Turning up the volume on the property view of sound

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Forthcoming in Inquiry 2016, DOI *10.1080/0020174X.2016.1159979*

Abstract. In the present article, I show that sounds are properties that are not physical in a narrow sense. First, I argue that sounds are properties using Moorean style arguments and defend this property view from various arguments against it that make use of salient disanalogies between sounds and colors. The first disanalogy is that we talk of objects making sounds but not of objects making colors. The second is that we count and quantify over sounds but not colors. The third is that sounds can survive qualitative change in their auditory properties but colors cannot survive change in their chromatic properties. Next, I provide a taxonomy of property views of sound. As the property view of sound has been so rarely discussed, many of the views available have never been articulated. My taxonomy will articulate these views and how they are related to one another. I taxonomize sounds according to three characteristics: dispositional/non-dispositional, relational/non-relational, and reductive/non-reductive. Finally, mirroring a popular argument in the color literature, I argue that physical views in the narrow sense are unable to accommodate the similarity and difference relations in which sounds essentially stand. I end replying to three objections.

Keywords: *Sound; property view; taxonomy; physical; secondary qualities*

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1 Introduction

Views on what sounds are can be divided into two categories: property views and non-property views. The property view is classically and most notably endorsed by John Locke who held that sounds are secondary qualities like colors, smells, and tastes. A version of the non-property view is popular in the natural sciences, namely the view that sounds are waves (vibrations transmitted by an elastic medium). Waves seem to be objects, events, or something we might call 'disturbances.' The natural sciences tend to prefer non-property views. For example, a popular view on color in the natural sciences is that colors are waves of light. Philosophers have departed from the natural sciences when it comes to the non-property theory of color. The non-property view is so unpopular that taxonomies of philosophical views on color do not even mention views such as the wave theory (Cohen 2009; Brogaard 2010; Roberts 2014).[2] The problem with the wave theory of color is that it commits us to massive unexplained perceptual error. If colors were light waves, the stable red that we perceive tomatoes as having would really be something that is all around us and, in fact, even in our eyes.[3]

Aristotle, Galileo, and Descartes could all perhaps be interpreted as endorsing something like a wave theory of sound, but modern era philosophers have largely abandoned the view. The reason is that it, like the wave theory of color, commits us to massive unexplained perceptual error. Pasnau (1999) points out that we hear sounds as having relatively specific locations, and that those locations correspond to the objects that produce the sounds.[4] However, sound waves do not have similarly specific locations. When an object is making a noise, the sound waves produced are all around us. So, if sounds are sound

[2]Perhaps there is room for a halfway plausible event view of color (Pasnau 2009), but further discussion of views on color is outside the scope of this paper on the property view of sound.

[3]Perhaps this unintuitive consequence could be outweighed by other considerations in favor of the wave view. I am not trying to argue against the wave view of color but trying to explain why it is so unpopular in philosophy.

[4]There is disagreement. Nudds (2014) holds that we do not hear sounds to be anywhere.

waves, our ears are constantly deceived about the locations of sounds. It would be the case that we perceive sounds as having relatively specific locations when they are, in fact, all around us, even in our ears. Pasnau's arguments have had a strong impact on philosophers. The fact that sounds seem to have relatively specific locations is now taken very seriously in philosophy (as it has been for a while in psychophysics, Blauert 1997).

However, unlike color, where the property view is philosophical cannon, in the recent literature on sound, a non-property, event view is the most often defended type of view. This is because of various apparent disanalogies between sounds and colors. For example, it is said that we count and quantify over sounds like we would particulars but not colors (e.g. that there were three chimes before noon). Some take this to support the view that sounds are events created by objects. Casati and Dokic (1994) propose an event theory that sounds are events in the resonate object. More recently, O'Callaghan (2007) has defended a relational event theory that sounds are relational events that involve both the object and the nearby medium. Specifically, the view is that sounds are events of interacting bodies disturbing a nearby medium and setting it into motion.

Philosophers have mainly been concerned with color. So, the concentration on non-property views in the recent sound literature has resulted in basically no fresh attention being given to the Lockean view that sounds are properties. In this article, I want to turn up the volume, so to speak, on the property view of sound. I will first argue that sounds are properties and defend this from the various arguments against it that make use of salient disanalogies between sounds and colors (Section 2). Next, I will provide a taxonomy of property views on sound. As so little recent work has been done on the property view, few of the views available have ever been articulated. My taxonomy will articulate these views and how they are related to one another (Section 3). Finally, I shall argue that physical views in the narrow sense are unable to accommodate the similarity and difference relations in which

the sounds essentially stand (Section 4). Thus, in this article, I show that sounds are properties that are not physical in a narrow sense.

2 Sounds are properties

In this section, I argue that sounds are properties and defend this view from various arguments against it. Jonathan Schaffer (2009) is an ontological permissivist, because he thinks that it is trivial that numbers exist, that properties exist, that mereological composites exist, and so on. He thinks this because he believes that one can show these things exist via trivial arguments based on Moorean facts. Schaffer argues that numbers exist like so: there are prime numbers; therefore, there are numbers (2009, 357). He argues that composites exist like so: my body has proper parts, for example, my hands; therefore, there are things with proper parts (2009, 358). I think that one can produce some powerful arguments that sounds are properties based on Moorean facts too. Here is one.

1. Some plane *is* roaring.
2. Therefore, sounds are properties.

Here is another.

3. Some fly *is* buzzing.
4. Therefore, sounds are properties.

And another.

5. Some watch *is* ticking.
6. Therefore, sounds are properties.

Premises 1, 3, and 5 are Moorean facts. 2, 4, and 6 follow, respectively. A property is *a way* something is, in this case, roaring, buzzing, and ticking, and it cannot be that some sounds are properties and some are not. Whichever ontological categories a perceptible

property is in (e.g. a sound property), all perceptible properties of that kind are in those categories, necessarily. This is a prime presupposition in most of the relevant literature on perceptible properties, especially in the color literature. For example, it is assumed that colors are relational or not, properties or not, real or not, and this goes for sounds and tastes as well. Regardless, the entire debate between property theorists and non-property theorists of sound presupposes that (at least something like) the prime presupposition holds for sound: if it did not, the debate would be based on a false premise. So, it (or something like it) is an acceptable presupposition. Assuming the prime presupposition holds (or at least something like it), it follows from 1, 3, and 5 that sounds are properties.

Even if the prime presupposition were false, premises 1, 3, and 5 would still pose a problem for the non-property view. As there are many true statements for different sounds which take the form of 1, 3, and 5 (e.g. some alarm is beeping, some dog is barking, some cat is meowing), there is an abductive case to be made for the following claim: for any sound S, there is some *x* such that *x* is S-ing, or at least would if in the right situation. To get from this to the conclusion that sounds are properties does not require the prime presupposition mentioned, but a weaker one to the effect that every perceptible property has its ontological categories necessarily.[5] There is an obvious argument for this claim: something's ontological categories are determined by its identity, and identity is necessary. A corollary is that there can be no change in an ontological category without a change in identity.

If 1, 3, and 5 are true, then the non-property view is in serious trouble. So, one might attempt to argue against the property view of sound, by attempting a paraphrase of 1, 3, and 5. For example, one might attempt to say that 'some plane is roaring' is short for 'some plane is currently *making* roaring sounds.' I will not attempt to anticipate and respond to every possible paraphrase. Rather, I offer a general response in line with the Moorean style of

[5] I am of course assuming, as is intuitive, that if S-ing is a property than S is.

argument I am using and similar to those Schaffer gives in reply to a similar style of criticism: the premises 1, 3, and 5 (and others like them) are obviously true as stated; one cannot deny that some plane is roaring, that some fly is buzzing, that some watch is ticking, and so on, because these claims are more certain than any claim to the contrary. Not everyone will find Moorean-style arguments satisfying. However, they have a respected history in philosophy, and they are available to support the property view of sound.[6]

My opponent may be worried about certain purported disanalogies between sounds and colors (Casati and Dokic 1994; O'Callaghan 2007, 2008). I shall look at these purported disanalogies and show that none constitute a reason to reject the property view. The first disanalogy I will examine is that we talk of objects making sounds but not of objects making colors. The second disanalogy I will investigate is that we count and quantify over sounds but not colors. The third disanalogy I will look at is that sounds can survive qualitative change in their auditory properties but colors cannot survive change in their chromatic properties. My responses depend on the following strange color world:

> Imagine a world in which all objects were (mostly) transparent but when caused to vibrate suddenly became colored and would exemplify one color after another for some time before again becoming transparent. The exact colors objects would exemplify would depend on the type of object and how much it vibrated. For example, dense objects would exemplify different determinable colors on average than less dense objects, and objects would exemplify different determinate colors of the density-determined determinable color dependent on how much they were vibrating. If a very dense object were caused to slightly vibrate it would become light red, then a lighter red, then lighter, then white, and then the white would fade and the

[6]Of course, stepping back, it must be admitted that further engagement with what people mean by sound attributions is relevant. Ultimately, what people mean seems at least partially empirical.

> object would again be transparent, and if the object were caused to vibrate a lot, it would suddenly become a very dark red, and then a lighter and lighter red until it became white before fading back to being transparent. If a less dense object were caused to vibrate lightly it would become a light blue, then a lighter blue, then lighter, and then white before fading back to being transparent, and if the object were caused to vibrate more heavily it would become a dark blue, and then a lighter blue, and lighter, then white, and again the whiteness would fade to transparency.

The first disanalogy, as I said, is that, unlike with colors, we talk of objects making sounds. In reply, consider the strange color world. In this world, intuitively, we would speak of objects as 'making' colors. We would say things like 'steel makes a very dark red color' and things like 'if you hit steel hard enough it will make a red so dark it looks black.' Colors would be properties in this world, as they are properties in the actual world. Colors in this strange color world are similar in the relevant ways to sounds in the actual world. Hence, we should not think that the mentioned disanalogy shows that sounds are not properties. (Colors being properties in the actual world is almost universally accepted in the literature. Thus, I will not argue in-depth for this claim; it is an assumption on which my arguments are based. All arguments require assumptions. Regardless, clearly the Moorean arguments provided for the property view of sound could be applied mutatis mutandis for color.)

One might question my claim that intuitively we would speak of objects 'making' colors in the strange color world. Here is why I endorse the claim: we use the word 'make' to convey causal production. In the actual world, objects' causal production of colors occurs at the atomic level and so cannot be noticed with simply our senses (science suggests that colors

are caused by the atomic-workings of objects).[7] Thus, the causal production of colors is not salient to us in the actual world, and it seems that for this reason we do not, in the actual world, talk of objects 'making' colors. If the causal production of a property is not salient to us, we are unlikely to speak of its causal production in typical conversation. In the world described, however, an important part of the causal production of colors can be noticed using simply our senses. Thus, in this strange color world, it seems, because of the salience of the causal production of colors in it, we would talk of objects 'making' colors. A corollary is that our 'making' talk with regard to sounds but not colors in the actual world can be explained by an important part of the causal production of sounds but not colors being noticeable perceptually (e.g. objects' vibrating when hit). Another corollary is that objects can make sounds and have sounds too, just as is the case with colors: an object's color is caused and so is made (in the relevant sense) by various physical phenomena but colors are properties.

The second disanalogy is that, unlike with colors, we count and quantify over sounds. We say, for instance, that there were three chimes before noon. Cohen (2010) points out that we do count colors just not through time in the way we do sounds. He goes on to make the lucid point that the disparity in how we talk about sounds and colors may be due to our perceptual systems being more sensitive to the spatial rather than temporal locations of colors and the temporal rather than spatial locations of sounds. I wish to make a separate point: the disanalogy is anodyne. Consider the strange color world. In it we would count and quantify over colors. It would be natural to say that the object was first a deep red and second a lighter red, and third a lighter red, and fourth that it became white, and then fifth that its whiteness faded away and that the object was again transparent. Hence, we could naturally ask the question, 'how many colors did the object have?' and respond like so: 'it had three different

[7]One might reject the causal view that the colors of objects bear a causal relation to objects' atomic-workings, but this view at least seems true in the strange color world. So, it seems that the causal view is not necessarily false. This said, whether one agrees with the causal view probably depends on what one thinks colors are and on what one thinks causation is. So, further discussion is really outside the scope of this article.

reds and then a white.' Colors would be properties in this world, as they are properties in the actual world. Colors in this strange color world are similar in the relevant ways to sounds in the actual world: we would count and quantify over them. Hence, we should not think that the disanalogy shows anything about the ontology of sounds.

The third disanalogy is that sounds, unlike colors, can survive qualitative change in their auditory properties (pitch, timbre, and loudness). This disanalogy, in my opinion, like the others, does not show much. Cohen (2010) differentiates between the view that sounds survive qualitative change and the view that sounds do not survive qualitative change, what he calls 'survivalism' and 'non-survivalism.' Cohen thinks that what is known about the neutrally described facts about sound is agnostic between these two views. I do not disagree with this response, but there is, I think, a better way to defend the property view of sounds. My explanation relies on the intuitive idea that there are composite sounds, for example, a whirling siren, and non-composite sounds, the discrete sounds that make up the siren, as defined by the three phenomenal auditory dimensions: pitch, timbre, and loudness.

A whirling siren sound can survive being composed of different sounds at different times, because that is the kind of entity it is. However, are colors more accurately compared to discrete sounds or to composite sounds? Upon reflection, the answer is that colors are more accurately compared to discrete sounds: colors and discrete sounds are both defined by three dimensions but composite sounds are not. Can discrete sounds unlike colors survive qualitative change? No, a discrete sound is defined by its pitch, timbre, and loudness just like a color is defined by its hue, saturation, and lightness. So, a discrete sound in a siren, for instance, would not be the sound it is if it were qualitatively any different from how it is. By definition, if the pitch, timbre, or loudness of a discrete sound were changed, the discrete sound would cease to be the sound it is. Thus, the best response to the third disanalogy

between sound and color is to say that the proper analogy is between colors and discrete sounds in particular and that neither can survive qualitative change.

What about composite sounds? What we should say here is similar to what I have said in response to the other worries. Consider the strange color world. This is a world in which it would be natural to sometimes talk about something we would likely call 'a color' that would be composed of different colors (red, green, blue…) at different times. We would sometimes want to differentiate between objects based on the colors they 'make,' and the colors they 'make' would change through time depending on various factors (e.g. density in the world described). Objects that when normally encountered were vibrating, a whirling siren, would have composite colors unique to them. Hence, we would want to compare such objects based on their composite colors. We would say things like 'the US police siren is c-red [a composite color; doesn't matter what it looks like for this abstract example] but the UK police siren is c-yellow [another composite color].' Composite colors are properties in this described world, because they are ways that objects are (c-red, c-yellow…). Therefore, by analogy, we have no reason to believe that composite sounds are not properties in the actual world. In fact, it is hard to believe we ever had a reason, because it is a Moorean fact that some siren is (or soon will be) whirling (a composite sound).

3 A taxonomy of property views of sound

As the property view of sound has been so infrequently discussed, the many views available have never been articulated in any detail. I can distinguish between eleven respectable candidate views for what properties sounds are. I am here focusing on discrete sounds not composite sounds. An understanding of the former allows for an understanding of the latter, because composite sounds are composed of discrete sounds. I choose to group these eleven property views on (discrete) sound as follows:

Dispositional	Relational	Reductive	Views on what sounds are
No	No	No	Non-relational primitivism
No	No	Yes	Vibrationism, Disjunctive vibrationism, Disjunctive wave/vibration dispositionalism, ???
No	Yes	No	Primitive appearance relationalism, ???
No	Yes	Yes	Reductive appearance relationalism, Vibration relationalism, ???
Yes	No	No	Not available
Yes	No	Yes	Appearance sound dispositionalism, wave dispositionalism, vibration dispositionalism, ???
Yes	Yes	No	Not available
Yes	Yes	Yes	???

The question marks illustrate the logical space for unthought-of of views.

According to this taxonomy, property views of sound are grouped according to three characteristics: dispositional/non-dispositional, relational/non-relational, and reductive/non-reductive. This taxonomy is flexible. Additional characteristics can be added as needed. (To suit my purposes in Section 4, I simply add to this taxonomy the characteristic of being physical in a narrow sense.) A property P is dispositional =df for some manifestation M and circumstances C, P is identical with the disposition to M in C. Dispositional properties connect objects with counterfactuals in a special way that non-dispositional properties (also called 'categorical properties') do not.[8] So, if sounds are dispositions, one must hold that they give objects a special connection with counterfactuals. It is natural for the sound

[8]The simple conditional analysis (SCA) of dispositions is unpopular, thus it is unclear how exactly dispositions are related to counterfactuals. See Johnston (1992), Bird (1998), and Martin (2008) for arguments against the SCA. With this being said, even though the SCA is unpopular, most everyone agrees that there is some connection between dispositional properties and counterfactuals.

categoricalist to understand sounds similarly to shapes, and say that what it is to have a sound is to have a certain structure. To have a certain structure is to have a property that varies over certain dimensions, for example, shape varies over width, length, height, and internal angles. A categorical reductivist, for instance, would point to a vibrational structure described mathematically. Vibrationism and disjunctive vibrationism both understand sounds in this way. Vibrationism is the view that sounds are properties of vibrating in such and such ways. A categorical primitivist would point to the phenomenal structure of auditory space by referring to the dimensions which describe this space: pitch, timbre, and loudness.

Vibration dispositionalism is the view that sounds are dispositions to vibrate if certain generally specified conditions are met. Kulvicki's (2008) view is one of this kind. He holds that sounds are dispositions to vibrate if 'thwacked.' A related view is wave dispositionalism. This is the view that sounds are dispositions to produce sound waves if certain generally specified conditions are met. Wave dispositionalism is similar to the vibration dispositionalist view but does have distinct consequences. The wave view is compatible with an object having a sound that does not vibrate. This may be an advantage of the view. Imagine a highly advanced jet engine that does not itself vibrate but sounds very loud because of the air disturbances it makes. One might think it is intuitive that the jet engine has a sound even though it does not itself vibrate. Regardless, the wave view has distinct consequences from the vibration view and so is a distinct theory. Both vibration and wave dispositionalism come in disjunctive varieties. Although the disjuncts are dispositions, the disjunctive properties themselves are not (they do not meet the definition given). Thus, these views are best classified as non-dispositional alongside vibrationism and disjunctive vibrationism.

Appearance (sound) dispositionalism is the view that sounds are dispositions to auditorily appear certain ways (e.g. to be C minor on a piano, to be B flat, etc.) if certain generally specified conditions are met. Mirroring the literature on the ontology of color,

appearance dispositionalism can be divided into internal and external variants. Internal (sound) dispositionalism is a view of the same type as contemporary dispositionalism about color. Specifically, it is the view that sounds are dispositions to cause auditory experiences in us if certain generally specified conditions are met (e.g. if heard by normal observers in normal circumstances). External (sound) dispositionalism is a view of the same type as Noë's (2004) ecological color dispositionalism. Namely, it is the view that sounds are dispositions to modify auditory appearances as the relevant conditions change, where auditory appearances are properties of external objects in addition to (and separate from) sounds.

One may prefer external dispositionalism to internal dispositionalism because of considerations that mirror the debate in the color literature having to do with changing appearances in normal conditions (Kalderon 2008). An intuitive version of internal dispositionalism would hold that loudness is the disposition to auditorily appear loud to normal observers in normal conditions. There is at least some degree of sound constancy. For example, as one walks away from a jackhammer there is a sense in which it auditorily appears to get quieter and quieter even though there is another in which it appears just as loud (a sense in which the loudness is constant). Such constancy phenomena are ubiquitous with colors and shapes: a circle looks oval in some sense when viewed at a 45-degree angle while remaining circular in appearance in some other sense. To what degree constancy phenomena occur with sounds is unclear, but is seems reasonable to hold they are widespread.

The intuitive variant of internal (sound) dispositionalism may seem ill equipped to explain such constancy phenomena because it holds, for example, that a certain beep is the disposition to auditorily appear to have that specific beep in or throughout normal conditions. The problem is that if constancy phenomena are widespread for sound how things appear in normal conditions is seldom that simple. The jet plane would auditorily appear to be making a single sound throughout normal conditions in one sense but would in another sense appear

to be making different sounds as it approached, passed, and flew away. External dispositionalism may seem to have the tools to better explain such constancy phenomenon. The external dispositionalist distinguishes between two properties of objects: apparent sounds and sounds. Using this distinction, the external dispositionalist would say that what is going on regarding constancy is that the plane, for example, has a sound and an apparent sound, and that the latter property remains constant and the former changes.

A reason to be suspicious of external dispositionalism is that it is intuitive that sounds are the only properties of external objects represented by auditory experiences as of things having sounds. One might say that this is analytic: experiences as of sounds are experiences as of sounds and nothing else. Hacker (1991) would seem to agree: he would say that experiences are differentiated by their objects, so sound experiences have as their objects sounds, color experiences, colors... Further, rejecting the intuitive assumption requires that the external dispositionalist provide additional insight into what exactly apparent sounds are supposed to be, because one might think they are mysterious properties. Apparent sounds cannot be C minor on a piano, B flat, etc., because these are sounds. Thus, what are apparent sounds supposed to be exactly? It seems they have to be like sounds phenomenally while neither being sounds nor experiences as of sounds, and this is quite odd. Of course, it is possible that these worries can be put to rest. They are obvious concerns though.

A view on a type of property P (e.g. sound properties) is relational iff it says that the tokens of this type (sounds) are relational properties. There are positive and impure relational properties (Khamara 1988; Humberstone 1996). Being married is an example of the former and is biconditionally dependent on the relation ‘married to’ such that a person *x* is married iff *x* is married to someone. Being married to Tom is an example of the latter and is such that a person *x* has the property iff there is an individual Tom and *x* is married to him. Both of these types of relational property fit this analysis (Roberts 2014, 1803):

> *Relational property analysis*: A property P is relational iff there is some relation R such that it is essential to P that for all *x*, if *x* has P at time *t,* then for some thing(s) $y_{1..}y_{n}$, R$xy_{1..}y_{n}$ at *t*. ('Essential' here and elsewhere does not mean 'necessary' but something stronger. It is necessary to Socrates that he is in the singleton set containing Socrates but it is not essential to him, Kit Fine 1994.)

Dispositions are not ipso facto relational properties. Dispositional properties like the disposition to cause experiences as of loudness in normal observers in normal conditions (if caused to vibrate in the right ways) are not relational properties. It is *not* essential to an object being so disposed that it bears a relation to anything. An object can have the relevant disposition even in a world in which it is the only thing that exists. (I argue for an analogous claim in-depth in Roberts 2014, Section 3 and so will not do so again here.) The same goes mutatis mutandis for wave and vibration dispositions. Unlike these dispositional properties, it is clearly essential to something having the relational property being west of New York, for example, that it bears the relation 'west of' to something, namely New York. So, west of New York is a relational property whereas appearance, wave, and vibration dispositions are not. Further, there can be relational properties that are not dispositional. For instance, spatial relational properties like being west of London are clearly not dispositional properties. So, there can be relational views on sound that are also categorical.[9]

The reductivist says that what sounds are is given by a description (e.g. sounds are dispositions to give rise to auditory experiences if heard by normal observers in normal conditions, or sounds are vibrational structures described mathematically), while the non-reductivist or primitivist denies this. The primitivist holds that what sounds are is given by

[9]So, arguments for dispositional monism (Mumford 2004; Bird 2005, 2007) may apply to certain relationalist sound views, while arguments for categorical monism (Armstrong 1997) need not rule out sound relationalism.

our auditory phenomenal experiences and not by a description, so that what sounds are is just how they sound. In other words, the primitivist holds that the intrinsic natures of sounds are the phenomenal sounds or the sounds as we hear them. Phenomenal sounds are defined ostensively just as phenomenal colors are, by pointing. Hence, sound primitivism holds that the answer to 'what are sounds?' is given by pointing to sounds: *that* is a beep*; that* is C minor. No further answer to what are sounds is available according to the primitivist. The reductivist, on the other hand, holds that this is not the case: the intrinsic natures of sounds are not given phenomenally but by a description, for example, sounds are dispositions to vibrate when thwacked. Primitivism is incompatible with sounds being dispositions, vibration properties, types of vibration properties, types of wave dispositions, and so on, because the identities of these properties are given by descriptions, not phenomenally.

Relationalism comes in primitivist and non-primitivist varieties. It may seem that primitivism is incompatible with relationalism, but this is false. To understand why, I must explain an important distinction between the intrinsic nature of a property and an essential property of that property. The property of being a triangle essentially has the property of being more similar to being rectangular than to being pentagonal, but the intrinsic nature of the property of being a triangle is not that it is the property of being more similar to being rectangular than to being pentagonal. The intrinsic nature of the property of being a triangle is that it is the geometric property of being a three-sided figure. Using this distinction, the primitivist can hold that sounds fit the relational property analysis. The intrinsic nature of being C minor is that it is like *that* (pointing to a C minor sample), but *that* property has as an essential property being such that it is essential to it that for all x, if x has it*,* then for some thing(s) $y_{1..}y_{n}$, $Rxy_{1..}y_{n}$. In other words, primitivism is compatible with sounds being relational properties, because we can understand this not as saying what the intrinsic natures

of sounds are but as merely giving an essential property of sounds. For these reasons, a corollary is that sound primitivism is compatible with both positive and impure relationalism.

A plausible non-primitivist relational view is vibration relationalism: sounds are properties of vibrating in a medium (or in a certain kind of medium). The argument from vacuums that it is intuitive that things do not have sounds in a vacuum could motivate this view (Berkeley 1975). The relational event theory of sound (O'Callaghan 2007) is the non-property cousin of the vibration relational view. Further relational views can be borrowed from the color literature. Mirroring Cohen's relationalism (2004, 2009, 8-12, 24-36), one can create appearance sound relationalism: it is essential to any sound L that there is a relation R such that for any object *x*, *x* is sound L iff there exists an observer *y* (which need not be the same for different *x*'s) such that *x* bears R to y. This view can come in primitivist or reductivist variants, depending on what one takes the intrinsic natures of sounds to be.[10] Appearance relationalism must state the conditions under which R holds of <*x*, *y*> as involving subjects' appearances, experiences, or something similar. (If the conditions are stated counterfactually, a case could perhaps be made for such an instance of appearance relationalism also being a dispositional view, but I will fall short of endorsing such a categorization.) Appearance relationalism can be tailored to accommodate auditory disagreement without misrepresentation thus avoiding the epistemic worries associated with, for example, vibrationism of saying who is right in cases where normal observers disagree in normal conditions. To some, though, appearance relationalism will seem too subjective.

So far, I have argued that sounds are properties (Section 2) and presented a taxonomy of property views of sound (Section 3). My arguments that sounds are properties are based on Moorean facts, for example, one such argument went like so: some watch is ticking;

[10]Cohen (2009, 10, footnote 16) says that his view is reductive. However, given my explanation for how relational views can be primitive, we can see that it need not necessarily be reductive.

therefore, sounds are properties. The arguments presuppose the almost universally accepted presupposition that whichever ontological categories a perceptible property is in, all perceptible properties of that kind are in those categories, necessarily. For instance, it is assumed that all colors are relational or not, properties or not, real or not, and this goes for sounds too. I also examined three purported disanalogies between sounds and colors and showed that none pose a problem for the property view of sound. My taxonomy of property views of sound grouped such views according to three characteristics: dispositional/non-dispositional, relational/non-relational, and reductive/non-reductive. I defined each of these characteristics, and presented various views on sound, some of which had yet to be mentioned in the literature. I pointed out that dispositions are not ipso facto relational properties, and that there could be relational primitivist views on sound.

4 Which properties are sounds?

I will now narrow down what I think are the most plausible views of sound. I shall argue that sounds are probably appearance dispositional, appearance relational, or primitive. Call this disjunction, 'AAP.' Call non-AAP property views in my taxonomy 'Physical' property views (with a capital 'P'), where this means physical in a narrow sense (physical in the sense that the properties are like those talked about in physics or composed of those properties). One should not take this talk of 'the Physical' to suggest anything interesting about which properties in my taxonomy are physical (I cannot here provide a definition of 'physical,' as that is a hotly debated topic, Stoljar 2015). My argument for AAP views is that they are probably the only views that can accommodate the following intuitive proposition:

> *Unity*. Sounds essentially stand to each other in relations of similarity and difference. (For example, essentially, some high-pitched sound H1 is more similar to some other similarly high-pitched sound H2 than to some low-pitched sound L1.)

I shall argue that sounds are probably AAP by (a) showing that appearance dispositionalism, appearance relationalism, and primitivism can all accommodate Unity, and then by (b) arguing that Physical views on sound probably cannot accommodate Unity. This argument mirrors arguments from unity in the color literature (Pautz 2003, 2006). (I will not argue for Unity further, as its cousin in the color literature is generally accepted as an intuitive principle that any view must at least say something about, Pautz 2003, 2006.)

Sounds might be primitive, because primitivism can accommodate Unity. I have already explained the distinction between the intrinsic nature of a property and an essential property of that property. Using this distinction, the primitivist can say that due to the intrinsic nature of sounds as given in auditory phenomenal experience, sounds essentially have second-order properties of standing to each other in relations of similarity and difference. So, the primitivist can say that essentially, a high-pitched sound H1 is more similar to a high-pitched sound H2 than to a low-pitched sound L1. This answer may not satisfy the desire for a reductive explanation, but it shows what I need to show for this part of my argument. Sounds might be appearance relational. Such a view can accommodate unity, because the relata of the properties the view says are identical with sounds include sound appearances. So, the appearance relationalist can say that essentially, H1 is more similar to H2 than to L1 in that the appearance of a H1, which is in some logical sense part of H1, is more similar to the appearance of H2, which is in this sense part of H2, than to the appearance of L1, which is in the relevant sense part of L1. The same goes mutatis mutandis for the appearance dispositionalist view of sound. Thus, sounds might be appearance dispositional, appearance relational, or primitive (AAP). This completes part (a) of my argument for the time being. I will come back to it again briefly at the end of the article.

Part (b) will require more effort. The property theorist will hold that pitch, timbre, and loudness are second-order properties of sound properties. So, a Physical view needs to account for the similarity and difference relations that the sounds essentially stand in to each other using these second-order properties of sounds. (A Physical non-property view needs to account for the similarity and difference relations using Physical properties of events or waves, so much of the below applies mutatis mutandis to such views.) For simplicity, I will concentrate on pitch. As Physical views hold that sounds are Physical properties, such views must account for pitch using second-order Physical properties. Periodicity is the best-known Physical predictor of pitch (Schnupp, Nelkan, and King 2011).[11] So, for the sake of argument, I shall assume that periodicity can be said to be a second-order property of non-disjunctive Physical properties. It makes no sense to ascribe periodicity to a disjunctive property. The disjunctive Physical theorist will have to account for Unity using the periodicity of disjuncts. Hence, if non-disjunctive Physical views cannot account for Unity using periodicity, then the prospects of a disjunctive Physical theory being able to do so are poor indeed.

If the Physical theorist is to account for Unity using periodicity, it must be the case that essentially H1 is more similar to H2 than to L1 with respect to periodicity. As I said, periodicity is our best-known Physical predictor of pitch, and it is certainly a good predictor. However, as I shall soon show, the predictive power of periodicity is imperfect: physical properties with the same periodicity can appear to have different pitches. Thus, there is no guarantee that Physical properties that match in periodicity are going to match in pitch. This is a serious problem for using periodicity to account for Unity. The reason is that there is nothing stopping L1 and H2 from having the same periodicity. Thus, just as physical views on color like reflectance dispositionalism have a difficult time accounting for the color

[11] A sound composed of consecutive repetitions of one short segment is called 'periodic.' The duration of the repeated segment is the sound's period. Periodicity is normally quantified by fundamental frequency (which I will explain soon) (Schnupp, Nelkan, and King 2011, Ch. 3).

version of what I call ‘Unity’ (Pautz 2003, 2006) (also called ‘Unity’ in the color literature), Physical views on sound are going to have a difficult time accounting for sound Unity.

I will now investigate the predictive power of periodicity and conclude by showing that Physical properties with the same periodicity can appear to have different pitches. As much of the following comes from Schnupp, Nelkan, and King (2011, Ch. 3), I will, so as not to depart too far from the source neuroscience text, speak of periodicity as a property of sounds. However, as a Physical theorist, this should be taken to mean a property of whatever Physical properties sounds are. Periodicity is quantified by fundamental frequency (F_0). This is the number of times that the period repeats in one second ($F_0 = 1/T$). So, if the period is one ms (1/1000s), the F_0 is 1,000 Hz. *As a rule*, the pitch a sound appears to have corresponds to its F_0. This *rule* is often exaggerated as being a *law*. For example, O’Callaghan (2007) says, ‘A given pitch includes all sounds, simple and complex, that share a fundamental frequency’ (p. 80). This is questionable. There are important deviations from the rule that are a problem for the Physical theorist. It is as Schnupp, Nelkan, and King (2011, 96) say,

> ‘As we will see again and again, every statement about the relationships between a physical characteristic of sounds and the associated perceptual quality will have many cautionary notes attached (often in “fine print”).’

I shall now look at the deviations from the rule that the pitch a sound appears to have corresponds to its F_0. The first is that periodic sounds appear to have a pitch as predicted by their F_0 only if their periods are between about 25ms (an F_0 of 40 Hz) and about 0.25ms (an F_0 of 4,000 Hz). If the F_0 of a sound is less than 40 Hz, then either the sound will be perceived as a flutter or perceived to have a pitch at a value that is different from that predicted for a sound with its F_0 according to the rule. If the F_0 is greater then 4,000 Hz, the

perception of pitch may not occur at all. The ability to differentiate between sounds with different F_0 values declines rapidly the shorter the period after passing the 0.25ms mark.

The second deviation from the rule involves complex sounds (sounds composed of more than one frequency). The F_0 of a complex sound is the greatest whole number factor of the sound's composing frequencies (O'Callaghan 2007, 79). So, the F_0 of a sound composed of 1,000 Hz, 3,000 Hz, 5,000 Hz, and 7,000 Hz is 1,000 Hz. There are many cases where a complex sound's F_0 predicts the pitch it appears to have. However, even when a complex sound's F_0 is between 40 Hz and 4000 Hz it is not guaranteed to follow the rule in question. For example, a sound composed of 2,100 Hz, 2,200 Hz, and 2,300 Hz has an F_0 of 100 Hz, but the pitch it appears to have is not the same as that which the rule predicts. Instead, it appears to have a pitch that the rule would predict for a sound with an F_0 of 2,200 Hz. There are many exceptions to the rule for high-order composite frequencies of limited complexity. In fact, psychoacousticians say that the rule only applies in what they call 'existence regions.' These are complex empirically constructed lists of periodicity and Hz numbers under which the rule applies (Plack and Oxenham 2005).

The issue with the rule that the pitch a sound appears to have corresponds to its F_0 is twofold: first periodic sounds appear to have a pitch as predicted by their F_0 only if their periods are between about 25ms (an F_0 of 40 Hz) and about 0.25ms (an F_0 of 4,000 Hz); second, there are a lot of exceptions to the rule for high-order composite frequencies of limited complexity. Thus, it is not always going to be the case that essentially some sound H1 is more similar to some sound H2 than some other sound L1 with respect to periodicity. H2 and L1 could have the same period. Thus, the Physical theorist cannot accommodate Unity using periodicity. Periodicity is the best-known Physical predictor of pitch. Thus, if periodicity does not allow the Physical theorist to account for Unity, then the Physical theorist is in serious trouble. Perhaps future discoveries in psychoacoustics will uncover a

Physical property that corresponds with pitch. Even if a Physical correlate of pitch is discovered, the Physical theorist may still be unable to accommodate Unity. I chose to examine pitch, because the rule that the pitch a sound appears to have corresponds to F_0 is exaggerated. However, timbre (tone quality) is another feature of sounds. Timbre is the quality that can differ for a single note played at the same volume on different instruments. Finding an underlying Physical correlate of timbre has been difficult. In fact, Handel (1995, 441) has said that '*no* known acoustic invariants can be said to underlie timbre.' Thus, we can conclude that probably AAP theories are true and Physical theories false.

I will now consider three objections to my argument of this Section. I will not consider an extended list of objections, as doing so would be redundant with the color literature. The purpose of Section 4 is not to convince those who are unconvinced by the argument from Unity in the color literature. The purpose is to show that an influential and strong argument used against Physical views of color can be applied to Physical views on sound. I have shown via an investigation of psychoacoustics that the rule that the pitch a sound appears to have corresponds to its F_0 is just that, *a rule*, and it is a rule with notable exceptions. Periodicity is the best-known Physical predictor of pitch. So, if periodicity does not permit the Physicalist to account for Unity, then Physical theories are in trouble.

I shall now consider the three objections. First, my opponent may suggest that one hears falsidically in cases where the rule that the pitch a sound appears to have corresponds to F_0 is broken. In reply, it is unclear whether there are any independent reasons for holding this. The rule can be broken in what seems to be normal circumstances for normal observers. To break the rule one need not alter one's usual environment or one's ears, or otherwise make any changes to one's person. All one needs to do to break the rule is to produce a complex sound of the appropriate type. It is true that the rule is most often broken for sounds not naturally created (Schnupp, Nelkan, and King 2011, Ch. 3). So, my opponent may claim that

we only auditorily perceive naturally created sounds veridically. This appeal to naturalism has a high price. Many of the sounds we listen to on a daily basis are not naturally created. Many of the colors that we perceive are not naturally created either, but if one is a naturalist about sound, one should be one about color (and perhaps other properties too like tastes and smells). The same considerations apply in the case of color: colors produced unnaturally often do not have natural reflectance profiles, and metamerism is more frequent (for example, with car paints). If naturalism is true for perceptible properties, many experiences we take to be veridical are really illusions: the sounds and colors from one's TV are illusions, cars do not have the colors they seem to, stoplights are not really red, and so on.

Second, my opponent may attempt to accommodate Unity by appealing to appearance dispositions, appearance relational properties, or primitive properties that supervene on the Physical properties. Specifically, the reply is to say that Physical properties can accommodate Unity in that properties which supervene on the Physical properties can. The issue with this response is that Unity states that the similarity and difference relations are essential to sounds, but it does not seem essential to the Physical properties that certain AAP properties supervene on them. Indeed, it does not even seem necessary that the AAP properties supervene on the Physical properties they do. I can easily conceive of a world in which the laws are different. In fact, that the laws of nature are contingent is the dominant position in philosophy (Carroll 1994). So, the issue with this reply is that it does not succeed in convincingly accommodating Unity fully. It accounts for the similarity and difference relations but not the component of Unity that these relations are essential.

Third, my opponent may appeal to an analogue of a particularly popular Physicalist response in the color literature which says claims about the structure of color space do not have the truth conditions that anti-Physicalists think they do (Hilbert 1987, Shoemaker 1991, 519; Lewis 1997, 330; Mclaughlin 2003, 115). Namely, my opponents may claim that the

truth conditions for Unity are of the following form: essentially, *experiences* as of H1 resemble *experiences* as of H2 more than *experiences* as of L1. If correct, there is no need for the Physicalist to account for Unity using second-order Physical properties of the Physical properties they say sounds are. A lot has been said about this style of argument for color (Pautz, 2006). I will just look at the fundamental problem. Many believe that it is the colors, not experiences of them, for which Unity is true (Westphal 1987, 125; Hardin 1988, 66; Boghossian and Velleman 1991, 95; Pautz 2006; Allen 2009, 205). The reason has to do with what is called 'the transparency of experience': when we focus on our experiences as of color no mental properties are discovered, instead we end up looking straight through them to the colors in the external world. The same can be said mutatis mutandis for sounds.[12] Thus, the truth conditions for Unity would seem as if they must involve the external world.

The fact that the truth conditions for Unity seem as if they must involve the external world brings us back to my argument that AAP views can accommodate Unity. Specifically, one may worry about whether appearance dispositionalism and appearance relationalism really satisfy this element of Unity: ultimately, both of these views satisfy Unity by appealing to experiences. In reply, it is true that the views appeal to experiences, but not as things *merely* had by us. The views in question appeal to experiences as logical parts of the external-world properties they identify with sounds. Thus, unlike Physicalist views, they can accommodate both the essentiality component of Unity and the external world component without having to deny veridicality in rule breaking cases. This said, primitivism may have an advantage in that it does not define sounds by experiences at all. Primitivism holds that the intrinsic natures of sounds are given phenomenally and so that sounds are defined

[12]It is true that one sometimes has a sensation in one's ear when hearing a loud sound, but this sensation is not itself a sound but a pain of sorts. Similarly, when one looks at a bright light, one has a pain in one's eyes. So, the phenomena described is not unique to sound. There are no experiences *of sounds* as mental properties internal to us that we discover when introspecting. This is sufficient for my argument.

ostensively: *that* is a beep, *that* is C minor. The things pointed to are not normally supposed to be internal experiences or composed of experiences but primitive properties of the external world. A view on sound that appeals to experiences to accommodate Unity is not a strongly objective view. So, primitivism is the only view that has a chance of accommodating Unity and being strongly objective. Thus, primitivism ought to be seriously considered.

Summary

There has been very little recently published on the property view of sound. In this article, I first argued that sounds are properties and defended this theory from the various arguments against it that make use of salient disanalogies between sounds and colors (Section 2). Next, I provided a taxonomy of property views on sound. My taxonomy articulated many views and how they are related to one another (Section 3). Finally, I argued that what I called 'Physical' views (views that hold that sounds are physical properties in the narrow sense) are probably incapable of accommodating the similarity and difference relations in which sounds essentially stand, what I called 'Unity' (Section 4). I have shown that sounds are probably properties that are not physical in a narrow sense of the term.

Acknowledgments. I would like to thank Keith Allen, James Andow, Ben Smart, and Kelly Ann Schmidtke for their helpful comments and advice. I am also especially grateful to an anonymous referee for their helpful remarks and suggestions.

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