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ORIGINAL RESEARCH

# Virtual Properties: Problems and Prospects

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**Abstract**
According to David Chalmers, the virtual entities found in Virtual Reality (VR) and Augmented Reality (AR) environments instantiate *virtual properties* of a specific kind. It has recently been objected that such a view (i) can't extend to all types of properties; (ii) leads to a proliferation of property-types; (iii) implausibly ascribes massive errors to VR and AR users; and (iv) faces an analogue of Jackson's "many-property problem". My first objective here is to show that advocates of virtual properties can deal with each of these objections. The other goal of this paper is to examine the consequences of Chalmers' theory in the particular case of AR. If we countenance virtual properties, AR highlights that non-virtual objects can possess both non-virtual and virtual properties. With AR, it also appears that a same non-virtual object can have *different* and even *incompatible* properties across augmented environments. Lastly, considering properties in light of AR highlights the risk of an "augmented solipsism", and calls forth interesting questions about the persistence conditions of non-virtual objects in AR environments.

## 1 Introduction

Virtual Reality (VR) technology affords its users a strongly immersive and interactive experience of computer-generated environments, through a dedicated headset. Because of certain remarkable features of these head-mounted displays (stereoscopy and motion-tracking, in particular), VR users report a strong sense of "presence": they feel as if they were really located within a "virtual world", which seemingly comes to replace their physical surroundings. With Augmented Reality (AR) devices, ranging from goggles to ordinary smartphones, 3D computer-generated imagery is projected onto physical space, thereby "augmenting" the user's surroundings with an overlay of virtual entities.

In his recent work, David Chalmers has argued that VR and AR count as genuine realities (Chalmers, 2017, 2019, 2022). On the ontological level, this so-called

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“virtual realism” holds that virtual entities are real digital objects, rather than mere fictions. It also maintains that VR and AR environments involve *virtual properties* of a specific kind. On this view, there would exist such things as *virtual colors* and *virtual shapes*, as opposed to non-virtual colors and non-virtual shapes.[1] A virtual tomato, for instance, would be *virtually* red and *virtually* round, where a non-virtual tomato is *non-virtually* red and *non-virtually* round.

These *sui generis* virtual properties, however, may seem to be mysterious posits. It has also been objected recently that the theory of virtual properties (i) can’t extend to all types of properties; (ii) leads to a repugnant proliferation of property-types; (iii) implausibly ascribes massive errors to VR and AR users; and (iv) faces an analogue of Frank Jackson’s “many-property problem”. My first objective here will be to defend the theory of virtual properties against these objections, which haven’t yet received any straightforward answer.

The other goal of this paper is to examine the consequences of Chalmers’ view in the specific case of Augmented Reality (AR) —a matter which hasn’t been discussed until now in the literature, often too focused on VR. If we countenance virtual properties, AR brings out several interesting facts. It reveals, firstly, that property instantiation is *cross-modal*, as non-virtual objects can have *virtual* properties. AR also shows that a given non-virtual object can have different and even superficially *incompatible* properties across virtual and non-virtual environments. Lastly, I’ll show why considering properties in light of AR highlights the potential risk of an “augmented solipsism”, and also calls forth issues about the persistence conditions of non-virtual objects in AR environments.

The plan is as follows. In Sect. 2, I examine Chalmers’ theory of virtual properties, along with its rationale and noteworthy consequences. In Sect. 3, I discuss several objections to that view and attempt to show how they could be answered. Lastly, Sect. 4 examines the notable implications of the theory of virtual properties in the particular case of Augmented Reality.

## 2 Virtual Properties

VR and AR users readily speak of “virtual objects” or “virtual events” to refer to what they perceive or interact with in their headsets or onscreen. For example, they’ll claim to see a “virtual table”, to interact with a “virtual kitten”, to attend a “virtual concert”, and so on. According to Chalmers’ virtual realism, we should take these assertions seriously. Virtual tables and virtual kittens exist no less than non-virtual tables and kittens. Virtual concerts are events which really occur, just as non-virtual concerts do. Virtual realism thus considers that the things we perceive and

[1] This type of claim need not be seen as presupposing any form of Platonism about properties. The “existence” of virtual F-ness might simply be understood as the fact that some things are virtually F.

interact with in VR and AR —*virtualia*, as we may call them generically— aren't merely fictional, despite common assumptions to the contrary.[2]

To be more specific, the core ontological assumptions of virtual realism are the following (Chalmers, 2019: 1):

(1) Virtual objects are real digital objects.
(2) Events in virtual worlds are digital events that really take place (involving virtual properties that are really instantiated).

We should stress that (1) and (2) involve a commitment to *digitalism*, roughly understood as the view that *virtualia* are "digital objects, constituted by computational processes on a computer" (Chalmers, 2017: 317). More precisely, digitalism sees *virtualia* as "data structures" which themselves reduce, at a more fundamental level, to arrays of *bits*, i.e. collections of 0s and 1s. It is a matter of controversy to know what should be understood exactly by "data structure" or "digital object" here.[3] Digitalism is also ambiguous between an *identity* claim (*virtualia* are identical to digital objects) or as a *dependence* claim (*virtualia* are distinct from but depend on digital objects).[4]

What I am interested in here isn't digitalism per se, however, nor even the controversial claim that virtual entities are real rather than fictional. I shall assume from the outset that there are digital and virtual objects, as virtual realism requires. My concern is rather with Chalmers' suggestion that *virtualia* possess *virtual properties* of a specific kind. What exactly are these special properties, and why should virtual realists admit any such things?[5]

For a start, let us see why and how Chalmers introduced this notion. Virtual properties initially appear as a solution to an objection against digitalism, which can be presented through a simple argument:

(1) Any virtual entity $x$ is a digital entity $y$.
(2) $\exists F (Fx \wedge \neg Fy)$.
$\therefore x \neq y$.

The first premise is digitalism (at least in one of its readings). The second premise states that any virtual entity and its corresponding digital entity will differ with respect to a least one property. A particular virtual apple, say, may appear as being red to users. However, the digital object or data structure corresponding to the

[2] For a defense of "virtual fictionalism", see e.g. Beisbart (2019), Juul (2005, 2019), McDonnell & Wildman (2019), Robson & Meskin (2016).

[3] See Ludlow (2019), Beisbart (2019), Chalmers (2019).

[4] On the distinction between these two versions of digitalism, see Chalmers (2017: 317; 2019: 454-5) and McDonnell & Wildman (2019).

[5] To be clear, virtual fictionalists have no need for virtual properties: they can account for the apparent properties of *virtualia* in terms of the (real) properties of the *props* guiding our games of make-believe when we interact with VR or AR (see McDonnell & Wildman, 2019).

virtual apple clearly does not have the property of being red. Data structures, indeed, are not the kind of things that we can observe with the naked eye, and do not as such possess any color properties (even if they did, there'd be no reason to think that the data structure under consideration would be red rather than another color). From these two premises, and by Leibniz' Law, it follows that the virtual apple and the corresponding data structure are not identical. If so, *virtualia* cannot be identical to digital objects, against what digitalism assumes.

Chalmers' answer to this worry is that the virtual apple is not red in the way a non-virtual apple would be. Rather, it is red in a different sense: it is *virtually* red. As he writes:

> A virtual flower is not red in the ordinary sense (non-virtually red), but it is virtually red. The corresponding digital object is also not red in the ordinary sense, but it is virtually red. (2017: 321)

Now, the question is to say what *virtual* redness is, as opposed to ordinary or *non-virtual* redness. The property of non-virtual redness, Chalmers contends, can plausibly be characterized as what causes red experiences in normal circumstances for human perception (2017: 321). A non-virtual tomato is red in this sense, since it brings out reddish experiences in normal viewing conditions. Now, the data structure corresponding to a *virtual* tomato is clearly *not* red in this sense: it does not bring about any reddish experience in standard viewing conditions, if only because it can't be seen with the naked eye. Yet, this data structure *does* bring about reddish experiences when it is accessed in the conditions which are *normal for VR* (i.e. when we are equipped with a functional VR headset). As such, Chalmers contends, it is *virtually* red:

> The data structure corresponding to a virtual red rose really does cause reddish experiences when viewed in these conditions, so the data structure is virtually red. This allows us to say that the virtual rose is virtually red, even though it is not non-virtually red. (2017: 322)

Ordinary (non-virtual) redness and virtual redness can then be distinguished as follows:

> <u>Non-virtual redness</u> = that which produces reddish experiences in normal conditions *for ordinary human perception*.
> <u>Virtual redness</u> = that which produces reddish experiences in normal conditions *for VR*.

This distinction at hand, we can answer the initial objection to digitalism. Although the data structure corresponding to the virtual apple isn't red in the ordinary sense, it does have the property of being *virtually red*. If we accept digitalism, the virtual apple inherits that property (for it is either identical with, or at least closely related to that data structure). Problem solved!

Now, Chalmers argues that the same analysis extends to *spatial properties*, such as shapes or sizes. A virtual apple, for example, may appear to users as being round and being 10 cm tall. The underlying data structure, of course, is neither round nor 10 cm tall. However, it is *virtually* so, because it brings about roundish experience and 10 cm tall-ish experiences when perceived in normal conditions for VR (Chalmers, 2017: 323). The virtual apple, then, can be said to have these properties *virtually*. For any spatial property F, we would thus have the following distinction:

> Ordinary (non-virtual) F-ness = that which produces F-ish experiences in normal conditions for ordinary human perception.
> Virtual F-ness = that which produces F-ish experiences in normal conditions for VR.

To a first approximation, Chalmers' account of virtual properties is therefore the following:

> Virtual properties: X instantiates virtual F-ness iff, when X is perceived in normal conditions for VR, X produces a F-ish experience.

Now that we have a more precise understanding of what Chalmers' theory of virtual properties is supposed to mean, I would like to make a number of remarks on this view and its implications:

1. The first thing to say is that the view advanced here is a "functionalist" theory of properties, insofar as it characterizes properties (whether virtual or not) in terms of their functional/causal role. That is to say that properties are singled out by what they do, rather than what they are made of. A virtue of functionalist theories is their ability to account for *multiple realizability*. A same functional role (e.g. being in pain or being a calculator) can be realized by different physical structures or substrates. Likewise, the particular role corresponding to virtual redness (i.e., bringing about reddish experiences in standard VR conditions) can have multiple realizers. As a result, Chalmers' view has the resources to explain why very different data structures may nevertheless correspond to one and the same virtual same property. The data structure corresponding to virtual redness in the VR game *Beat Saber*, for instance, may be very different (in terms of algorithmic structure or code) from the data structure corresponding to virtual redness in *Oblivion VR*. But this isn't an issue: since both correspond to the same functional role, these data structures can still be counted as different realizations of the same property.
2. We saw that Chalmers explicitly acknowledges virtual colors, virtual shapes, and virtual sizes. But his view arguably stretches much further. Chalmers indeed seems to endorse what I'll call a "Principle of Correlation", according to which *every* ordinary (or non-virtual) property could have a correlate virtual property in a virtual environment. As he puts it: "For any property X, there will be a corresponding virtual property virtual X. When a non- virtual object has X, the corresponding virtual object will have virtual X" (2017: 324). The Principle of Correlation delivers a mirror image of each ordinary property, so that F-ness always comes with its virtual counterpart, virtual F-ness. If bounciness and solubility, say, are genuine properties, we'll then also have virtual bounciness and virtual solubility. The same principle presumably goes for relations: for every relation R

(being on top of, being taller than), there will be a corresponding *virtual* relation R* (being *virtually* on top of, being *virtually* taller than).

3. Third, Chalmers's view is committed to a sort of *property dualism*. Virtual entities, indeed, are here taken to have two distinct kinds of properties. On the one hand, *qua* data structures or digital entities, they possess a bunch of ordinary, *non-virtual* properties. The data structure corresponding to a virtual apple, e.g., has a non-virtual spatiotemporal location, non-virtual causal powers, and a bunch of other non-virtual properties. But on the other hand, virtual entities also possess *virtual* properties of a specific kind. The virtual apple has a virtual color, a virtual shape, a virtual location, and so on. Any virtual object, then, has both virtual and non-virtual properties. The result is a kind of dualism, because virtual properties are taken to be *sui generis*: F-ness and virtual F-ness are different *kinds* of properties. Consequently, there is an important ontological difference between the properties of a virtual object *x* and a non-virtual object *y*. Even when *x* and *y* are visually indiscernible, they have different *types* of properties, which cannot be conflated.
4. Another interesting consequence of Chalmers' view should be mentioned. Imagine two different VR applications @ and @*, such that @-users see a red tomato, while @*-users see a pink banana. Here, @-users won't perceive anything virtually pink: the property of virtual pinkness isn't instantiated in the environment that they perceive. It is also clear that if @* was blown out of existence (perhaps because the VR app is deleted from all servers and computers), the virtual pink banana would cease to exist —and with it, its particular virtual pinkness. What this shows is that virtual properties exist and are instantiated only *relative* to a particular VR system.[6] Put otherwise, no virtual property exists independently of a VR or AR app. This indexation of virtual properties to particular virtual environments means that we should qualify Chalmers' theory as follows:

    <u>Virtual properties</u>: X instantiates virtual F-ness *in virtual environment E* iff when X is perceived in normal conditions *for VR-environment E*, X produces a F-ish experience.

5. A last point deserves mention. Alissa Ney (2019) takes Chalmers' view to be a brand of "phenomenal functionalism". This is because his theory accounts for properties (whether virtual or not) in terms of a functional or causal role, which is itself characterized through a certain type of phenomenal experience: being F, on that view, is to bring about F-ish *experiences*. Such a view is quite plausible

[6] An additional point, made obvious through the practice of "modding", is that a same data structure on the server-side can be rendered in different ways, depending on the users' client-side software (see Ludlow, 2019: 352). As a consequence, a same digital entity can be displayed to different users as having different virtual properties (e.g. as being virtually red for X and virtually blue for Y). Chalmers (2019: 464–465) contends that this is no more problematic than the case of a non-virtual object appearing differently to different observers. At any rate, one might accept that virtual properties do not depend solely on the makeup of the data structure on the server-side, but that they stem from a combination of the server-side and client-side software. This means that a single digital entity could have different virtual properties across users/clients.

in the case of colors, insofar as they are *response-dependent* properties: they are characterized in terms of the response they bring about in perceivers. For Ney, however, this does not go for spatial properties, such as shape or size. These properties are *intrinsic*, and as such, independent of the type of response that they produce in observers. What makes something round isn't its ability to bring about "roundish" experiences for perceivers in standard observation conditions, but rather a bunch of intrinsic geometrical facts. If that is right, Chalmers' view is inadequate, at least in the case of spatial properties.

I won't be going into the details of this discussion here. The important thing to note is simply that functional/causal roles need not be characterized in terms of phenomenal experiences (see Chalmers, 2020: 4–5). Space, Chalmers says, is whatever mediates motion and interaction. Likewise, he suggests that (virtual) solidity can be understood as resistance to (virtual) penetration (2022: 432). These functional characterizations have nothing to do with phenomenal experiences. Therefore, a virtual property need not be characterized in terms of a phenomenal role. It can also be singled out through a *non-phenomenal* functional role (or perhaps through a mix of a phenomenal and non-phenomenal role). As such, Chalmers' theory seems more accurately described as involving a disjunction:

> Virtual properties: X instantiates virtual F-ness in virtual environment E iff: (i) when X is perceived in conditions normal for VR-environment E, X produces a F-ish experience, or (ii) X has in E a causal or functional role analogous to that associated to non-virtual F-ness.

## 3 Four Issues with Virtual Properties

Now that Chalmers' theory of virtual properties and its noteworthy consequences have been presented, I shall discuss several objections which have recently been advanced against this view, and which yet have to be answered. It is my contention that none of them seriously threaten the theory of virtual properties.

### 3.1 The Scope of Functionalism

A first issue, which I gather and develop from some remarks made by Rebuschi (2022: 3), regards the scope of Chalmers' theory of virtual properties.

Suppose that you see a red apple in your VR headset. For the virtual realist, the corresponding data structure is virtually red, because it brings about a reddish experience for you in normal conditions for VR. But now, the very same scene is also one where you see a virtual apple, i.e. something which has the property of *being a virtual apple*. What is this property of "virtual applehood"? It seems that one ought to answer in the same fashion, and say that *x* has virtual applehood if *x* brings about an "apple-ish" experience in normal conditions for VR. And, when you see the virtual apple, you also perceive something which has the property of *being a virtual object*. This property of "virtual objecthood", by parity of reasoning, corresponds to whatever brings about a "object-ish" experience in normal conditions for VR. And so on for any other predicate corresponding to a species or kind of object. But can we really extend the theory of virtual properties in this fashion? Does the theory apply to *sortal properties*, which denote kinds of things, such as cats or apples or tornadoes or unicorns?

A related worry arises with higher-order properties, such as the property of being a primary color. Should we say that a virtual color has the higher-order property of being a virtual primary color if it brings "virtual primary color-ish" experiences in normal VR-settings? Likewise, is the property of being a virtual property analyzable in terms of generating "virtual property-ish" experiences?

Lastly, what about relations? Suppose a VR environment in which we see a dog attacking a cat. Should we analyze this as a case where virtual objects are interacting in such a way that they bring about a cat-ish experience, a dog-ish experience, and a dog-attacking-cat-ish experience? What about other relations such as killing, loving, buying,… (Rebuschi, 2022: 3)?

Overall, the worry here lies with what I called earlier the "Principle of Correlation", i.e. the claim that any non-virtual property (relation) can have a virtual correlate or counterpart.[7] Does Chalmers want to hold that *any* ordinary property can have a virtual counterpart? Does this extend to relations? Is a functional analysis possible for every property/relation? The problem isn't just that the analysis will be complex or awkward in some cases. It is, more fundamentally, that it seems doubtful that there's really a distinctive type of experience associated to each possible (virtual) property or relation.

Now, what could we say in reply to this particular concern?

(i) A first option would be to deny that some of problematic examples considered above represent genuine properties. In that case, there'd be no need to countenance their virtual counterparts. To illustrate this type of strategy, consider the so-called "sparse" conception of properties. On this view, we should only admit a restricted number of "elite" properties (generally taken to be those of fundamental physics, such as rest mass, charge, or spin). In this perspective, sortal properties (e.g. being a hat) and higher-order properties (such as being a primary color) shall count as *abundant* properties, i.e. mere semantic value of predicates, rather than fundamental constituents of one's ontology. Now, someone who accepts that kind of view and who also wants to countenance virtual properties won't be too bothered by the previous worries about the scope of Chalmers' view. Since there would only be a selected class of non-virtual "sparse" properties to begin with, one would just have to countenance a corresponding restricted class of virtual sparse properties. "Abundant" virtual properties—such as virtual sortal properties and virtual higher-order properties— could be ruled out as non-fundamental.

However, I do not think that this suggestion is really promising, if only because paradigmatic sparse properties do not have any obvious counterparts in virtual

[7] I do not mean to say that the above examples are the only issues concerning the scope of Chalmers' view. For instance, another matter of controversy is whether virtual objects have any essential properties. If they don't, and if non-virtual objects do, the Principle of Correlation is false. On this, see Ludlow (2019: 349–350) and Chalmers (2019: 463).

environments. For instance, there is no such thing as virtual spin or virtual electric charge in current virtual worlds, simply because they do not, or perhaps cannot, push the simulation that far. (It may well be, however, that such sparse virtual properties will exist in future highly sophisticated VR.) In addition, Chalmers' privileged examples of virtual properties all seem to qualify as "abundant", rather than sparse properties. It is true that there might be other ways to restrict one's inventory of non-virtual properties, and thereby, the virtual properties which are to be countenanced. Still, I think that this sort of "eliminativist" strategy quickly shows its limits. For even if we had good reasons to reject sortal properties and higher-order properties (and with them, virtual sorts and virtual higher-order properties), it seems much less plausible to think that one can squarely eliminate relations. Admittedly, we might consider that *some* virtual relations are "internal", in the sense that they supervene on the individual virtual properties of their relata (see Armstrong, 1997: 87 – 9). For instance, the relation "...is taller than..." holding between two virtual objects *x* and *y* might simply hold in virtue of the virtual sizes of *x* and *y*. But in the case of "external" relations, such as distance, this won't do: in themselves, the intrinsic virtual properties of *x* and *y* do not allow one to specify at which distance they stand to one another. Likewise for relations such as "…kills…", "…buys…", "…attacks…", which seem to call for some analysis or other in virtual worlds (Rebuschi, 2022). For that matter, I am not convinced that this first strategy, which would amount to *eliminating* problematic properties or relations, can take us too far.

(ii) Alternatively, and I take this to be a better option, we can simply answer the previous concerns by stressing that virtual properties and relations are not necessarily associated to a distinctive type of phenomenal experience. As we saw above, Chalmers' stressed that functionalism need not take a purely phenomenalistic form. As such, a nonphenomenal functional role could suffice to characterize certain virtual properties and relations.

This strategy, I think, can deal with at least some of the cases discussed previously. For instance, the (sortal) property of being a door might correspond to the functional role of being a movable barrier that allows entry or exit from an enclosure. If *x* has this role in a non-virtual environment, then it is a non-virtual door; and if *x* has this role (or rather, a closely analogous role)[8] in a virtual environment, then it is a virtual door.[9] The higher-order property of being a virtual primary color, now, could be characterized in terms of membership within a set of virtual colors whose mixture generates a wide array of different virtual colors. Lastly, it seems quite possible to account for many virtual relations in *mechanical* terms, depending on the

[8] A reviewer notes that since there is only *apparent* (rather than *actual*) movement in virtual worlds, the functional role of non-virtual and virtual doors can't be exactly the same. This does not mean, however, that the property of being a virtual door could only be characterized from a phenomenal standpoint. Something could arguably be recognized as a virtual door at the level of the code itself by programmers, independently of any door-ish phenomenal experience.

[9] Some might point out that this means that doors which do not open in virtual environments do not qualify as virtual doors. I think that the diagnosis is correct, though: such items may *look* like doors, but they are really just door facades. We could characterize them as *virtual door representations* or *virtual door pictures*.

characteristics of the virtual environment under consideration. In a VR videogame, for instance, the binary relation "A kills B" might be characterized as the fact that A inflicts $\geq x$ damage points to B; and the ternary relation "A gives $x$ to B" may be analyzable as "$x$ moves from A's inventory to B's inventory". It is true that the specific non-phenomenal functional role associated to each (virtual) property and relation will then have to be characterized on a case by case basis. Still, nothing implies that no such analysis is possible in principle.

The upshot of this discussion is that there are several potential ways to deal with the concerns about the scope of Chalmers' theory. These worries, at any rate, are not *sufficient* to reject the theory of virtual properties. It might be that the "Principle of Correlation" is false, and that the advocate of virtual properties can or should only admit a selected few virtual properties and relations. But even should this concession be made, it wouldn't show that there are no virtual properties, or that Chalmers's view would be fundamentally mistaken.

### 3.2 Ontic Proliferation

For Chalmers, virtual F-ness is whatever produce F-ish experiences or whatever plays the F-role in *conditions which are normal for VR*. Note that this clause about the appropriate conditions is crucial. Without it, there is no difference between ordinary redness and virtual redness, insofar as the associated functional role (i.e., bringing about reddish experiences) is the same in both cases. But one may wonder: why accept an ontological divide merely because of these differing viewing conditions? Why would such observational differences make an *ontological* difference? According to Schuppert (2022), this is because Chalmers tacitly accepts the following principle:

> Ontological innovation (OI): For any $x$ and any P such that $x$ isn't P, if $x$ depends of technology T and $x$ brings about P-ish experiences in circumstances which are normal for T, then there is a special property $P^T$ corresponding to P and $x$ is $P^T$. (Schuppert, 2022: 6)

It seems that it is indeed such a principle which leads Chalmers to introduce virtual redness or virtual roundness as *sui generis* properties. However, as Schuppert goes on to argue, this principle will lead to an unpalatable ontological proliferation of property types – at least if the virtual realist commits to the full and irreducible reality of virtual properties. Let's consider the following example, which I adapt from Schuppert.

We said that a data structure is not red in the ordinary sense, but that it may be virtually red, when it produces reddish experiences in normal VR settings. Likewise, a film roll is not red or square in the ordinary sense, but it may produce reddish or squarish experiences in normal film settings (i.e., when plugged in a working projector aimed at a white screen). So, in virtue of (OI), we would have to say that the film roll, though it isn't ordinarily red or square, is *filmically* red or *filmically* square. The objection is therefore that Chalmers' argument for introducing virtual properties leads, by parity of reasoning, to the admission of *filmic* properties. We would then already have three different types of redness (ordinary, virtual, filmic). But if we accept *sui generis* filmic properties, why stop there? After all, (OI) shall lead us to countenance many other property types corresponding to various other technological media. Our ontological inventory would thus include *n* other *sui generis* types of rednesses, corresponding to *n* technological revolutions. This unpalatable ontological proliferation, Schuppert argues, is a strong reason to reject Chalmers' account of virtual properties. Virtual fictionalism, by contrast, seems more parsimonious, since it only countenances one type of properties (viz., non-virtual ones).

The previous objection relies on a supposed analogy between the case of VR and that of films. However, this analogy seems quite fragile. In traditional (non-digital) movies, the film roll is made up of stills which have been produced through *photographic* means. But given this photographic process, there's a causal story to tell. The stills composing the film roll are photographs which track *ordinary* properties of the photographed entities: what is depicted on the screen are the properties we would have perceived had we been present when and where the movie was shot. Chalmers says as much: facing a photograph or film of Churchill, we should agree that "Churchill [is] the causal basis of our experience, and the features of our experience depend systematically on the features of Churchill when he was filmed" (2017: 319).[10] The same does not go for VR, since what is displayed in the headset isn't a photograph of independently existing entities. Rather, we users see are *computer-generated* objects and properties, produced by a 3D engine. If that's right, it seems that we have a reason to reject the notion *sui generis* filmic properties. A movie picture simply reflects the ordinary properties of the recorded objects, while VR obviously does not resort to any kind of photographic process. As such, the supposed symmetry underlying Schuppert's objection does not withstand scrutiny.

The previous answer, however, seems much too quick. Many movies, of course, do not resort to this photographic process, as they are produced (partially or fully) through digital means. Think, for instance, of digital animation movies, such as *Toy Story*, which involve computer-generated imagery akin to that found in VR. In *Toy Story*, there's a green dinosaur named Rex. It goes without saying that there's no photographic process at play here—Rex isn't an actor who was filmed in a studio. Does this show that Rex is not green in the ordinary sense, but *filmically green*? Should the case of computer-generated movies push virtual realists to admit at least *some* instances of filmic properties?

I don't think so. Indeed, Rex is not an entity which *lacks* the ordinary property of greenness, but which would possess this property in some other special sense. If we leave aside its nature and identity as a fictional character, it seems that Rex (or at least, the prop which guides our imaginings of Rex) is just a *picture*, or a set of pictures. And like other pictures, it has color properties in a mundane sense. Given its entrenchment in our modern cultures and daily lives, cinema or TV imagery has become a standard condition for normal human perception. If that's right, we can simply maintain that Rex is green in an ordinary sense, just as many other

[10] This is reminiscent of Walton's notion of "photographic transparency" (Walton, 1984). For a discussion in the case of VR, see Tavinor (2019).

non-photographic representations. Even in the case of digitally made movies, then, Chalmers has no reason to accept *sui generis* filmic properties.

Some might wonder why the foregoing wouldn't equally apply to the properties of virtual entities. Why not say that these are simply *ordinary* pictorial properties (i.e. properties of pictures), rather than seeing them as virtual properties of a special type? A first answer is that VR, to the difference of cinema, does not count as of now as a normal condition for ordinary human perception, the result being that virtual properties do not count as ordinary properties.[11] More fundamentally, the suggestion that *virtualia* are pictures can be rejected on the ground that "multiple people may see different images on different displays while they all perceive the same virtual object." (2017: 319). If several people can perceive the *same* virtual entity while seeing *different* pictures in their VR headsets, the picture and the virtual/digital entity should be distinguished. Identifying *virtualia* with pictures (and virtual properties with iconic properties) would also imply that each screen or display of a VR headset represents *unique* virtual entities, distinct from those perceived by all other users: the red virtual tomato in *my* headset wouldn't be the same virtual entity as the tomato in *your* headset, however similar they might appear. Such a claim multiplies virtual entities without ground. It also leads to the implausible claim that different VR users can never simultaneously perceive the same virtual entities, even when they are in a multi-user environment (see Declos, 2022: 13).

All this being said, I think that the objection from ontic proliferation fails, at least in the following sense: the reason provided for virtual properties does not force virtual realists to also admit *sui generis* filmic properties, against what Schuppert assumes. True, the consequences of the (OI) principle remain to be explored *vis-à-vis* other kinds of technologies. It remains to be seen whether the ontic proliferation of property types generated by this principle is inevitable or necessarily problematic. Meanwhile, the specific case discussed by Schuppert isn't enough to warrant this conclusion.

### 3.3 Massive Errors?

Another objection, also due to Schuppert (2022), is that Chalmers' theory of virtual properties leads to ascribe massive errors to VR and AR users.

Consider the following scenario: S perceives a virtual tomato in her VR headset, and later sees a non-virtual stop sign in the street. Suppose that the two objects produce two reddish experiences E and E* in S, such that the color content of E and E* seems to be the same to S, who can't tell the colors apart. In this situation, S will quite naturally think that E and E* are experiences of the same color property, and describe her experiences in these terms.

However, Chalmers can't say this. For him, the virtual apple and the non-virtual stop sign aren't red in the same way, even if they are phenomenally indiscernible. E and E* are experiences of *different rednesses*: the stop sign is *non-virtually* red, and

[11] "Using a virtual reality headset is not (yet) a normal condition for ordinary human perception, so this is not enough to make the digital object count as red in the ordinary sense" (Chalmers, 2017: 322).

the apple is *virtually* red. So, Chalmers has to say that S is mistaken when claiming that E and E* are just experiences of the "same color". Likewise, it would be mistaken to compare the sizes of virtual and non-virtual objects in AR, as when people contrast the height of a virtual couch and that of their non-virtual coffee table in the IKEA Place app. This would count as a category mistake on Chalmers' view, for no *virtual* property can be "the same property" as a *non-virtual* property. As a result, Chalmers' theory of virtual properties leads to ascribe massive errors and categorial illusions to VR and AR users. This consequence, besides being implausible, is more generally antagonistic to the epistemological component of Chalmers' virtual realism, according to which perception in VR and AR is (at least for sophisticated users) generally veridical (see Chalmers, 2017, 2022).

Now, I do not think that this objection is really threatening for the advocate of virtual properties. For a start, Chalmers agrees that *naïve* VR users are prone to illusions and mistakes, as they will be inclined to believe that virtual objects are physical objects located in a physical space. That such users would also be mistaken about the properties of virtual objects would hardly be surprising. In addition, Chalmers considers that such mistakes or illusions disappear with practice and experience, insofar as sophisticated VR users come to perceive virtual objects *as virtual*. He briefly notes that he is also "inclined to say that the sophisticated user may see objects as having virtual colors, though perhaps this is not as straightforward as the case of perceiving virtual space" (2017: 332).

This succinct remark, to my sense, suggests how Schuppert's objection could be dealt with. Indeed, if it is possible to perceive virtual properties *as virtual*, the risk to conflate them with non-virtual properties shall be null, or at least, greatly reduced. Now, what it is exactly to perceive a virtual color *as virtual*? What is the distinctive phenomenology of virtual properties?

I think that this qualified perception might be characterized in terms of certain beliefs and/or dispositions. To perceive a particular redness *as virtual*, for instance, might involve the belief that this color appearance could be changed at the whim of the programmers; that it wouldn't be visible without the appropriate VR headset; that it is produced by certain pixels lightning up, etc. Perceiving a virtual color *qua virtual*, I think, might also involve a behavioral disposition to not treat it exactly as its non-virtual counterpart. For instance, to perceive a redness as virtual might involve a disposition to change the luminosity of our headset when we have a headache, or to activate the color-blind mode in the app's menu if one suffers from this pathology (two things that can't easily be done, alas, in ordinary reality). The perception of virtual properties could more generally be associated to different ranges of behavior for sophisticated users. When encountering a shrieking virtual sound or a violent virtual flash, for instance, they might remove their headset or activate the pause menu, instead of trying to cover their eyes and ears.

My suggestion that the perception of virtual properties qua virtual is linked to beliefs and dispositions could be developed in different ways. A first option would be to say that one's beliefs about VR affects the phenomenal character of one's perception: if I believe that I see a virtual color or shape, my phenomenal experience would turn out different, compared to a case where I see a non-virtual color or shape. On this account, virtual properties would have a different and distinctive phenomenology. Such a view could plausibly be motivated in terms of cognitive penetration, much in line with Chalmers has to say on perception of virtual objects as virtual (see Chalmers, 2017: 331–332; 2022: 215–216). A second option would be to say that perceiving a virtual property qua virtual leaves the phenomenal character of my experience unaffected, but that this involves acquiring certain beliefs about the object instantiating that property, which lead me to relate to it in a particular fashion. Perceiving the properties of a virtual apple *as virtual*, here, would not be having a special or distinctive perception, but simply gaining certain beliefs about this object (e.g., the belief that the apple's redness couldn't be perceived without a headset); which may lead me to such or such behavior and expectations. The problem with this second option, however, is that it arguably does not describe a process where one comes to *perceive* something as virtual. Rather, it seems to be a case where one comes to *believe* that something is virtual. For this reason, the first option seems preferable.

At any rate, and even if the specifics of this virtual property phenomenology still have to be explored, the general idea is enough to tackle Schuppert's objection: if sophisticated VR users can come to perceive virtual properties *as virtual*, they won't risk conflating them with non-virtual properties any longer. This makes them immune to the mistakes or illusions that Schuppert invokes. The fact that some of these sophisticated users might still quite naturally speak of virtual and non-virtual objects as having a "same property" (e.g. a same color) doesn't have much weight. Virtual realists can simply see this as loose talk, as evidenced from the fact that these users will have different beliefs and dispositions regarding the virtual color and the non-virtual one.

### 3.4 The Many-Property Problem, Again

The last objection I want to discuss, which is due to Rebuschi (2022), is that the theory of virtual properties faces an analog of the notorious "many-property problem" for adverbialism.

Consider the so-called "adverbial theory of perception", a.k.a. adverbialism. According to this view, perception is a *modification of experience*, such that to perceive P it is to have a P-ly modified experience. To perceive redness or roundness, for instance, is to perceive *redly* or *roundly*. Frank Jackson (1975) has raised the following objection to this theory, which became known as the "many-property problem". Consider a scene where S perceives a red circle and a blue square. Adverbialism will analyze this as follows:

(1) S senses roundly and redly and squarely and bluely.

But how can adverbialists differentiate this situation, Jackson asks, from one where S would perceive a blue circle and a red square? The analysis, here, would be:

(2) S senses roundly and bluely and squarely and redly.

Since conjunction is commutative (the order of conjuncts within a conjunctive sentence do not matter for its truth value), (1) and (2) amount to the same thing. Therefore, adverbialism cannot differentiate these two visual scenes: it fails to account for the structure of our visual experience.

Now, Rebuschi suggests that the same issue extends to Chalmers' theory of virtual properties. Take a VR scene where one sees a virtual red circle and a virtual blue square. These entities have the virtual properties they have, Chalmers says, because they produce reddish and roundish and blueish and squarish experiences in conditions normal for VR. But this analysis, it seems, is no different from that of a situation where we'd have a virtual blue circle and a virtual red square. For here too, we'd have a blueish and roundish and reddish and squarish experience. In other words, Rebuschi's worry is that Chalmers cannot differentiate the two perceptual scenes. If that's right, this theory of properties fails to account for the structure of our perceptual experience in VR.

My reply to this objection is that it is illegitimate to extend the many-property problem to Chalmers' theory. The core intent behind adverbialism is the rejection of relational theories of perception, for which perceptual experiences involve relations to perceptual objects (e.g. *sense-data*). The theory of virtual properties, however, does presuppose a background of virtual objects, which virtual properties stand in relation to. After all, virtual properties do not float free in the virtual space: they are always instantiated *by particular virtual objects*. This, I think, explains why we can't apply Jackson's objection to the theory of virtual properties. To see why, compare these two visual VR scenes:

<u>Scene 1</u> = a virtual blue square, a virtual red circle.
<u>Scene 2</u> = a virtual red square, a virtual blue circle.

On Chalmers' view, what we can say here is this. In VR scene 1, there is *a virtual square* which instantiates the property of being virtually blue; and *a virtual circle* which instantiates the property of being virtually red. In VR scene 2, there is *a virtual square* which instantiate the property of being virtually red; and *a virtual circle* which instantiates the property of being virtually blue. The analysis is different in each case, as it should be, because although the properties exemplified in both scenes are the same, *the property-bearers* are different. So, as long as we admit that virtual properties are had by particular objects, or "inhere in" the virtual objects which have them, we have the means to differentiate cases such as the above, where (virtual) properties are swapped.

This reply has a cost, though. For it to work, it seems that one has to deny that being a virtual square or being a virtual circle count as properties. Otherwise, the analysis of the two previous scenes would have to be:

<u>Scene 1</u> = virtual squareness and virtual blueness and virtual redness and virtual circularity.
<u>Scene 2</u> = virtual squareness and virtual redness and virtual blueness and virtual circularity.

Given the commutativity of conjunction, we'd get the result that scene 1 = scene 2, so that we can't recover the structure of the perceptual scene (i.e. say which property is had by which virtual object). This hints that Chalmers cannot understand virtual sorts in terms of properties, on pain of facing Jackson's problem. Virtual objects should then be introduced as *sui generis* entities, irreducible to properties.

For those who find the latter conclusion repugnant, another option is to admit something like virtual substrata, i.e., objects which play the role of (virtual) property-bearers. If we introduce something besides virtual properties — something which "bears" them—, we can then safely construe virtual sorts as properties. Actually, there is something in Chalmers' view which is precisely tailored to that substratum role, namely, the digital entities underlying virtual objects. This is also in line with digitalism, as Chalmers says that it is the *data structure itself* which is virtually red or virtually round. To revert to our previous example, since the data structures underlying the visual scenes 1 & 2 are different, they provide a way to distinguish the two scenes. We can say now that we have two digital objects *x* and *y* such that:

> Scene 1 = *x* is virtually square and virtually blue, *y* is virtually circular and virtually red.
> Scene 2 = *x* is virtually square and virtually red, *y* is virtually circular and virtually blue.

Jackson's problem can be avoided by virtual realists, then, provided they do not construe virtual sorts as properties, or alternatively, as long as they see digital entities as property-bearers.

## 4 Properties in AR

In the previous section, I have surveyed several objections to the theory of virtual properties, and attempted to show how they could be answered. I wish to conclude this discussion by examining the consequences of this theory in the specific case of Augmented Reality technology, which I have intentionally left aside until now. What singles out AR environments is that they are only *partly* computer-generated: they are made up both of virtual and non-virtual entities, in varying proportions. Although Chalmers did not specifically discuss virtual properties in light of AR, I think that such "hybrid" or "mixed" environments reveal a number of interesting things for those who accept the existence of virtual properties.

Before seeing why, a technical note is required. If we revert to our previous characterization, the theory of virtual properties, adapted to AR, would be:

> Virtual properties (AR): X instantiates virtual F-ness *in AR environment E* iff: (i) when X is perceived in conditions normal for AR-environment E, X produces a F-ish experience or (ii) X has in E a causal or functional role analogous to that associated to non-virtual F-ness.

However, although this characterization works fine in the case of VR, this isn't so with AR. For thus stated, it entails that a *non-virtual* tomato, when perceived in

AR, is *virtually* red! This is obviously mistaken. This consequence can be avoided, though, if we amend the definition.

Virtual properties (AR): X instantiates virtual F-ness in AR environment E iff: (i) when X is perceived in conditions normal for AR-environment E, X produces a F-ish experience, that X would not bring about outside of E, OR (ii) X has in E a causal or functional role analogous to that associated to non-virtual F-ness, and X would not have this role outside of E.

The revised definition introduces modal clauses, in order to avoid counting some non-virtual properties as virtual, and vice versa. A non-virtual tomato is non-virtually red, for it would bring about a reddish experience even outside of the AR environment. A non-virtual hammer has the non-virtual power of hammering nails, for it would still have this causal role outside of the AR environment. Now, a non-virtual tomato painted blue in AR is virtually blue, for it would *not* produce this blueish experience outside of the AR environment. Likewise, a non-virtual hammer that can be used to hammer virtual nails or to kills virtual zombies only has these properties virtually, for it would not have this causal role outside of the augmented environment.

This being said, let's examine the noteworthy consequences of the theory of virtual properties in the case of AR.

(1) AR environments are composed, in varying proportions, of virtual and non-virtual entities. At first glance, it seems intuitive to think that the properties instantiated by non-virtual objects in AR must be *ordinary* (non-virtual) properties, which are instantiated in physical space. For virtual realists, however, non-virtual objects can also possess *virtual properties*, which are only instantiated in the augmented environment. The blue car in the street may be virtually green in the augmented environment of a nearby AR user who decided to apply a color filter on it. Of course, unaugmented passersby will see nothing green there. But while the car is not green in the physical environment, it is virtually green in that AR space.[12] This is no more mysterious than the case of a virtual piano which is not *physically* in Washington square, while being *virtually* located there (see the discussion in Chalmers, 2022, 228–230). According to virtual realists, AR therefore reveals that property instantiation is *cross-modal*: a non-virtual entity can instantiate *both* virtual and non-virtual properties.

[12] Some might complain virtual properties, when ascribed to non-virtual objects, are mere "Cambridge" properties, rather than genuine features of these objects. For a non-virtual car to be virtually red would be like its being more than 2 miles away from Mike Tyson: such a property does not seem to owe anything to the object's intrinsic features. Look at the car all you want, you won't see anything there that makes for its virtual redness. However, this complaint is misguided. It is clear that virtual properties are highly relational and extrinsic: they depend for their existence and instantiation on certain software/hardware basis; and perhaps additionally on certain mental states and social conventions. This does not mean that they aren't real, however; nor that they wouldn't be genuine features of objects in the relevant augmented spaces. In addition, virtual properties are perceptible, to the difference of Cambridge properties such as being south of Paris.

(2) A second noteworthy point is that a same non-virtual object can have *different* virtual properties across AR environments. Say that there's a (non-virtual) blue car in the street. With a given AR app @, I use a filter to repaint the car red. With AR app @*, you paint it pink. It is crucial, here again, to stress that the virtual color properties are instantiated only *relative* to particular AR environments (those of @ and @*). Otherwise, we'd get a contradiction, insofar as nothing can be uniformly red and uniformly pink at a same time, whether in ordinary reality or in virtual environments. This consequence is avoided, though, once we reckon that the car is virtually green *in AR environment* @ and virtually pink *in AR environment* @*. A same non-virtual object can therefore unproblematically have different virtual properties in different AR environments.

(3) The previous claim, however, seems less obvious when we consider people using *the same AR software*. Suppose that we are both at a same place, and that we are using the same device running the same AR app. Say that I decide to "reskin" all the surrounding non-virtual objects in pinkish tones; while you recolor everything in greyish tones. What should we say, in this case? If we maintain that we both see the same non-virtual objects located in a same AR space, we will be committed to saying that these objects have *incompatible* virtual properties at a given time, viz. that they are both uniformly virtually grey and virtually pink at the same time. This seems unacceptable. So, we should conclude that we are perceiving *different* AR spaces. In *my* AR space, the non-virtual tree in the park is virtually pink; while in *your* AR space, it is virtually grey. Here again, contradiction is avoided by relativization.

(4) The previous conclusion comes at a cost, though. It entails that AR users, as long as they customize their AR environment differently, end up perceiving (and interacting with) numerically different AR environments. For advanced and highly customizable AR software, the chances of users modifying their surroundings exactly in the same fashion will be quite low. Thus, users would almost never see the same AR environment as others. Doesn't this give rise to a form of "augmented solipsism", in the sense that each user would end up inhabiting their own private AR world, irremediably different from that of any other user?

I do not think that this concern is entirely motivated. In AR environments, the non-virtual layer will generally remain identical across users. In our previous example, the non-virtual objects are the same for both users, and just differ in terms of their virtual colors. As a result, the AR environments perceived by users, though technically distinct, will still have shared components —namely the non-virtual objects populating them. True "solipsism" is then avoided, for the experiences of different users will still have much in common. Moreover, we should recall that individuals using the same AR app will have the same *functionalities* at their disposal. As such, they will always be capable to modify their environment to fit that of the people they are interacting with, when the circumstances call for it.

Leaving this concern aside, the claim that each user might perceive their own private virtual space seems much more acceptable in AR than in VR. User-based customization is one of the most prominent and promising feature of AR. It also seems to be a design principle and expected outcome, in the case of AR apps involving filters or "skins". Though VR environments can also be customized through mods, many users won't engage in such practice. As such, VR users will in most cases perceive exactly the same thing. This, I think, gives some plausibility to the conclusion that AR users often won't perceive exactly the same environment, even when they use the same app. In this respect, and against what is often claimed, AR is more insulating than VR.

(5) The previous remarks reveal another interesting thing about AR. As we saw, a non-virtual object can possess virtual properties, and can instantiate different virtual properties in different AR spaces. But in fact, AR reveals that a non-virtual object may even possess *superficially incompatible properties at the same time*. My car may be black in physical reality, but pink in a given AR environment. This isn't problematic, however, for the considered *property types* are different: my car is *virtually* pink; while it is *non-virtually* black.[13] And since these properties are instantiated in different spaces (one physical throughout, the other partly virtual), there really is no conflict here. Likewise, the car may possess incompatible *virtual* properties at a same time, provided these are instantiated in different AR spaces. What AR highlights, then, is that a non-virtual *x* can instantiate superficially *incompatible* pairs of virtual and non-virtual properties, as long as these are instantiated by *x* in different spaces. This, I think, is a remarkable metaphysical fact.

(6) I would like to mention a last interesting point. As we saw, an important feature of AR is that it allows users to modify (some of) the virtual properties of the surrounding non-virtual objects. This raises issues about the persistence conditions of non-virtual objects in AR spaces. Suppose that my non-virtual black car is painted blue in AR. Here, the virtual realist will say:

> The non-virtual car gains the property of being virtually blue in the corresponding AR environment.

This claim seems natural, as we consider that the non-virtual object (i.e. my car) *survives* the property change in the AR space. However, other sorts of property changes might not be identity-preserving. For instance, in a case where my car was suddenly "transformed" into a virtual pancake in the AR space, I doubt that we would say:

> The non-virtual car gains the property of being virtually a pancake in the corresponding AR environment.

Leaving aside the worries about the status of virtual sorts, it does not seem possible for my car to gain the property of being a virtual pancake while remaining numerically the *same* object. What's really going on, here, is an *occlusion*: my car is still out there in the physical space, but it occluded by the AR space by

[13] This is why the appearance of "incompatibility" here is only superficial: it only arises if one forgets that one color is virtual, while the other is non-virtual.

some other virtual object. As such, the non-virtual car does not exist any longer in the augmented environment. It has been *replaced* by a non-virtual object.

AR, then, brings the issue of the persistence conditions of non-virtual objects to forefront. We have to settle which of their virtual property-changes are identity-preserving, and which aren't. More generally, this involves saying taking a stand on the properties (if any) which are essential to non-virtual objects. Since virtual properties changes also occur with *virtual objects* (whether in VR or AR), it also remains to be seen which virtual properties (if any) are essential to them. These issues about identity and persistence in VR and AR environments have yet to be explored in more detail, and constitute a promising topic for future research.

## 5 Conclusion

According to David Chalmers, the virtual entities that users perceive in VR and AR environments possess virtual properties of a specific kind. After presenting the specifics and rationale of this theory, I tried to show how it might be defended against several objections. Then, I explored the remarkable consequences of this account in the specific case of Augmented Reality environments. If the existence of virtual properties can be defended, virtual worlds gain in ontological thickness, and seem less easily seen as mere fictions. As such, much of the realism vs. fictionalism debate may eventually hang on the fate of these ontological posits.

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