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The fate of presentism in modern physics:

A matter of perspectives and contingencies

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Abstract

Within the philosophy of time, there is an ancient debate between *eternalists* who defend the unreality of time and *presentists* who want to reify the time of our experience. Contemporary debate has clarified and crystallised the strongest arguments for these two disparate ontologies of time, drawing from modern physics in the case of eternalism and from common-sense intuitions relating directly to our experience of time in the case of presentism. Recent attempts at resolving this ontological dispute purport to be able to reconstruct the time of our experience from our physical conception of time as a perspectival phenomenon, thus integrating both approaches to ontology. This paper argues that a principled investigation of mental representations of time will serve to further motivate such a reconciliatory project but also does important explanatory work alongside the considerations from physics seen in existing accounts such as Jenann Ismael's. Specifically, an analysis of mental representations of time through the teleosemantic framework reveals our sense of time as *domain specific* and *rhythmic*, undermining presentists' justificatory basis for drawing inferences regarding absolute simultaneity from our perception of simultaneity as well as exposing our perception of temporal *flow* as an artifice of cognitive processing. Similarly, considerations from teleosemantic theory regarding the faithfulness of our mental representations seem to refute eternalists' justification for discarding our experience of time as illusory. Finally, I briefly suggest an avenue for further investigation into understanding the emergence of the various properties of subjective time from physical time through the observation that we are not simply subjects in time, but, in some sense, embedded and embodied participants in time.

Introduction

In the philosophical debate on the ontology of time there is strong disagreement between those who insist that time is a real thing which has more or less the characteristics of time as we experience it and those who maintain that time as we experience it is an illusion. The first of these views is known as presentism - the quintessential dynamic theory of time where everything that exists does so only in the present moment - and is largely motivated by the way we intuitively interact with time and temporality through our everyday experience of it. The second view is known as *eternalism* - the static ontological thesis that time is an illusion and that there is no genuine ontological distinction between what was, what is and what will be - and is typically taken to be entailed by our theories of modern physics. The crucial point upon which the debate between these two camps typically pivots is the concept of simultaneity, in particular the relativity of simultaneity that emerges from the theory of special relativity (henceforth, SR). That is, the relativity of simultaneity which follows directly from the highly empirically successful scientific theory of SR constitute a problem for presentists in that it makes it hard to define an absolute conception of simultaneity which is essential to presentist theories (Wüthrich 2013). On the other hand, the eternalist ontology of time and its treatment of many of the properties which characterise time as we experience as illusory leaves much to be desired in its failure to account for these properties in a plausible way.

To address the shortcomings of these opposing views, recent work has proposed a way of squaring the particular merits and avoiding the downsides of each of the opposing views by means of a reconstruction of time within the laws of physics as a perspectival phenomenon (Ismael 2016; Rovelli 2019). Such a view can also be taken to be further motivated by appeal to the concept of the empirical adequacy of our scientific theories; they should not only explain empirical data, but also our day to day experience (Allori 2013a; Barrett 2021; Maudlin 2019). While this reconciliatory approach lays a strong foundation for a solution to the ontological dispute between presentists and eternalists as it pertains to the relevant physics, an account attempting to bridge the gap between time as we experience it and time as treated in modern physics is incomplete without also a principled investigation of temporal experience.

In this paper, I will argue that a principled investigation of mental representations of time can be used to further validate and corroborate Ismael's approach to clarifying and resolving this ontological dispute. There are several ways in which a principled investigation of the way time is mentally represented to us accomplishes this:

The first way such an investigation can shine light on this situation between presentists and eternalists is by identifying the actual content of our temporal experience. Without a principled investigation of temporal experience and perception, we cannot say with certainty what it is that we are actually perceiving when we perceive time and so we should not be too quick to draw conclusions directly from what we take to be our untarnished experience. What we might think of as immanent within our temporal experience, might have their origin elsewhere such as in culture or linguistic convention. For instance, when Brontë's Catherine Earnshaw from *Wuthering Heights* (Brontë 1978, 82) says "my love for Linton is like the foliage in the woods; time will change it," it is questionable whether we actually *perceive* time itself as changing either love or the foliage in the woods - as though it had this kind of causal power - or if this is merely a very recognisable kind of figure of speech which seeps into our thinking regarding time.

Second, a principled investigation of mental representations of time will reveal whether these have the right kind of grounding to be taken as testimony for a certain kind of ontology. By understanding the manner in which the properties that characterise our subjective experience of time are presented to us in the mental representations that form these experiences, making precise the mechanisms by which this happens and exploring their origins, we can begin to determine how reliable our intuitions regarding these properties are as foundations for an ontology. It might be the case that such an investigation, for instance, uncovers contradictions between the functions these mental representations are evolved to perform and the inferences presentists want to draw from them regarding the ontology of time. This would serve as a negative argument against the presentists and thus indirectly support views more in line with Ismael's.

Finally, a principled investigation of mental representations of time will also further substantiate Ismael's project of reconstructing the subjective time of our experience from physical time, thus assisting us in appeasing concern regarding the empirical adequacy of our scientific theories. Such an investigation, importantly, can also potentially serve to elucidate whether more work needs to be done in our interpretation of physics to understand how it is that we come to experience time the way that we do. In particular, this might be of interest to the very lively part of the debate that concerns the arrow of time and whether the second law of thermodynamics describing the temporally asymmetric increase of entropy provides enough of a physical foundation to explain our experience of asymmetry (see eg. Gołosz 2021; Ismael 2016; Rovelli 2015).

The paper will proceed from here, in section one, to discuss scientific realism with regards to time broadly, laying out the debate very briefly introduced above concerning the ontology of time and the empirical adequacy of our scientific theories, as well as introducing Ismael's perspectival theory of time. In section two, I motivate thinking about the mental representations of time through a thought experiment on the magnitude of relativistic effects inspired by Hilary Putnam (1967) and follow this with an introduction of teleosemantic theory in which we find precedent for thinking about mental representations as evolved features. In the third and final section, I apply this teleosemantic framework to an analysis of our *sense* of time and its origin through Viera's work on the topic (Viera 2016; Viera 2020) as well as a discussion of mental representations of simultaneity and asynchronies. Such an analysis yields insight into aspects of mental representations of time - eg. its domain specificity and rhythmicity - in a way that discredits presentist ontologies but also exposes eternalist talk of illusion as missing the mark and instead seems to support reconciliatory efforts such as Ismael's.

Section One: Scientific realism with regards to time

Scientific Realism

One of the most important debates in contemporary philosophy of physics, and more broadly in philosophy of science, concerns the interpretation of our scientific theories as it pertains to ontology. More specifically, the further our scientific understanding deviates from our every-day experience, the greater the tension becomes between the inferences we might draw about ontology from our direct experience as opposed to the inferences we might draw about ontology from our ever-expanding scientific understanding of the world. Sellars captures this tension nicely in his distinction between what he calls the "manifest image" - loosely speaking, a pre-science kind of conception of the world - and the "scientific image" - the world as presented to us through our scientific understanding of the world (Sellars 1962).

Now, we might say that those who adhere strongly to a manifest-image approach to ontology whenever there is tension with the scientific-image approach, typically seem to be driven by a kind of concern with the strength of the *epistemic premise* of scientific conclusions. That is to say, given the highly presumptively warranted beliefs we developed from observing the manifest image, we can question the strength of the scientific theories that are taken to show these beliefs unreality (Korman 2019). We see this sort of response to evolutionary debunking arguments of moral truths (Street 2006), for instance, from those who want to maintain the reality of moral truths (eg. Nagel 2012; Schafer-Landau 2012). As it pertains to the topic of this paper, this is also the sort of argument proponents of presentism's

compatibility with SR (eg. Lowe 2013; Markosian 2004; Prior 1996; Zimmerman 2008) implicitly seem to be invoking by relying so heavily on manifest-image considerations to motivate their proposed ontology.

On the other hand, those who favour the scientific-image approach to ontology in case of conflict seem to be motivated, broadly speaking, by a commitment to a strong kind of *scientific realism*. Such a commitment typically comes from the kind of intuitions captured in the "no miracles argument." It seems like it would be highly unlikely, almost like a miracle, if it just so happened that our scientific theories were so successful in predicting, retrodicting and explaining empirical results. The best explanation for the success of our scientific theories, thus, is that they are true (Putnam 1975). Furthermore, we typically also see an appeal to ontological parsimony from those committed to this kind of strong scientific realism, because unless the manifest-image adherents want to outright deny the science they inevitably have to *add* something to it. This is a strong point of contention, for instance, in interpretations of quantum mechanics with regards to the reification of the wave function (see eg. Albert 1992; Maudlin 2019).

Summed up briefly, the wave function describes the states of quantum systems and evolves linearly with the Schroedinger equation. Despite this linearity and mathematical simplicity it has several quirks such as allowing for *superposition* - particles doing multiple classically incompatible things at once - and *quantum entanglement* - non-local (instantaneous) communication between separated particles - and finally also a very high dimensionality of 3N dimensions, where N is the number of particles (of which there are roughly 10⁸⁰ in the universe). If we want to avoid the reification of the wave function, we have to *add* something (eg. particles), to the ontology to get a complete picture of what there is. In a sense, although perhaps less intuitive, the reification of the wave function thus gives us a more *parsimonious* ontology (Albert 1992). This example, while not directly related to the main topic of this paper, serves to illustrate the generality of the broader point of the paper with regards to the tension between manifest-image approaches and scientific-image approaches to ontology.

Whether we prefer the less intuitive, but more parsimonious ontology or otherwise the more intuitive but less structurally parsimonious ontology is ultimately a matter of taste. Lewis, for instance, in putting forth his *modal realism* - the idea that possibilities are all realised in parallel worlds - wants to distinguish between *qualitative* and *quantitative* parsimony (Lewis 1973). Applied to the example above, we might say that while the reification of the wave function yields a quantitatively more parsimonious ontology, in that there is now only one fundamental entity which is the wave function, but qualitatively less parsimonious ontology in that this wave function comes with strange features such as its high dimensionality.

The metaphysics of time

There has been a very strong relationship historically between the physics of time and the philosophy of time. There seems to be an intuition that goes deeper than simply scientific realism at play in this relationship that what we are typically referring to when we speak of time is some sort of physical conception of time. With the Newtonian image of *absolute time* as something flowing equally everywhere at a steady pace and according to which the laws of physics neatly operate as systems evolve, such an intuition can be made sense of. In this

picture, we have a neat correspondence between *metaphysical* time - time in *veritas rerum*, or *as it truly is* - and the subjective time of our experience, with *physical* time - time as described by physics - mediating in some sense between the two. There are still problems of course, for instance with regard to the metaphysics of time and temporal logic (Mctaggart 1908), or with regards to physical time and understanding what is known in the literature as *the arrow of time* - why time only seems to move in one direction (Rovelli 2017).

With Einstein's development of the theories of special and general relativity, however, the picture is no longer so clear. The physical time which previously might have been construed as mediating between our subjective experience of time and metaphysical time no longer seems to correspond well to either of them. In light of SR, the concept of simultaneity in physical terms can only be understood relative to an inertial frame of reference and is limited in its spatial extension. We furthermore have no clear reason for privileging one inertial frame of reference over another. Those who wanted, in rough terms, to maintain a correspondence between our subjective experience of time and metaphysical time have to now find an explanation for how physical time fits (or does not fit) into this intuitive picture, a version of which is more explicitly sketched just below (Wüthrich 2013).

This shift in our understanding of physical time prompts a reevaluation of common-sense metaphysical views of time, such as the presentist ontology, where everything that exists does so only in the present. This view is common-sensical in the way that it has the very straightforward consequences of flow, passage, openness, and asymmetry, which Ismael characterises as follows:

(v) Asymmetry: there are dynamical asymmetries in the behavior of macroscopic systems that make it easy to distinguish a film of everyday macroscopic processes run forward from their temporal reverse;

(vi) Flow: at any given moment, the world seems to be changing, or in flux; (vii) Passage: when we look back over our histories, we see that what was once future is now present, and what was once present is now past;

(viii) Openness: at any given moment, there is one possible past and many possible futures. (Ismael 2016, 109)

These four properties correspond well with the properties we typically attribute to subjective time, or time as we experience it. All of these properties hinge indelibly on a strong notion of simultaneity which is by necessity emphasised - or we might even say, as we shall see in the last section of the paper, *exaggerated* - by the presentist view. To capture the point of contention very explicitly, without a strong concept of simultaneity which *defines a present moment*, it is difficult to make sense of a clear distinction between *past* and *present* which further disrupts our understanding of these four properties. Those who defend that presentism can be maintained in light of these kinds of manifest-image considerations against the challenge of SR without outright rejecting SR are known in the literature as *compatibilists* (Wüthrich 2013).

The tension outlined in the discussion of scientific realism above captures this tension between those who take SR to be a defeater for presentist common-sense views of the metaphysics of time and those who want to maintain compatibilism between presentism and SR out of manifest-image style considerations. Wüthrich, in a critique of presentism, categorises the possible compatibilist responses into three categories. The first and arguably most peculiar strategy compatibilists can adopt, is to modify the ontological thesis of presentism to accommodate SR in the manner of Harrington's pointilliste here-now presentism. In this here-now presentism, the only thing that can really be said to exist at any given moment from any particular inertial frame of reference is that which is precisely here and now. The second strategy is to separate metaphysical time and physical time, in the manner that Prior and Lowe attempt to do. Prior's version of this strategy is guite simply to say that our lack of empirical access to facts about the ordering of events between different inertial frames of reference does not preclude such facts from obtaining (Prior 1996). Lowe similarly argues, with more specificity, that simply because we do not have access to knowledge about which inertial frame of reference is the privileged one does not mean that there is no privileged inertial frame of reference (Lowe 2013). Finally, compatibilists can reinterpret SR to accommodate their presentist ontology in the manner of for instance Markosian and Zimmerman. Between the two, Markosian adopts the more minimalistic version of this approach, claiming that SR comes with some implicit "philosophical baggage" which must be taken to preclude any relation of absolute simultaneity. In Markosian's view, although we might accept the empirical success of SR we need not accept this philosophical baggage (Markosian 2004). Zimmerman, similarly, rejects the "unnecessary clause" in SR's description which precludes presentism with the further addendum that just because SR posits a particular structure within spacetime does not necessitate that this structure excludes the possibility of further structure to space-time (Zimmerman 2008).

Ignoring for now the solipsistic *pointilliste* presentism of Harrington, we are left with four approaches fitting into the two categories of either separating metaphysical time and physical time or reinterpreting SR. Wüthrich's contention is that both approaches incur unique and unwarranted ontological costs, and that this is reason for rejecting these views on the basis of a principle of ontological parsimony (Wüthrich 2013).

More generally, presentism has guite a few problems even without the added challenges of SR such as explaining cross-temporal relations; what does it mean for someone now to admire someone who is no longer alive such as Shakespeare if all that exists is the present? More specifically, the ontological costs of maintaining presentism on the assumption of SR's truth include things like positing a metaphysical time as separate from physical time (Prior 1996; Lowe 2013) or making ad hoc claims that there is a fact of the matter with regards to objective simultaneity (Markosian 2004; Zimmerman 2008). The former has to explain what precisely this "metaphysical time" is as separate from physical time, the latter seems like it needs an accounting for what the relation would be between this metaphysically objective fact of simultaneity with the relative simultaneity of physical time. Both of them face the charge of obscurantism because they both leave their solutions untestable even in principle. It is furthermore clear that simply accepting the conclusion of eternalism that seems more straightforwardly compatible with SR is more *qualitatively* ontologically parsimonious in that it does not require us to add any structure to the already strongly empirically supported theory of SR. Notably, a presentist ontology is *quantitatively* more ontologically parsimonious than the eternalist ontology in that it is only committed to the number of things that exist now, rather than the number of everything that ever has existed, exists and will exist.

So, given this preference for qualitative ontological parsimony, Wüthrich demands that for us to complicate our ontology in this manner "we better have very good reasons for believing presentism." (Wüthrich 2013, 10) As he further reaffirms, the justification for the ontological thesis is typically found in certain intuitions we have about time. Such intuitions doubtlessly differ from person to person in their particular origins and representation, but to catch the strongest and presumably most well-founded of these intuitions we can simply refer to the four aforementioned properties of subjective time as described by Ismael, along with the strong sense of simultaneity (Ismael 2016).

It seems uncontroversial to say that there would be something peculiar about disregarding these intuitions altogether as "illusions," which is what the eternalist ontology prima facie seems to do. These are not just some vague intuitions, they are intuitions which universally among us seem to define our experience of being at the most fundamental levels. In Mctaggart's words, an assertion of time's unreality "involves a far greater departure from the natural position of mankind than is involved in the assertion of the unreality of space or of the unreality of matter." (Mctaggart 1908, 31) We might say, according to the epistemic premise style argument outlined above, that we have strongly presumptively warranted beliefs about time which the scientific theory of SR is not entirely sufficient to simply discard. Leaving things here thus, we would be at a stalemate between what seems to be the scientific-image approach to the ontology of time and the manifest-image approach to the ontology of time. However, a more agreeable approach to ontology which stands between these two extremes is to maintain, as Sellars himself does, the primacy of the scientific image but constrain it by imposing very strong criteria of *empirical adequacy* on our scientific theories.

To elaborate, there is a question regarding what our scientific theories *ought* to account for and in what manner. It is not immediately clear that it is sensible to take scientific theories as showing aspects of the world as it very convincingly appears to us through the manifest image to be "illusions." The starting point of science can never be anything other than observation. Observation, as Allori correctly identifies, following Sellars in her example regarding the evolution of our thermodynamic theories, began with the manifest image. This seems like it must be the starting point of our ontologies, and insofar as science informs our ontology, it only *gradually* departs from the manifest image to accommodate scientific empirical results. For this reason, Allori thinks "a primitive ontology in the familiar three-dimensional space evolving in time (or a space-time primitive ontology) is the natural metaphysical choice." (Allori 2013a, 5)

Now, regardless of whether we agree with Allori's conclusion of a primitive ontology which she also insists is an appropriate way of characterising all the various popular interpretations of quantum mechanics (Allori 2013b), the premise of the manifest image seems like it warrants serious consideration. This sentiment is echoed in Barrett's assertion that the strongest criterion of the empirical adequacy of a physical theory is that it actually explains our *experience*, (Barrett 2021) and also in Maudlin's insistence that our theories need to account for what we observe (Maudlin 2013, 126-153). This concern with empirical adequacy characterises a kind of *methodological conservatism* whereby we maintain the primacy of the scientific image - or scientific realism, in a broad sense - but we do so while treating the manifest-image in some sense as additional empirical data, broadly speaking, which needs to be accounted for.

In this instance in particular, we might take these properties of our subjective experience of time and say:

If we can explain how it is that these particular properties of time - flow, passage, openness, asymmetry and a strong sense of simultaneity - come to characterise our subjective experience of time despite considerations from SR, then we have managed to maintain the primacy of the scientific image, spared ourselves the ontological costs briefly described above and nevertheless validated the concerns of those who favour a manifest-image approach to ontology.

Ismael's perspectival reconstruction of subjective time from physical time

Ismael's work on reconstructing the subjective time of our experience from a scientific-image eternalist ontology of time attempts to do precisely that; explain how the particular properties that seem to characterise our subjective experience can be accounted for *within* the limits of modern physics. The approach she takes is to characterise these properties as *perspectival* properties emerging at the level of an observer operating *within* what she calls "history," which refers to the "block" of the block theory of time. If we take the "history" to refer to all of what happens from the beginning of time to the end of time we can distinguish between seeing things unfolding from within that history and seeing things from outside that history. While it may be that seeing things from outside that history for us will only ever be an unattainable abstraction, what Ismael calls "the temporal analogue of the view from nowhere," it is enough that we have this conception of history as it appears *sub specie aeternitatis* or *from the perspective of eternity* (Ismael 2016, 110). The time of physics, in Ismael's account, becomes the eternalist view of time and the four aforementioned properties which pertain to temporal experience uniquely emerge from our experiencing time from *within* history rather than from the perspective of eternity (Ismael 2016).

By separating the *sub specie aeternitatis* view of time from the view of time from within history - or from within "the block," from the block theory of time - she is able to reconstruct the four properties characteristic of subjective time through the logic that emerges more or less naturally from her initial characterisation of differing temporal perspectives. In rough terms, we would in this understanding reconstruct the phenomenology of flow as a consequence of sensory processing; "the fact that the content of experience at any time spans a finite interval means that the world at any moment is perceived as moving, changing, constantly in flux." (Ismael 2017, 30) Time seems to be flowing not because time is somehow *flowing* outside of us but because of our cognitive limitations - our finitude - as we move through history. With this movement through history, there is also an evolution in our temporal point of view as the frame defined by this finite interval of the content of experience centres on different points at different times, and this accounts for our perception of *passage* (Ismael 2017, 30).

The asymmetry of time has a pseudo-physical story in the sense that there is a physical asymmetry in the thermodynamic gradient of the universe as described by the second law of thermodynamics. This physical asymmetry further paved the way for what Ismael, following the theoretical physicists James Hartle and Murray Gell-Man, calls information-gathering and -utilising systems; entities, such as humans, that gather information about their environments and use it to make decisions (Hartle 2005). Finally, according to Ismael, this pseudo-physical asymmetry translates to an epistemic asymmetry because whereas we can remember the past, we can only make inferences about the future. So, our perceived asymmetry of time is pseudo-physical because it in some sense relies on the physical structure detailed by the second law of thermodynamics but also, importantly, on the different ways in which we relate to and approach knowledge about the past as opposed to the future (Ismael 2017, 29). As we begin to elaborate on the process of turning information into actions, we have to consider now ourselves and our own decision-making processes as a source of information about the future, this means we become agents with apparent ability to impact future outcomes in a number of ways. The fact that there are, at any given point in time, many decisions we could make which would cause different outcomes in the future presents to us a fixed past and a future which "awaits decision," and is thus open (Ismael 2017, 29).

The strength of Ismael's view is that it elegantly accounts for both the manifest-image intuitions which defenders of presentism are unwilling to relinquish as well as what the very precise and well-developed science of modern physics seems to imply. Importantly, without extraordinary metaphysical costs. It is an *interpretation* of the theory, but not a reinterpretation which significantly contradicts what is broadly understood as the fundamental claims of the theory such as the relativity of simultaneity. That being said, it is not quite clear in the end where this leaves our conception of time metaphysically speaking. It seems that many of those whom Ismael refer to as "parmenideans" - defenders of the unreality of time - would on this account be able to maintain that time as we experience it is indeed an illusion. Ismael herself denies that this follows, and that what her account entails is rather a set of perspectival or relational facts or properties of time. That is, there would be nothing illusory or subjective about saying one object is far away from another in space. Furthermore, one conception of time is not more real or fundamental than the other, it is simply that the manifest-image conception of time is frame-dependent and the eternalist scientific-image conception is frame-independent. What separates the two is a mere transformation of mathematical representations from the invariant (frame-independent) spacetime interval, s²:

$$s^{2} = c^{2} \Delta t^{2} - \Delta r^{2}$$
$$\Delta t = t_{1} - t_{2}$$

Where the frame-dependent intervals are simply the individual components (eg. Δt) which can be measured in different frames and transformed between the frames according to the lorentz equations:

$$t_1' = \gamma(t_1 - \frac{vx_1}{c^2})$$

To say that one of the mathematical representations is somehow more "real" than the other seems like an odd choice of interpretation, but if we now want to do so it is clear that what we would effectively be saying by this is that one is frame-dependent and the other is frame-independent (Ismael 2017, 33). From this, she concludes:

"To think that accepting the Block Universe as an accurate representation of time as it appears sub specie aeternitatis means rejecting passage, or flow, or openness, as illusory is like thinking that accepting a map as a non-perspectival representation of space means that you are under an illusion that anything is nearby." (Ismael 2016, 119)

Pooley would argue that Ismael's account does not take the passage of time seriously, a reconciliation of the phenomenon of time's passage with relativity is impossible because, as outlined above, it is impossible to establish a privileged global present with SR (Pooley 2013). What Pooley has in mind is something like Prior's conception that passage implies, in an objective sense that is *independent* of us, that as time "passes" past events become ever more past, just as future things become present and then past (Prior 1968, 1-2). To this kind of criticism, Ismael simply bites the bullet but insists that her account takes passage seriously even if not as seriously as Pooley would like. Once again, it seems clear that the strongest evidence of passage is found in our direct experience of it and the intuition which guides that experience and our self-reflective relation to the experience; that is, in approaching ontology through the manifest image. This intuition is so strong that many physicists and philosophers go to great lengths to rescue the time of our experience as a representation which captures the ontological reality of time above and beyond what physics seems to strongly suggest. We might consider that beyond these strong intuitions defenders of presentism rely on, there is also an appealing ontological elegance in the idea of time as this great equaliser which has everything existing in its grip as a vast global present sweeps from moment to moment and pulls everything along with it. There is, as Rovelli repeatedly emphasises in his work on the topic of time, a strong emotional attachment that we have to certain conceptions of time in that its passage seems to define our lives in so many ways (Rovelli 2017). However, as Ismael convincingly shows in her account, it seems that time, to us, would plausibly appear the same regardless of whether we can establish a global present or we stick with the block theory of time that is very strongly implied by modern physics. The fact that we can plausibly reconstruct the time of our experience from the eternalist picture of time from modern physics, seems to deflate the motivations we might initially take to justify attempts at maintaining our manifest-image approach to the ontology of time given the compelling evidence we find for the scientific image of time.

Now, Ismael's approach seems to be motivated by similar concerns for the empirical adequacy of our physical theories as those outlined above. As she puts it, "what physics owes to phenomenology is a non-reductive reconstruction of the contents of the point of view of the agent that tells us how the representational states of an evolved system with a particular combination of epistemic and practical needs would be organized." (Ismael 2017, 36) While her account provides a strong foundation for thinking about how we might explain the subjective experience of time from the scientific image of time, it does leave some explanatory gaps open.

With regards to *passage* and *flow* for instance, it is not clear to what extent her explanation of how these properties emerge in our experience are contingent on our cognitive capacities.

You can make a plausibility argument, as Ismael does, that time as seen by conscious agents like ourselves from within history would seem to *flow* and to *pass*, but such an argument is further contingent on a very particular understanding of our temporal perception. The question becomes, does simply delineating the two different perspectives of time sub-specie aeternitatis and from within history actually explain, fully, how our subjective experience of time is what it is? It seems that some of the explanatory burden necessarily falls on our understanding not just of physics and frame-dependent (perspectival) as opposed to frame-independent facts about physical time, but also on our understanding of temporal perception. However, it is not so clear where the task of physics ends and the task of cognitive science begins. When it comes to the question of *asymmetry* and *openness*, this lack of clarity becomes even more prominent as Ismael admits in expressing that "more work needs to be done to understand the nature of the practical asymmetry, but within the framework described here both [physical and epistemic] asymmetries get explained together in a story that is part physical science and part cognitive science." (Ismael 2017, 31)

As it stands, we've begun to see how we can maintain the primacy of the scientific image while validating considerations from the manifest image and without incurring unnecessary ontological costs such as positing extra epistemically inaccessible ontological structure or significantly reinterpreting scientific theories. While Ismael's perspectival approach goes a long way to this end, whether it actually obtains remains contingent on facts regarding temporal perception. The plausibility of Ismael's account already weakens the position of those who want to approach the ontology of time purely through the manifest image. To further substantiate Ismael's account and clarify the debate between the manifest-image and scientific-image approach to ontology, we can investigate mental representations of time and their evolutionary origins to get an idea where the explanatory ends of cognitive science and physics meet.

Section Two: Mental representations and their evolutionary origins

A thought experiment on mental representations of time

To begin thinking about mental representations of time we might consider the kind of thought experiment regarding relativity that Hilary Putnam leverages against presentism (Putnam 1967). If we consider two observers, A and B, with observer A on earth and observer B on a spaceship moving with a velocity, v, towards the star system Alpha Centauri with v constituting a substantial fraction of the speed of light. An event on earth, E_1 , that is simultaneous with an event on alpha centauri, E_2 , in observer A's frame of reference would not be simultaneous in observer B's frame of reference. In particular, for observer A with events E_1 and E_2 being simultaneous:

 $\Delta t_{A} = t_{2} - t_{1} = 0$

This time interval between the events which is 0 for observer A would be given for observer B by the lorentz transformation from observer A's frame of reference to observer B's frame of reference:

$$t'_{1} = \gamma(t_{1} - \frac{vx_{1}}{c^{2}}) \text{ and } t'_{2} = \gamma(t_{2} - \frac{vx_{2}}{c^{2}}) \implies \Delta t_{B} = t'_{2} - t'_{1} = -\gamma \frac{v}{c^{2}}d$$

Where d is the distance x_2 - x_1 between earth and alpha centauri (4 x 10¹⁶m) and the lorentz factor $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$.

This would guite obviously give a non-zero answer for the time interval between the two events in observer B's frame of reference, in the order of magnitude of years depending on our choice of the relative velocity of B moving with respect to A towards alpha centauri, demonstrating in a simple way the relativity of simultaneity as we discussed in the previous section (Putnam 1967). However, it is clear that these are not distances nor velocities that we would typically deal with in our day to day lives. Given the typical distance from our line of sight to the horizon:

$$d = \sqrt{2hR + h^2} \approx 5km$$

d = distance to horizon for a human observer h = 1.75m (Height of human observer) $R = 6\,371\,000m$ (The Earth's radius)

We can guite safely say that the order of magnitude for a typical experience is at the very highest 10³m, and more importantly the order of magnitude of velocity is going to be at about 10²m/s including for instance the speed of sound. Filling these numbers into the equation above, we can get the largest relativistic effects that we could potentially be exposed to:

$$\Delta t_{B} = t'_{2} - t'_{1} = -\gamma \frac{v}{c^{2}} d \approx -10^{11} s$$

That would be an asynchrony of the order of magnitude of 0.00000001ms. For reference, temporal order judgements of asynchronous stimuli have been shown to be stimulus dependent with the highest sensitivity to asynchrony found in audio-tactile stimulus judgements sensitive to about 15.6ms (Fujisaki & Nishida 2009). In other words, an asynchrony of 0.0000001ms would be completely undetectable.

So even if we were justified in approaching the ontology of time through the manifest image, it seems we would never truly be exposed to situations that would clearly delineate the presentist ontology from an eternalist ontology. For that, we would need two observers moving at high velocities relative to one another observing the same two events that happen with great spatial separation coming together to discuss whether or not these two events were simultaneous. Otherwise, an ontology in which simultaneity is relative or frame-dependent would look exactly the same as one in which simultaneity is absolute or frame-independent.

Now, that is *if* we are justified in approaching the ontology of time through the manifest image, which it is not at all self-evident that we are. On the contrary, if we accept as a premise that not only our cognitive faculties, but also the mental representations they give rise to are *evolved* features, it seems highly unlikely that such a manifest-image approach to ontology could be justified in a straightforward way. Understanding our cognitive faculties as well as our mental representations as evolved features means that these would be adaptations to selective pressures which would have had to be consistent enough over a sufficiently long time period for these adaptations to be selected for. Given the relatively slow velocities we move at in our day to day lives, which would have been even quite a bit slower in our evolutionary past, as well as the limitations we have in terms of the spatial distance between events in our perceptual fields, what selective pressures could possibly have driven us to be more sensitive to the relativistic effects of physics and asynchronies?

Even if we imagine that aliens have visited humanity with advanced technology and that our ancestors travelled on spaceships at near-speed-of-light velocities every once in a while, this would have needed to be both consistent and in some sense also have conferred some fitness-enhancing benefit upon those who developed higher sensitivity to relativistic effects. This seems like a highly unlikely scenario and if anything, as we shall see later, evolutionary considerations seem to suggest that a slight exaggeration of simultaneity would be more beneficial than the opposite, corroborating William James' influential idea that the present as we perceive it is *specious* (James 1890).

Teleosemantic theory and the evolutionary origins of our mental representations

Precedent for approaching mental representations as evolved features has been set by the already well-developed framework of teleosemantics. The trick of teleosemantics is to understand biological *functions* and their *usefulness* as grounding mental representations in an *evolutionary history* in which they emerged as adaptations to specific problems within specific conditions. More specifically, within the teleosemantic framework we would take the *proper function* - the function for which a mental representation was selected - to dictate the mental representations content.

As an example, we can take the paradigmatic case of the frog and the fly where a frog has evolved a specific neural mechanism which causes it to shoot out its tongue whenever it spots a small, dark, moving object. This mechanism would have been selected for because it is fitness-enhancing for the frog and its *proper function*, defined by the evolutionary history of its selection, is to detect flies. Because of this, when the frog sees a small, dark, moving object it represents this object as a "fly," and misrepresentations occur when the frog mistakenly represents something (eg. a small, dark, moving piece of dirt) as a fly. This conceptual constellation forms the foundation of teleosemantic theory and the concepts and their various extensions and implications have been explored at length (Godfrey-Smith 1996; Millikan 1989; Neander 1991).

We have begun to see just above how this could help us think about mental representations of time. However, this is not truly a refutation as such of the presentist ontology but rather

casts doubt on the idea that we can justify approaching ontology through the manifest image. More generally, in the teleosemantic framework, mental representations are held to accurately represent aspects of the world to us, but only aspects that are useful to us and only in a way that is thoroughly contingent on the usefulness of these aspects. The accuracy of mental representations are not only contingent on usefulness but also on domain (Dretske 1988). As an example, we might consider how the evolution of colour vision has been fitness-enhancing because it allowed us to identify ripe fruits as well as distinguish between different types of plants and animals. The accuracy of the mental representations this cognitive capacity gives rise to is domain specific in the sense that it can give us accurate information about certain aspects of the world (eg. the ripeness of fruit) but not about others such as radiation outside the visible spectrum (Sterelny & Griffiths 1999).

By the same token that this casts doubt on the idea that approaching ontology through the manifest image is justified, it also challenges the justification of the eternalists' (or Parmenidians', as Ismael calls them) tendency to talk of temporal perception or experience as *illusory*. Literature on temporal illusions deals with phenomena such as temporal order illusions and temporal duration illusions. As an example, there are asynchronies in visual perception where people will perceive two events where a moving object changes colour and direction of motion simultaneously asynchronously. Despite the two changes occurring simultaneously, observers will register and report that the change in colour happened 60-100ms before the change in direction (Nishida & Johnston 2002). This is an example of what is typically referred to in the literature as a temporal order illusion. Similarly, we might find temporal duration illusions in situations where subjects systematically fail to track duration accurately (Martinelli & Droit-Volet 2022). Such empirically observed illusions are frequently cited in discussions of temporal isomorphism - the idea that our experience of temporal order reflects the temporal ordering in which those same events are processed in the brain - this is also known as the brain-time view. Typically, the brain-time view is contrasted with the event-time view; the view that our subjective experience of temporal order reflects the temporal ordering of the events themselves (Arstila 2019).

There are multiple ways in which we might interpret these temporal illusions or try to make sense of them. We can begin by noting that these so-called illusions or errors of judgement are systematic, and sensitive to particular types of stimuli or states. Martinelli and Droit-Volet report a particular sensitivity to attention-related factors for the estimation of short durations and emotions, with boredom having the strongest positive effect, for a person's ability to accurately estimate long durations (Martinelli & Droit-Volet 2022). Viera also nicely summarises a number of ways in which we can selectively impair different aspects of our temporal perception through pharmacological interventions through substances such as haloperidol, midazolam, benzodiazepine and psilocybin and mechanical interventions such as rapid transcranial magnetic stimulation. This is to be understood as impairments for our ability to accurately estimate the duration of phenomena on different timescales ranging from 50ms to hours (Viera 2019, 13). The systematicity of these phenomena suggests that under a teleosemantic lens, it might not be appropriate to conceive of these perceptions or estimations as erroneous.

In evaluating the kind of temporal perceptions discussed just above as illusions, we are invoking, as a premise, a very particular kind of correspondence theory of truth; namely one where mental representations are meaningful or true in virtue of their accurate

correspondence with a scientific description of reality. Under the teleosemantic approach, considerations of whether there is a correspondence between our mental representations and scientific descriptions of reality is a much more layered and intricate question. If these aspects of our temporal perception are systematic, the more appropriate question to ask from the teleosemantic perspective would be what function these perceptions have served evolutionarily speaking.

We could see how the teleosemantic framework implicitly seems to align well, in some sense, with the normative premise of Ismael's approach to the ontology of time captured well by those who want to maintain the strong criterion of empirical adequacy that scientific theories ought to explain our experience. That being said, there are also multiple complications that we take on board by employing this explanatory framework.

Teleosemantic theory has been criticised on multiple accounts, we might for instance ask what such a framework would say about mental representations in new environments which would have no ties to our evolutionary history. If we think in higher levels of abstraction, however, of mental representations as representing more general categories of things such as *textures, hardness, danger* and so forth this might not be so much of a problem (Millikan 1989). More troubling, the literature seems to suggest, is the *indeterminacy problem*. Broadly speaking, this is the problem of precisely identifying the actual content of a mental representation given that we might have multiple evolutionary stories and functions associated with that mental representation (Papineau 1987, Martínez 2013, Artiga 2021). We also have the sort of general criticism of the epistemic credentials of evolutionary grounding of traits and functions given the multiplicity of mechanisms other than adaptation by which evolution happens (Gould & Lewontin 1979). While developing and exploring these particular criticisms is beyond the scope of this paper, these are the kinds of criticisms defenders of the manifest-image approach to the ontology of time could wield in challenging the epistemic premise of the teleosemantic concepts which casts doubt on their justification.

To address these complexities, many recent prominent attempts adopt a *signalling framework* in which mental representations are understood as signals mediating between a sender and a receiver. This allows for a mechanistic approach to questions which in this framework can be very precisely defined and addressed through information-theoretic models. Typically, the sender-receiver systems discussed with regards to the question at hand will be very simple systems internal to organisms such that complex organisms like human beings are understood to be comprised of a great plurality of such sender-receiver systems working in chains as well as well as parallel to each other. An example of such a chain being the processing network through which incident light on the lens of an eye becomes a perceptual experience. That being said, the framework is fully generalisable to higher forms of signalling, such as natural language interactions. The fundamental conception can be traced back to the early authors of teleosemantics (Millikan 1984; Papineau 1987) and was further developed, formalised and defended by recent proponents taking a more explicitly information-theoretic approach (Skyrms 2010; Godfrey-Smith 2010; Artiga 2019; Martínez 2019).

Now, as we have seen, various proponents of teleosemantic theory maintain that our mental representations do accurately represent certain aspects of the world that are useful to us and in ways that are thoroughly contingent on this usefulness. This, however, need not

necessarily follow from the premises laid out by the theory. If we want to think, thus, more clearly about the extent to which we may take our manifest image to carry information about ontology, we can do so more precisely through the briefly outlined information-theoretic approach to teleosemantics outlined in the paragraph above. One such, controversial and yet influential approach, claims to show the grounding of mental representations in biological functions and their usefulness make the *truthfulness* or *accuracy* of mental representations redundant. This kind of argument leads us down a path of radical doubt to a kind of idealism in which not even our scientific knowledge, let alone our manifest image, can be said to give us insight into things as they really are (Hoffman 2019). Even in principle, this is a tricky place to be because if we admit that we have no way of grasping reality, we have no basis on which to establish what is in actuality an illusion and what is real. To say definitively that something is an illusion we have to have some kind of grasp on reality against which to measure this illusion. For this reason amongst others, the kind of evolutionary debunking argument that Hoffman employs is liable to the aforementioned epistemic premise style criticisms (Korman 2019). That is, we can call into question the adequacy of the account on which he draws his very radical conclusions based on the fact that we have very good reasons to believe that our mental representations have some veridicality.

Challenging the epistemic premise of a debunking argument is a very minimalistic strategy, and only one of two strategies that Korman outlines as possible ways of rebutting a debunking argument. Martínez, in response to Hoffman, takes his criticism a step further with an explanationist approach (Korman 2019) and shows very convincingly, using Hoffman's own models with very minor modifications that in a more "ecologically realistic" modelling of the sender receiver system, maximal utility is gained when the sender actually relays "agent-independent cues." In other words, it is not enough that the sender and receiver have some codified signals relating to different behaviours or actions on the part of the receiver (agent) but the sender actually has to relay some information about that which is presumably being represented when the response is context dependent. That is, if the utility of responses to some particular information relayed in a signal depends on other particular information relayed through a different sensory modality, the best a sender can do is to relay agent-independent cues (Martínez 2019). In these instances where the utility of a response is dependent on multiple cues coming from different signals and we have synergy, Martínez insists that "truth-tracking signalling strategies will be necessary." (Martínez 2019, 15) We cannot infer from this with full generality that perceptions are truth-tracking, although Hoffman's conclusion of radical idealism certainly seems to be overstated given his explanatory framework.

Furthermore, Martínez's argument regarding synergy as the informational property which leads representations to tracking truth tows an intuitive line. The concepts through which we understand and engage with the world are in many ways very interconnected, general and abstract. We see things in categories with varying degrees of overlap rather than in single instances and in this way are able to deal very well with unfamiliar events. A signalling system that had only specific signals divorcing usefulness from truth entirely for every particular event would be very costly and inefficient, first of all, but also very bad at dealing with unfamiliar situations. It also makes sense, intuitively, that it would be more efficient to integrate all these different sensory signals into a single unified experience, rather than leave them as scattered individual impulses. This would also allow for a simple sifting of relevant information. We might also speculate that similar considerations may be employed in

addressing the problem of the perceived unity of time relating to the fragmentary model of temporal perception (Viera 2019; Viera 2022).

So far, this has been a very general discussion about mental representations within a teleosemantic framework and the accuracy with which we can take these to actually represent the world. Given the domain specificity as well as contingency on usefulness and evolutionary history that characterises the teleosemantic approach, it does not seem reasonable to attempt to draw inferences from the manifest image of time to the ontology of time. Nor, however, does the teleosemantic framework give us licence to talk in a simple way about illusions as many of those who want to approach ontology through the scientific image with only minimal criteria of empirical adequacy. To be very precise, we can rely on the manifest image to give us information about the world as it actually is, but only in a limited way. Thus, we cannot take this initial teleosemantic approach to entail a wider scepticism. Instead the task becomes to understand the content of our mental representations, in this case of time, by developing a plausible history for their selection which will reveal to us precisely what it is that they are tracking as well as why. If we accept Hoffman's game-theoretic debunking argument against the truthfulness of our mental representations, this is disastrous not only for the manifest-image approach, but also for the scientific-image approach to ontology. However, Martínez seems to show in a very convincing way that Hoffman's argument would fail in most realistic contexts.

While this is the case, we cannot with full generality accept Martínez's argument as necessarily applying to any and all mental representations of time. Mental representations of time, in particular, are difficult because they seem to be somehow different in kind to other types of mental representations such as mental representations of objects or entities. Even more so than space, some form of temporality seems to be necessarily present in all experience. Tyler Burge argues that temporal representation is constitutively necessary for perceptual experience in general (Burge 2010). I do not intend here to say that we ought to accept this argument, but rather to say that the exact relation between mental representations of time and other "garden-variety" mental representations is not at all clear. In short, we require a deeper understanding of the nature of mental representations of time to be able to say if and to what extent considerations regarding the truthfulness of mental representations in general from the teleosemantic debate can be applied to mental representations of time.

Section Three: The biological functions of mental representations of time

In addressing the question of the biological function of our mental representations of time, we have to ask also the question of what the evolutionary conditions would have been like that we evolved to perceive temporal order, duration, rhythms and so on in, and also what unique problems our capacities for perceiving temporality were solving. Now, these are incredibly complex and epistemically challenging questions to contend with. The kind of answer that would fully satisfy the question would have to involve an evolutionary narrative

with at least some level of detail, and such narratives are notoriously hard to justify epistemically.

An answer that would fully satisfy the question is also beyond the scope of this present investigation, and ultimately unnecessary to the matter at hand although it would be a valuable contribution to the field as a whole. However, there are two very interesting avenues which I will briefly explore before we reach a conclusion that will serve to illustrate the kind of considerations the teleosemantic perspective brings to the discussion. The first addresses the question of whether temporal perception in the terms in which it is largely discussed in contemporary literature is *genuinely sensory* or *direct perception*, and the second avenue involves a discussion surrounding an *exaggerated sense of simultaneity* which seems to characterise our temporal perception.

A genuine sense of time

In cognitive science, the underlying structure of the human mind is typically discussed in terms of what is called *cognitive architecture*, networks of modules responsible for different tasks such as *attention*, *language*, *memory*, *prediction* and so forth. The cognitive architecture of the human mind (and animal minds in general) as a whole is composed of three subsystems; the sensory input subsystem, the central processing subsystem and the output subsystem (Viera 2017, 71). There is a large debate in the philosophy of cognitive science regarding what it is that delineates the *sensory* subsystem of cognitive architecture from the *central processing* and the *output* subsystems, in particular as it relates to the perception of time (Gallistel 1996; Matthen 2015; Phillips 2010; Viera 2020; Zakay & Block 1997).

Furthermore, there is a question of what separates one sense from another within the sensory subsystem. In research both theoretical and empirical on temporal perception, the most commonly discussed modalities of temporal perception are those of *temporal order* and of *temporal duration*. Merging these two fields of inquiry, the question naturally presents itself whether we truly have *direct* perceptions of these temporal properties or whether we are somehow indirectly apprehending them. The former suggestion would imply that temporality is apprehended already at the sensory level of cognitive architecture (eg. Viera 2020), whereas the second suggestion implies that temporality is apprehended at the *central processing* level (eg. Matthen 2015; Phillips 2010). While the complexity of this question is further compounded by the previously discussed fragmentary nature of temporal perception, it may also in some sense untangle and thus provide at least a partial solution to this fragmentation problem.

The problem of ascertaining whether our perception of time is direct is a difficult question to even begin answering. If we consider as Viera does, that "in order for animals to be able to successfully navigate their environments they need to be able to coordinate their behaviours, at a variety of time scales, with the temporal structure of the events in their environment," (Viera 2017, 105) it might seem like this requires some sort of representation of temporal structure. However, those who defend that there is no genuine sense of time typically explain how we come to successfully coordinate our behaviours with the external world by reference

to external *cues*. That is, there are plenty of contextual cues regarding the temporal structures of the day, examples being for instance sunlight or a lack of sunlight with all the degrees of intensity in between, that would allow animals to synchronise their activity and behaviours in some sense with the temporal structure of the world without actually directly representing time. Empirically, this can and has been tested experimentally by attempting to separate animals (typically rats) from external cues and observing whether their different time-dependent behaviours persist (Holloway & Wansley 1973; Rossenwasser et al 1984; Bolles & Moot 1973). While there are some open questions regarding the empirical adequacy of such experiments for demonstrating the intended demonstrandum, it seems that we do have a genuine sense of time, at least under some descriptions, that cannot merely be understood as a byproduct of other senses (Gallistel 1996; Viera 2017).

On the point of the empirical adequacy of these experiments for showing what it is that they are typically held to show, it seems unclear whether what they are testing for could be said to be actual "representations" of time. The experiments outlined above can control quite adequately for external cues, but if we are coordinating our behaviour with the world based on internal cues - such as hunger, to give an example relevant to the cited experiments - can this be said to be a representation of time at all? We would still have to say something more about how mental representations of time actually emerge in our field of experience then, and the story might perhaps involve something regarding precisely these internal cues. That is, temporal experience in general seems to be framed by activity, by happenings, and happenings are not only external but also, importantly, internal. We could frame this statement as a counterfactual as well; if there were no happenings whatsoever, there would be no experience of time. Trivially, this seems true. Viera's argument seems to suggest some such connection between internal activity and representations of time, evidenced by his repeated insistence that "the circadian system, like clocks in general, **not only represent time but also participate in time**." (Viera 2017, emphasis mine)

An insistence that temporal experience is framed somehow by activity, especially internal activity, is very similar to the *qualitative multiplicity* of Bergson's conception of our experience of time. For Bergson, our experience of temporal duration had nothing to do with an external temporal reality at all, but rather with the evolution of life from interpenetrated moment to interpenetrated moment and the conscious experience of the bodily changes involved in that evolution. Interpenetration here is characterised by the qualitative multiplicity of different goings-on at the same time, overlapping and changing (Bergson 1910). The emphasis on consciousness of bodily changes giving rise to the phenomenology of time seems to echo William James' conception of the phenomenology of emotions as being simply the conscious experience of bodily changes. Such a similarity of characterisation also accounts well for the puzzling fact that our judgements of duration seem to be systematically affected by our various affective states (James 1890). There are many points at which Bergson's and James' conceptions of temporal experience converge, another being the notion of the specious present - the idea that the psychological present moment has a thickness - first presented by James. This concept is also implicit in Bergson's notion of *interpenetration*, which can be fruitfully analysed in terms of simultaneity.

Empirical results furthermore seem to confirm that the psychological present is indeed specious, we will return to this in a second. What Bergson's conception of temporal experience does not account for, however, is that it seems that even as we come to

represent time from particular activity, the representation then extends beyond the mere activity in which it is framed to - we want to say - represent external temporal structure. This is where Viera's grounding of these timekeeping mechanisms, not just in internal activity, but in internal activity adapted to regular external natural rhythms does explanatory work. Combining the two, we begin to form a plausible picture of not only how it is that we have an experience of time, but how it seems that it at least on some level represents external temporal structure.

Setting aside, for just a moment before moving on, this issue of internal activity and the explanatory gap between how biological timekeeping becomes representation, we can see that we have empirical reason to say that there is at least some form of timekeeping taking place within organisms in terms of different rhythms or cycles. Granting this, we may now be able to explicate temporal order judgements and temporal duration judgements in terms of reference to the timekeeping of various *external natural rhythms* that we are internally keeping track of. Such an account of a genuine sense of time falls neatly within the domain specificity we would expect to encounter in the teleosemantic framework, and it is also clearly grounded in the evolutionary advantage of having the ability to keep track of the important environmental determinant of the day and night cycle. By keeping track of the day and night cycle, activities such as gathering or hunting could presumably be structured in advantageous ways compared to those who could not keep track of day and night. This sense of time, would also presumably have conferred predictive powers on those who possessed it with regards to the movements of both potential predators and prey.

This rhythmicity of our sense of time is further corroborated by research on the perception of *time continuity* and the disruption thereof in patients with schizophrenia which also seems to suggest that our immediate perception is not actually continuous but instead rhythmic (Girsch 2023). The perception of *flow* - at least in terms of continuity - is exposed as an artifice of our temporal processing, as hypothesised by Ismael in her perspectival reconstruction of our subjective experience of time. This, as well as the domain specificity of our sense of time that emerge out of these evolutionary considerations surrounding our temporal perceptions immediately seem to be more or less devastating to the aforementioned presentist compatibilist ontologies of time. Similar considerations about the biological function and usefulness of our temporal perceptions can be leveraged to argue for what seems to be an exaggerated sense of simultaneity which further clarifies the origins of the intuitions which seem to drive presentists.

An exaggerated sense of simultaneity

Let's imagine ourselves as primates in a prehistoric jungle environment where upon hearing a sudden sound of rustling leaves a little distance behind us, we turn around and see something orange moving amidst the green. We need to know, is that moving thing large enough to be the cause of rustling leaves or are the two impressions - the orange moving amidst the green and the sound of rustling leaves - the same thing? It might be a strange flower swaying in the wind in the distance and some bird foraging through the underbrush or it might be a stalking tiger. If we were perfectly sensitive to simultaneity, there would be an asynchrony between the sound and the visual impression simply because light travels faster than sound and so the two impressions would not seem to belong to the same cause. This could be a fatal flaw. Such a narrative begins to explain why it is, as Viera says that "for a pair of stimuli to be perceived as simultaneous, they needn't be objectively simultaneous..." (Viera 2019, 17)

The scenario outlined above can be stated with much greater generality in simply saying that we experience the world through a great variety of modalities, including the sensory modalities of vision, audition, proprioception, as well as all the internal signals we get in terms of muscular tensions, pains, pleasures and so forth. These various constituents of our experience of being have to be integrated into a coherent timeline. Empirical research suggests that we accomplish this by perceiving synchrony even between asynchronous stimuli, by necessity, because as demonstrated by the example above many natural signals from the same sources may travel at different speeds (eg. light and sound) and so arrive asynchronously even though they at their causal origin may be simultaneous. Now, this does not merely seem to happen by sort of a low temporal resolution being that we can, in fact, distinguish between events as little as 20ms (even as low as 15.6ms if we are to believe the previously cited study on temporal asynchronies) apart but in some situations perceive as simultaneous events which are upwards of 250ms apart (Vroomens & Keetels 2010).

It has been suggested that the mechanisms that guide this ordering (or re-ordering) of the temporality of events integrated through different modalities of experience are actually considerations on the part of our cognitive processing for accuracy with regards to temporal-causal relations between these events (Hoerl et al 2020: Viera 2024). In Viera's words:

"The mechanisms are such that in normal conditions they order events in such a way that causes precede their effects and that therefore allows an individual organism to navigate and make sense of its environment." (Viera 2024, 10)

Ironically, thus, it seems like we cognitively warp incoming signals in the interest of accurately representing the temporal-causal order of the world. This can be made sense of in a teleosemantic framework through the kind of example of the tiger above. That is, organisms that could more accurately track potential predators - or more generally, temporal-causal order - across multiple sensory modalities were naturally selected for in our distant evolutionary history. One consequence of this with regards to our temporal perception is the speciousness of the present, as first hypothesised by William James (James 1890). We have *an exaggerated sense of simultaneity* that extends beyond mere considerations regarding temporal resolution.

Interestingly, this very form provides quite a precise fitting of the criteria laid out in Martínez' game-theoretic argument for truth-tracking mental representations. If we hear a sound, as in the above scenario, it could be a bird foraging through the underbrush or a tiger, and we rely on other contextual cues such as visual cues as we turn around to investigate, to determine the appropriate response. That is, we have multiple sensory modalities yielding information about a situation and potential responses in a way that is synergistic and so, per Martínez game-theoretic argument, truth-tracking will be the optimal perceptual strategy (Martínez 2019). Furthermore, it is the truth of temporal-causal ordering of events that is being tracked, not the timing of received stimuli *at a present moment*.

That is, we do not seem to be tracking *the present*, which further complicates the already contentious debate on how to define what it means for something to be present (eg. Correia & Rosenkranz 2015; Deasy 2017). Now, presentists might defend their view against this observation of the speciousness of the present which seems to blur strict distinctions between past, present and future by insisting that this is only a reflection of our cognitive processing and not of the actual ontology of time. However, there would be something vaguely circular in that unless we specify what other motivations we might have for the presentist ontology than the very manifest-image driven intuitions discussed in section one of this paper. It would seem strange to motivate an ontology by reference to the manifest image, then when confronted with the complication of defining the present moment within that manifest image, turn and say that ontology and manifest image are two separate things.

Some final remarks

We have begun to see in this last section how grounding mental representations of time in terms of biological function and evolutionary history seems to discredit both the manifest-image approach to ontology and the Parmenidian talk of illusions with regards to the properties of time as hypothesised in the second section. Furthermore, the image which emerges from this analysis seems to suggest strongly that something akin to Israel's perspectival reconstruction of the time of our experience from physical time might be the more auspicious way to think about the ontology of time. In particular, considerations relating to the evolutionary origins of our sense of time confirms the domain specificity and consequently also frame-dependence of temporal perception as well as exposing flow as an artifice of our temporal processing. Considerations regarding the mechanisms by which we temporally integrate stimuli from different sensory modalities into a coherent unified timeline also may be interpreted as accounting for a strong bias towards emphasis on simultaneity in our thinking about time. This nevertheless complicates the debate on what it means for something to be present which is crucial to any formulation of presentism, perhaps with the exception of presentist views which claim to be complete and coherent without any such. notion (Correia & Rosenkranz 2015).

All of what pertains to temporal perception in this analysis seems to hinge indelibly on an observation that both Israel and Viera emphasise in their works; that we are not merely observers of time, but embedded and embodied *participants* in time (Ismael 2016, 110; Viera 2016, 246; Viera 2020, 15-17). I want to propose at the very end of this paper, that this observation might be productive in thinking about what is missing so far from the story of the ontology of time developed in this paper, namely an elaboration on how our mental representations of time would help to explain our perception of the three properties of *passage*, *asymmetry* as well as *openness*.

As it pertains to passage, the story might begin even before thinking about this participatory nature simply in the observation laid out before that our experience of time seems to be framed in some sense by activity. That is, because inasmuch as we are experiencing anything at all there has to be content in the form of *happenings* or *activity* that we can experience, which furthermore might give rise to our sense of time in the way outlined above. Where the participatory nature of our relation to time may do further explanatory work

with regards to our experience of passage is in accounting for its directionality. This question of the directionality of our experience of passage, while maybe conceptually distinct from the other properties of asymmetry and openness, seems like they plausibly would have common origins. We cannot *viscerally* conceive of ourselves as observers standing somehow outside the universe with all its various peculiarities and contingencies looking in; this would be the perspective, as Ismael calls it, *sub species aeternitatis* or *from eternity*.

Rather, we are embedded and embodied participants in this temporally unfolding cosmic play with contingencies and peculiarities that are deeply interconnected with the world around us, particularly the natural, biological world. As such, the fact that time seems to pass from past to present to future two-fold asymmetrically, more than a reflection of some universal ontological fact about time, is a reflection of our own place and contingencies in that universe. We might see ourselves, with a little romanticism, as passengers on a temporal train of biological processes which makes it seem to us as though time is passing, but it is really the biological processes moving us along in time. This sense of passage and asymmetry is reiterated and emphasised through our deep interconnectedness with our social and natural environments, which like us are riddled with biological contingencies.

Certainly, such conjecture warrants further investigation and specification, in particular as it relates to the physical foundations for these vaguely characterised biological contingencies. It seems likely that, as has been suggested time and time again, the answers to this question would have at least something to do with the thermodynamic gradient described by the second law of thermodynamics (Ismael 2016; Rovelli 2015). Unfortunately, that part of the story will have to be investigated elsewhere.

Conclusion

In this paper, I have discussed the interpretation of scientific theories as it pertains to the ontology of time. In particular, I have laid out a broad argument rejecting both a manifest-image approach to ontology yielding presentists conceptions of time as well as a scientific-image approach to ontology which treats aspects of the manifest image of time as illusory. The former seems to fail, initially, due to the ontological costs incurred by attempting to maintain presentism through the challenge presented by modern physics in the relativity of simultaneity. The latter, on the other hand, fails to meet the strong criterion for empirical adequacy which demands, in essence, that it is not enough for our scientific theories to explain the empirical data of experiments, but that they must also account for the world as we experience it. In this latter consideration of empirical adequacy, however, we find a strategy for a strategy which unites the types of considerations both of these initial approaches are trying to account for in maintaining the primacy of the scientific-image but also giving a plausible explanation for the appearance of time in our subjective experience of it. Perspectival reconstructions of the properties of our subjective experience of time in the style of Ismael show great promise in playing this explanatory role which bridges the manifest image and the scientific image.

The main contribution of this paper is to begin to ground this perspectival approach in a coherent and well-founded understanding of our mental representations of time and their

origins. To do so, this paper has examined literature from the cognitive science and philosophy of temporal perception and experience through a teleosemantic lens. The results which organically emerge from such an investigation seem to strongly validate concerns with the presentist ontology and the ontological costs they pay to maintain this view in the light of modern physics. In particular, the domain specificity of our sense of time originating in the evolutionary advantage of being able to track the day and night cycle seems fatal, and on the back of that also the way this fact of temporal perception as fundamentally rhythmic exposes the perception of time as *flowing* as an artifice of temporal processing. This approach also opens up for drawing inferences regarding other intuitions - passage, asymmetry, openness and simultaneity - that presentists rely on to motivate their ontology that further seem to discredit these as emerging, as Ismael contends, from the frame-dependence of our temporal perception. Although it has been suggested here that we might find an explanatory approach to this in observing the participatory relation that we have with time, more needs to be said about this.

More trivially, this approach also dispels the eternalist ontology of time talk of our subjective experience of time as illusory as both inappropriate and unhelpful. While the account provided here is not complete, I believe it is sufficiently developed to motivate more consideration and attention to such explanatorily powerful approaches to thinking about time.

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