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Seeing Motion and Apparent Motion

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Abstract: In apparent motion experiments, participants are presented with what is in fact a succession of two brief stationary stimuli at two different locations, but they report an impression of movement. Philosophers have recently debated whether apparent motion provides evidence in favour of a particular account of the nature of temporal experience. I argue that the existing discussion in this area is premised on a mistaken view of the phenomenology of apparent motion and, as a result, the space of possible philosophical positions has not yet been fully explored. In particular, I argue that the existence of apparent motion is compatible with an account of the nature of temporal experience that involves a version of direct realism. In doing so, I also argue against two other claims often made about apparent motion, *viz*. that apparent motion is the psychological phenomenon that underlies motion experience in the cinema, and that apparent motion is subjectively indistinguishable from real motion.

In a well-known experimental paradigm in psychology, with a history stretching back into the nineteenth century, participants are asked to look at a screen, on which all that actually happens is that two brief stationary stimuli (or 'flashes') are presented in succession, each at a different location on the screen. Let us say that the first stimulus is presented at time t_1 in location A, and that the second stimulus is presented at time t_3 in location C. If the interval between t_1 and t_3 and the spatial distance between A and C are each within a certain range, subjects viewing such a display will often report an illusory impression of movement between A and C. This is what psychologists typically refer to as *apparent motion*.[1]

In the example just given, we are dealing with visual apparent motion. Vision is not the only modality that can give rise to apparent motion phenomena, but it is the case I will focus on in what follows. My topic will be the ways in which philosophers have made use of the example of apparent motion in arguing for specific theoretical accounts of temporal experience. What I want to suggest is that existing arguments in this area are in fact premised on a mistaken view of the phenomenology of apparent motion. As a result, the full range of available philosophical positions has not yet been explored. This is of some importance, I will also argue, because the existing philosophical debate on apparent motion has wider, but rarely explicitly acknowledged, ramifications for the philosophy of perception in general.

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1. Grush and Dainton on Apparent Motion

My point of departure will be a critical examination of a recent debate between Rick Grush and Barry Dainton that centres on apparent motion.[2] As presented by Grush and Dainton, the primary question of interest in that debate is whether *extensionalist* theories of temporal experience, of which Dainton's is a representative, can accommodate apparent motion phenomena, or whether they can only be accounted for by *intentionalist* theories of temporal experience, of which Grush's is a representative.[3]

Dainton (2010: sec. 1.1) gives a first, rough, characterization of extensionalism in terms of the claim that 'our episodes of experiencing are themselves temporally extended, and are thus able to incorporate change and persistence in a quite straightforward way'. To understand the substance of the extensionalist's view, however, some further clarification is in order, especially with respect to what the second clause in this quote is trying to get at. Clearly, part of the idea is that, in so far as there can be episodes of perceptually experiencing one flash followed by another, for instance, such episodes themselves *necessarily* extend through a period of clock time. Yet, the extensionalist wants to say more than just this. For it might be the case that, for reasons quite generally to do with the nature of perceptual experience, episodes of perceptual experience have to extend through some period of clock time, irrespective of what they are experiences of. The extensionalist, by contrast, wants to make a claim specifically about temporal experience—namely that we can explain how it is that we can perceive instances of, say, succession or movement by appealing to the idea that episodes of perceptual experience themselves extend through a certain period of clock time. For present purposes, we can allow a certain leeway as to which particular explanatory commitments this should be seen to imply. We can simply illustrate the point by giving some examples of what such commitments might look like. As a minimum, the extensionalist seems to be committed to there being a mapping between the temporal *structure* of episodes of experience and the temporal structure that experienced episodes are experienced to have. Thus, for instance, in order for me to experience a flash at *A* being followed by a flash at *C*, I must undergo an experiential episode as parts of which I experience the flash at *A* and the flash at *C* in turn. Another aspect of the extensionalist's position might be that I experience the period in which the two flashes occur to have a certain *duration* because I undergo an episode of experiencing that lasts through that duration of clock time.

This sketch of the extensionalist's position is enough, for the moment, to get started on the debate between Grush and Dainton. As stated so far, the characterization of extensionalism I have given dealt only with the kinds of claims an extensionalist might make to explain how it is possible for us to experience, e.g., a flash at *A* being followed by a flash at *C*. Yet, as we have seen, in cases of apparent motion, all that is actually displayed is simply a flash at *A*, followed by a flash at *C*, but, at least on the face of it, this isn't all that is reflected in the phenomenology of the experience. Grush thinks such cases provide

conclusive counter-examples to extensionalism, because they cannot be coherently accommodated on the extensionalist's view. Here is how he puts the point:

> Presumably the proponent of [extensionalism about temporal experience] will maintain that the temporally extended perceptual act will not, at t_2 [i.e., a point in time intermediate between t_1 and t_3], be able to magically predict that there will be a flash at location *C* in the immediate future. And so the act will represent the environment as having a flash at *A* at t_1 and nothing at t_2. But what happens at t_3, when the second flash occurs at *C*? There is no comfortable answer here. (Grush 2008: 155)

Grush's argument seems to be the following: In the case of apparent motion, the overall experience of what happens between t_1 and t_3, as conceived by the extensionalist, must have as a part an experience (covering the time between t_1 and t_2) of the first stimulus, followed by nothing, i.e., simply of a solitary, stationary stimulus. But then it seems that the overall experience of what happens between t_1 and t_3 cannot, at the same time, be an experience in which something looks to be moving from *A* to *C*.[4]

Grush's alternative to extensionalism is a variant of what is sometimes called an intentionalist view of temporal experience, which he calls the *trajectory estimation model*. Much of the more technical aspects of this model, which Grush develops at a considerable level of detail, are not relevant to our present purposes. Instead, I will just focus on how this model is meant to deal with cases of apparent motion.

Key to Grush's view is the idea that the perceptual system, at regular intervals, creates a representation of the environment the subject inhabits. Each time such a representation is created, it is based on the sensory input gathered up to that time, but it goes beyond the input received in that it uses that input (which is of necessity incomplete) in order to generate the most likely estimate of what is actually the case in the subject's environment. Crucially for Grush's account of temporal illusions, the relevant representations generated are not just representations of objects and static properties. Rather, as he puts it, 'the perceptual system interprets the represented system in terms of trajectories or processes. These form, so to speak, the basic vocabulary of the perceptual system' (Grush 2009: 600). What this means is that the representations in question are actually estimates of what happens over a short interval of time that extends a certain distance into the past, as well as into the future, with respect to the time at which each representation itself is generated.

On this view, then, apparent motion involves a situation in which a representation generated at one time conflicts with and supersedes one created earlier, as further input received in the meantime makes a different estimate more likely. Thus, in the case of our example, we have an initial representation, say at t_2, as of a static flash at *A* followed by nothing, but this is overwritten

by a later representation, at t_3, as of a movement between *A* and *C*, because the perceptual system has received the additional sensory input from the flash at *C*.

Against the background of Grush's own theory, his criticism of Dainton's rival extensionalist position can be seen to turn on the thought that apparent motion necessarily involves conflicts in experience over time. Grush's intentionalist approach to temporal experience can accommodate such conflicts through the idea that the course of experience takes the form of a sequence of representations, each of which presents one version of how things unfold over a period of time, where later representations in the series can overwrite earlier ones, even if the periods of time they represent overlap. The extensionalist, by contrast, seems to have no similar way of accommodating conflicts in experience over time.

Thus put, though, one question to ask is whether the extensionalist actually needs to accept the assumption that apparent motion involves conflicts in experience over time. Dainton, for one, thinks he doesn't. Here is his response to Grush:

> [A]lthough the initial stationary flash is registered at a pre-conscious level, it never actually reaches consciousness: as soon as the second flash registers, our visual systems reach the conclusion that the likely source is a moving light, and this is what we experience. It is thus only to be expected that subjects deliver the reports they do. Until this construal of events can be ruled out, the extensionalist has little to fear from this sort of case. (Dainton 2010: Supplement: Interpreting temporal illusions)

Note that, on Grush's view, apparent motion involves a conflict in experience over time because he thinks that the flash at *A* must initially (i.e., before the flash at *C* occurs) be experienced as a static flash. The key thought behind Dainton's response is that our actual conscious experience is the output of a perceptual mechanism that delivers its verdict only after a delay. Thus, by the time the flash at *A* first registers in conscious experience, the perceptual system has also already received the information about the flash at *C*. As a result, the flash at *A*, from the time it first registers in conscious experience, is in fact experienced as the beginning of a movement.

It is possible to pursue the dialectic between Grush and Dainton yet further, for instance by asking how psychologically plausible the idea of a delay of the type envisaged by Dainton is (cf. Grush 2005: S215f.). However, I think it is perhaps more worthwhile to take something of a step back at this point and consider some of the underlying assumptions in play in Grush's and Dainton's theories. In fact, I believe that perhaps the philosophically most interesting dimension of the debate between them is one neither of them seems to pay much attention to or make much of. Putting that dimension centre stage, though, might also help bring out that there are in fact more theoretical possibilities than either Grush or Dainton acknowledge.

2. Experience and Time: The Bigger Picture

In order to get a picture of the wider issues at stake in the debate between Grush and Dainton, we need to bring two further sets of distinctions to bear on that debate, in addition to the distinction between extensionalist and intentionalist approaches to temporal experience. One of them is a distinction pitched at a more specific level, in so far as it is concerned specifically with ways of approaching temporal illusions such as apparent motion; this is the distinction between *Orwellian* and *Stalinesque* approaches to such illusions. The other distinction is pitched at the more general level of accounts of the very nature of perceptual experience; this is the distinction between *representational* accounts of perceptual experience, on the one hand, and what are sometimes referred to as *relational* accounts of such experience, on the other.

The terminological distinction between Orwellian and Stalinesque approaches to illusions of the type exemplified by apparent motion is due to Dennett (1991). The basic idea common to both approaches is that such illusions involve the operation of perceptual mechanisms that construct an ecologically plausible but not always veridical representation of events from sensory input, and that, as a result, what is being experienced, e.g., in apparent motion, is something other than things as they are. What the distinction between Orwellian and Stalinesque approaches then turns on is the extent to which the relevant mechanisms operate outside consciousness. On a Stalinesque approach, it is only the end product of their operation—the definitive version of events, so to speak—that reaches consciousness. On an Orwellian approach, by contrast, the relevant mechanisms operate on representations that are themselves conscious; yet, where a representation generated at one time contradicts a representation generated earlier, that earlier representation is simply overwritten by the newly generated one and can also no longer be retrieved from memory.

Put in those terms, Grush's account of apparent motion clearly falls on the Orwellian side of the distinction. Dainton's account just as clearly falls on the Stalinesque side. Do they exhaust the theoretical possibilities? This, I believe, is where the debate between Grush and Dainton has wider ramifications for the philosophy of perception, for each of their respective accounts is informed by a particular view of perceptual experience in general, and there is an alternative, third, such view that both of them implicitly rule out.[5]

One particularly active general debate in the philosophy of perception at the moment concerns two rival views of perceptual experience sometimes referred to as the representational view and the relational view of experience, respectively.[6] In the current context, one way of introducing the distinction between the two views is by noting a difference in the way Grush and Dainton use the term 'content' in talking about perceptual experience. Along with perhaps the majority of philosophers writing about perception today, Grush appears to think of perceptual experiences as having a representational content in the sense of veridicality or accuracy conditions. Put very crudely, this is a view on which

perceptual experiences are essentially assimilated to judgements, because judgements, too, have a content in this sense.[7]

Dainton, by contrast, typically uses the term 'content' in quite a different way, which is connected to him subscribing to a form of indirect realism inspired by Locke. There is a sense in which Dainton, too, thinks of perceptual experience as representational, and as having veridicality or accuracy conditions, but this is not why he talks about such experience having contents. Rather, the contents of experience, in Dainton's sense, are particular occurrences or features that form constituents of the experience—items we are directly aware of, where this is a matter of us standing to them in a primitive non-representational relation. For Dainton, these take the form of purely phenomenal items, and a representational element enters into his view only because it is these phenomenal items that then, in turn, serve as representations of non-mental entities or occurrences. In other words, in as far as perceptual experience involves contents in Dainton's sense, these figure in experience in a way that cannot itself be accounted for in representational terms, but involves a distinctive and more primitive psychological relation of awareness in which the subject stands to them.

This understanding of perception as involving a distinctive psychological relation of awareness that cannot be accounted for in representational terms places Dainton's views on the side of a relational view of perceptual experience. We can distinguish between two broad forms that such a relational view can take. In Dainton's case, we are dealing with a variant of the relational view on which the items to which the subject stands in such a relation are phenomenal, i.e., mental, items. The historical model for this type of view are sense-datum theories. Yet, there is also an alternative form that relational views of experience can take, which I will refer to as direct realism. On this form of relational view, perceptual experience of mind-independent objects and their properties is in fact to be analysed as involving a distinctive psychological relation of awareness to those mind-independent objects themselves, rather than just to sense-data which then, in turn, represent those objects. Thus, just as, for Dainton, certain phenomenal items figure as constituents in experience, so, according to direct realist versions of a relational view, do mind-independent objects or their properties.

Making the distinction between the representational and the relational view of perceptual experience, and between the two different forms that the relational view can take, helps to bring out a crucial presupposition that is in fact shared by both Grush and Dainton (as well as other authors discussing apparent motion such as Tye 2003, and Paul 2010).[8] The argument between them, basically, takes for granted that the only possible views of perceptual experience that have the resources to account for apparent motion are the representational view or a sense-data version of the relational view.

Dainton does at one point acknowledge that his own view belongs to a wider class of views—i.e., what I have called relational views of perceptual experience—which also admits of a direct realist variant. In the same context, he also claims that 'there is no obvious obstacle to combining [extensionalism] with a direct realist construal of perception' (Dainton 2010: sec. 5.1). But it should really be clear that

the Stalinesque strategy he adopts to make his extensionalist view of temporal experience compatible with the existence of apparent motion involves a denial of direct realism. Recall that the extensionalist's key claim is that we can explain how we can experience, say, one flash followed by another in terms of the idea that our experience itself extends through a period of clock time, and during that period, each of the flashes is experienced in turn. Dainton, in short, takes it that in order to account for apparent motion phenomena we have to introduce the idea that what is in fact experienced during the relevant interval does not necessarily correspond to the actual stimuli presented, but is a construct created by our perceptual system.[9] But clearly, whatever the visual system can create, it can't be such things as flashes of light or moving lights. Thus, in as far as experience is to be construed as a distinctive psychological relation to certain items, they must be mental items, as Dainton's version of a Locke-inspired indirect realism envisages. A direct realist construal of apparent motion is ruled out.[10]

3. Wertheimer on Pure Motion

Is there, contrary to what Dainton and Grush both assume, a way of accounting for apparent motion that is available to the direct realist? Obviously, this might just be regarded as an instance of an entirely general question as to how direct realists can account for illusions. However, what I want to suggest in this section is that the possibility of a realist account of apparent motion will seem to be particularly remote if we make a particular assumption about the phenomenology of apparent motion that both Grush and Dainton make, and that this assumption can be challenged on empirical grounds. As a way into the issue, it may help to clear up what looks to be a terminological confusion that can be found in some recent discussions of apparent motion.

Some contemporary authors call what I have been referring to as apparent motion phenomena ϕ-phenomena. Others use ϕ to pick out a particular kind of apparent motion phenomenon, as contrasted with some others that are designated by other Greek letters—in particular, ϕ is meant to contrast with β.[11] In each case, Wertheimer (1912) is typically credited with coining the relevant usage. In fact, though, it is at least arguable that neither usage actually corresponds with what Wertheimer had in mind. The first reference to ϕ in his 1912 monograph comes in the following passage.

> The facts are these: Two objects were successively given as stimuli. These were perceived. First *a* was seen, then *b*; between them, a 'motion from *a* to *b* was seen', without the corresponding motion or the spatially and temporally continuous positions between *a* and *b* actually being exposed as stimuli.
>
> The psychic state of affairs can be called—without prejudice—$a\phi b$. ϕ designates something that exists outside the perceptions of *a* and *b*. (Wertheimer 1961: 1049)

On the face of it, the purpose of this passage is to introduce ϕ as a placeholder. It is clearly not being used to pick out one particular apparent motion phenomenon from others. But it is also not obvious that it is being used to label the class of apparent motion phenomena in general. For it is not even clear that Wertheimer, at this stage, means to rule out that a 'psychic state of affairs *aϕb*' may also be present in cases of veridical motion perception.

Rather, Wertheimer's main concern seems to be with picking out—as he says, 'without prejudice'—that which makes experiences involving an impression of motion different from experiences simply of two successive stimuli at two different locations, in a way that does not already involve making substantive assumptions about what exactly is involved in a subject's having such experiences. His point is precisely that there is scope for debate about any such further assumptions, a point he brings out by focusing on the following two candidate claims.

> I. ϕ is something which uniformly concerns *a* and *b*, something which is built on them, which both embraces and unites them.
>
> II. The phenomenal content of ϕ is given by subjective supplementation (or on the basis of subjective supplementation) of the between positions which are not objectively manifest as spatially and temporally continuous. (ibid.: 1050)

Both (I) and (II) may initially seem plausible. Yet what Wertheimer takes his own empirical studies to show is that neither (I) nor (II) are in fact necessary for a 'psychic state of affairs *aϕb*' to hold. Thus, for instance, he notes that under some experimental conditions, participants reported that they had experiences in which only the first stimulus looked as though it was moving, whereas the second didn't. From this he concludes that (I) is not generally true of all instances of apparent motion.

For our purposes, though, perhaps the most significant aspect of Wertheimer's discussion concerns what he refers to as experiences of *pure motion*, which he believes show that (II) is also not true.[12] Thus, he says of an experiment in which the relevant stimuli were two lines presented in succession:

> What is psychically given in the field of motion? The thesis previously quoted . . . said that the intermediate positions of the object are subjectively supplied. (One could also quote the a priori argument, that motion is unthinkable unless an object, a thing, a seen-thing moves.) [. . .] But it appears that the essence of the passage across [. . .] has nothing to do with subjective intermediate positions. There are cases where ϕ, the motion across [. . .] is clearly given, without a line being present in the field of motion in any way. The initial and final positions were present, and between them the motion, but in the field of motion, no optical supplementation, no seeing or imagining of the intermediate positions of the [line]. (ibid.: 1057)

Thus, in cases of pure motion, there is an impression of movement, yet it is also introspectively obvious that nothing more than two stationary stimuli is actually being perceived.[13] One of Wertheimer's participants, for instance, provided the following description: 'The exact situation is this: the passage across, the compelling motion from *a* to *b*, is there clear and distinct, strong and entirely continuous, but nothing of white passes across, and no stripe passes across' (ibid.: 1062). Similarly, Higgson (1926: 79) writes of apparent motion studies he carried out: 'It must not be assumed that "full-movement" always meant that a line was apprehended to move, as a line, across the field [. . .]. The observers instead reported at times that the experience meant that one line moved from one position to the another; but that the actual movement of a line across the field intermediate to the two perceived positions was not seen'.[14]

How can we conceptualize the phenomenology of pure motion, thus characterized? Note that there is actually at least some prima facie difficulty in fitting pure motion into the mould of either Grush's or Dainton's account. Grush explicitly invokes the idea of a form of subjective supplementation of intermediate positions to account for apparent motion (see, e.g., Grush 2009: 601), and some of what Dainton says is also naturally interpreted as involving a commitment to such an idea (see, e.g., Dainton 2008a: 381f, and Dainton 2008b: 624).[15] This is not to say that these accounts could not be tweaked some way to deal with cases of pure motion, but in each case this would also likely come at a price, as far as the strength of Grush's and Dainton's respective overall argument is concerned.

In Grush's case, for instance, one idea might be that, in the case of pure motion, the subject's perceptual state ends up having a representational content that is contradictory. Thus, the subject's perceptual state in such a case might perhaps be thought to represent a stimulus as moving from *A* to *C*, but also represent that stimulus as not moving through the intervening space between *A* and *C*.[16] Remember, though, that Grush's case against the extensionalist was that apparent motion phenomena involve a conflict in appearances over time, which the intentionalist can accommodate—by postulating a sequence of distinct representations—without committing himself to the idea that experiences can be contradictory within themselves. Thus, if it turned out that Grush himself, in order to make sense of pure motion phenomena, has to allow that experiences can have contradictory contents, his case against the extensionalist would become less compelling.

However, adjustments would also have to be made to Dainton's version of extensionalism in order to make it compatible with the existence of pure motion. Recall that, on Dainton's account, in order for there to be an experience of apparent motion, the perceptual system literally has to 'fill in' the relevant experience. That is to say, it has to supply further contents, in Dainton's sense of phenomenal items or features that can serve as objects of awareness, in addition to those corresponding simply to the flashes at *A* and *C*. The idea of subjective supplementation of intermediate positions, as Wertheimer puts it, would clearly provide one way of understanding what such filling in might

come to; yet it can't account for pure motion experiences. Thus, Dainton, it appears, would have to say that there is another, special kind of phenomenal feature that the perceptual system adds in the case of experiences of pure motion—something like a motion quale—which can indicate motion even in the absence of subjective supplementation of intermediate positions. Yet, recall that extensionalism aims to explain our experience of temporal features in terms of the structural features episodes of experience themselves have, as episodes that extend over periods of clock time. And it is far from obvious how the presence of a motion quale, as envisaged here, could amount to a structural feature in the relevant sense. If pure motion experiences don't involve experiencing something traversing the space between the two stimuli, they arguably simply take the form of experiencing the two stimuli in turn, and nothing in between them. At best, then, a purported motion quale could make a difference to the *way* each of the stimuli (or the display as a whole) is being experienced—i.e., a qualitative, rather than a structural difference. Thus, the idea of a motion quale at the very least sits ill with Dainton's extensionalism, in as far as it implies the existence of at least one aspect of experience that can represent the presence of motion, but which is not accounted for in extensionalist terms.

The main question I want to raise at this point, though, is whether there isn't also an altogether different way of thinking of what is entailed in experiences of apparent motion. If we were committed to explaining apparent motion phenomena in terms of the idea of subjective supplementation of intermediate positions, the choice between a representationalist view of perceptual experience and an indirect realist view would indeed seem unavoidable. That is to say, we would either have to think of experiences of apparent motion as having a representational content to the effect that those intermediate positions are being traversed by the stimulus. Or we would have to think of such experiences as involving the awareness of purely mental items that would correspond to the stimulus as actually located at such intermediate positions. Once we drop the idea of such subjective supplementation, though, we can avail ourselves of quite a different, much more theoretically neutral, strategy for capturing what is going on in apparent motion. In particular, we can avail ourselves of a strategy that is compatible with direct realism, as it allows that all that is in fact experienced in apparent motion is things as they actually are in the subject's environment.

The general type of strategy I have in mind here has received what is probably its most comprehensive treatment in a recent paper by Michael Martin. As described by Martin (2010), the strategy, put very crudely, is to give an account of the semantics of 'looks' statements according to which they express an implicit comparison. Here is how Martin summarizes the basic idea.

> On the whole, we convey information to each other both about the looks of objects and about sensory episodes in which things look some way or other to us through the use of implicitly comparative claims: that the object, or the sensory state, is relevantly similar to some other, paradigm case. [. . .] On such a minimalist approach, it would be mistaken to look

> to our semantic competence to argue in favor of one substantive theory of sense experience over any other. (ibid.: 161)

There is a temptation among philosophers to read 'looks' statements, particularly as made in the context of visual illusions, as direct reports of psychological states. On the view described by Martin here, this is a mistake. Such statements about how things look are in fact statements about the manifest visible properties of the things perceived. There is an element of subjectivity or perceiver-relativity to such statements, though, which explains the temptation to read them as reports of psychological states. We might illustrate these points by considering how exactly the view in question might be applied to apparent motion phenomena.

Note, first of all, the appeal to 'paradigm cases' in the quotation from Martin.[17] In what sense might there be paradigm cases of visible movement? When we look at something that is moving we can often make out that it is moving just by looking. But that does not mean that we can do so, or do so equally well, in all cases. The humming bird's moving wings are just a blur to us; the abrupt, short movements of a lizard's head are hard to catch; and we might have to look twice to see whether a snail is moving or stationary. Also, a movement may occur at a speed that makes it easy for us to see, but go on for too long, so that we cannot take it in in one glance, but have to follow it with our eyes.[18] There are only certain ranges of movement, involving certain ranges of displacement at certain speeds, that we seem particularly well equipped to see. In other situations where we are in fact looking at something that is moving there may be too little movement, or the movement may be too slow, too fast, or go on for too long for us to make it out, or do so easily in a glance.[19] It is in this sense that we can talk about paradigm cases of visible movement, and of cases in which something is in fact moving, but which don't constitute such paradigm cases.

Yet, once the idea of paradigm cases of visible movement, understood along those lines, is in place, we might also be able to make sense of the idea that cases in which there is no actual movement occurring might be visually similar, in certain respects, to such paradigm cases of movement—indeed more so than to paradigm cases of things staying visibly stationary. If there is a characteristic range of displacements that objects undergo, taking up a characteristic range of times doing so, in paradigm cases of visible movement, then a display of two stationary flashes may, for instance, be similar to a paradigm case of visible movement because the spatial distance and temporal interval between the two flashes correspond to those between the starting and finishing points of a paradigm case of visible movement.

It might be held against this that nothing can be similar to a paradigm case of visible movement unless it involves the appearance of a continuous displacement. Note that, if this was true, it would indeed be difficult to avoid the conclusion that apparent motion must involve subjective supplementation of intermediate positions, and with it the idea that what is experienced in apparent motion is something other than things as they are. But I take it that it is precisely

what Wertheimer's studies show is not true. At least in some cases of apparent motion, it can be perfectly obvious that there is nothing in continuous motion that is being seen, but this does not make the impression of movement go away. So it must be possible to explain the latter by appeal to ways in which what is being experienced even in these cases can bear a similarity to paradigm cases of visible movement—say, in terms of the idea that the appearance of similarity is driven by a correspondence in certain dynamic features, as suggested above. But if we can give such an explanation, we have removed the need to appeal to the idea of subjective supplementation of intermediate positions, and can allow that all that is actually experienced in apparent motion is just things as they are—i.e. two stationary flashes.

Crucial to the approach to apparent motion sketched here is the thought that we need to distinguish between the idea that apparent motion displays a certain kind of psychological *relativity* and the idea that it involves psychological *construction* in the sense of Wertheimer's notion of subjective supplementation of intermediate positions. Clearly, which particular cases of movement do constitute paradigm cases of visible movement is dependent on certain features of our sensory and psychological make-up (and also, plausibly, certain ecological factors).[20] What exactly we find similar to what, too, will depend in certain ways on our psychology. But this need not alter the point that we can interpret the statement that the display looks as if there is something moving as a statement primarily about the display and its features. More specifically, in as far as that statement implicates something about one's psychology, namely how the display strikes one, it need not imply that there is anything more being experienced to be occurring, apart from the two stationary flashes. Thus, the statement can be understood in a way that is compatible with direct realism. Apparent motion experiments, on this type of view, can reveal something psychological, but it is not some fact about the nature of perceptual experience of the type at issue, for instance, in the debate between Grush and Dainton. In particular, this type of view gives no support to their shared assumption that there is no possible way of accounting for apparent motion within a direct realist framework.

4. Cinematic Motion

The line of thought just offered is likely to face an immediate objection, which is that I have been cherry-picking my example. The account I have given may fit the case of what Wertheimer called pure motion. But this is because, in the case of pure motion, it is in fact introspectively obvious that nothing that is in motion is being seen. But there are other cases of apparent motion where this is not the case and which are in fact phenomenologically no different from experiences of real motion. Or so the objection will go.

One particular way of fleshing out what exactly the objection might come to here is by linking it to a further claim frequently made by philosophers writing about apparent motion, and to some extent also by psychologists. That claim is

that apparent motion of the kind discussed so far is also the psychological phenomenon that explains why, in the cinema, we have an impression of motion when we look at what is in fact a fast succession of discrete, static, images projected onto the screen—call this *cinematic motion*. There is a strong intuitive sense that the account I have given at the end of the preceding section does not fit cinematic motion experience. In the case of pure motion, the impression of movement does not involve the impression of something that is visibly in motion, and, to that extent, it may seem plausible to say that the experience is merely similar, in some respects, to an experience of actual movement. But in the case of cinematic motion, the impression clearly is as of something moving. In other words, it doesn't seem right to say that the experience is just similar to a case in which something is moving. The very thing that is moving seems to be seen, and it seems to be seen as it moves.

In this section, I will focus on this way of framing the objection in terms of an appeal specifically to cinematic motion. I will argue that cinematic motion should not in fact be classed together with apparent motion phenomena of the type discussed by Wertheimer (indeed, for the very reason just mentioned), but that it, too, can be accounted for in a way that is compatible with direct realism. In the next section, I will then look at the question as to whether there are other cases of apparent motion, less clearly distinct from experiences of real motion than what Wertheimer called pure motion experiences are, that threaten the account I have given.

The discussion up to this point should in fact, I believe, already cause us to regard with some suspicion the claim that apparent motion of the type studied by Wertheimer is the psychological phenomenon that also explains motion experience in the cinema.[21] Note in particular that a key issue at stake in the preceding section was whether we need to postulate a process of what Wertheimer called 'subjective supplementation of intermediate positions' in order to account for apparent motion phenomena. This might seem to be a pressing concern when we are dealing with the kind of stimuli used by Wertheimer and others working in his tradition, as there is a clearly visible gap between the location of the first stimulus and that of the second one, in which other stimuli could be presented and be perceived as such. Paradigm cases of cinematic motion, by contrast, are clearly not like this. So it is not at all obvious, at least in those cases, that there is even a temptation to explain our impression of motion in terms of the idea of subjective supplementation.

On an even more fundamental level, though, it is also possible to question whether cinematic motion should be classed as an instance of illusion in the first place, whereas apparent motion, of the type discussed so far, clearly is. Gregory Currie, for one, takes the line that what we experience in the cinema should actually be classed as a genuine instance of motion, rather than as something that merely generates an illusion of motion (cf. Currie 1996). What we see when we look at the cinema screen are images that persist over a period of time, and, during that period of time, can move from one location on the screen to

another—call these *cinematic images*. And it is just the movement of such cinematic images that explains why we have an experience of motion.

One aspect of Currie's argument is the idea that, in order for a subject to have an illusory experience as of an x, there has to be something about the appearance of x that suggests that it is other than it actually is. Our experience in the cinema, by contrast, does not obviously meet this condition—or so Currie thinks. Thus put, though, it might seem that the view can quite easily be shown to be wrong, as has been argued by Kania (2002). If we slow down the projector, it becomes apparent that what we are really looking at are individual static images projected onto the screen, separated by brief periods of darkness. Does this not show that there is an important respect in which our experience, when the projector runs at normal speed, misleads us?

The problem with this response is that rests on a substantive, and challengeable, assumption about what it would take for cinematic motion to be a real instance of motion. Consider the following example of Mark Kalderon's as a potential analogue:

> Imagine [. . .] viewing a minimalist painting in a gallery. From your current vantage point, the surface of the painting appears a uniform if luminous green. Closer inspection is revealing, however. As you move in for a closer look, the painting is discovered to be not only minimalist, but pointillist. The luminous green appearance of the surface was achieved by painstakingly painting minute yellow and blue dots across the surface. In fact no part of the surface of the canvas is painted green—every part of the surface is painted either yellow or blue. (Kalderon 2011: 755)

Kalderon argues that this is not a case in which the green appearance of the painting is illusory. The painting really is green, though this is something that we can only discern from a certain distance; and, from that distance, we can't see all there is to see about the painting's colour. The reason for this is that colour is not, as Goodman (1977) termed it, dissective. If something has a property that is dissective, then every part of that thing will also have that property. This is clearly not the case for colour.

Colour is spatially non-dissective, but there are also phenomena that are temporally non-dissective. Take auditory pitch, for example. At a low repetition rate of, e.g., 10 Hz, a train of clicks is simply heard as a succession of clicks, but as the repetition rate increases and individual clicks become increasingly difficult to tell apart, it also takes on an additional quality, *viz*. a pitch that varies with the repetition rate. At 100 Hz, for instance, a sound with a pitch corresponding to 100 Hz is heard. It again seems wrong to describe the appearance, in these circumstances, of a pitch of a certain quality as illusory. Lowering the repetition rate merely makes manifest that there are temporal parts of the process that is being heard that do not themselves have that quality, and which, in turn, have other qualities that cannot be made out at higher repetition rates.[22]

In a similar vein, the realist about cinematic motion may argue that cinematic motion is not temporally dissective. Kania may be quite right in saying that certain aspects of what is happening on the screen are invisible at the normal speed of projection, and that slowing down the projector can make us aware of those aspects. But if cinematic motion is not temporally dissective, the converse can also hold, i.e. it is also possible that there are certain aspects of what is actually happening on the screen at the normal speed of projection that are invisible at slower speeds. The fact that cinematic motion becomes invisible when we slow down the projector does nothing to show that the appearance of it at normal speed must be illusory.

Yet, this response, in turn, may invite a further objection, as ordinary motion *is* temporally dissective. As Kania (2002: 249) puts the point, 'the putative motion of cinematic images is under debate precisely because it seems a very different kind of thing from the motion of bicycles, billiard balls, and so on'. Setting aside the possibility that time itself is discontinuous, the motion of bicycles and billiard balls is temporally dissective. By contrast, cinematic motion objectively lacks continuity. This much, at any rate, can be established by slowing down the projector. Thus, cinematic motion, to be real, would have to be temporally non-dissective. Yet, this means that motion can come in two quite different varieties: dissective and non-dissective, which would make the case quite different from that of colour or pitch, because colour and pitch, arguably, do not come in dissective and non-dissective varieties.

I think the best response to this argument, on behalf of the realist about cinematic motion, is to say that the difference here lies not in the way the concept of motion gets applied, but in the kinds of things it applies to. Any movement of a billiard ball does of course have to be continuous. But we can view this as a consequence of the continuous existence of the billiard ball, rather than making such continuity an essential feature of movement. The fact that, on a view that allows that cinematic motion is real, such motion is discontinuous, should then come as no surprise. After all, we are dealing with the movement of a quite different type of thing, with very different identity conditions. Thus the key issue here is not whether we should allow that there are two different types of movement. Rather, the key issue is whether we should allow into our ontology re-identifiable spatial particulars other than physical objects. Once we do, these can clearly undergo movement.

In line with this last point, Ponech (2006) has argued that a position such as Kania's seems to involve an unreasonably restrictive conception of the kinds of things that can undergo movement. Apart from objects such as billiard balls, Ponech argues, common sense also recognizes 'a horde of mundane if comparatively less thingy, more ephemeral movers, like airborne soap bubbles, smoke rings and cloud formations [and] such higher-order entities as schools of anchovies, spots of light, reflections and shadows' (ibid.: 363). Pointing out that there is a certain pluralism in our common sense views about potential movers will not clinch the argument, though. For there might be specific reasons for thinking that allowing cinematic images of the type envisaged by

Currie into our ontology would be a step too far. It might constitute an ontological opening of the floodgates, i.e., force us to recognize a much wider—and clearly unacceptably wide—class of things as potential movers.[23] In fact, as I will argue in the next section, the present discussion provides a context for making this last worry more concrete. However, as I will also argue, once it is thus made more concrete, it also becomes clearer how it might be responded to.

5. The Difference between Apparent and Cinematic Motion

The suggestion in the preceding section was that cinematic motion should and can be given a very different theoretical analysis from that which I gave, in Section 3, of apparent motion of the type studied by Wertheimer. This was in response to the worry that the analysis of apparent motion I gave in Section 3 does not seem to fit cases of cinematic motion. What I have suggested is that cinematic motion, instead, should be seen as an instance of real motion. There really is something moving that we perceive, and the appearance of motion can thus be explained simply in terms of the idea of a direct awareness that we have of this moving thing. To this extent, the argument of the last section is also in line with my general aim of making space for a direct realist account of temporal experience.

Yet, it may be thought that, in a different respect, the argument presented in the last section is actually damaging to the one in Section 3. For it may be thought that the realist account of cinematic motion I have just offered undermines, or at least makes unnecessary, the account I gave earlier of apparent motion of the type studied by Wertheimer. Once we have made our ontology liberal enough to admit the kind of persisting entities that can undergo cinematic motion, why not say that even the two-stimulus displays used in apparent motion research should count as containing genuine instances of motion of some form of re-identifiable particular?[24] This, I believe, also provides us with a means for making more concrete the worry sketched at the end of the last section, that adopting realism about cinematic motion threatens to make our ontology unacceptably liberal. The suggestion that even in the displays used by Wertheimer we should recognize the existence of a real particular that actually undergoes movement just seems absurd.

Yet, this very absurdity of the suggestion, in turn, can also be seen to hold the key to the question as to how one might respond to the worry. In the case of apparent motion, the thought would go, there are *phenomenological* grounds against the claim that we are dealing with a case of real motion. What Wertheimer called experiences of pure motion are in fact only those cases of apparent motion where the phenomenological difference from real motion experience is introspectively particularly obvious. But the difference is also there in other cases of apparent motion, though it may be less obvious. They, too, are phenomenologically different from cases of real motion perception, and they are different

precisely in virtue of the fact that (unlike in the case of real or cinematic motion) there is nothing that is seen to be moving.

The line of thought I am sketching here is, of course, once again at odds with a claim frequently found in the literature on apparent motion, in so far as it is frequently asserted that cases of apparent motion can be introspectively indistinguishable from cases of in which there really is a moving object, and it is seen to be moving—call this the *indistinguishability claim*.[25] Taking a closer look at the relevant psychological literature, though, it is in fact difficult to find any good evidence in favour of the indistinguishability claim, those findings that are framed in terms of the indistinguishability claim actually allow for alternative construals, and indeed there is some evidence against the indistinguishability claim. Or so I will argue.

One example of an apparently unambiguous assertion of the indistinguishability claim can already be found in Wertheimer. In connection with apparent motion experiments carried out with the help of a slide projector, he states that '[i]n most cases, real movement and apparent movement were generally indistinguishable' (Wertheimer 1961: 1038). Yet, most of the slide combinations actually reproduced in the text don't actually allow for comparison of cases of apparent motion and cases of real motion, as they can only produce apparent motion displays. There are only two that can be used to produce simultaneous presentations of both apparent and real motion.[26] Given the assertion of the indistinguishability claim, one would expect them to feature prominently in the text, but Wertheimer in fact mentions them only briefly (the relevant passages are not even reproduced in the abridged English version of the text). No details are given about the precise procedure used in experiments that featured them, and the text also leaves it open whether it is in fact such experiments—i.e., experiments in which subjects were actually shown instances of real as well as of apparent motion—which lead Wertheimer to claim that the two were 'generally indistinguishable'. Even more to the point, just after making this claim, Wertheimer in fact suggests that closer attention to the phenomenology, after repeated exposure of the same apparent motion display, can reveal differences in appearance from real motion after all—indeed, what really seems to be at issue for Wertheimer is not so much the idea of indistinguishability, but that, even when real and apparent motion were distinguished from one another 'one was not denoted as motion and the other as non-motion' (ibid.: 1039).

An explicit statement of the indiscriminability claim can also be found in Boring (1942: 598), who says that '[s]everal studies [have shown] satisfactorily that optimal apparent movement, obtained from successive discrete stimuli, may be indistinguishable from real movement'. Yet, Boring in fact cites only one study in the context, and that study, arguably, shows something quite different. The study in question is that of Dimmick and Scahill (1925). Dimmick and Scahill's subjects were told that they would be presented with trials featuring non-moving stimuli as well as with trials featuring a genuine moving stimulus. When they were then asked in which trials they could see 'movement', they did indeed overwhelmingly say that they could do so in both types of trial.

However, as Dimmick and Scahill also point out, by this they did not mean what they experienced across the two types of trial seemed to be the same. They still gave different characterizations of the types of 'movement' in each type of trial.

Another study frequently cited in support of the idea that apparent motion is indistinguishable from real motion is De Silva (1929).[27] It is true that De Silva, for one, sets out systematically to examine the distinguishability of apparent and real motion. Indeed, he explicitly criticizes many of his predecessors for asserting their indistinguishability without providing convincing empirical support for the assertion. What De Silva finds in his own experiments, though, arguably also falls short of establishing the indistiguishability claim, as understood above (or as put by Boring, for that matter). There were indeed some conditions under which participants in De Silva's study were unable to distinguish cases in which real motion was present from cases in which there were only stationary stimuli. But these were conditions in which the real or apparent motion only covered a very small distance, and, in these conditions, participants mis-classified real presented motion as merely apparent as often as they mis-classified apparent motion as real. That is to say, the indistinguishability only concerned cases in which there was no clear impression of motion, even when what was presented was in fact an instance of real motion.

Perhaps the most interesting empirical evidence bearing on the indistinguishabilty thesis, though, comes from a set of experiments carried out by Miriam Kaplan and George Sperling (Sperling 1976; Sperling et al. 1985). In those experiments, participants were shown two-stimulus apparent motion displays of the type studied by Wertheimer. They were also shown matched multi-stimulus displays that featured the same two stimuli, but as part of a longer, linear sequence of stimuli, each separated from its predecessor by the same spatio-temporal interval. Kaplan and Sperling asked the participants in their study to rate, on a scale from zero to ten, the quality of the appearance of motion in each type of display, whilst varying, across trials, the spatial distance by which successive stimuli were separated, Δx, and/or the temporal interval separating successive stimuli, Δt. Sperling et al.'s summary of the results is worth quoting in full:

> In multi-stimulus displays, the subjects used all ratings except ten, depending on the combination of Δx and Δt. The most significant finding was that whenever a motion path was made to more closely approximate real motion by doubling the number of points along the path (i.e. by halving Δx and Δt), the rated quality of motion always increased. The most interesting result of the two-stimulus experiments was that, once subjects had seen the multi-stimulus displays, they virtually never used a rating of more than one for the two stimulus displays. [In the two-stimulus experiments, the] highest proportion of non-zero motion responses occurred with large Δx and Δt. [In] multi-stimulus displays, the best motion was seen with small Δx and Δt, directly the opposite result. (Sperling et al. 1985: 48)

The very low rankings that participants in this study gave to the two-stimulus displays, once they had seen the multi-stimulus displays, stands in stark contrast to the frequent assertions of the indistinguishability claim, which are usually made with the former type of displays in mind. This provides further support for the idea that when participants in apparent motion studies such as Wertheimer's say that instances of apparent motion were indistinguishable from real motion, what they in fact mean is not that the experience is just like the experience they would have had if confronted with a case of an object in real motion. Rather, it seems more plausible to think that what they are actually trying to express is the idea that they can't shake off the impression of movement, even though the phenomenology of the experience is perhaps in other respects quite unlike that of an experience in which something is really being seen to be moving.[28] Kaplan and Sperling's experiment can then be seen to show that observers are quite able to discriminate between the strength of the impression of movement, in this latter sense, and closeness in appearance to real motion, if given the right control condition.[29]

The worry articulated at the beginning of this section was that allowing cinematic images of the kind envisaged by Currie into our ontology would amount to an opening of the floodgates that would also commit us to postulating the existence of re-identifiable entities undergoing motion in cases where this clearly seems absurd. I suggested that we could see the force of that worry, if there was no way to draw a line between postulating such entities in the case of cinematic motion and postulating such entities also in the case of apparent motion phenomena of the type studied by Wertheimer. However, as we have now seen, there is a way of drawing such a line on phenomenological grounds. We have seen that, while apparent motion involves an impression of motion, this is different in kind from the impression of motion in cases of real motion. And if the account I have given in Section 3 is along the right lines, this gives us a way of understanding what exactly the difference comes to here. It allows us think of this difference as being precisely due to the fact that apparent motion does not involve the visual presentation of something that is moving. At best, apparent motion displays suggest that there is something moving, because they resemble paradigm cases of visible movement in certain respects. This is different from the case of seeing a physical object move, but arguably from the case of the cinema too, where it is part of the phenomenology of our experience that we are visually presented with something that is moving. And it is because of this distinguishing feature of cinematic motion, which it shares with physical motion, that the realist about cinematic images can argue that the two should be classed together as forms of real motion.

6. Conclusion

In general terms, my question in this paper has been how we should account for appearances of motion in situations where there is no moving physical object

present (or at least, no relevant such object is seen). If what I have been saying is along the right lines, the answer as to how to account for appearances of motion in such cases can be seen to turn on whether, in the relevant situation, there is some other type of moving object that visually presented in the experience. There is either no such moving object that is visually presented—in which case the experience is merely similar to an experience of motion—or we are visually presented with such a moving object—in which case there is such an object, and it moves. I have also pointed out that accounting in this way for the relevant cases of motion experience is compatible with direct realism about perceptual experience. In apparent motion, the direct realist can maintain, all that is actually seen are stationary spots of light, and these are not seen to be moving. Yet, the display may still look in certain respects like there is something moving in it. In cinematic motion, conversely, what is seen are moving images; these are seen to be moving; and they actually move.[30]

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NOTES

[1] It is sometimes referred to, more specifically, as 'long-range apparent motion' or 'two-stimulus apparent motion'. The significance to my argument of these more specific ways of delineating the phenomenon will become clearer in Section 5.

[2] My main focus will be on Grush and Dainton, because I think the debate between them brings out particularly clearly a number of dimensions of the philosophical debate on the phenomenology of apparent motion that I am interested in. Other philosophers who have recently discussed apparent motion include Tye 2003, Paul 2010, and Prosser forthcoming. I will indicate ways in which Tye's and Paul's views intersect with those of Grush and Dainton in subsequent notes. In addition to the types of phenomenological claims at stake in Grush and Dainton, Paul and Prosser also make the claim that there is in fact an illusory ingredient that is present both in cases of apparent motion and in cases of real motion perception, and which corresponds to the idea of 'passage', as understood in debates about the metaphysics of time. I discuss this claim elsewhere.

[3] As Dainton (2010: sec. 1.1) notes, there is little by way of terminological uniformity in this area. 'Extensionalism' (which I adopt from Dainton) refers to one variant of a group of views Grush identifies by the term 'specious present theories'. What I characterize as 'intentionalism' encompasses the position Dainton calls 'retentionalism'.

[4] Note that Grush's argument, thus put, relies on the assumption that how we experience things as being at one point in time is independent of how we experience them as being at subsequent times. Ian Phillips (2011: 397ff.) has recently argued that this is precisely what the extensionalist should be seen as denying. In his words, we should understand the extensionalist as claiming that 'there are certain durations of experience which are metaphysically prior to their sub-temporal parts' (ibid.: 398). Yet, even if Phillips is correct in saying this, it is at least not immediately obvious how exactly the idea

of such a metaphysical priority might be put to work in making sense of the case of apparent motion. Specifically, as we shall see, both Grush and Dainton make an assumption about the phenomenology of apparent motion on which it would indeed seem to require an appeal to some form of magic to try to explain apparent motion in terms of the idea that what is experienced at one time can be dependent on what is experienced at later times. It is the purpose of Sections 3ff. in this paper, to identify that assumption and see how it can be avoided.

[5] Dennett's own 'multiple drafts model' (Dennett 1991; Dennett and Kinsbourne 1992) constitutes yet a further possible view, which I will not discuss in this paper. Dennett, too, rejects the very idea that we must opt for either an Orwellian or a Stalinesque account of apparent motion. In fact, though, his view can be construed as a variant on Grush's Orwellian account, in so far as Dennett, like Grush, thinks that apparent motion phenomena are to be explained by appealing to a succession of representations that are generated in the course of perceptual processing, later ones of which can override earlier ones. Where Dennett differs from Grush is that he also maintains that, due to the distributed nature of information processing in the brain, there is a sense in which there is not just one succession of representations being generated, but a multitude of them, at different points within the perceptual system. As a result, there may, for instance, be two quite different means of asking a subject in an apparent motion experiment to indicate, at a certain moment in time, whether he or she experiences the stimulus at *A* as stationary or as moving. And because the corresponding two different types of responding may depend on the operation of different brain areas, there is no guarantee that we would receive the same answer in each case. In such a situation, Dennett claims, there is simply no further question to be asked as to which of the two reactions reflects what the subject is really consciously experiencing. And it is because of this that Dennett thinks that we should reject the very idea that there is a fact of the matter of the kind that is supposedly at issue between Orwellian and Stalinesque approaches.

[6] I adopt these labels from Campbell (2002), though he typically uses the term 'relational view' for the more specific type of view he holds, which I will describe below as a direct realist version of a relational view of experience. My usage of the distinction between a representational and a relational view corresponds roughly to the distinction Brewer (2011) draws between a 'content view' and an 'object view' of perceptual experience.

[7] See Siegel (2010) for a much more nuanced discussion of the relevant notion of content. To say that perceptual experiences, on this view, share the feature of having a content with judgements does, of course, allow that there are a number of other respects in which they differ from them, e.g., with respect to the nature of the content in question, or the sense in which they involve a certain attitude towards that content.

[8] Both Tye and Paul also hold a representational view of perceptual experience and take apparent motion to involve the visual system constructing a non-veridical perceptual representation. The main way in which their positions differ from Grush's is that they in fact combine this view with a Stalinesque, rather than an Orwellian, approach to apparent motion. That is to say, whereas Grush thinks that the stationary flash at *A* is initially experienced as such, but this experience is overwritten by a non-veridical experience of movement when the flash at *C* occurs, Tye and Paul both subscribe to the idea of a delay during which our visual system collects information, and only after which it generates an experience (see Tye 2003: 91; Paul 2010: 349). In this specific respect, their views are more similar to Dainton's, although they don't endorse his extensionalism.

[9] See also, e.g., Dainton 2008a: 381f. Note that a Stalinesque approach specifically to apparent motion, thus described, goes beyond the mere idea that perceptual experience must be 'backward looking' because 'I cannot see *e* precede *f* until I see *f* ', as, e.g., Mellor (1998: 115) argues. (Tye 2003: 88 makes a similar argument.) The latter idea, as such, need not rule out direct realism, but it is also silent on why we should sometimes have an impression of motion when we are in fact only presented with a relation of precedence between two separate stimuli. See also the following note.

[10] It is important to distinguish between the particular way in which the idea of a processing delay figures in Stalinesque accounts such as Dainton's, and the idea—invoked in what is sometimes called the time-lag argument—that, in our experience of physical events, the actual time when those events happen is different from the time when they are experienced (as becomes particularly obvious in cases of very remote events such as supernovas). In contrast to Dainton's position on apparent motion (and *pace* the time-lag argument), the latter idea seems compatible with direct realism. It is true that there is one understanding of the phrase 'when events are experienced' on which, if x is experienced at t, my experience is veridical to the extent that x happens at t. On this understanding, which the time-lag argument exploits, we need to think of an experience of a supernova, for instance, as having a representational content that is non-veridical. Yet, there is another way of understanding the phrase 'when events are experienced', on which it articulates something like the idea of a perspective the observer has on events. On this reading, to say that x is experienced (by me) at t, simply means that, given factors such as my own position in space, it is only at t that I can experience the happening of x—nothing follows from this for my experience having a representational content that is non-veridical. (See also Langsam 1997 on the compatibility of direct realism with a time-lag of this kind.)

[11] Steinman et al. 2000 remark on the considerable confusion there is, in the literature that uses both φ and β to name allegedly different types of apparent motion phenomena, on what exactly the difference between them is meant to come to. They then point out that traditional two-stimulus displays can in fact give rise to two quite different illusions. They can produce the impression of movement involving something that is the shape and colour of the two actually exposed stimuli, but they can also, at slightly shorter inter-stimulus intervals, produce the impression of movement involving something that is the colour of the background, and which obscures the two actually exposed stimuli during parts of its movement. They also suggest that Wertheimer used φ specifically to refer to the latter type of illusion. From what I will go on to say below, it should be clear that I disagree with this interpretation of Wertheimer (see, e.g., the passage from Wertheimer 1961: 1057 quoted below), which is not to deny the existence of the two different forms of apparent motion that Steinmann et al. describe. (More on the latter in note 20.)

[12] It might be thought that there could be neurophysiological evidence for the truth of (II), and indeed that such evidence has been found by Muckli et al. (2005; see also Larsen et al. 2006). In their paper, Muckli et al. provide or cite evidence for the following two claims: (1) apparent motion experience involves activity in regions of the primary visual cortex (V1) that represent locations on the 'path' of the apparent motion, including regions that are not activated by either of the two the apparent-motion-inducing stimuli presented on its own (though see also Liu et al. 2004); (2) there is 'a close relationship between activation in V1 and conscious perception of visual stimuli' (Muckli et al. 2005: 1506f.). Note, though, that Wertheimer's candidate claim (II) would require a more specific claim to be true, namely that activity (of the form found by Muckli et al.) in a

particular region of V1 implies conscious visual experience as of a stimulus in the location represented by that region. Muckli et al.'s findings could contribute to a neurophysiological explanation of the difference between apparent motion experience and experience simply as of two stationary stimuli without this latter claim being true. Thus, for instance, the account I will present at the end of this section denies the truth of Wertheimer's candidate claim (II), but is compatible with Muckli et al.'s claims (1) and (2) above.

[13] Wertheimer also carried out experiments designed to provide further empirical confirmation of the idea that the illusion of movement is not based on subjective supplementation. Those experiments, later continued and refined by Kolers (1963, 1964), involved presenting additional stimuli in between *A* and *C* to see whether the way they appear, or their detectability, is influenced by the apparent motion. Thus, Kolers (1963), for instance, used two vertical lines as the stimuli that were briefly presented at *A* and *C*, respectively, but also flashed up a smaller line (a 'probe') in the 'path' of the apparent motion. In a case of real movement of a vertical line from *A* to *C*, detectability of the probe is strongly inhibited by the movement, with the strength of the effect depending on the closeness, at the time the probe occurs, between the position of the probe, and the position of the moving line. In the case of apparent movement, by contrast, the effect of the apparent motion on the detectability of the probe is much weaker, and also does not vary significantly, given a particular position of the probe, with the timing of the probe within the interval in which the apparent motion occurs. Kolers (1964: 102) concludes from this that 'the neural mechanisms for the two types of perception must be quite different, because [they] seem to be constructed in the nervous system according to different rules'.

[14] Cf. also Münsterberg 1970: 30: '[T]his feeling of movement is in no way interfered with by the distinct consciousness that important phases of the movement are lacking'.

[15] See also Paul 2010: 350.

[16] This seems to be what Dennett (1991: 123) wants to say about pure motion cases. Accounts of other forms of illusion also sometimes make use of the idea that the relevant illusory experiences involve a representational content that is contradictory, cf. Crane 1988.

[17] Cf. also Brewer 2006: 172: 'Illusions are simply cases in which the direct object of experience has [visually relevant] similarities with paradigms of a kind of which it is not in fact an instance'. The idea that illusions involve something's bearing a similarity to a paradigm case of something else is developed in a somewhat different way in Brewer and Martin, but we can set the differences between them aside for present purposes. Also, I want to leave open the possibility that only certain types of illusions can be accounted for in this way—the point at issue here is simply to see whether apparent motion phenomena can.

[18] Compare here the notion of the specious present, or related notions of a limited stretch of experience over which we can directly perceive movement and change, as they figure in a number of contemporary approaches to temporal experience such as Grush 2005: S217, Dainton 2008b, and Tye 2003: 88.

[19] Note that apparent motion is less pronounced, or disappears altogether, when the spatial distance between the two stimuli is reduced. On a supplementation account, this seems difficult to explain, since there is less to supplement if the spatial distance between the stimuli is reduced. By contrast, it can be made sense of on the account proposed here, because very fast movements over a very short distance with a sudden onset and a sudden termination are unlikely to be paradigm cases of movements that we encounter in vision. Compare also the discussion of De Silva's (1929) experimental results in Section 5.

[20] Compare here, for instance, Steinman et al.'s (2000) distinction between two different impressions apparent motion displays can generate. The display may bear similarity to one in which an object of the same colour as the two actually presented stimuli is moving; but, at slightly shorter inter-stimulus intervals, it may also bear similarity to one in which an object of the colour of the background is moving, which obscures the two presented stimuli during parts of it movement. If the display can bear similarity to either, what determines the change in which one it in fact strikes us as similar to as the inter-stimulus interval is decreased? It would appear that our visual system has a built-in assumption that movements above a certain velocity, as measured in degrees of visual angle, are more likely to be those of a slower moving object in closer proximity to us, rather than those of a faster moving object travelling at some distance from us. Note that the general thought that findings such as Steinmann et al.'s reveal assumptions of this kind built into the visual system is not tied specifically to the kind of view I am advocating here. On a view such as Grush's or Dainton's, on which apparent motion involves the visual system constructing a non-veridical perceptual representation, there also needs to be some story as to why the visual system constructs the particular representations it does, and such a story, too, might appeal to such built-in assumptions. Compare also Goodman 1978: 85–9.

[21] So should, in fact, reflection on certain practices and rules of cinematography. The idea of a 'bad cut', for instance, seems related to the possibility of inadvertently generating an experience of apparent motion between elements depicted in the pre- and post-cut frames. To the extent that this is classed as a 'bad cut', though, it also seems clear that such experiences are in fact quite different from, and indeed detract from, ordinary motion experience in the cinema. See Hochberg and Brooks 1978.

[22] This is just one example that makes particularly vivid the fact that pitch is not temporally dissective. There are in fact a variety of different types of stimulation that can give rise to the same pitch perception, as illustrated, e.g., by Walker et al. 2011.

[23] For a somewhat analogous worry about an 'undesirable explosion' of colours, and a response to such a worry, cf. Campbell 2005.

[24] See also Currie 1996: 338 for discussion of a similar worry.

[25] One might not even want to concede this much, and argue that introspective indistinguishability need to imply phenomenological sameness. But I will not rely on such an argument here.

[26] Well, that is if pools of light, at any rate, are things that can undergo real motion. Note that a great deal of work on motion perception in psychology is in fact itself premised on the implicit assumption that real motion perception can be studied using stimuli such as projected pools of light or computer generated images.

[27] See, e.g., Larsen et al. 2006. At the beginning of their paper, Larsen et al. acknowledge that De Silva actually only found indistiguishability when the spatial separation between stimuli was very small. Their own study, by contrast, shows that there can be activity in the primary visual cortex at locations corresponding to locations between the stimuli even in apparent motion over large visual angles. This is again a reason for thinking that presence of such activity in apparent motion falls short of providing conclusive evidence of a 'subjective supplementation' account on the phenomenological level (as I have already suggested in note 12).

[28] What about the multi-stimulus displays in Kaplan and Sperling's experiments? As a referee has noted, some of these do seem to be judged to be indistinguishable from real perceived motion, or at least to come very close to being so in the cases in which subjects gave a rating of 9/10. In the example of a typical subject that Sperling et al. 1985 provide,

such ratings involved displays in which Δt was no more than around 30 ms and Δx no more than 3 minutes of arc. It appears that the way in which Kaplan and Sperling achieved multi-stimulus displays with such small Δxs and Δts was to increase the number of stimuli presented along a path of the same length as that used in multi-stimulus displays with large Δxs and Δts (see, e.g., the reference in the quotation above to 'doubling the number of points'). Thus, the displays in question would have contained a very large number and high density of stimuli, and these would have been presented at a rate that is comparable to the projection speed of a traditional movie projector, which displays a separate image approximately every 20ms, and a new image approximately every 40ms (the two figures are different because each individual image is actually displayed twice). Given this, it is at least arguable that the relevant cases in fact constitute very simple cases of cinematic motion, involving a cinematic image of a single moving dot. If the argument regarding cinematic motion that I have offered above is along the right lines, this would explain the indistinguishability from real motion in a straightforward way, because there is really something that moves that is being perceived.

[29] The difference between two-stimulus and multi-stimulus motion is also underscored by another study of Kolers'. In this study, Kolers presented subjects with a typical apparent motion display featuring just a flash at *A* followed by a flash at C; yet he also presented them with further displays in which the spatial and temporal distance between the flash at A and the flash at C were the same, but which also featured additional flashes in between *A* and *C*, which, together with the flash at *A* and the flash at *C*, formed a linear sequence (cf. Kolers, 1972: 37f.). Some of Korte's (1915) work on laws governing apparent motion phenomena would suggest that adding further and further such intermediate flashes should improve the appearance of movement. What Kolers in fact found, though, was that the impression of motion actually decreased once additional such flashes were added between the flash at *A* and the flash at *C*, and only increased again once the number of such additional flashes increased beyond a certain point—in the case of the experiment he reports, not until there were 32 such additional flashes with very small spatiotemporal gaps between them. As he summarizes his result, 'if "quality of motion" . . . were rated as a function of [flashes] presented, the result would be a U-shaped curve' (Kolers 1972: 38). We may add to this that what Sperling's experiments suggest, in essence, is that 'quality of motion', as measured at the two ends of the curve Kolers mentions, in fact corresponds to two quite different things.

[30] I was prompted to write this paper after Josefa Toribio invited me to speak at a workshop on 'Perception, Action and Time' in Barcelona in June 2011. I subsequently also presented a version of the paper to the departmental colloquium at Warwick. On both occasions I received very helpful comments from members of the audience. I am also grateful to an anonymous reviewer for *The European Journal of Philosophy* for further comments, and to Tim Bayne and Ian Phillips for drawing my attention to a number of papers on apparent motion of which I had not been aware.

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