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Comment on Jenann Ismael's "The Open Universe: Totality, Self-reference and Time".

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This paper by Jenann Ismael is a brilliant contribution to our understanding of the openness of the future. But I think it is also relevant for a constellation of fundamental problems in the philosophy of mind, general epistemology, and more. Here I explain why I think this is the case, and what is the key a bit implicit idea of the paper that I find especially important.

The problem Ismael addresses is the source of the vivid sense of openness and indetermination of the future, that we all experience. She dismisses as relevant but insufficient two popular answers (which I myself have often evoked). The first is the epistemic dissymmetry—the fact that we know more about the past than the future. The epistemic dissymmetry is rooted in the fact that the macroscopic present contains more information about the past than about the future, because it contains memories and traces that have no future equivalent (Rovelli 2022). The second is the agencial dissymmetry—the fact that the entropy gradient permits processes that have the same macroscopic past and different futures. The agencial dissymmetry is rooted in the fact that branching macroscopic histories towards the future is possible because the information gained in the branching can be paid off by an increase of entropy (Loewer 2020, Rovelli 2021). In the light of the alternative Ismael offers, I find this dismissal convincing.

Ismael traces the breaking of basic physics' time-reversal symmetry to the thermodynamic entropy gradient. This is right and unavoidable: first, there is nothing else in the natural world that could do the job: second, it is largely sufficient. The general naturalistic framework she starts from is therefore solid. The problem she addresses is not why the macroscopic world behaves differently in the two directions of time: it is to understand how the markedly time-oriented macroscopic word in which we live, which allows traces, memories and macroscopic branching towards the future, leads us to the vivid sense of the openness of the future that we experience, and what we call the power of affecting it.

The brilliant intuition that grounds this paper offers a compelling solution to this problem. This is based on a series of observations. First, the sense of openness of the future concerns the way we represent the world: we represent it as open, namely capable of alternative futures, which may depend on us. Second, any representation of the world is embodied in a physical system—this is the key—and therefore is itself part of the world. Third, the representation of the world that we use in our daily life is embodied into our own physical nature and has evolved biologically as part of a natural survival mechanism that determines our actions on the basis of

information acquired about (the body itself and) the environment. Fourth, the actions determined in this manner—by us as natural physical systems—themselves affect the future. They are a relevant part of the chain of dynamical links that connect past and future happenings.

Two consequences derive from all this. First, the future of interest to an intelligent animal is not just what will happen, but rather the ensemble of hypothetical futures considered in the process of deliberating. For a strictly deterministic computer that plays chess and explores many alternative possible developments of the game before choosing its move, the future is, in a very literal sense, open: the meaning of this openness is precisely the existence (within the representation of the game that the computer holds and embodies) of the ensemble of possible future developments of the game itself, that the computer is exploring. Second—and this is the key point that Ismael emphasizes—the future is actually going to be partially determined exactly by the deliberations itself of the agent. Deliberation here is a physical process, but a physical process that admits a description as considering alternative futures, precisely because deliberation itself contributes in determining the future. Which is precisely what needed to be understood.

I find this understanding of the meaning of the openness of the future brilliant and convincing.

The technical key to this understanding is what Ismael calls interference. The world represented includes, and for this reason is affected by, the physical system holding the representation itself. Hence the knowledge of the future cannot be disentangled from self-knowledge and from the effect of this knowledge itself. The unfolding of the future and the representational activity are inextricable, creating an obstacle to the closure of predictability.

Isamael's contribution builds on a central idea: knowledge is embedded. This is the idea that I find of major importance. There is an apparent tension between the fact that the future is determined by physical evolution and yet is open to the deliberating agent. But this tension is only produced by the misleading idea that knowledge could be disembodied, living in a realm separated from reality. It dissolves by realizing that knowledge is embedded.

Ismael is aware and does not deny the fact that a specific process including deliberating agents can be described from the neutral perspective of an external observer that collects a lot of data and does not interfere. We have all reasons to believe that with sufficient data the deliberating process can in principle be accounted for as one of the solutions of the system's basic microscopical dynamics, which satisfies (deterministic or probabilistic) fundamental laws that do not distinguish past from future. In this sense, the future is no more open than the past, when a process is described from an exterior perspective, and its full microphysics is taken into account.

But in the more genuinely philosophical closure of the paper, Ismael also observes, in a typical Ismael's move, that this third person account can only be the knowledge of another physical holder of knowledge: therefore it is still an incomplete approximation (because it cuts the observer out). In this sense, the openness of the future is irreducible. Hence dismissing it as illusory, psychological, epistemic, or incomplete, is to miss the crucial point. The epistemic/ontological circle can be satisfactorily closed, not avoided. Not because of the trite observation that the world we know is the world we experience, but for the opposite reason: because of the much more acute observation that knowledge is embedded in the world, hence cannot be disentangled

from the events: interference is unavoidable and becomes flagrant precisely for the immediate future of the spacetime region where the knowledge happens to be located.

I think that the general realization that knowledge is necessarily embedded is deep, general, and profoundly consequential. We make many conceptual mistakes by forgetting this fact. The mistake is always to slide inadvertently into what becomes de facto a confusing dualism where knowledge, propositions, beliefs, language, and similar, live in an unphysical empyrean world, instead of being activities of natural beings (Price 2011). All this does not live in an unphysical empyrean world: in particular, knowledge exists because it is realized by physical configurations of brains, books, computers, memories, or other physical systems (Rovelli 2014). In general terms, information is physical (Adlam 2022).

In the specific instance addressed in this paper, the openness of the future is correctly identified not as an aspect captured by a disembodied knowledge outside the world, but as the proper characterization of the world known by an agent for which knowledge is evolutionarily meant to determine action, giving rise to Ismael's interference.

The reach of this fundamental idea—knowledge is embodied—is vast. Let me illustrate it by mentioning only a very simple example where the same idea resolves a persistent confusion. This regards the famous story of Mary, erroneously meant to prove the irreducibility of the qualia (Jackson 1982, 1983).

Mary is a natural scientist in the future, who studies and understands perfectly well how vision happens in the brain, but she has never actually seen the color red. One day she sees the color red and this experience—we reasonably expect—is genuinely new for her. The story is presented as an argument for the incompleteness of physics: Mary knew all the physics of vision, and yet did not know what it is like to see red. The error is to separate Mary's knowledge from Mary. Mary's knowledge is not disembodied: it is a process in Mary's brain. Once this is realized, it is obvious that there is no reason to deduce that her seeing red fails to be a physical fact: the reason is that her seeing red is simply a different process, in her brain, from the process that is her knowledge about vision.

To see the difference, consider a computer capable of analyzing integrated circuits and detecting failures. The computer undergoes different processes when it analyses failures, and when it itself fails. This does not show that failures are unphysical qualia. On the contrary: it shows that failures are aspects of the physical world. Equally real as (but distinct from) the physical processes that underpin the computer's competence about failures.

We have information about the world only via our knowledge of it, but our knowledge of it is itself a feature of the physical world. The circle closes, without dualism nor contradictions. The mistake is to take knowledge out of reality or to identify it with the reality that is known.

Realizing that knowledge is always embodied is crucial, in my opinion, to come out from a number of similar widespread conceptual confusions. Ismael has brilliantly realized that it is the key to understand the openness of the future.

I close this comment with a few marginal observations, indirectly related to the beautiful picture that Ismael presents in the paper.

- Ismael mentions the evolutionary account of the existence of deliberating agents only very briefly. It seems to me that the Darwinian insight plays a substantial

role in the story, for the following reason. Ismael's agents are assumed to be *interested* in determining the future. Why are they so, unless the future is open? It may appear that the openness of the future is assumed upfront as a grounding the concern of the agents, before justifying it via the interference due to their action. The objection is harmless, but requires, it seems to me, a closer use of Darwin's main insight: the ubiquity of the role of final causes in biology is accountable even in a deterministic world that admits a good description in terms of efficient causes only. Darwin's solution to this apparent paradox (rooted in Empedocles (Kingsley 2020)) is of course that the current teleological aspects of the structure and behaviour of the biological organisms can be viewed as the result of a past process that—precisely because of these aspects—has lead these organisms to exist as they are, in the present. This grand idea—the core of natural selection's logic—needs a time-oriented world to make sense. Hence it is itself rooted in the entropy gradient. In the presence of an entropy gradient, macroscopic structures, or structured processes, can form because they are sourced by free energy, namely past low entropy (in fact, they are *favoured*, because they allow faster dissipation (Jeffery 2019)): from the point of view of physics, the entirety of current macroscopic information, and in particular any present knowledge, is sourced by past low entropy (Rovelli 2019). This clarification shows that the picture is not vulnerable to the criticisms that the openness of the future is implicitly assumed in the account of the agent and her interest in juggling with deliberations. It is not: what is assumed is only the entropy gradient, and the Darwinian evolution that this gradient has fueled (Rovelli 2021). More specifically, the knowledge embodied into an organism is ultimately meaningful for the agent because it is rooted in an evolutionary purpose: it is ultimately motivated by its relation to agency, as Ismael's story illustrates. I believe that this (possibly implicit or indirect) "having purpose" is what originally distinguishes meaningful knowledge from pure physical correlation, as argued in (Rovelli 2018).

- A second observation regards the assumed epistemic asymmetry. The fact that the agent has abundant knowledge of the past at her disposal is a key ingredient of Ismael's account. She grounds this in the fact that there is past entropy. This is correct, but the way this happens is far from trivial. The fact that the present abounds with traces of the past (as opposite to traces being merely possible) depends on the fact that many systems are nearly isolated and on the fact that it takes a long time for many systems to reach thermal equilibrium (Reichenbach 1956). A detailed reconstruction of the link between the entropy gradient and abundance of traces of the past in the present is in (Rovelli, 2019), where a quantitative relation between the information stored in traces and the increase of entropy that sources it is given.
- In my earliest attempts to understand Ismael's paper, I overestimated the paradox presented in the opening. Isamael's interference concerns the effect of knowledge on the future, whether or not there is anything paradoxical in the situation. Hence the threat of paradoxical situations is not strictly necessary to explain this openness: what matters is the more general phenomenon of interference. Being a physicist, not a philosopher, I am more impressed by actual accounts of physical processes than a priori arguments. I tend to look for easy ways out of paradoxes. Programming a computer to reply to the question "Is 'no' the answer (to this question) about to be displayed in the output channel?" is the same as programming it to

print 'no' in the case it prints 'yes' and print 'yes' in the case it prints 'no'. These are plainly self-contradictory instructions and as such one can easily dismiss them as simply irrelevant. For a physicist reader like me, the importance of interference in accounting for the openness of the future is therefore not so much that it may lead to paradoxes; it is rather in the connection between knowledge and action, whether this leads to logical paradoxes or not. Realizing that knowledge is embodied, and that the openness of the future is related to the agency of the knower, is sufficient, seems to me, to account for the openness of the future. Self-reference plays a key role, because the knowledge in question includes knowledge about oneself, and so interference impedes complete knowledge acquisition, but the future would still look open even without paradoxes. I mention this because other readers might have gone down a similar path as mine, thus missing Ismael's central argument.

- A final comment concerns the relativity argument in the paper (if the knowledge available at a spacetime location P comes only from the past of P, then it is insufficient to predict what happens in the future of P, because in Minkowski space any point in the future of P is outside the domain of dependence of the past of P). Ismael uses this observation to argue that the existence of many future possibilities is not just an artefact of the macro-perspective. Rather, she argues, it is unavoidable in the perspective of any holder of information located in spacetime. This is correct, of course; this fact underscores the fact that the local present is necessarily incapable of holding sufficient information to predict the future with certainty. But there are so many additional concrete reasons for which the local present is incapable of holding sufficient information to predict the future, that to a physicist this observation sounds redundant. More to the point, many physicists see the apparent clash between determinism and the openness of the future not so much in terms of the knowledge available at some time, but rather in the apparently puzzling fact that in a deterministic theory the data (that can be gathered *much later*) about a given spacetime region are not compatible with different events in the future causal domain of dependence of that region. The observation about the information available at some time does not address *this* puzzle. Besides, if the solution of the puzzle was only in the insufficiency of the data available on a given spacetime point, the puzzle would re-emerge in a box with perfectly isolated walls, or in a suitably closed universe, where the domain of dependence of the past of P does include its future. There are stronger and more general reasons that make the future open, as this very paper itself beautifully shows.

Altogether, I find that Ismael has convincingly pinpointed the meaning and the source of the openness that we experience of our local future: the potential for negative interference prevents us from stabilizing our representation of the future. If we make the logic of representation explicit, we find self-reference. Not because we are outside nature and can change the natural course of events, but because we are part of it and our knowledge is an embodied part of it, interrupting *from the inside* our ability to know in advance. This account of the openness of the future is fully within the framework of Spinoza's naturalism (Spinoza, 1667). This, in my opinion, is naturalism at its very best.

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References

Adlam, Emily and Carlo Rovelli (2022) 'Information is Physical: Cross-Perspective Links in Relational Quantum Mechanics', *Philosophy of Physics* **1**. doi :10.31389pop.8arXiv:2203.13342

Jeffery, Kate, Robert Pollack and Carlo Rovelli (2019) 'On the statistical mechanics of life: Schrödinger revisited', *Entropy* **21**: 1211. arXiv:1908.08374.

Jackson, Frank (1986) 'What Mary Didn't Know', *Journal of Philosophy* **83**: 291–295.

Jackson, Frank (1982) 'Epiphenomenal Qualia', *Philosophical Quarterly* **32**: 127–136.

Kingsley, K Scarlett and Richard Parry (2020) 'Empedocles', in *The Stanford Encyclopedia of Philosophy*. Edward N Zalta, ed., https://plato.stanford.edu/archives/sum2020/entries/empedocles

Loewer, Barry (2020) 'The Consequence Argument Meets the Mentaculus' http://philsci-archive.pitt.edu/17328/.

Price, Huw (2011) *Naturalism Without Mirrors.* Oxford University Press.

Reichenbach, Hans (1956) *The Direction of Time.* Dover.

Rovelli, Carlo (2014) 'Where is knowledge in the physical world?' Unpublished notes.

Rovelli, Carlo (2018) 'Meaning and Intentionality = Information + Evolution', in Anthony Aguirre, Brendan Foster and Zeeya Merali, eds., *Wandering Towards a Goal:* 17-28. Springer.

Rovelli, Carlo (2019) 'Back to Reichenbach', https://nam12.safelinks.protection.outlook.com/?url=http%3A%2F%2Fphilsci-archive.pitt.edu%2F20148%2F&data=05%7C02%7Ctandfrevises%40com%7Ce7ff30b10a6a4fe535ba08ddbfcbab60%7Ca03a7f6cfbc84b5fb16bf634dbe1a862%7C0%7C0%7C638877603663061135%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=wMW9%2FGKlAckcF78M%2B7CafH8V5y1sXRvRU4NTeYbo1uY%3D&reserved=0.

Rovelli, Carlo (2022) 'Memory and Entropy', Entropy **24**: 1022.

Rovelli, Carlo (2021) 'Agency in Physics', in *Experience, abstraction and the scientific image of the world. Festschrift for Vincenzo Fano.* Franco Angeli editore. arXiv:2007.05300.

Spinoza, Baruch (1667) *The Ethics*. https://nam12.safelinks.protection.outlook.com/?url=https%3A%2F%2Fen.wikisource.org%2Fwiki%2FEthics_&data=05%7C02%7Ctandfrevises%40com%7Ce7ff30b10a6a4fe535ba08ddbfcbab60%7Ca03a7f6cfbc84b5fb16bf634dbe1a862%7C0%7C0%7C638877603663125927%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C%7C&sdata=HxJbyppuPBAhOqBvlqHq42khA6HbwOZiEXi1n5ciBvs%3D&reserved=0(Spinoza).