Absolute velocities are measurable: Response to Jacobs

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Abstract

In 2020, Caspar Jacobs developed a response to Middleton and Murgueitio Ramírez (MMR) who argued that absolute velocity is measurable. In particular, Jacobs argued both that MMR's analysis of measurement is not reasonable and that it does not entail that absolute velocities are measurable. In this note, we show that both parts of Jacobs' criticism fail. Thus, pace Jacobs, MMR's case remains a challenge to the orthodoxy.

1 Introduction

In 2020, there was a lively discussion about whether or not absolute velocities could be measured in a Newtonian world. The discussion started when

Middleton and Murgueitio Ramírez (2020) published a paper criticizing the widely accepted view that absolute velocities are not measurable in Newtonian worlds. According to Middleton and Murgueitio Ramírez ('MMR' henceforth), (1) there are significant issues with the main arguments in favor of this claim, and (2) there is a reasonable analysis of measurement according to which, in at least some cases, absolute velocity is measured. MMR's proposed analysis of measurement is as follows:

(The Counterfactual Analysis) A device d with pointer variable P measures quantity Q at time t iff (i) $P(t) = Q(t)$ and (ii) for any $x \neq Q(t)$ in the range of d, if it had been the case that $Q(t) = x$ then it would have been the case that $P(t) = x$.

Soon after publication, Jacobs (2020) published a response note arguing against (2) on the basis that MMR's proposed analysis of measurement (i) is not in fact reasonable and (ii) fails to entail that absolute velocities are measurable. Thus, Jacobs, ends his note with the claim that "absolute velocities are and remain unmeasurable."

In this paper, we respond to Jacobs' two-pronged critique of (2), and argue that both prongs of his critique fail. In section 2, we respond to Jacobs' argument according to which MMR's proposed analysis is unreasonable. In section 3, we respond to Jacobs' arguments regarding the claim that MMR's proposed analysis fails to entail the measurability of absolute velocity. Pace Jacobs, we believe that the case presented by MMR in favour of the possibility of measuring absolute velocity remains a viable challenge to the orthodoxy.

2 Is the counterfactual analysis reasonable?

Jacobs suggests (pp. 203-204) that a more reasonable analysis of measurement is one that supplements MMR's counterfactual analysis with an additional condition:

(Robustness) In all nearby worlds where $Q(t) = x$, where x is the actual value of $Q(t)$, $P(t) = x$.

Jacobs motivates robustness by drawing an analogy between the counterfactual analysis of measurement and Nozick's analysis of knowledge. Jacobs says that "the Counterfactual Analysis bears some similarities to Nozick's (1981) 'truth-tracking' account of knowledge [...] , and so a comparison between the two is instructive" (pp. 203). Nozick believed that in order to know p, it is not enough that an agent's belief is sensitive to p (in the sense that if p had been false, the agent would not have believed p), but in addition the agent must believe p in all nearby worlds where p is true (call this extra condition "doxastic robustness").

For what it's worth, in our view doxastic robustness is not a necessary condition on knowledge.[1] However, we do not want to stake the plausibility of MMR's counterfactual analysis of measurement on the plausibility of (some version of) the counterfactual analysis of knowledge. For although there are surely interesting connections between measurement and knowledge, these two relations strike us as importantly different (for one, measurement devices are usually not agents!). By itself, an analogy with knowledge is not sufficient to establish the need for robustness in the context of measurement, and so Jacobs would need to provide an argument motivating this move.

Putting aside our skepticism about the tightness of the knowledge-measurement analogy, suppose, for the sake of argument, that robustness *is* a necessary condition on measurement. Does it then follow, as Jacobs claims (p. 204), that absolute velocity is not measurable? Not obviously. Consider the example of the basic world, which consists of an infinitely long straight road with a car moving along it. Suppose the absolute velocity of the car is v at time t. For the speedometer to measure the absolute velocity of the car at t, robustness requires that in all nearby worlds where the car has abso-

[1] We find Kripke's (2011) example of Mary the physicist to be a persuasive refutation of doxastic robustness as a necessary condition on knowledge.

lute velocity v at t, the speedometer indicates v at t. Jacobs' view is that worlds where the absolute velocity of the road is altered (such as the "boosted world") would count as nearby worlds where the car has absolute velocity v at t (p. 204). Consequently, if Jacobs' view is correct, the speedometer would not measure the absolute velocity of the car at t in the basic world.

In our view, however, it is not clear that a world where the absolute velocity of the road is altered *is* a nearby world. To us, such an alteration to the basic world looks like a significant one (recall that in the basic world, the only object that undergoes alterations in absolute velocity is the car). Here it seems judgements about nearness are mainly driven by prior judgements about whether or not absolute velocity is measurable. Consequently, although it is perfectly consistent for a proponent of the non-measurability of absolute velocity to maintain that a world where the absolute velocity of the road is altered is nearby, it is not clear why someone with no strong prior views about the measurability of absolute velocity should share this view. In other words, it seems that by assuming that such a world is a nearby world, Jacobs is already assuming that absolute velocities are not measurable, which is precisely what is at stake in the debate.

3 Does MMR's counterexample fail?

In MMR's view, if the car in the basic world had a different absolute velocity at time t, the absolute velocity of the road would be unchanged. Jacobs rejects this by offering both critiques of the two arguments MMR give in favor of their view and by offering two positive arguments in favor of the view that if the car had a different absolute velocity at t, the road would also have a different absolute velocity at t.

3.1 Jacobs' Critiques

3.1.1 The temperature Analogy

MMR's first argument for the view that the absolute velocity of the road does not change is that this is what happens with other kinds of counterfactuals in science. For example, if a scientist is wondering what would happen if the temperature of a particular body had been different, they imagine varying only the temperature of the body and holding fixed the temperatures of all other bodies. It therefore seems odd to treat absolute velocity differently — if we want to know what would happen if the absolute velocity *of the car* had been different, we should imagine varying only the absolute velocity of the car and holding fixed the absolute velocity of the road.

Jacobs responds:

> ...if we are to defer to scientific practice we surely ought to take into account the fact that most scientists believe that absolute velocity does not exist: this is the lesson from the equivalence of inertial frames. But if this is true, what do scientists even mean when they consider a world in which some object has a different velocity? It seems to me that scientists must refer to a world in which that object has a different relative velocity with respect to some salient frame of reference (2020, p. 205).

What Jacobs says here can be interpreted in at least two different ways. One, MMR's appeal to scientific practice for motivating the counterfactual reading that they propose (such as the one concerning temperature) is, in some sense, limited because they do not take scientific practice into consideration regarding the measurability of absolute velocities — after all, scientists would not say that absolute velocities are measurable. Second, Jacobs might be suggesting that, since most scientists believe absolute velocity does not exist, MMR do not have enough evidence to know what most scientists would do when evaluating counterfactuals about absolute velocity (such as the ones relevant to the discussion).

Even if these are different charges against MMR, they both fail for the same reason: they miss the point of the temperature example. The purpose of the temperature example is not to suggest that we should defer to scientists on all issues related to the measurability of absolute velocity (after all, as Jacobs points out, scientists do not take this property seriously in the first place, and so would have a hard time engaging in these discussions!). Rather, the purpose of the temperature example is to stress that, in general, when considering counterfactuals of the form 'if property P for object O had been different, then the device would have indicated a different value', scientists do not consider possible worlds where P changes for all the objects in the universe. Hence, it seems *ad hoc* to treat counterfactuals about absolute velocity differently from counterfactuals about other scientific properties.

3.1.2 Critique of Using Past Observations as Evidence

MMR's second argument for the view that the absolute velocity of the road would not change were the absolute velocity of the car to change is that when the absolute velocity of the car changed in the past (supposing it did), the road remained at absolute rest. Consequently, since we typically evaluate counterfactuals by looking at what happened in relevantly similar situations in the past, following our typical practice would lead us to conclude that the absolute velocity of the road would not have been different at t, had the absolute velocity of the car been different at t.

Jacobs points out that what happened in the past is not an infallible guide to what would happen in a counterfactual scenario. To motivate this point, Jacobs offers the following counterexample (p. 205):

> ...consider a world similar to the Basic World but with two cars: Car A has always travelled at a speed of 90 km/h, while Car B travels at a speed of 30 km/h at time t, but travelled at a speed of 100 km/h at an earlier time t_0. Consider the counterfactual claim that exactly one of the two cars travelled at a velocity of 100 km/h at time t. If [the authors] are right, the closest world in which this claim is true is one in which Car B travels at 100 km/h, since that car has had that same speed at t_0. However, in fact the closest world is one in which Car A travels at 100 km/h at time t... (p. 205).

Now, we grant that Jacobs' counterexample successfully refutes the following thesis:

(Strong Past Principle) For all $t_0 < t$: if it is true at t_0 that (P and Q) then if it had been true at t that P, it would have been true at t that Q.

However, MMR's argument does not rely on such a strong and arguably implausible principle. Instead, MMR's argument only relies on the following weaker principle, which is not affected by Jacobs' counterexample:

(Weak Past Principle) Suppose that at both time t and time $t_0 < t$, $P = r_P$ and $Q = r_Q$. Suppose that the background conditions at t_0 are the same in all relevant respects to the background conditions at t. Finally, suppose that the value of P changed from r_P to s_P an instant after t_0 without a corresponding change in the value of Q. Then, were P to have had value s_P at t, the value of Q would have remained r_Q at t.

The Weak Past Principle is intended to support cases such as the following. Right now B_1 has temperature 10°C and B_2 has temperature 15°C. We want to know what the temperature of B_2 would have been had B_1 instead had temperature 5°C. We look at the historical record and notice that at 2pm last Wednesday, B_1 had temperature 10°C, B_2 had temperature 15°C and then the temperature of B_1 fell to 5°C without a corresponding change in the temperature of B_2. We check the relevant background conditions and notice that they are the same now as they were at 2pm last Wednesday. Consequently, we conclude that if the temperature of B_1 had been 5°C, the temperature of B_2 would still have been 15°C.

Turning to the example of the car in the basic world: in the past, changing the absolute velocity of the car did not alter the absolute velocity of the road.

Since all relevant background conditions seem to be the same at t as they were in the past, the Weak Past Principle entails that were the car to have had a different absolute velocity at t, the road would have remained at absolute rest at t.

3.2 Jacobs' positive arguments

3.3 Counterpart theory

Suppose the absolute velocity of the car is v_0 at t in the basic world. According to the similarity semantics for counterfactuals, when we evaluate what would have happened were the absolute velocity of the car to have been $v \neq v_0$ at t, we should look at what happens in the most similar world where the car has absolute velocity v at t. In MMR's view, the most similar world in which the car has absolute velocity v at t is one in which only the absolute velocity of the car is different (call this world the "relative world" because it produces a different relative velocity between the car and the road). Changing *both* the absolute velocity of the car and the absolute velocity of the road (as happens in the boosted world) creates a more dissimilar world.

Jacobs disagrees with MMR's judgement about relative similarity on the basis of counterpart theory (p. 205). According to counterpart theory, no object (strictly speaking) exists in more than one possible world. Thus, to evaluate what the properties of some object would have been in some counterfactual situation, we are required to identify a *counterpart* for that object in whichever possible world represents the counterfactual situation.

Suppose we interpret Newtonian mechanics in Newtonian spacetime (which assumes absolute space). We then obtain the boosted world by altering the spacetime trajectories of the car and the road by a constant amount. Let s_c and s_r be, respectively, the spacetime regions occupied by the car and the road in the basic world. Let s_c^+ and s_r^+ be, respectively, the spacetime regions occupied by the car and the road in the boosted world. Jacobs claims that the counterpart theorist ought to identify the counterpart of s_c in the boosted word with s_c^+ and the counterpart of s_r in the boosted world with s_r^+. Furthermore, given this choice of counterpart relation, Jacobs claims that the boosted world will be more similar to the basic world than the relative world. This is because the boosted world represents the car and the road as being, at each moment of time, in the same place as they are in the basic world, but the relative world does not.

For what is worth, we think that counterpart theory is false (for instance, we find Kripke's (1981) famous Humphrey objection in *Naming and Necessity* to be persuasive). However, since counterpart theory retains a significant number of supporters, we will grant, for the sake of argument, that counterpart theory is true. Does Jacobs' argument now succeed in refuting MMR's purported counterexample to the non-measurability of absolute velocity? We think not.

First, the standard way to judge similarity between worlds in counterpart theory is to compare their *qualitative* character — i.e., to what extent do the worlds agree on facts which can be stated without using proper names (e.g. "there is a car with such-and-such a trajectory")? Qualitatively, the boosted world is, in our view, more dissimilar to the actual world than the relative world. This is because the two matter-occupied spacetime regions in the boosted world both have different (absolute) trajectories to the two matter-occupied spacetime regions in the basic world. By contrast, one of the matter-occupied spacetime regions in the relative world has the same (absolute) trajectory as one of the matter-occupied spacetime regions in the basic world.[2]

So for Jacobs' argument to work, the counterpart theorist needs to judge similarity between worlds in the following non-standard way. When evaluating a counterfactual at w, judge the degree of similarity between w and u on the basis of *both* (i) the extent to which u agrees with the qualitative facts at w and (ii) the extent to which the way u represents *particular* objects in w (via the appropriate counterpart relation) agrees with the way those objects

[2]It is true that the relative world involves qualitative differences concerning facts about relative velocity, but we agree with MMR's (p. 814) argument according to which, in a Newtonian world, facts about absolute velocity are more fundamental than facts about relative velocities.

really are in w. So, for example, if Bob, a person in w, is bald, and Bob's counterpart in u is bald, then, all else equal, this increases (according to (ii)) the degree of similarity between u and w for the purposes of evaluating a counterfactual at w.

Given Jacobs' preferred counterpart relation, the boosted world represents the car and the road as occupying the very same spacetime regions that they occupy in the basic world. This counts in favor of the boosted world being more similar to the basic world than the relative world (given (ii) above). On the other hand, it remains true that the relative world is *qualitatively* more similar to the basic world than the boosted world, for the reasons outlined above (this counts in favor of the boosted world being less similar than the relative world, given (i)). So, even under this non-standard measure of similarity, it is unclear whether the boosted world is more similar to the basic world than the relative world.

Furthermore, there is a significant problem with Jacobs' proposal: if it turns out that, under the non-standard similarity measure, the boosted world *is* more similar to the basic world than the relative world, then the measure is going to incorrectly evaluate some counterfactuals. For example, the following counterfactual will be evaluated as true:

If the absolute velocity of the car had been different then the car would have occupied the same spacetime region that it actually occupies.

On its face, however, this counterfactual is clearly false.

3.4 The wall argument

Jacobs offers a second positive argument in favor of the boosted world being the most similar world where the absolute velocity of the car is different (p. 206). However, the argument assumes that when evaluating counterfactuals, we need to consider worlds that would maximize overall similarity. This assumption generates bad results when applied to other cases (e.g., consider Fine's (1975) famous Nixon example). Rather than maximizing overall similarity, we should evaluate "if it had been the case that p at t, it would have been the case that q" by going to the world which is most similar to the actual world up until t, at which point the smallest possible change is made to make p true. We then let the world unfold from t however the laws of nature dictate, even if this leads to a very dissimilar future.

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