

My main target here is the nature and perception of ordinary environmental sounds, such as bangs, rattles, beeps, clicks, chirps, and rustles. It might surprise some that I do not address, at length, the phenomenon of speech perception. Speech is a complex, vexed topic that deserves its own book-length philosophical treatment. Furthermore, it is not immediately evident either how speech sounds bear upon the metaphysics of ordinary sounds or how perceiving speech impacts our account of the perception of ordinary environmental sounds. Speech perception, and, in particular, the seemingly perceptual grasp of words, their force, and their content, likely involves perceptual mechanisms that are, in significant measure, distinct from those that deal with other sorts of environmental sounds. Speech perception is not, after all, afforded simply by the capacity to hear in one's environment—many animals perceive sounds but do not perceive speech. So I have kept from attempting a full account of the sounds of speech, and of perceiving speech. Nonetheless, the theory I propose, according to which sounds are events, and my conclusions concerning cross-modal illusions have natural applications to the philosophical problems of speech.

Similarly, I do not attempt to develop an account of music or musical experience. I leave that, for now, to the philosophers and cognitive scientists of music. I hope that my remarks about the nature of sounds and auditory perception will enrich their discussion.

The landscape this small move reveals leaves work enough. This book is not my attempt to reconcile auditory perception with a general theory of perception. Though certain themes will become evident, and I make proposals concerning how to move ahead, I hope for now to provide a framework for that dialogue. My aim here is to bring into view those features of sounds and auditory experience that inform metaphysical and perceptual theorizing, and that constitute the central problems of the philosophy of sound.

C.O.

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of material objects can seem compelling. All you have to do to confirm it is to close your eyes and reflect on the character of your auditory experience. (Nudds 2001: 210)

If vision is the paradigm for perception, and perceptual awareness involves in the first instance the experience of ordinary material things and their attributes, then it is no surprise that sounds should be suspect (and favored terrain of enterprising idealists). And it is no wonder that some have understood the world of sounds as a world without space. For sounds do not seem in auditory experience like ordinary objects, and we do not hear them to qualify ordinary objects in the way that visible attributes do. The world of sounds confounds visuocentric thought.

1.3 Toward Sonic Realism

Vision, in fact, seems a dubious paradigm if we hope to understand all the senses as ways of encountering, experiencing, and perceiving one's environment. At first impression, it is shocking that considerations relevant to theorizing philosophically about smells, odors, pitches, or warmth should mirror those that impact the theory of colors, brightness, or visible shapes. What is striking is the diversity of experience, and that experience reveals so much variety. Awareness in heterogeneous modalities discloses items that appear as particulars or as attributes, though not necessarily as ordinary objects or their attributes. Such items and features may appear bound to particulars, but they may seem produced or generated by distinct entities. They may seem located in three-dimensional space or to have no sensible location. The information our senses furnish about commonplace material objects and happenings may seem more direct or at great remove. Their qualities may constitute spaces with one dimension or with many, and they exhibit seemingly incommensurable characteristics. If we hope to discover what it is to perceive or to discern the natures of the things we sense, devoting attention to the umpteen ways of experiencing is unavoidable. A clearheaded philosophy respects where

experiences and their objects are alike and recognizes where they differ.

Abandoning visuocentrism frees us to regard sounds as of interest not only for what they reveal about the world and about what is visible, but also as entities in their own right. Freedom from focus on the visual encourages us to eliminate confusion about the place of sounds and to capture the character and usefulness of auditory awareness. This does not mean we should be indifferent to what unifies perceptual experience, or to what constitutes perception's nature and distinctive function. Rather, we should resist uncritically permitting a privileged modality to drive the unifying explanations where we risk leaving out important facets of what we aim to explain.

If sounds are mysterious, ethereal, or mental artifacts, it is in fact difficult to grasp why it might be so useful to perceive them. Taking sounds seriously does not mean considering them in isolation. Audition furnishes 360° awareness of a three-dimensional spatial field and directs the orientation of visual attention toward the sources of perceived sounds. Awareness of sounds provides information about the sorts of objects that populate the environment, about what those objects are doing, and about how they interact. Audition surpasses vision in the ability to detect change and in the ability to monitor multiple sources of information. These capacities suit audition for the perception of speech, a task that for most of us frustrates unaided vision. Investigating the nature of sounds, as we perceive them, without excessive pressure from the visual model allows us to make sense of how hearing functions and why it functions as it does.

Suppose sounds are not merely mental artifacts of sensation. Suppose that a sound can seem distinct from oneself, and that subjects sometimes really do hear sounds. Sounds, that is, frequently are the targets of a perspective. Realism about sounds—*sonic realism*—is the view that the world contains sounds whose existence is not entirely dependent upon the auditory experiences of subjects. Realism about sounds as I shall develop it maintains, furthermore,

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requires awareness of nothing more than that sound and its attributes.¹

Sounds frequently are characterized by the pitch, timbre, and loudness they seem to have. But this still tells us very little about what kind of thing a sound is—what ontological category it belongs to. That is a question any theory of sounds must answer.

From the outset, two initial kinds of constraint bear on the theory of sounds. The first is phenomenological. Given that sounds are among the things we hear, how we hear them to be is relevant, *prima facie*, to theorizing about what sounds are. All else equal, an account that captures the phenomenology of auditory perception is preferable to one that does not. The reason is straightforward. Sounds, as we hear them, seem to have certain features. All else equal, the best explanation for why audition presents sounds to have a given feature is that sounds have that feature. Presumably no such pressing phenomenological constraint pertains to theorizing about electrons, for example.

The second set of constraints is epistemological. Given that hearing grounds beliefs about sounds, ordinary objects, and happenings, an account of sounds and their perception should make possible such beliefs. The account therefore should be compatible with our having some form of perceptual access to the sounds. But, since audition informs us about the world beyond sounds, sounds also must bear to ordinary things and happenings relationships appropriate to furnishing such information. It is natural to hope that the phenomenology of auditory perception will not be at crossed purposes to an adequate epistemology of auditory belief. We might hope, therefore, that according to our account sounds audibly bear information consonant with auditory beliefs.

¹ Compare the discussion of Snowdon (1992), who claims that the immediate object of perception is just what a subject may demonstratively identify.

2.2 Sounds as Properties

The traditional philosophical outlook has, I noted earlier, grouped sounds with the colors, tastes, smells, and other secondary qualities or sensible attributes. Popular analyses of such qualities or attributes then imply that sounds are dispositions to cause auditory experiences in suitably equipped perceivers under the right sorts of circumstances, categorical bases of such dispositions, physical properties, manifest primitive or simple properties, or mere projections of qualities of experiences. The options are familiar from the literature on color.²

John Locke, for one, thought sounds were secondary qualities: powers grounded in the primary qualities of bodies to produce auditory experiences (Locke 1689/1975: II, viii, 10). To which *bodies* did Locke mean to attribute such powers? He may have meant to attribute them to ordinary sounding objects—bells and whistles—so that sounds, like colors, are dispositions objects have to affect perceivers' experiences (see, in particular, II, viii, 9–14).

What I have said concerning *Colours* and *Smells*, may be understood also of *Tastes* and *Sounds*, and other the like sensible *Qualities*; which, whatever reality we, by mistake, attribute to them, are in truth nothing in the Objects themselves, but Powers to produce various Sensations in us, and depend on those primary *Qualities*, viz. Bulk, Figure, Texture, and Motion of parts; as I have said. (ibid. II, viii, 14)

Locke may have meant, however, to attribute sounds to the *medium* that intervenes between object and perceiver so that sounds are dispositions of the medium itself, considered as a body, to produce auditory experiences. Though this reading does not seem in the spirit of the relevant chapter of the *Essay*, in Locke's later *Elements of Natural Philosophy*, he remarks:

² See, for instance, the collection of papers in Byrne and Hilbert (1997a) for a sampling of representative views.

That which is conveyed into the brain by the ear is called sound; though, in truth, till it come to reach and affect the perceptive part, it be nothing but motion. The motion, which produces in us the perception of sound, is a vibration of the air, caused by an exceeding short, but quick, tremulous motion of the body, from which it is propagated; and therefore we consider and denominate them as bodies sounding.³ (Locke 1823: III, 326)

Depending on whether Locke meant to attribute sounds to objects or to the medium, we get two views that differ on where sounds are located.

Robert Pasnau (1999, 2000) takes a stand on this issue concerning the locations of sounds. Pasnau introduces a view according to which sounds are properties of what we ordinarily take to be the sounding objects and not of the medium. Sources themselves *have* or *possess* sounds on this view. For Pasnau, sounds either are identical with or supervene upon the vibrations of the objects we ordinarily count as sound sources, so sounds are *properties* that depend upon the categorical bases of Lockean powers. Pasnau and Locke thus both reflect the traditional understanding of sounds as secondary qualities or sensible attributes. We can classify views developed in the spirit of the traditional model of sounds as sensible attributes according to their stance on two questions. (1) What is the correct account of the sensible qualities in general? That is, are they dispositions, physical properties, or primitive properties with which perceptual experience acquaints us? (2) Are sounds properties of the medium or of the objects? A matrix of property views of sound is the result.

However, independent of providing the details of a philosophical account of sounds as secondary qualities, we need to ask whether the sensible attribute model is the right approach to sounds in the first place. I want in what follows to suggest that it is not. Both questions that yield the matrix of property views depend upon a misguided supposition. The suggestion that sounds themselves are sensible qualities is attractive only if we are in a mood

³ Thanks to Matthew Stuart for bringing this passage to my attention.

that overemphasizes similarities with color and entices us to provide an account that subsumes sounds with colors under a single metaphysical category.

This is because sounds themselves are not *properties* or *qualities* at all. Sounds, I claim, are *particular individuals* that possess the audible qualities of pitch, timbre, and loudness, possibly along with other inaudible properties. They enjoy lifetimes and bear similarity and difference relations to each other based on the complexes of audible qualities they instantiate. Sound sources, among which we count ordinary objects and events such as bells, whistles, and collisions, stand in causal relations of making or producing sounds, but are not at intervals simply qualified by their sounds.

This intuitive philosophical picture finds empirical support from research on audition. According to our best understanding of the central task of auditory perceiving, sounds are the particulars that ground the grouping and binding of audible qualities.

Perceiving sounds requires discerning coherent and significant streams of auditory information from an intertwined set of signals bound up with irrelevant 'noise'. Audition researcher Albert Bregman (1990: 3–6) likens this problem, which he calls *auditory scene analysis*, to determining the number, size, location, and identity of items on a lake by observing just the motions of a pair of handkerchiefs moved by the waves that travel up two narrow channels dug at the lake's edge, as in Figure 1. Right now I am able to discern the shrill sound of a small dog barking, the groan of a bus passing, the ticking of my clock, and a man's loud voice outside. The waves at my ears entwine information about these sounds into a knotty web of pressure differences.

Hearing, as we experience it, is made possible in information-rich environments by the auditory system's ability to sort through the complex information available at the ears and to extract cues about significant items the environment contains. The experienced result is a set of distinct temporally extended sounds heard as generated in the surrounding space. From pressure differences we discern the sounds of the breaking and of the sweeping. Audition accomplishes

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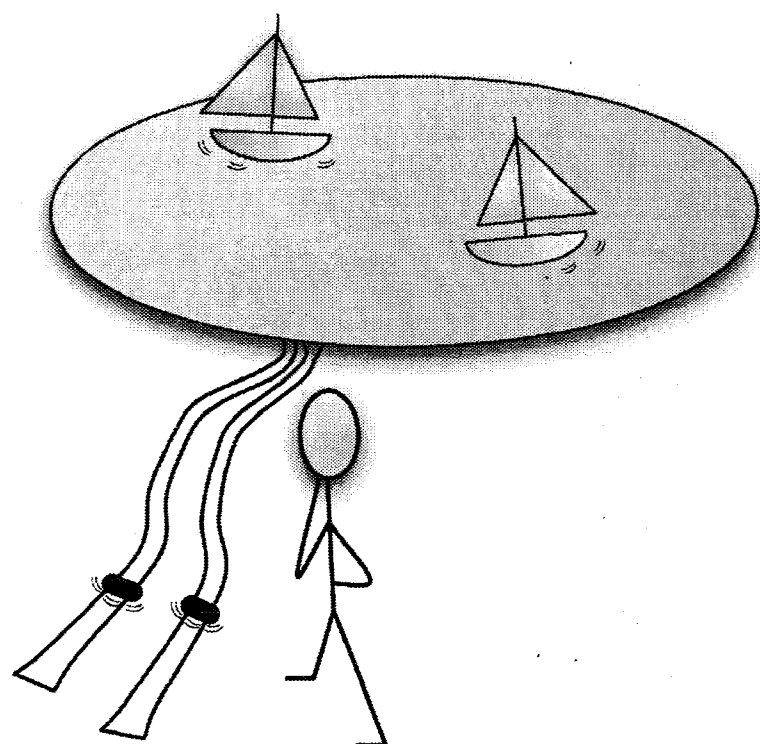


Figure 1. Auditory scene analysis

this by grouping or bundling audible qualities into distinct auditory perceptual 'objects' or 'streams'. A set of grouping principles that involves assumptions about the objects of auditory perception enables us to associate correctly the *low pitch* with the *soft volume* and *faraway location*, and at the same time to group correctly the *high pitch* with the *loud volume* and *nearby location*, without mixing things up into a garbled 'sound soup' of *high pitch*, *nearness*, *soft volume*, *low pitch*, *loud volume*, and *distance*. Our ability to group correctly the qualities of auditory perceptual objects or streams grounds our ability to discern complex individual sounds in the environment on the basis of information arriving at the ears. Auditory scene analysis amounts to sound perception precisely because the auditory system

invokes principles founded upon assumptions that capture genuine regularities in the world of sounds.

The auditory system answers the problem of auditory scene analysis by segregating the auditory scene into separate sound objects or streams characterized by complexes of pitch, timbre, loudness, and location properties. This answer, in effect, turns on the auditory system's treating the auditory objects or streams in question as particulars. First, auditory objects or streams bear complexes of pitch, timbre, and loudness, and serve as the primary locus for audible property binding. Color, by contrast, is a characteristic of particulars, not a locus for further visible attributes. Second, discrete auditory objects may be represented as distinct both at a single time and across time. That is, distinct sounds can be heard as simultaneous or successive, but qualitatively similar sounds need not be heard as identical. Third, as the term 'stream' indicates, the objects of auditory experience last through time and persist by having duration. Finally, auditory perceptual objects or streams regularly survive changes to their properties through time, as the sound of a spoken word or waning siren demonstrates. These considerations strongly indicate that auditory objects or streams are particulars that ground the grouping and binding of audible properties. Awareness of a particular auditory object or stream constitutes awareness of a sound. Sounds are audible particulars.

One might object that what researchers call auditory objects or streams are just attributions of properties to the ordinary objects we commonly think of as sound sources. To these everyday objects, we ascribe the audible property complexes that result from correct grouping. The sounds, according to this objection, are the audible property complexes. Ordinary objects serve as the particulars that ground audible property grouping.

This suggestion is *prima facie* plausible because we nearly always experience sounds as sounds of something: we hear the sound of the piano or the sound of the door closing or the sound of a car starting in the driveway. We might say that guesses or assumptions about auditory objects or streams are guesses or assumptions about

that bear similarity and difference relations to each other based on their complexes of audible qualities—the properties of pitch, timbre, and loudness—to which their identities are tied. Sounds, I want to suggest, have identity, individuation, and persistence conditions that require us to distinguish them from properties of the sources that we should understand to make or produce sounds.

The identification of sounds with properties has a defect that in my view cannot satisfactorily be repaired. The defect is that it fails to account for the essential temporal characteristics of sounds. Property bearers may instantiate and persist through the loss and gain of properties and qualities, while properties, qualities, and their instances exhibit quite different temporal characteristics. This is the most convincing indication that sounds are not just properties that objects, events, or sources gain and lose.

In short, sounds have durations. A sound has a beginning, a middle, and an end. But not only do sounds continue through time, sounds also survive changes to their properties across time. A pitch shift is not the end of a sound. Unlike the way that a wall loses one color and gains another when it is painted, an object does not lose its sound and gain an entirely new one when it goes from being low-pitched to being high-pitched, as with an ambulance siren's wail. A sound can have a low-pitched part and a high-pitched part, and this is not just a matter of some source's being low-pitched at one time and high-pitched at another. Rather, a distinct particular survives the change. The orange color of the car's exterior does not survive the priming, and the dingy smell of its interior does not survive the pine scenting. The sound of the cracked muffler does, however, survive the increase in loudness and pitch upon acceleration.

It is a central fact about sounds and hearing that the identities of many recognizable sounds are tied to the pattern of audible qualities they exhibit over time. To *be* the sound of a duck's quack or the sound of a spoken syllable requires a certain complex pattern of changes in pitch, timbre, and loudness over time. The sound of the spoken word 'forest' differs from the sound of the spoken word

'foreign' precisely because the corresponding patterns of change in audible qualities differ over time. That hearing and speech researchers have spoken of sounds as *streams* reveals the significance of the role of time in understanding sounds and their perception. The auditory scene has a thoroughly temporal horizon.

This means that if sounds were properties at all, they would need to be complex structural properties characterized not just at a single time, but over many moments. And the particulars to which audition attributed sounds would have to share their existence conditions with those of the instances of sounds. Finally, the sounds would need to be capable of causing and being caused. It is, therefore, the persistence and duration of sounds that distinguishes them most sharply from the traditional secondary quality understanding implicit in much philosophical work on sensation and perception. Once appreciated, the temporal characteristics of sounds present the greatest theoretical obstacle to a phenomenologically plausible and perceptually tractable account of sounds along the contours of the property model.

All of this is not to say that no account of properties could make sense of the particularity and temporal character of sounds in a way that dealt with auditory grouping and binding through time. A trope theorist, for example, might capture the particularity of sounds not in terms of the source but by understanding sounds as particularized complexes of particularized pitch, timbre, and loudness complexes bearing particularized temporal relations to each other. The success of the theory of sounds, however, should not rest on such a controversial theory about the metaphysics of properties. My claim is that given the particularity of sounds, which is required to capture how we perceptually individuate sounds, and given the temporal characteristics of sounds, including duration and change, the property model assumed both by traditional secondary quality views of sounds and by Pasnau's more recent account of sounds as sensible physical attributes is ill-suited as a perceptually realistic candidate for an account of the metaphysics of sounds. Abandoning that model of sounds and their perception frees us

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from a host of cumbersome and weakly motivated metaphysical commitments. This points the way to a richer and more nuanced understanding of the objects of auditory perception.

2.3 Sounds as Waves

The standard philosophical understanding of sounds, of which I have been critical, has not gained a wide audience. Acoustic science has taught that sounds are waves. We learn early on that sounds are longitudinal pressure waves that travel from a source to our ears and that these waves are the proximal causes of auditory experiences. The sound just is the wave train leading from source to subject.⁴

Just what the customary wave view of sounds amounts to metaphysically is somewhat obscure. One way to characterize the wave is as a pattern of pressures at each point in the surrounding medium over time. This interpretation makes the wave a complex property of the medium that evolves through time. On the version of the secondary quality view that ascribes sounds to the medium, pressure patterns are candidates for the categorical bases of dispositions to produce auditory experiences. This proposal, however, is a version of the property understanding of sounds and faces just the problems that stem from treating sounds as repeatable properties instead of particular individuals. As an account of the metaphysics of sounds it makes little headway. There are, however, other promising ways to develop the view that sounds are waves. If the wave view is

⁴ Sometimes the story in school is more nuanced. Consider the following description from a NASA research center educational website:

Air is a gas, and a very important property of any gas is the *speed of sound* through the gas. Why are we interested in the speed of sound? The speed of 'sound' is actually the speed of transmission of a small disturbance through a medium. Sound itself is a sensation created in the human brain in response to sensory inputs from the inner ear. (We won't comment on the old 'tree falling in a forest' discussion!) (<http://www.grc.nasa.gov/WWW/K-12/airplane/sound.html>)

The claim that sound is a sensation is one I reject. My interest here is realist views that do not attribute the kind of massive projective error endorsed, for example, by Boghossian and Velleman (1989, 1991) and Hardin (1993) in the case of color experience.

plausible as a view about what sounds are, then *the wave* in question is a *particular* that *persists* and *travels* through the medium.

First, waves stand in causal relations. Waves are produced or generated by their sources. Sound waves are the causal by-products of the activities of objects and interacting bodies and have among their effects the motions of resonating bodies and the auditory experiences of hearers.

Second, the wave bundle responsible for the experience also has spatial boundaries. It is characterized by a wavefront that propagates outward from the source, and its spatial extent depends on when the wave-generating activity ceases and the last pressure disturbance brings up the rear. Even when the wave train rebounds from a reflecting surface, its spatial boundaries may remain intact, even if altered or distorted. Furthermore, these spatial boundaries are perceptually significant. For example, the onset of periodic pressure differences at one ear is assumed to share a cause with their onset at the other ear, despite a delay. The shared spatial boundary responsible for differential onset is critical for auditory localization.

Third, the waves propagate or travel at a speed determined by the density and elasticity of the medium. In 20°C air at sea level, we say that the speed of sound is 344 meters per second (1497 meters per second in water; 6420 meters per second in aluminum).

Finally, waves are capable of surviving changes to their shape and to other properties and qualities. A wave's form and amplitude may change as it propagates, resulting in different heard attributes, but the wave persists throughout.

Such spatially bounded, traveling particulars are in certain respects surprisingly object-like. They can be created; they have reasonably defined spatial boundaries but persist through deformation; they survive changes to their locations and other properties; and they are publicly perceptible. To be sure, they make peculiar sorts of objects: their capacity to overlap and pass through themselves makes them stranger than most everyday objects. Though this may be a mereologically interesting problem, it seems to pose

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no fundamental obstacle to viewing wave bundles as in some, perhaps minimal, sense object-like.

Another important qualification to this object-like nature is that waves are dependent particulars. Sound waves depend for their existence on a medium. Their survival conditions differ from those of the medium, and they depend on different bits of the medium at different times, but without an elastic medium no sound waves exist. It is likely that lots of other things are dependent particulars, too, like tables and chairs and anything else not identical with its constituting matter. This seems to pose no obstacle to viewing the waves as object-like.

The dependence of waves on a medium is significant for a different reason. In light of the awkward fit of understanding waves as object-like particulars, the dependence points to an alternative take on the wave bundle altogether. The wave is in an important sense something that *happens to* the medium. The wave is not just a parasitic item passing through the medium; it constitutes a dynamic occurrence that takes place within the medium. The existence, propagation, and boundaries of the wave depend on processes that occur in and essentially involve a medium, so to highlight the medium dependence of the wave and its attributes is to highlight the wave's event-like characteristics. It is more plausible to think of *the waves* the wave conception of sound identifies as the particular sounds not as the object-like bundle, but instead as a variety of event that takes place and evolves in the medium through time.

Whether or not the wave view of sounds can accommodate it, the event-like construal is far more plausible as an account of *sounds* than the object-like construal. Features central to how we conceive of object-like particulars, in contrast to time-taking particulars like happenings and events, make for poor characterizations of sounds. One telling point already played a key role in rejecting the property understanding and delivers a central desideratum in theorizing about sounds. An account of sounds should capture the fact that the qualitative profile of a sound over time is crucial to its being

the sound that it is, as we recognize in the difference between the sounds of 'protect' and 'protean'. But it is an intuitive feature of the way we perceive and perceptually understand objects that they persist by enduring through time, as opposed to perduring by having numerically distinct temporal parts at different times. That is, we intuitively think of objects, as opposed to time-taking particulars, as being wholly present at each time at which they exist. Intuitively, all that is required to be the desk is before me. That is what led Judith Jarvis Thomson to say of perdurantism, 'It seems to me a crazy metaphysic—obviously false' (Thomson 1983: 210). And that is why the perdurantist must motivate the view with philosophical considerations. In fact, evidence from empirical psychology may soon support an endurantist conception of the contents of object perception.⁵ This fact about the way that objects appear to persist does not apply to events and other time-taking particulars, which intuitively have parts that exist and take place at different times. The soccer match, for instance, takes ninety minutes. In particular, it does not apply to sounds as we perceptually individuate them, since sounds simply are not candidates for being entirely present at a given moment. Sounds, instead, are things that occur over time.

Now, if objects do perdure, in contrast to the intuitive way we perceive and understand them, then the difference between events and time-taking particulars and objects may be just a matter of degree. In that case sounds are quite a distance from the end of the continuum occupied by tables, chairs, and even persons. In any case, I do not want my account of the metaphysics of sounds to hinge essentially on a discussion of how objects persist. What is clear is that sounds are in important respects different from ordinary objects in their ways of extending through time.

My goal in this section has been to point out that the widely accepted wave view is not completely clear either from a metaphysical standpoint or as a theory of sounds. The understanding of

⁵ See Feldman and Tremoulet (2006) for a useful review and discussion of relevant results.

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waves as event-like particulars is the most promising way to develop the view that sounds are longitudinal compression waves. That work seems worthwhile because the view that waves are dependent, spatially bounded, event-like particulars that persist and travel from their sources outward through the surrounding medium captures many of our commonly held beliefs about sounds. But as we will see in the next chapter, the science-inspired model of sounds as waves, like the traditional philosophical model of sounds as properties, qualities, or attributes, has important shortcomings that make it unsuitable as a philosophical account of sounds.

It is a strength of the wave view that it counts sounds as event-like particulars that persist through time. But any realist account of sounds should say not only what ontological kind sounds belong to, but also just where in time and space sounds exist. The wave account's problems stem primarily from its implication that such particulars exist or occur in different parts of the medium as time passes. The wave theorist cannot avoid this consequence. Nonetheless, the claim that sounds travel turns out to be an unnecessary and, indeed, an undesirable commitment for a theory of sounds.

3

The Locations of Sounds

3.1 Where Are Sounds?

When you hear the sound of a car driving by on the street outside your window, you learn not only whether the car has a hole in its muffler or has squealing brakes. You also learn something about the location of the car because hearing furnishes information about the locations of its objects. By listening, you learn not only about the character of the things and happenings around you, but also about where they are in the surrounding environment.

Hearing frequently prompts a grasp on the spatial arrangement of sound sources in one's environment. This, however, leaves open how audition grounds locational beliefs. Beliefs about the locations of sound sources might require 'working out'. They might stem from inferences based on auditory data, they might involve detecting changes to audible qualities, or they might demand correlation or appeal to spatial features discerned with other sense modalities. This, at least, is the dominant philosophical view spurred by Strawson's influential claim that auditory experience, in contrast to visual and tactile-kinaesthetic experience, is not 'intrinsically spatial' (Strawson 1959: 65-6). Nonetheless, according to an attractive alternative, audition itself furnishes awareness of space and locations. If audition has spatial content of its own, then audition-based beliefs about the locations of sound sources are perceptual beliefs based upon the spatial aspects of auditory experience.

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sense of 'minimally', auditory experience differs from purely visual and tactile-kinaesthetic experiences in being non-spatial is false.

The only sense in which audition arguably is not 'intrinsically spatial' is one that involves experienced features of the primary objects of audition. Pitch, timbre, and loudness are not inherently spatial attributes, as are shape and size. In addition, sounds are not experienced as having the rich *internal* spatial structure and articulation that ordinary visually experienced objects possess. A sound does not auditorily appear to have a detailed surface with texture and sharp edges. But to say that audition fails to represent richly detailed internal spatial features of sounds does not imply that audition is non-spatial or that audition fails to represent the locations of sounds in space. Clearly, there are places in egocentric space that auditorily appear to contain sounds and there are places that do not. Audition's coarseness of spatial grain does not constitute an all-out inability to represent space or spatial characteristics of sounds, such as their locations and approximate boundaries. It also does not imply that sounds themselves lack all spatial features we are unable to discern.

3.6 Locatedness and the Metaphysics of Sounds

I have argued that sounds, as we auditorily experience them, seem located and that sounds seem to travel only if their sources do. In addition, awareness of sounds provides our conscious mode of perceptual access to the locations of things and events in the environment through audition. For these reasons, a theory of sounds should locate the immediate objects of hearing at a distance from perceivers in the neighborhood of their sources. The alternative is to ascribe systematic and pervasive illusion to auditory perception. Not only do we sometimes get the locations of sounds wrong in hearing if sounds are not distally located and relatively stationary, we never perceive a sound to occupy its

* See O'Callaghan (2007b) for a full defense against skeptics about spatial audition.

true location. If the phenomenological claim is correct, and if auditory experience is not systematically illusory with respect to the locations of its objects, then sounds do not travel through the surrounding medium. If sounds do not propagate or travel through the medium, the understanding of sounds as waves fails.

3.7 The Durations of Sounds

The illusions multiply. If sounds indeed propagate through the medium, then the illusion is not isolated to locational hearing. The wave understanding of sounds is unable to account satisfactorily for a critical dimension of both sounds and auditory experiences. It, like the property understanding, fails to capture the striking and essential temporal features of sounds.

Clearly, perceiving the durations of sounds is an important part of auditory perception. Sounds inform us about happenings in and states of our environment, and part of what they inform us about is how long those happenings and states last. I learn through hearing when the coin stops spinning, when the fridge starts up and shuts down, and how long the car idles in the driveway. I experience how long the nine-year-old who lives next door practices the violin each afternoon—I sometimes wish the sessions had shorter durations. Now, if sounds are spatially bounded particulars whose locations in the medium change from moment to moment as do those of waves, what in fact I experience when I take the sound to have duration is not the duration of a sound at all. Rather, my encounter with a *spatial* boundary of a sound leads to my enjoying an auditory experience while the sound passes. On later encountering the far boundary of the sound, I experience the sound to end. Whether the wave is an object-like particular that passes by or an event-like particular that unfolds at different places in the medium over time, domino-wise, my experience of the sound is caused by the spatial parts of the sound wave bundle as it passes. In experiencing the sound, I do not experience the lifetime of an object-like entity or the duration of an event

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other than my own sensing. Apparent duration perception results from encounters with the spatial boundaries of sounds, according to the wave view. This means that each time I hear a sound, I mistake an experience of the spatial boundaries of a sound for an experience of the duration and temporal boundaries of that sound. The experienced duration of a sound, therefore, is nothing more than a form of crude projective error: I mistake the duration of an experience alone for the duration of a thing I am experiencing. Duration perception is a wholesale illusion if sounds are waves.

Perhaps you are willing to live with the illusion to preserve the commonly accepted scientific view of sounds. So suppose the experience of a sound's duration is an illusion. Since experiencing a sound mediates awareness of sound-producing events, and, in particular, since experiencing the duration of a sound mediates awareness of the duration of a sound-producing event, awareness of the durations of sound-producing events is mediated by illusory awareness of the durations of sounds. We have no reason, however, to doubt that awareness of the durations of sound-producing events is veridical. Such awareness regularly grounds true perceptually based beliefs. It follows that this case constitutes an instance of veridical mediated awareness that is mediated by an illusion. It is important here to keep in mind that the mediation in question is of a sort to which the subject has access. It is not, for example, the kind of mediatedness in question when we say that hearing is mediated by activity in the cochlea or auditory nerve.

Perhaps veridical awareness mediated by an illusion is intelligible. Things are not so bad, you might think, since the illusion informs you about something you really care about: the duration of the event that produced the sound (though it should be clear by now that I think you have good reason to care about the duration of the sound itself). But consider the source of the justification for your perceptually based beliefs about the durations of sound-producing events. That justification is based on your experience of the durations of sounds, and requires no more than enjoying such an experience. Furthermore, it is plausible to think that

information available to the subject of the experience is what justifies the belief. Veridically hearing the duration of a sound *could* therefore justify your belief that a corresponding sound-producing event lasted, say, thirteen seconds. If, however, your experience of the duration of the sound is an illusion, then that experience cannot *by itself* serve as your guide to the duration of a sound-producing event. Information from the experience of duration alone cannot introspectibly justify your beliefs about the duration of sound-producing events. The experience is at best a justifier in virtue of its reliable connection to the durations of sound-producing events. If such experiences justify corresponding beliefs in virtue of information available to the subject, to the experience must be added the further belief that the durations of auditory experiences typically are tied to the durations of sound-producing events. That belief cannot be justified on the basis of auditory perceptual experience alone because it is a matter of empirical discovery; it might have been, for instance, that waves in a packet did not travel at uniform speed. The claim is not that you *could not* be justified in your mediated beliefs about the durations of sound-producing events; the claim is that such beliefs cannot be held simply on the strength of information accessible in auditory experience alone.

These complications strike me as important negative consequences of a commitment to illusory sound duration perception, since it is arguably among the primary functions of auditory perception to inform us about the temporal characteristics, including the durations, of happenings in our environment. We care about how things change and how events unfold over time, and we value audition for its superior capacity thus to inform us. The account of sounds as waves entails that we do not hear the temporal features of sounds things make as those sounds unfold over time. It entails that we do not hear the durations of sounds and that our justification for believing that the violin practice lasted forty-five minutes cannot come just from hearing because what we experience in hearing is an illusion. These consequences result from the claim that sounds construed as waves travel and pass through the medium.

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The other important consequence is that our ways of perceptually individuating and tracking sounds through time are wildly misguided. If sounds persist and travel in the manner of the waves, then our perceptually based estimates of the lifetimes and survival conditions of sounds all are incorrect because the waves may continue to exist long after the sound has seemed to cease. It is simply a mistake according to the wave account to state that 'Time Is on My Side' by the Rolling Stones is three minutes and one second long if the song is the sounds. I shall have more to say about the temporal features of sounds, and about the relationship between duration and travel, when I turn later to the topic of echoes.

I have claimed that the account of sounds as waves runs into problems with duration perception. The wave account makes the perceived duration of a sound, in addition to its perceived location, a systematic illusion. The problem lies in saying that the sound—what one most immediately hears—is the passing bundle of waves. Suppose we omit the claim that sounds travel. Because it is a central fact about pressure waves that they propagate or travel through a medium, we must then abandon the suggestion that sounds are waves. I contend that the illusions of location and duration warrant doing just this.

Sounds, I claim, are located roughly where we hear them to be: at or near their sources. The sound does not travel as do the waves. The waves, however, are causally intermediate between the sounds and the auditory experiences of perceivers. The waves bear or transmit information about the sound events through the medium and furnish the materials for auditory experience. Sounds are stationary relative to their sources. If sounds are stationary events, then the auditory experience of location does not involve a systematic and pervasive illusion, and audition-based beliefs about the durations of sounds are for the most part true.

4

The Argument from Vacuums

4.1 Sounds in Vacuums?

A commonly shared assumption is that vacuums hold no sounds. If the standard science-inspired view that sounds are waves that exist in and travel through a medium such as air or water is correct, then there are no sounds in vacuums and the shared assumption is true.

But in the last chapter I presented what I take to be two of the strongest arguments on behalf of the claim that sounds are not themselves located in the surrounding medium. If sounds occur in and propagate or travel through the medium, we are subject to a systematic illusion of locatedness in auditory perception. No phenomenologically plausible account that fails to locate audible sounds near their sources explains how auditory perception conveys information about the locations of everyday events and objects. I argued, in addition, that if sounds travel through the medium, then we mistake the duration of an experience for the duration of a sound perceived. This amounts to a failure to make contact in one constitutive respect with the world of sounds.

Both problems, we should note, can be avoided by the version of the secondary or sensible property account that ascribes sounds to ordinary objects. Pasnau's (1999) account, for example, makes sounds properties objects possess just in virtue of their vibrations. This locates sounds at their sources and precludes travel through the medium. But it avoids the problems at the expense of removing the medium from the account of what sounds are. Pasnau's account makes the *medium*—the air or water in which

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sound waves travel—a mediator to perception, but not something required for the existence of a sound. The medium bears and transmits information about sounds, but it is neither an essential component of the sound nor a condition necessary for a sound. It follows, counter to our long-tutored intuitions, that sounds can exist in vacuums. Sounds occur even when an object vibrates alone in the absence of a surrounding medium. One need not, however, endorse a secondary or sensible property account of sounds to hold that sounds occur even in a vacuum. Casati and Dokic (1994, published in French; 2005) claim that sounds are events constituted by the vibrations of objects. Sounds, according to Casati and Dokic, therefore can exist in a vacuum.

I have claimed that sounds are not properties, but that sounds are extra-mental particulars that persist through change. I have argued that sounds are best understood as particular events, that they are located at or near their sources—where we hear them to be—and that they have roughly the durations we hear them to have. This supports a natural account of audition's capacity to reveal information about the locations and temporal characteristics of things and happenings in the environment. The places and durations of sounds are reliably connected, in a way that is open to perceptual experience, with the locations, durations, and patterns of change to objects and events around us.

Locating sounds at or near their sources appears, *prima facie*, in sympathy with the claim that the medium is not a necessary condition on a sound's existence. However, I have claimed that sounds are produced or generated by the activities of ordinary objects and events, and so stand in causal relations to those objects and events. This perhaps supports the requirement of a medium. Under the conditions in which we ordinarily hear them, sounds involve the disturbing or setting into wavelike motion of a surrounding medium. That sort of event has to do with the way a medium is affected by the disturbing activities of everyday objects and happenings. It requires a medium for its existence. An object's vibrating is not the disturbing of a medium if no medium is present.

Are there sounds in vacuums? The question should be decided neither by simply consulting common sense nor by reading off the consequences of one's favorite metaphysical theory of sounds. I will argue, however, that even independent from explicit theoretical commitments concerning the nature of sounds, we have reason to resist the claim that there might be sounds in vacuums. This suggests that vacuums place a correctness constraint on theories of sounds, and are not mere spoils to the victor. If there can be no sounds in vacuums, a medium is not just a necessary condition on veridical sound perception; the presence of a medium is a necessary condition for the existence of a sound.

4.2 The Argument from Vacuums

In Berkeley's first dialogue between Hylas and Philonous, Hylas deploys this *argument from vacuums* in service of the claim that sounds must be in the medium:

Philonous. Then as to sounds, what must we think of them: are they accidents really inherent in external bodies, or not?

Hylas. That they inhere not in the sonorous bodies, is plain from hence; because a bell struck in the exhausted receiver of an air-pump, sends forth no sound. The air therefore must be thought the subject of sound. [The sound which exists without us] is merely a vibrative or undulatory motion in the air. (Berkeley 1713/1975b: 171–2; also quoted in Pasnau 1999: 321)

Since we hear no sound when a bell is struck in a vacuum, Berkeley's first premise—that there are no sounds in vacuums—finds support from the idealist dictum that nothing exists unperceived. Barring the dictum, however, we would like to have some reason for denying or affirming that sounds exist in vacuums. The problem (though no problem for Berkeley) is that the fact that no sounds ever are heard in the absence of a surrounding medium shows only that a medium is ordinarily required for there to be veridical perception of sounds. It does not show that a medium is

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rise, for example, to reverberant vibration, auditory experiences, and recordings. According to the standard account of causation, causal relata are events.

Though sounds appear to have clear temporal boundaries that circumscribe durations, the spatial boundaries of a sound are less obvious. Unlike objects, whose spatial boundaries are relatively clear and whose temporal boundaries are more difficult to discern, events are characterized by clear temporal boundaries but by spatial boundaries that may be unclear (Casati and Varzi 2006). Sounds, in addition, appear to tolerate colocation or overlap with other sorts of things and events. A sound might occupy part of the same region as a fiddle or a bowing. Sounds, that is, appear to relate to space and time in ways characteristic to events. Understanding sounds as events of some sort amounts to a powerful framework for a satisfactory account of both the metaphysics of sound and the contents of auditory experience.

There is one caveat. The critical features of the theory of sounds should not turn on some one account of the metaphysics of events. I would like the theory of sounds to be reasonably neutral on the nature of events and viable no matter what events turn out to be (candidates include, for instance, theories stemming from Davidson 1970, Kim 1973, Galton 1984, Lewis 1986, and Bennett 1988). One might even hold it against a theory of events if it fails to capture facts about sounds. So, within reason, whatever events turn out to be, sounds should count as events. I think there is good chance for this, though once we get down to the detailed theory of sounds, some decisions will turn on just what is the right account of events. I want for now to operate with an intuitive conception of events as potentially time-taking particulars—as happenings that may or may not essentially involve change. Events as I wish to understand them are immanent or concrete individuals located in space and time.

Sounds, among the events, are akin to processes or activities, though some sounds—such as spoken words, birds' calls, or an eighth-note at C sharp—may lend themselves to treatment as

performances or accomplishments with a certain natural trajectory toward completion. Sounds are not instantaneous events, but require time to unfold. They may tolerate shared location with their sources and with other events that occur in the medium. Sounds construed as audible occurrences are poised as causal relata. They stand in causal relations to the activities of the objects and events that we call the producers or sources of sounds, and they fulfill the causal requirement on any account of their veridical perception.

I have argued up to now that sounds are non-mental, that sounds are particulars and not repeatable properties or qualities, that sounds are located near their sources but do not travel through the medium relative to those sources, that sounds have roughly the durations we hear them to have, that the medium is a necessary condition on the existence of a sound, and that sounds are events. A theory of sounds must, in addition, identify the sounds among the events.

5.2 Disturbings

Which events are the sounds? Consider the case of a tuning fork struck in air. The striking of the fork makes or causes a sound in virtue of the oscillating arms of the fork disturbing the surrounding air and creating regular compressions and rarefactions. However, since sounds do not travel through the medium but remain stationary relative to their sources, the sound does not travel as do the waves. Since sound waves that reach the eardrums cause auditory experiences, sounds must be causally intermediate between ordinary, everyday events and traveling sound waves. Since waves bear and transmit information about sounds, sounds cause waves. And since sounds indicate something about the events and happenings that occur in an environment, ordinary objects and happenings cause sounds.

Recall that what you perceive as the duration of a sound is in fact the duration of the process of sound wave production.

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Since the event in which sound waves are produced occupies a role causally intermediate to ordinary sound-producing events, such as collisions and strummings, and subsequent sound waves throughout the medium, this event plays a centrally important part in developing the theory of sounds. My claim is that such events are strong candidates for the particular events that are the sounds.

Consider the tuning fork. The sound, I propose, is the event of the tuning fork's disturbing the medium. According to this way of articulating the proposal that sounds are events, particular sounds are events of oscillating or interacting bodies disturbing or setting a surrounding medium into wave motion. This event occupies the appropriate causally intermediate role between the everyday events that cause the sounds and the compression waves that travel through the medium bearing the marks of sounds and producing experiences. If a sound just is an object or interacting objects disturbing the surrounding medium in a wavelike or periodic manner, then sounds do not travel through the medium but remain stationary relative to their sources. A sound unfolds over time at a location determined by the sound source. It does not travel through the medium, but it necessarily involves a medium. If sounds are the immediate objects of hearing, such disturbing events are the best candidates for the sounds. Its creating the disturbance constitutes the tuning fork's sounding.

The view that sounds are events of objects or interacting bodies disturbing a surrounding medium in wavelike fashion is not without historical precedent. The common interpretation of Aristotle is that he held a version of the received view according to which sounds are waves (see Pasnau 1999, 2000). *De Anima* says that 'sound is a particular movement of air' (II, 8, 420b10). This hints at a wave conception of sounds. Aristotle, however, understands 'movement' as active, which yields a view that differs in important respects from the view that the sound is the motion of the air. The idea of this alternative event account is to treat 'movement' as the nominalization of a transitive verb and to focus on constructions

like 'x moves y' instead of 'y is moving'. The sound on this understanding is the movement of the air by the activities of ordinary bodies: 'For sound is the movement of that which can be moved in the way in which things rebound from smooth surfaces when someone strikes them' (420b20). We can understand 'disturbance' in a similar way as what takes place when x disturbs y, as the disturbance of y by x, rather than as the result of that event of interaction. The sound is the air's being disturbed by the motion of an object. A sound is not motion in the medium, but the activity of one thing's moving or disturbing another. This is not the wave account that most attribute to Aristotle, but the beginnings of the event theory of sound.

According to this account, sounds are particular events of a certain kind. They are events in which a moving object disturbs a surrounding medium and sets it moving. The strikings and crashings are not the sounds, but are the causes of sounds. The waves in the medium are not the sounds themselves, but are the effects of sounds. Sounds so conceived possess the properties we hear sounds as possessing: pitch, timbre, loudness, duration, and spatial location. When all goes well in ordinary auditory perception, we hear sounds as they are.

This characterization of sounds as events of objects' disturbing a medium amounts to a sketch of what sounds are. The rest of this book is an attempt to articulate and defend this conception as the most promising account of the metaphysics and perception of sounds. To begin to answer more fully the question 'What is a sound?' requires a more careful consideration of the individuation conditions of sounds understood as events.

5.3 Individuating Sounds

The event understanding counts among its greatest strengths the resources to capture convincingly the conditions under which sounds are identified and individuated from each other. I have mentioned already that sounds have durations, are capable of

waves move away from their source. This fails to comport with the perception of loudness.

6.4 Timbre

Timbre has been dubbed 'the psychoacoustician's multidimensional wastebasket category' (McAdams and Bregman 1979). Fittingly, it has been timidly defined as that attribute in virtue of which sounds that share pitch and loudness might differ (ANSI 2004). Sometimes timbre is referred to generically as 'sound quality' or 'sound color'. However timbre is characterized, a tuba and a trumpet playing the same note at the same volume differ audibly. Two people singing that same note sound different from each other and from both the tuba and trumpet. Timbre is the audible difference. Timbre as such is critical to us when we identify the everyday objects and events that we are able to recognize just by hearing. Since the acoustical properties of audible objects and events depend upon characteristics of the interaction between participating objects and the surrounding medium, our ability to recognize sound sources thanks to hearing depends upon information about the characteristics of medium-disturbing events. Which characteristics?

Most prominent among features that contribute to sound and source recognition, and to timbre itself, is the spectral shape of the sound. Spectral shape is determined by the relative amplitude of each sinusoidal constituent across the spectrum. The vibration modes of a source determine a sound's spectral composition, and the tonotopic organization of the auditory system, which is required for pitch perception, preserves information about spectral constituents of a sound. Since medium-disturbing events have various modes of vibration at different amplitudes, spectral shape presents no unique problem.

Features also relevant to timbre and to source recognition include aspects of the onset (or attack) and offset (or decay) of particular sinusoidal constituents or frequency ranges; patterns of inharmonic

noise, especially for natural events; transitions and overlap between sounds; and timing and rhythm of continuous, oscillating, or discrete sounds. Each aids subjects in some fashion to identify the sounds of particular musical instruments, speech, voices, natural objects, actions, and events (Handel 1995). Nevertheless, Handel claims, 'At this point, *no* known acoustic invariants can be said to underlie timbre' (Handel 1995: 441). The acoustic cues to timbre that ground identification of objects and events vary and depend on context: 'the duration, intensity, and frequency of the notes, the set of comparison sounds, the task, and the experience of the subjects all determine the outcomes' (441). Most striking, however, is that each cue depends upon the particular source's distinctive manner of disturbing the medium across a range of conditions. 'The cues that determine timbre quality are interdependent because all are determined by the method of sound production and the physical construction of the instrument' (441). Handel suggests that timbre is something like the distinctive *look* of a face. The look of a face is determined by the arrangement and characteristics of particular visible features. The timbre of a sound is determined by the arrangement and characteristics of audible features. The recognizable look of a face is constant across changes to profile and hairstyle, those due to age, and even mild plastic surgery. The timbre of a sound is constant across changes to frequency, intensity, attack, decay, and even mild vocal chord damage. This suggests that the timbre quality of a sound depends at least in part upon features of the source and the characteristic manner in which it disturbs the medium. That is, after all, what remains constant across changes to its determinate audible qualities. The uniformity of timbre across sounds and circumstances is best explained by constancy in factors beyond the attributes of waves. The event understanding according to which sounds are events of objects or interacting bodies' disturbing a surrounding medium therefore better serves the needs of an account of timbre perception and recognition. Shifting focus from waves to activities of sound sources, and to the ways things interact with and disturb the surrounding medium,

enables this event understanding of sounds to shed light upon regularities in auditory quality experience and thereby to capture critical aspects of what makes audition so informative. The event account has little to fear, and much to gain, in acknowledging the dependence of audible qualities upon physical attributes of sounds.

7

Sound-Related Phenomena: Transmission, Interference, and Doppler Effects

7.1 Explaining Sound-Related Phenomena

No theory that fails to address the facts about locational hearing can be a phenomenologically plausible account of the objects of auditory perception. Furthermore, no view that disregards the role of the medium in the generation of sounds can convincingly capture variation to the audible qualities of a sound across different mediums. The view according to which sounds are particular events of objects or interacting bodies disturbing a surrounding medium in a wavelike manner recognizes the distal locations of sounds while preserving the important truth in the wave conception that no sounds exist in vacuums. The event view thus avoids both horns of the dilemma over locating sounds in the sources or locating them in the medium.

The principal appeal of the view stems from its appreciation of the strikingly event-like characteristics of sounds. Sounds happen and take time to occur. Both the traditional visually influenced philosophical view of sounds as secondary qualities and the commonplace scientific view of sounds as waves that propagate through a medium fail because they do not, and perhaps cannot, fully confront the essential temporal characteristics of the immediate objects of auditory awareness. To be a sound as heard is to be a temporally extended particular whose identity is partly determined by a

pattern of qualitative changes though time. A sound, moreover, is constitutively tied to the activities of and changes to objects and a medium. Without either sort of activity and change, there would be no sounds.

The discussion so far leaves unresolved a host of questions about pervasive sound-related phenomena. The familiar wave model is fantastically successful at explaining the audible effects of constructive and destructive interference; transmission through interfaces, such as between water and air, and through barriers, such as walls and windows; echoes and reflected sounds; and the Doppler effects. Each involves an auditory experience that may not comport with what occurs at the source. In short, local wave characteristics at the ears contribute to audible effects. Divorcing the sounds from the waves traveling through a medium means the distal event view (indeed, any view that locates sounds at or near their sources) owes equally explanatory accounts of these phenomena and of the related contents of perception.

The event understanding of sounds surpasses the wave view's success at convincingly accounting for such phenomena. The event view claims that sound waves transmit information about the sounds and their audible qualities. It therefore explains interference, transmission, Doppler effects, and echoes as stemming from wave phenomena that have nothing essentially to do with sounds themselves. This kind of explanation, I argue in this and subsequent chapters, succeeds where the wave conception of sounds falls short. The distal event theory not only delivers an account of why auditory experiences with particular characteristics arise as a result of conditions in the acoustic environment, but it also motivates a compelling understanding of the corresponding contents of auditory perception. It succeeds here precisely because it refrains from identifying the sounds with the waves. The event understanding not only allows for veridical auditory experience where the wave view does not—in the experience of location and duration—but predicts auditory illusions where the wave view

cannot. It emerged in my discussion of the audible qualities of sounds that where wave-based accounts must attribute a veridical experience of wave characteristics, the event account may ascribe an illusory experience of a sound, where the illusion is due to wave effects or distortions. This, in certain circumstances, has benefits. The thesis I wish to develop by considering a number of cases is that the event theory of sounds furnishes a compelling and principled account of the conditions under which the auditory experience of a sound is veridical and of those under which it involves illusion.

The burden on the event theorist is not only to show that the preferred account is capable of explaining why a given experience arises in the face of some situation in the world of sounds, but also to motivate verdicts about the world of sounds in the face of sometimes confounding evidence from auditory experience. In arguing that the event view of sounds gracefully shoulders the explanatory burden, here and throughout I take as my foundation certain basic scientific explanations of the phenomena in question. The consequences of these scientific facts, however, are open to philosophical interpretation.

7.2 Transmission

So far, I have said that a sound is an event of a medium's being disturbed or set into motion in a particular way by the activities of an object, body, or mass. But this seems too lenient, to allow too many sounds. Consider the following two forms of objection.

Interface

Suppose you are underwater and hear the sound of something that happens in the air above, say, the striking of a bell. The event view seems to imply that there is a sound at the interface of the air and water since indeed there is a medium-affecting event there.