seem to have multiple sounds that differ in pitch.

The experience of sounds is most notable for its temporal characteristics. Sounds are creatures of time. Sounds appear to have durations and to occur, occupy, or unfold through an interval of time. It is difficult, in fact, to conceive of a sound lacking a lifetime: how could there be an instantaneous sound? Sounds not only take time, but also survive and persist through changes to their audible attributes over time. In many examples, such as the sound of a spoken word or a bird's call, the pattern of changes through time is central to the identity of a particular sound. It is intuitively plausible that not all that is required to be a given sound exists at any moment during its lifetime. The auditory experience of a sound in this respect differs from the visual experience of an object.

Sounds as consciously experienced thus are naturally taken as the bearers of audible qualities that persist through time and survive changes. Sounds, therefore, are best understood as particular individuals and not as repeatable properties. But sounds, unlike ordinary objects, are not intuitively wholly present at any moment at which they exist. A view according to which sounds are particular events, and not repeatable properties or object-like particulars, may therefore best capture the temporal characteristics revealed in the experience of sounds.

Is there empirical support for this view? Such a view is in fact vindicated by empirical work on audition. Bregman's (1990) work on *auditory scene analysis* describes perceptual mechanisms for the segregation of distinct *auditory streams* within acoustically complex environments. Auditory scene analysis is the task of individuating sound streams in the presence of interfering signals and background noise. Streams serve as the locus of binding for particular audible qualities, survive changes, persist through masking, and co-exist with simultaneous streams.

Which audible qualities do sounds possess? Sounds as they unfold through time can be distinguished in terms of patterns of pitch, loudness, and timbre. Arguably, other audible attributes of sounds depend upon these basic features. Characterizing these uniquely audible qualities requires confronting both familiar issues and novel questions concerning subjectivity and the sensible qualities. Since the apparent pitch, loudness, and timbre of a sound depend at least upon frequency, intensity, and spectral composition of a sound wave, and since such physical attributes depend upon patterns of movement and pressure variation over time, the audible qualities themselves depend upon temporal characteristics of waves.

What is pitch? Pitch is that attribute in virtue of which sounds can be ordered in respect of "height" of tone. Among pitched sounds, the apparent pitch of a tone depends upon the tone's fundamental frequency or periodicity, which is determined by the associated pattern of pressure differences through time. Tones heard to

match in pitch share fundamental frequency, though they may differ in spectral composition. Nonetheless, the predominant view of pitch among audition researchers holds that pitch is a purely subjective or sensational correlate to frequency. Strictly speaking, on this view, sounds do not have pitch. Conscious experiences have pitch, or else experiences misleadingly present sounds as having pitch. This form of philosophical subjectivism or error theory is motivated by empirical results taken to demonstrate that no straightforward physical attribute of sound waves corresponds to perceived pitch. In particular, it is commonly claimed that physical (fundamental) frequency is not identical with pitch as it is experienced because equal frequency intervals do not translate to equal pitch intervals. Frequencies therefore cannot not capture the structural relations among experienced pitches; if pitch were frequency, subjects would radically misperceive pitch relations. Many auditory researchers, finding no objective physical candidate for pitch, have developed alternative (extensive) pitch scales based upon units of *mels* or *barks* which capture subjective pitch magnitudes.

Is subjectivism mandatory? From a philosophical standpoint, familiar alternatives might avoid the epistemic consequences of the subjectivist and error-theoretic mainstream account while capturing the differences between apparent pitch and frequency. Pitches might be dispositions to produce distinctive pitch experiences, or primitive properties of sounds that depend upon but are not identical with any physical properties of sounds. In fact, the evidence does not even rule out physical pitches. Pitch might be a more complex physical property of sounds that is not identical with (fundamental) frequency, but which nonetheless causes pitch experiences in the appropriate manner. Such complex physical properties would be interesting from an anthropocentric point of view, though perhaps not from the point of view of physical theorizing, which aims for the simplest, most complete characterization of physical reality.

What is loudness? Loudness presents similar difficulties. The consciously experienced loudness of a sound does not vary as a simple function of either the amplitude, intensity, or power of a sound wave. The volume of sound one experiences also depends, for instance, upon aspects of the spectral composition of complex waves. As with pitch, no simple physical correlate to experienced loudness exists.

Are there any reasons to think loudness is objective? Subjects situated at different locations might enjoy different loudness experiences thanks to dampening that occurs with increasing distance from the sources. *Loudness constancy* effects might nonetheless support the claim that loudness is an objective feature of sounds and not a mere conscious sensation by avoiding arguments from variability: though wave attributes upon which experienced loudness depends change with distance from the source, subjects judge little difference in the loudness of a sound despite changes to their distance from the source.

What is timbre? Timbre is difficult to characterize, and derisively has been dubbed "the psychoacoustician's multidimensional wastebasket category." Tones that share pitch and loudness might differ in timbre, quality, or "tone color", and timbre therefore is critical to recognizing the identities of sound sources in one's environment. As such, it depends at least upon the specific sinusoidal constituents and overall wave shape of a complex signal. It depends, in addition, upon aspects of the attack (onset) and decay (offset) of a signal. Timbre therefore is closely tied to the particular medium-disturbing activity of a sound source. Handel (1995: 441) claims that "*no* known acoustic invariants can be said to underlie timbre" and

suggests that timbre is best likened to the distinctive *look* of a face, which remains recognizable across changes to determinate features.

Are sounds all we hear? Awareness of sounds and audible qualities seems to provide awareness of things and events distinct from sounds, such as bells and backfires. In hearing a bang, for instance, we often seem to hear a collision. One view holds that this is mere inference or association. However, cross-modal illusions and perceptual effects (see *cross-modal perception*) might shed light on how audition grounds genuine awareness of environmental sources of sounds. If explaining illusory interactions among perceptual modalities requires ascribing to them common objects of experience in non-illusory settings, then since sounds are not visible, sounds are not all we hear. Rather, we experience a sound *as* the sound of some significant event that *also* stimulates visual experience. Cross-modal illusions and interactions thus provide fertile ground for future investigation of audition and its relationships to other forms of conscious perceptual experience.

Bibliography

Blauert J (1997). *Spatial Hearing: The Psychophysics of Human Sound Localization*. MIT Press, Cambridge, Massachusetts.

Bregman A (1990). *Auditory Scene Analysis: The Perceptual Organization of Sound*. MIT Press, Cambridge, Massachusetts.

Casati R and Dokic J (2005). Sounds. In E Zalta, ed, *The Stanford Encyclopedia of Philosophy*.

Handel S (1995). Timbre perception and auditory object identification. Chapter 12 in B Moore, ed, *Hearing*. Academic Press, San Diego, California.

O'Callaghan C (2007). *Sounds: A Philosophical Theory*. Oxford University Press.

Pasnau R (1999). What is sound? *Philosophical Quarterly*, **49**, 309-24.

Zwicker E and Fastl H (2006). *Psychoacoustics: Facts and Models*. 3rd edition. Springer, New York.