"The Experience of Left and Right" Meets the Physics of Left and Right

David John Baker
Department of Philosophy, University of Michigan
djbaker@umich.edu

September 14, 2009

Abstract

I consider an argument, due to Geoffrey Lee, that we can know *a priori* from the left-right asymmetrical character of experience that our brains are left-right asymmetrical. Lee's argument assumes a premise he calls *relationism*, which I show is well-supported by the best philosophical picture of spacetime. I explain why Lee's relationism is compatible with left-right asymmetrical laws. I then show that the conclusion of Lee's argument is not as strong or surprising as he makes it out to be.

1 Introduction

What if a functional duplicate of me could experience as *right-handed* everything I experience as *left-handed?* In posing this question, Geoffrey Lee (2006) has put forth an original and compelling case study with important parallels to both Kant's classic handedness argument (Kant, 1992 [1768]) and the inverted spectrum example. He concludes that the manifest features of our experience may have much to teach us about which physical objects are *incongruent counterparts* of one another.

Lee's discussion of his example overlaps in several places with the domain of the philosophy of physics, where incongruent counterparts have long been a subject of debate. Because Lee's focus is the philosophy of mind, his discussion of these points of overlap is necessarily brief. I believe they deserve a deeper examination, which will in turn reveal that some of Lee's conclusions are not as radical as they initially seem. Along the way, I hope to correct what I see as a misconception in Lee's thinking about the theories of space, time and matter which underpin out concept of incongruent counterparts.

Lee suggests that the view he calls "absolutism" – that incongruent counterparts are intrinsically different – is supported by modern physics. But as I will show, Lee's absolutism is false according to both spacetime relationism and what I see as the most viable version of substantivalism. Lee claims that asymmetrical laws of nature which treat incongruent counterparts differently can only be explained by appeal to absolutism. In fact, such laws can be reconciled with relationism (and my favorite forms of substantivalism). Since relationism is inconsistent with Lee's absolutism, he is mistaken on this count.

The most surprising consequence Lee derives from his example is an apparent *a priori* fact about the structure of our brains. If our experiences represent the world as left-right asymmetric, he argues, our brains must be asymmetric as well, assuming Lee's absolutism to be false. Since I deny absolutism, the onus is on me to show how Lee's seemingly synthetic *a priori* result can be explained. I will show that Lee's result is not so surprising after all, once we understand that one of his premises is itself rather strong. His argument assumes that our experiences of left and right are reliable – and without this (presumably *a posteriori*) assumption his conclusion about the shape of the brain does not follow.

2 The inversion examples

Lee begins by establishing that it is possible for functional duplicates to to have mirror-reversed experiences, at least for a brief amount of time. I agree with his argument, but will restate it here in my own terms to motivate what follows.

Lee's point is made in two stages, both corresponding to different notions of what makes an object handed. Unfortunately, the names he gives these two views ('absolutism' and 'relationism') are very similar to the names of relevant, but logically distinct, views about the ontology of spacetime. To avoid confusion, I will refer to the two views about handedness as:

Lee's Absolutism: "[W]hat makes a glove left or right is its possession of an intrinsic shape property of 'right glovedness' or 'left glovedness."' (Lee, 2006, 295)

Lee's Relationism: "[T]here is no intrinsic non-relational difference between a left glove

> and a right glove. All there really is, is the relation of congruence – that is, the relation that two gloves stand in when they are of the same glovedness." (Lee, 2006, 295)

Lee fails to note that his two alternatives aren't exhaustive. In fact, Kant himself subscribed to neither view. He believed that a hand, or glove, is left or right in virtue of standing in some relation to space as a whole. This relation between the glove and space is evidently not an intrinsic property, but is also not merely a relation to other gloves. It could still hold even in the *absence* of other gloves.

That said, Kant's view is similar in spirit to Lee's relationism. Both positions oppose Lee's absolutism by requiring that we look to facts *external* to a right glove itself to explain its incongruence with a left glove. So from now on I will lump all views that explain handedness by appeal to extrinsic features under the moniker of Lee's relationism.

Until recently, Lee's absolutism was thought to be a consequence of the popular view that spacetime is a substance. Further work in the philosophy of physics has undermined this apparent connection, greatly weakening the basis for believing in absolutism. I will explain the rationale for this in the next section, but for now let's focus on Lee's argument, assuming his relationism, to the conclusion that mirror-inverted experiences are possible.

Lee's argument, in slogan form, is that mirror-inverted observers will have mirror-inverted experiences. As he puts it, "[A] subject who was *initially* a physical reflection of you (your mirror twin) would, when presented with the same stimulus as you, have an experience that was inverted with respect to yours." (Lee, 2006, 296) This holds because a proponent of Lee's relationism will recognize no physical difference between a world like just ours, but containing a mirror-reflected copy of you, and a world which is otherwise completely mirror-reflected but which contains an exact duplicate of you. Thus for the physicalist, there must be no mental difference between these two worlds.

Lee employs the example of a human named Lefty and his mirror-reversed duplicate, Righty. This sort of thing is easier to picture in two dimensions, especially when drawn on paper, so I will illustrate using the analogous example of a two-dimensional "flatlander Lefty."[1] Lee considers three situations. In the first, Lefty is presented with a sign reading 'TIM.' In the second, Righty is presented with a sign reading 'MIT.' In the third, Lefty is shown the 'MIT' sign. The claim is that Lefty's experience in the first case will be the same

[1]I represent Lefty with an L-shaped brain to signify that the supervenience base for his experiences is mirror-asymmetrical.

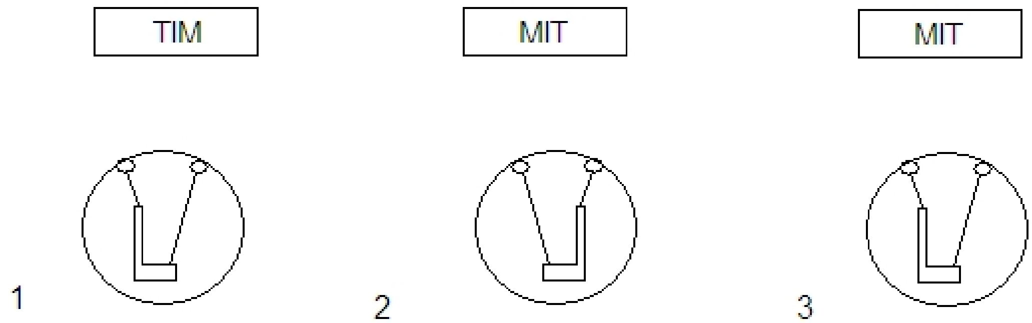

Figure 1: Three cases

as Righty's in the second case. (See Fig. 1) Indeed, cases 1 and 2 are physically equivalent according to Lee's relationist. But Lefty's experiences in case 3 are clearly the mirror image of his experiences in case 1. This establishes that Righty (in case 2) can be a functional duplicate of Lefty (case 3) with mirror-inverted experiences.

None of this should be terribly surprising on reflection. As Lee points out, Righty and Lefty are functional duplicates only when we don't pay attention to the details:

> [T]he complaint is that this could not be a genuine case of 'inverted qualia', because at the time when they are having inverted experiences of the same stimulus, Lefty and Righty are in physically quite different states (they are no longer merely incongruent), and so might be functionally quite different... My reply at this point is that we must distinguish different levels at which two subjects might be functionally alike. (Lee, 2006, 299)

In particular, Righty and Lefty have the same basic abilities to navigate in the world; "it is not the case that if Righty attempts to reach for an object on the left, he will reach to the right..." (Lee, 2006, 300) But the two are not exactly alike functionally, and will quickly become very different as they encounter more complicated handed stimuli. (For example, Righty will come across left-handed friends who he falsely remembers as being right-handed.) So we need not worry that we are all mirror twins of the people we take ourselves to be.

A more surprising case is that of a symmetrical subject whom Lee calls Simon. This case will be my primary concern here, as it motivates an apparently successful argument to the effect that, assuming Lee's relationism, asymmetrical experiences can be had only by asymmetrical beings. This forms the basis of a "transcendental argument," as Lee puts it,

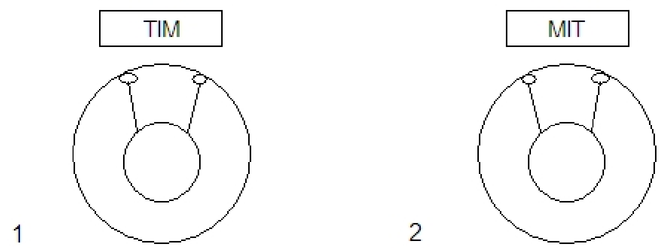

Figure 2: Simon

which establishes, based only on the handed character of our experience, that we must not have mirror-symmetric brains.

We're supposed to envision Simon as a being whose body and brain are left unchanged by mirror reversal (Fig. 2). This means that a world in which Simon is staring at a 'TIM' sign (case 1) is the perfect mirror image of a world in which he's staring at an 'MIT' sign (case 2). For Lee's relationist, these must therefore be the same world, so it follows that Simon must be having the same experiences in these two cases.

The argument assumes only that Simon is symmetrical when he is presented with the sign. Simon may not remain symmetrical forever – for example, he may someday get a paper cut on one side of his otherwise symmetrical body. His experience of the sign may then become asymmetrical – he could come to realize that the 'M' is on the same side as his paper cut. But while he remains left-right symmetrical, his experience must also be left-right symmetrical. This is quite surprising. As Lee points out,

> [I]t seems offhand that a brain whose initial design (i.e., prior to experience) was symmetrical could potentially achieve anything that our brains can achieve. There is no *obvious* reason for supposing that this design would necessitate any limitation on the range of psychological features that the brain could support. It therefore seems bizarre to suppose that this brain could not produce left/right experiences anything like ours. (Lee, 2006, 302)

In fact, as I will argue in what follows, our initial offhand impression is correct. Despite what's been said, nothing in Lee's argument implies that a being with a symmetrical brain could not achieve any handed experience that our own asymmetrical brains are capable of.

But first let's pursue an interlude into geometry and physics. For the reader may be tempted at this point to jettison some premise of Lee's argument, and may think Lee's relationism should be the first thing to go. As our interlude will reveal, Lee's relationism is in fact far superior to the alternative position.

3 Spacetime and Lee's absolutism

The conflict between Lee's relationism and absolutism falls square within the purview of the philosophy of physics. Lee does not endorse either position, although he does hint at an argument for absolutism (see the next section). I think I speak for a large population of specialists in asserting that his relationism is far more plausible than the alternative. To see why, we must understand how an important argument for another, different view called "relationism" has impacted the consensus on the metaphysics of spacetime.

This is the argument from "Leibniz equivalence," as it was named by Earman and Norton (1987). It owes to Leibniz the notion that applying a symmetry transformation to a solution of a spacetime theory does not generate a new physical possibility. In the context of Newtonian mechanics this means that – as Leibniz argued – if we translate the entire universe by an arbitrary amount in an arbitrary direction, the new translated universe is really identical to the one we started with.[2] The same goes for rotations of the entire universe by some arbitrary angle. More importantly for our purposes, the same goes for mirror reflections.

There is a powerful motive for Leibniz equivalence. The intuition behind the original principle of the identity of indiscernibles is best satisfied by a view like Lewis's, according to which the only metaphysical differences between possible worlds are *qualitative* differences.[3] And worlds that agree about everything except where in space the entire universe is located would seem to share the same qualitative character.

In geometry, we represent a symmetry transformation like a rotation or translation by changing which points are occupied by which things. For example, if P' is the point five inches up the $x-$axis from P, a translation of $+5$ inches along x will take any object located at P to the "new" location P'. If these are just two descriptions of the same possibility, as Leibniz equivalence would have it, it must be that there is no "automatic" metaphysical

[2]Leibniz's opponent, a classical substantivalist like Newton, would claim to the contrary that everything in the universe has a location *in space itself,* and that these locations could be different even if all the spatial relationships between the objects were to remain the same.

[3]One might also wish to permit qualitatively identical worlds with different laws of nature, but it remains implausible that qualitatively identical worlds could differ about physically contingent occurrent facts.

difference between an object located at P and one located at P'.

The way to bring a spacetime theory into accord with Leibniz equivalence is therefore to insist that there are no non-qualitative facts from world to world about which spacetime point is which. As a result, most specialists are split between two families of views.

Relationism: There are no spacetime points; spatiotemporal properties are nothing more than (actual and possible) relations between physical objects.

(Sophisticated) Substantivalism: Spacetime points exist, but there are no primitive facts about their identity across worlds; physical states related by spacetime symmetry transformations describe the same possible world.

On the most straightforward understanding of these views, neither allows for intrinsic differences between left and right hands.

Consider a hand. As Kant famously noticed, the relations of distance between its parts are the same whether it is a right or left hand. Now, if it is a right hand in three-dimensional Euclidean space it cannot be brought to coincide with its left-handed counterpart by any series of rigid motions (rotations and translations).[4] This is why we call the hands *incongruent counterparts.*

The fact that the two hands are incongruent doesn't follow from the relationships between the parts of either hand by itself, since these are all the same. But it *can* be derived from the relationships between the parts of the right hand and the parts of the left hand. The right thumb, for instance, will never occupy the exact same space as the left thumb if the right fingers are made to occupy the same space as the left fingers. So the familiar differences between nearby left and right hands can be accounted for by the spatial relations between the hands. All this is in accord with both the relationist and sophisticated substantivalism pictures.

Still, intuition inclines us to believe that there must be some intrinsic property of shape that differentiates between left and right hands (as in Lee's absolutism). It does seem that a hand alone in an otherwise empty universe would be either a right or left hand. These are indeed our intuitive impressions, but in this case there are reasons to resist our intuitions.

Consider a mirror-asymmetric two-dimensional object, like a scalene triangle or Lefty's L-shaped brain in Figure 1. When fixed to the two-dimensional surface of this paper, Lefty's

[4]Here we assume, probably contrary to fact, that distinct objects can overlap in space.

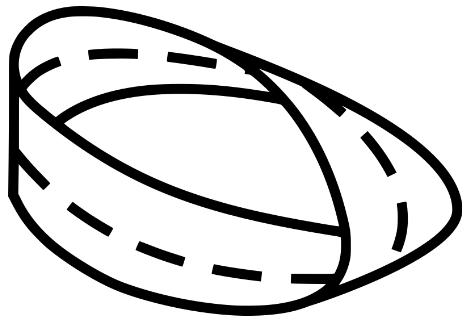

Figure 3: A Moebius strip

brain is incongruent to Righty's. But if you could lift Lefty's brain off the paper and flip it over in our third spatial dimension, it could be made congruent with Righty's brain. Something analogous is true of right and left hands. If a three-dimensional right hand were placed in a four-dimensional space, it could be rotated in such a way as to become congruent with its left-handed counterpart. Is the dimensionality of space an intrinsic feature of a hand?

Perhaps it is. But there is a more compelling example. If this paper had the structure of a Moebius strip (see Figure 3), we could, by translating Lefty's brain along the surface of the strip, bring it into congruence with Righty's brain. This is because a Moebius strip's surface is a two-dimensional *non-orientable* space, one in which long-distance rigid motions can bring any two shape-counterparts (like hands) into congruence. There are also three-dimensional non-orientable spaces. If you lived in such a space, and your right hand were sent on a long journey, it could come back congruent to your left hand. The hand's shape does not change over the course of its journey, which after all consists only of rigid motions. The explanation is simply that the relation of congruence is definable only locally in a non-orientable space. This suggests that the relation of congruence is all there is. No intrinsic handedness properties are needed to explain incongruence in non-orientable spaces, because there are no such properties in these spaces. Why should our own world, even if it is orientable, require the existence of such properties to explain incongruence?

According to relationism and sophisticated substantivalism, all intrinsic shape properties of a hand (if there are any; CITE BRAD) must be fixed by the spatial relations between its parts. Otherwise an identical hand alone in an empty universe (which should share all of the hand's intrinsic features) could not possess these shape properties. So handedness is not an intrinsic property on the relationist or sophisticated substantivalist pictures, making them both incompatible with Lee's absolutism.

There are powerful reasons, both philosophical and physical, to accept one of these two pictures. The intuitive appeal of Leibniz equivalence is the main philosophical reason. Moreover, many common intuitions resist haecceitism for material objects. Why should spacetime points (if they exist) be any different?

On the physics side of things, denying Leibniz equivalence introduces a pernicious, unobservable sort of indeterminism into general relativity, which is otherwise deterministic under normal conditions. This "hole argument" is the primary reason Earman and Norton (1987) use to motivate Leibniz equivalence. Briefly, although the evolution of distances and other geometric relations between material objects are deterministic according to general relativity, initial data does not always determine which spacetime points geometric objects will occupy. This is because the theory is symmetric under all diffeomorphism transformations, which are smooth (continuous) shifts in "what happens at which point." If points don't really exist, or if their identity is fixed by their geometric relations, as Leibniz equivalence would have it, this indeterminism disappears and the diffeomorphisms can be understood as nothing but formal re-labelings. The alternative is to suppose that all sorts of metaphysical facts about which points play which roles are not fixed (or even assigned objective probabilities) by the physics.

The denial of intrinsic handedness properties seems, by comparison, quite a minor price to pay. This explains why many philosophers of physics have rallied behind sophisticated substantivalism and/or relationism.

4 Asymmetrical laws without intrinsic left and right

The reader may be puzzled at this point. I have claimed that Lee's absolutism is incompatible with our best understanding of spacetime metaphysics, which must involve Leibniz equivalence. But the reader may have read somewhere (e.g. Gardner, 2005) that there is an experimentally measurable difference between "left- and right-handed" particles. The fundamental laws have been found to treat differently-handed particles differently. And as Lee writes,

> It is very plausible that there could only be such laws if absolutism was true. Oth-

Figure 4: The right-hand rule

> erwise the only way the asymmetry could be created by a law of nature would be if a canonical formulation of the law made explicit reference to a sample asymmetrical object, and then fixed the asymmetry universally using the congruence relation. It would surely be very surprising if a law looked like that, since we do not think that fundamental laws mention particular objects. (Lee, 2006, 309fn35)

"So there is empirical evidence," he continues, "that absolutism is true." (Lee, 2006, 309fn36)

This is puzzling indeed. Fortunately the puzzle has been resolved, in favor of Leibniz equivalence – and to the further detriment of Lee's absolutism. Before discussing the solution, we must first examine the asymmetrical laws that prompted it. The first step is to understand how an elementary particle can be "handed."

The key lies in the fact that quantum objects (like subatomic particles) can possess intrinsic *spin* properties with spatial orientations. Since fundamental particles are (apparently) extensionless, it is not literally correct to think of them as spinning or rotating extended objects. But like an extended object's rotation, a particle's spin gives it nonzero *angular momentum*, which we may still think of as a quantity with a magnitude, which picks out an axis (the axis along which the particle is "spinning").

Since it has a magnitude and a direction, angular momentum is represented as a vector quantity. But there is an element of arbitrariness in this representation, which will be important for our purposes. Consider an object rotating around the z axis of some coordinate system. The natural choice of vector to represent its angular momentum would point along the z axis. But there are two possible ways for the object to rotate around z – clockwise and counterclockwise. These two directions of rotation are physically different, so their angular momenta must be assigned different vectors. Luckily, there are also two directions we can direct along z – it can point either "up" in the $+z$ direction or "down" in the $-z$ direction. As a matter of convention, it is standard to represent the angular momentum of an object rotating counterclockwise with a vector pointing along $+z$. This is known as the "right hand rule" (see Figure 4) since an object rotating along with the curl of the fingers of the right hand will have an angular moment vector that points along the right thumb.

I belabor this point simply because the right-hand rule is a matter of convention. By using it, we have introduced an arbitrary handedness into the coordinates we use to describe angular momentum. And we could just as easily have chosen our convention differently, imposing a "left-hand rule" instead. Importantly, this convention can be defined only ostensively – we must demonstrate using a human right hand, or the face of a clock, to explain what we mean by the right-hand rule.

The convention we set using the right-hand rule enters into our definition of right- or left-handed particles. In the case of zero-mass particles (which we use for simplicity, although the definition can be generalized) a right-handed particle is one whose velocity vector points in the same direction as its spin angular momentum vector. A left-handed particle's velocity points in the direction opposite to its spin angular momentum. It is handedness, thus defined, that enters into the quantum theory of the weak interaction and helps determine how strongly a particle couples with the force-carrying boson fields. This effect can be experimentally measured, allowing us to distinguish between left- and right-handed particles by looking at their decay products.

The reader may be concerned at this point that the handedness of subatomic particles is not much like the handedness of hands. As extensionless objects, a right-handed particle and a left-handed particle can occupy the same region of space (i.e. the same point). In what sense, then, are they really incongruent counterparts? There are two main reasons for ascribing them this status. First, while oppositely-handed particles may occupy the same spatial point, they may not do so while possessing the same momentum.[5] Second, applying to a right-handed particle the same mirror-reversal (parity) transformation that turns a right hand into a left hand will produce a left-handed particle.

[5]This weird result arises because our definition of handedness relies on the notion of spin. Extensionless quantum objects, unlike point-sized classical particles, can carry angular momentum. This leads to all sorts of strange behavior, but it is also a well-documented physical fact.

To recap: we know that the physics of weak interactions discriminates between right- and left-handed particles. This is the main reason for supposing, as Lee does, that laws like these require handedness to be an intrinsic property. But we also know that the handedness of particles is defined using an arbitrary convention, chosen when we imposed the right-hand rule on angular momentum vectors. These two data points – the apparently intrinsic nature of handedness and its apparent conventionality – are obviously in conflict. I will now show how to resolve the conflict in favor of conventionality, leaving us with no compelling reason to accept Lee's absolutism.[6]

A concrete example will help; here I follow Pooley (2003, PAGE) in using the example of atomic beta-decay. Simplifying somewhat, the radioactive isotope Cobalt-60 is disposed to decay by emitting electrons along the axis of its spin. It can be shown that a right-handed, beta-decaying Cobalt-60 atom is *not* physically equivalent to its left-handed mirror counterpart. Instead, the left-handed counterpart is physically the same as an antimatter atom of *anti*-Cobalt-60, which will be disposed to emit positrons at the same rate that the right-handed atom emits electrons.

Here the laws seem to recognize a physical difference between right- and left-handed atoms. But we saw above that the mathematical difference between right- and left-handed atoms is a matter of arbitrary stipulation. For suppose we had used a left-hand rule instead of a right-hand rule to (ostensively) define the angular momentum vector; then the electrons we actually call "right-handed" would be recognized by the theory as left-handed, since their new angular momentum vectors would point in the direction opposite to their velocities. But then right-handed atoms would decay to produce electrons, and left-handed ones would emit positrons – seemingly a measurable difference. A mere change in notation cannot change a theory's empirical content. Something has gone wrong here.

Our mistake has been to recognize too many metaphysical possibilities. If handedness were an intrinsic property, as Lee's absolutism would have it, then the following would each be true in one of four distinct possible worlds:

1. Right-handed beta decays produce electrons and left-handed decays produce positrons (as in our world). The first beta-decay in the history of the universe was right-handed, and we use the world "right" to refer to right-handed beta decays.

[6] The resolution I will employ was first carried out by Hoefer (2000), Huggett (2000) and Pooley (2003).

2. Left-handed beta decays produce electrons and right-handed decays produce positrons. The first beta-decay in the history of the universe was right-handed, and we use the world "right" to refer to left-handed beta decays.
3. Right-handed beta decays produce electrons and left-handed decays produce positrons. The first beta-decay in the history of the universe was left-handed, and we use the world "right" to refer to left-handed beta decays.
4. Left-handed beta decays produce electrons and right-handed decays produce positrons. The first beta-decay in the history of the universe was left-handed, and we use the world "right" to refer to right-handed beta decays.

But it should be clear, from the fact that the handedness of particles can only be defined ostensively via the right-hand rule, that worlds 1 and 2 are just different descriptions (via different ostensive definitions) of the same possibility. The same goes for worlds 3 and 4.

If this is correct, as it seems it must be, then "worlds" 1 and 2 both admit the following invariant description:

> All beta decays producing electrons have opposite handedness to all decays producing positrons. The first beta decay in history produced an electron, and we use the word "right" to refer to beta decays with the same handedness as the first one.

This statement makes no appeal to intrinsic handedness properties; it requires only a relation of incongruence between decays of opposite handedness. Lee's relationism amounts to the view that worlds 1 and 2 are really the same possible world, and that (in general) some invariant description of this sort could provide a complete qualitative picture of any possible world.

It should now be obvious that such a view is compatible both with the mirror-asymmetrical predictions of quantum theory and with the experiments that confirm them. Properly speaking, we have not observed that "intrinsically right-handed" particles are treated differently by the laws of nature. Rather, we have discovered that particles of *opposite handedness* (bearing to one another the relation of incongruence) are treated differently by the laws – and this is in complete accord with Lee's relationism. Experimental evidence of mirror-asymmetry in nature is not evidence for Lee's absolutism.

5 Lee's assumption of reliability

We've now established that the most natural response to recent work in the philosophy of physics is to accept Lee's relationism.

But we saw earlier, in Section 2, that Lee's relationism is the only controversial premise (besides the supervenience of the mental on the physical) in Lee's transcendental argument. Recall that the conclusion of this argument – that a being (like Simon) with a mirror-symmetrical brain could not possibly have mirror-asymmetrical experiences – was quite surprising in its apparent strength. Do we really know a priori, from only our knowledge of spacetime metaphysics and the assumption of physicalism, that we are not symmetrical beings like Simon?

The substance of my answer is that Lee is right, but that his conclusion is not as surprising as he makes it out to be. He has made two additional assumptions which, although not central in his discussion, are crucial to his result. The first is that our (and Simon's) perceptions of handed objects are *reliable*, in the sense that they are veridical and would remain veridical even under different circumstances.[7] The second is that Simon's *entire body*, not merely his brain, is left-right symmetrical – including his sensory organs. Without these assumptions Lee's conclusion does not follow; with them it is not so surprising.

The first assumption is easy to see, by considering an alternative Lee neglects in his Simon argument. Couldn't it be that Simon, when confronted with an 'MIT' sign, has a mirror-asymmetrical experience which would have been exactly the same if he were instead presented with a 'TIM' sign? To put it another way: couldn't Simon's experience possess an asymmetrical character, but not one that reliably reveals the handedness of objects in his environment? This is easy to imagine. For example, it would hold if Simon were a brain in a vat and the deceiving scientists projected an image of an 'MIT' sign into his brain. It would also hold if Simon were so constituted that he experiences what you or I experience when we look at an 'MIT' sign, regardless of whether it's an 'MIT' sign or a 'TIM' sign that's placed in front of him.

An unreliable Simon of this sort could in principle have any experience you or I might have – but they would not be reliably connected with the handedness of the things around him. Whether his handed experiences would thereby have different representational content

[7] As Lee puts it in his introduction, "... I'm not going to argue against any skeptics..."

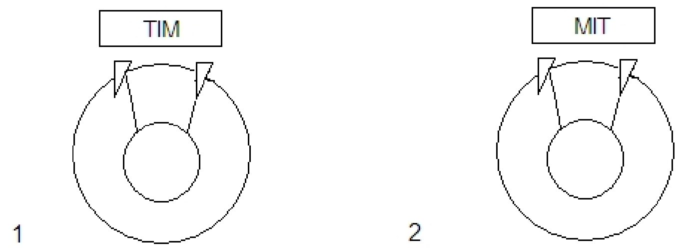

Figure 5: Triangle Man

from yours or mine is an interesting question. But it is a question about "wide" content, not the sort of experiential character that is inwardly accessible. So it is entirely compatible with the character of our experiences that you or I might be symmetrical beings like unreliable Simon.

It may seem to follow, at least, that beings with symmetrical brains cannot form reliable representations of handed features of their environment. This brings us to Lee's second assumption: the mirror symmetry of Simon's entire body.

Recall the central move of the Simon argument. The two possibilities in Figure 2 are incongruent counterparts; so by Lee's relationism they are physically the same; so by physicalism they are mentally the same. But the same could not be said of the two possibilities shown in Figure 5. The character in this figure, Triangle Man, has a mirror-symmetrical *brain*, but his *eyes* are scalene triangles which are altered by mirror reflection. So Lee's relationism does not apply to the two possibilities shown in Figure 5. Triangle Man looking at an 'MIT' sign is not (as with Simon) physically the same as Triangle Man looking at a 'TIM' sign. So Lee's argument gives us no reason to suppose that the two Triangle Men in Figure 5 are experientially identical.

But Triangle Man's brain in case 1 is physically identical to his brain in case 2. Absent some strange holism about the character of experience, we must still conclude that our two Triangle Men are experientially identical. This does not, however, show that a reliable Triangle Man is impossible. How would we go about making one? We would need a Triangle Man with reliable, counterfactually robust connections between the handedness of his environment and the character of his experience. Such a Triangle Man could easily be devised. For example, suppose that Triangle Man's asymmetrical eyes are reliably causally connected with both the handedness of his environment and his brain. For purposes of simplicity, we may suppose that when reliable Triangle Man sees an 'MIT' sign, his eyes cause his brain to become positively-charged, a state on which his MIT-experience supervenes. Then it might also be that a 'TIM' sign would cause his brain to become negatively-charged, leading him to experience the mirror-reversal of his MIT-experience – all without introducing any left-right asymmetry into his brain itself.

To put this another way, for Triangle Man to be truly reliable is for some particular subjunctive facts to be true of him. Namely, the state reliable Triangle Man is in while seeing a 'TIM' sign must be physically different from the mirror reversal of the state he would be in if he were to see an 'MIT' sign. More generally, mirror reversing reliable Triangle Man's environment must (if his environment is mirror-asymmetric) reliably cause physical changes *other than mirror reversal* in reliable Triangle Man. We may imagine a single nerve connected at one end to reliable Triangle Man's brain, and at the other end to a "juncture" of two nerves, one leading to each of his eyes. The signal sent from the juncture to his brain will be a simple electrical signal, which we may assume is mirror-symmetrical. But a different signal will be sent to his brain, depending on whether he is seeing (for instance) a 'TIM' or 'MIT' sign. I can think of no reason why this should be metaphysically, or even physically, impossible.

The message to take home from Lee's argument appears to be this: reliable perceivers of left and right must have some left-right asymmetrical features, not necessarily in their brains, but reliably connected to their brains and responsive to the handed features of their environment. All of this is mighty interesting, and we should be grateful to Lee for pointing it out. But it is not quite as surprising as would be a journey "transcendentally from facts about experience to facts about the *spatial* properties of the brain" – which is what we were promised (Lee, 2006, 291).

6 Conclusions

At the close of his paper, Lee paints the dialectical situation as a choice between five options (a quint-lemma?). The first he lists is:

> To say that if there are non-relational reflective properties, then they are irrelevant in determining experiences, and hence to accept that a physically sym-

metrical individual like Simon would be experientially symmetrical. (Lee, 2006, 312)

I have tried to show that this view, properly understood, accords both with our intuitions about experience and (more importantly) with our best understanding of modern physics. A symmetrical being like Simon is unable to have *reliable* asymmetrical experiences, because he is unable to reliably determine the handedness of objects in his environment. There is no reason to suppose that Simon could not have the same experiences you're now having – but if he did, they would not be a reliable indicator of the handedness of things around him. A being like Simon might understand handedness the way we understand radio waves. He could perhaps build instruments to measure it, but could not directly perceive it with his senses.

I do see a further, pressing philosophical question at play here. Could a creature like Simon come to rationally believe that his environment contained a relation of congruence like the one you and I perceive with our eyes? Or would a right-thinking, empiricist Simon eschew belief in measurable but unobservable properties like handedness? That's a question for another time, but you can probably infer, from the fact that I believe in elementary particles, what I'd be inclined to say.

References

Earman, John and John Norton (1987), "What Price Spacetime Substantivalism? The Hole Story," *British Journal for the Philosophy of Science* 38:515–525.

Gardner, Martin (2005), *The Ambidextrous Universe*, New York: Dover.

Hoefer, Carl (2000), "Kant's hands and Earman's pions: chirality arguments for substantival space," *International Studies in the Philosophy of Science* 14:237–256.

Huggett, Nick (2000), "Reflections on parity non-conservation," *Philosophy of Science* 67:219–241.

Kant, Immanuel (1992 [1768]), "Concerning the ultimate ground of the differentiation of directions in space," in Waldorf, D. and R. Meerbote (eds.), *The Cambridge Edition of the Works of Immanuel Kant: Theoretical Philosophy 1755-1770*, Cambridge: Cambridge UP, 377–416.

Lee, Geoffrey (2006), "The Experience of Left and Right," in Hawthorne, John and Tamar Szabo Gendler (eds.), *Perceptual Experience*, Oxford: Oxford UP, 291–315.

Pooley, Oliver (2003), "Handedness, parity violation, and the reality of space," in Brading, Katherine and Elena Castellani (eds.), *Symmetries in Physics: Philosophical Reflections*, Cambridge: Cambridge UP, 250–280.