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Models, Brains, and Scientific Realism

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Abstract. Prediction Error Minimization theory (PEM) is one of the most promising attempts to model perception in current science of mind, and it has recently been advocated by some prominent philosophers as Andy Clark and Jakob Hohwy. Briefly, PEM maintains that "the brain is an organ that on average and over time continually minimizes the error between the sensory input it predicts on the basis of its model of the world and the actual sensory input" (Hohwy 2014, p. 2). An interesting debate has arisen with regard to which is the more adequate epistemological interpretation of PEM. Indeed, Hohwy maintains that given that PEM supports an inferential view of perception and cognition, PEM has to be considered as conveying an internalist epistemological perspective. Contrary to this view, Clark maintains that it would be incorrect to interpret in such a way the indirectness of the link between the world and our inner model of it, and that PEM may well be combined with an externalist epistemological perspective. The aim of this paper is to assess those two opposite interpretations of PEM. Moreover, it will be suggested that Hohwy's position may be considerably strengthened by adopting Carlo Cellucci's view on knowledge (2013).

Keywords: Prediction error minimization; Scientific realism; Analytic method; Perception; Epistemology; Knowledge; Infinitism; Naturalism; Heuristic view.

1 Introduction

Prediction Error Minimization theory (PEM) is one of the most promising attempts to model perception in current science of mind, and it has recently been advocated by some prominent philosophers as Andy Clark (2015; 2013a; 2013b) and Jakob Hohwy (2015; 2014; 2013).

Briefly, PEM maintains that "the brain is an organ that on average and over time continually minimizes the error between the sensory input it predicts on the basis of its model of the world and the actual sensory input" (Hohwy 2014, p. 2). Top down predictions and bottom-up sensory signals combine to produce "a kind of internal model of the source of the signals: the world hidden behind the veil of perception" (Clark 2013b, p. 185).

This approach moves along that line of research which looks at the brain as an 'inferential machine', initiated by Hermann von Helmholtz (1867) and continued, among others, by Richard Gregory (1980), Irvin Rock (1983), and Chris Frith (2007).

An interesting debate has recently arisen with regard to which is the most adequate epistemological interpretation of PEM. The debate focused mainly on how the relation between the inner model of the world produced by the brain and the external world should be interpreted.

Indeed, Hohwy (2014) maintains that given that PEM supports an inferential view of perception and cognition, PEM has to be considered as conveying an internalist epistemological perspective.[1] Thus, if we accept that PEM is a reliable description of the mind, we should coherently draw the conclusion that we cannot reach knowledge of the way the world *really* is, i.e. the way it is independently of our mind, because of the indirectness of the relation between our inner model of the world and the modeled world. For example, Hohwy states that "perceptual content is the predictions of the currently best hypothesis about the world" (Hohwy 2013, p. 48). If this is the case, we cannot be sure that our best hypothesis truly corresponds to the world, because the brain cannot "simultaneously access both the internal estimates and the true states of affairs in the world" (Hohwy 2014, p. 4). The brain can only have access to the two homogeneous things that it can compare, namely the predicted and the actual input: "there is no possibility of independent evidence, which would require us to crawl outside of our own brains" (Ibidem, p. 7). Following this line of reasoning, since there is in principle no possibility of comparing our representation of the world to the world itself, it seems fair to conclude that PEM should be considered at odds with Scientific Realism (SR), the mainstream metaphysical view in philosophy of science according to which our best scientific theories are true and we can safely infer their truth from their empirical success (Psillos 1999).[2]

Contrary to this view, Clark (2013a) maintains that it would be incorrect to interpret in such a way the indirectness of the link between the world which is modeled and our inner model of the world, because the relation between the world and perception is indeed a direct causal relation. Thus, even if our representations of the world are internal and may be in some sense deemed indirect, the causal connection between the world and our brains which produces such representations guarantees that what is perceived is not just "the brain's best hypothesis. Instead, what we perceive is the world" (Clark 2013a, p. 492). On Clark's view, "biological beings are able to establish a truly tight mind-world linkage […] by individual learning and evolutionary

[1] On the internalist and externalist conceptions of epistemic justification see Pappas 2014.

[2] It may be objected that the scientific realist view would be better described as follows: supposing that empirical successful theories are true (or approximately true) provides the best explanation for their empirical success. But this 'explanationist' formulation of scientific realism is almost equivalent to that given above. The fact is that scientific realists usually consider Inference to the Best Explanation a valid and truth-conducive inference. For example, Harman describes IBE as follows: "one infers, from the premise that a given hypothesis would provide a 'better' explanation for the evidence than would any other hypothesis, to the conclusion that the given hypothesis is true" (Harman 1965, p. 89). So, if truth is the best explanation of success, and IBE leads to truth, an IBE may be performed to conclude that it is true that a successful theory is true. So, we can infer the truth of a theory from its success. Thus, those two formulations of realism are almost equivalent. I wish to thank an anonymous reviewer for having raised this issue.

inheritance," and the inferential functioning of perception does not introduce any sort of "worrisome barrier between mind and world" (Clark 2013b, p. 199). Thus, according to Clark's interpretation, PEM should not be considered at odds with SR.

The aim of this paper is to assess those two opposite interpretations of PEM. In order to do this, PEM is sketched in section 2; then Hohwy's and Clark's interpretations of PEM are presented in section 3; in section 4 those interpretations are evaluated, and it is argued that Hohwy's interpretation is more adequate to account for some of the salient epistemological features of PEM. In section 5, some of the difficulties which still afflict Hohwy's position are underlined. Finally, in section 6, it is suggested that Hohwy's position can be considerably strengthened by relating it to Carlo Cellucci's view on knowledge and science (2013), which will be briefly described.

2 Prediction Error Minimization Theory

PEM is an ambitious theory, which tries to account for the activity of the brain in a unified way. Indeed, according to PEM "prediction error minimization is the only principle for the activity of the brain" (Hohwy 2014, p. 2). PEM basically sees the brain as an organ that continually minimizes the error between the predicted sensory input and the actual sensory input. This view frames the activity of the brain into a wider conception according to which any self-organizing system that is at equilibrium with its environment must minimize its tendency to disorder. In this perspective the characteristic feature of living beings is their attempt to (locally) reduce entropy (Friston 2010). According to this view "biological agents must actively resist a natural tendency to disorder," and "agents are essentially inference machines that model their sensorium to make predictions, which action then fulfils" (Friston 2011, p. 89).

Since "the sum of prediction error over time is also known as free-energy, PEM is also known as the free-energy principle" (Hohwy 2014, p. 2). According to Friston's view, the free-energy principle says that "biological organisms on average and over time act to minimize free energy," and that "brains are hypothesis-testing neural mechanisms, which sample the sensory input from the world to keep themselves within expected states:" as "the heart pumps blood, the brain minimizes free energy" (Hohwy 2015, p. 2). Thus, according to PEM "the brain's main job is to maintain the organism within a limited set of possible states" (Ibidem), and many, if not all, brain functions may be accounted for in terms of free-energy minimization.

In other words, in order to maximize the chance of survival of an organism, the brain has to keep the organism in the range of states which are already known (through evolution, development, and learning) to be compatible with the existence of that organism. In order to do this the brain has to minimize 'surprise', which is a concept from information theory, "defined as the negative log probability of a given state, such that the surprise of a state increases the more improbable it is to find the creature in that certain state" (Ibidem).

The fact is that to accomplish its task, the brain cannot access directly the state of the world in which the organism is embedded. The brain has to create a model of the world, and try to anticipate and predict the incoming states of the world. The brain

"must harbor and finesse a model of itself in the environment, against which it can assess the surprise of its current sensory input," because the brain has access only to two quantities, "which it can compare: on the one hand the predicted sensory input, and on the other the actual sensory input. If these match, then the model is a good one" (Ibidem, p. 3). At any stage of this process, the brain deals only with its own 'reconstruction' of what is going on both in the world (*exteroceptive* states) and in the organism (*interoceptive* states). Indeed, even the actual sensory input arriving at the brain cannot be conceived as a direct transferring of a bit of information from the world to the brain. At any stage, there is an 'inferential step' through which the brain models the environment, the organism, and the course of actions. The brain makes hypotheses based on previous knowledge to form a coherent representation of present and future states, but it is also ready to modify or update such hypotheses on the base of the actual input. At any given time t we cannot have the certainty that our hypotheses will not be modified at time $t+1$.

It has to be stressed that PEM is a new way of accounting for perception, which contrasts the traditional "'passive accumulation' model of the perceptual process", which "depict[s] perception as a cumulative process of 'bottom-up' feature detection" (Clark 2013a, p. 470-471). According to PEM the role of the *predictions* made by the brain is essential. It is exactly this feature of the brain functioning which accounts for the ability of the brain to relate to the world without having any direct access to it. The brain is seen as a hypotheses producer and verifier, a sort of 'predictive device' which continuously refines (or changes) its predictions.

The idea of the brain as an 'inference machine' was firstly articulated by von Helmholtz (1867). PEM follows this line of reasoning and models brain activity in terms of statistical inferences over perceptual hypotheses. According to Hohwy, PEM is "inference to the best explanation, cast in […] Bayesian terms" (Hohwy 2014, p. 5). The basic idea is that since the brain continuously checks how good its model of the world is by confronting its model with the actual sensory input, its activity may be described in Bayesian terms. Indeed, in a nutshell, Bayes' rule tells us to update the probability of a hypothesis h, given some evidence e, by considering the product of the likelihood, i.e. the probability of the evidence given the hypothesis $P(e|h)$, and the prior probability of the hypothesis $P(h)$. The resulting probability of the hypothesis is the posterior probability of such hypothesis:

$$P(h|e) = P(e|h)P(h)/P(e) \quad (1)$$

Thus, 'minimize the surprise' for the brain means to maximize the probability of its hypothesis: "if the prediction error is minimized then the likelihood has been maximized, because a better fit between the hypothesis and the evidence has been created. This in turn will increase the posterior probability, $P(h|e)$, of the hypothesis" (Hohwy 2013, p. 46). According to PEM, the probability of a hypothesis h is continuously updated and refined, using the posterior probability of h at time t_n as the prior probability of h in the following inferential step, i.e. at time t_{n+1}: a "neat explanatory circle then seems to transpire: top-down priors guide perceptual inference, and perceptual inference shapes the priors" (Ibidem). The brain tries "to create a closer fit between

the predictions [...] and the actual sensory input. This corresponds to being less surprised by the evidence given through the senses" (Ibidem).

We can now recapitulate the three main tenets of PEM: 1) in order to account for perception, we should adopt an *inferential* conception of the mind; 2) the division between inner and outer is strict ('inferential *seclusion*' of the mind, see Hohwy 2014); 3) perception, attention, and action have to be conceived as *statistical* inferences.

3 Clark's vs. Hohwy's Interpretation of PEM

PEM is a stimulating and controversial proposal. There are many objections that can be (and have been) raised against this approach.[3] In what follows we will leave aside those objections. We will focus just on Clark's and Hohwy's interpretations of PEM, and on the issue of assessing which one should be preferred in the lights of the epistemological implications of adopting PEM as a theory of the mind.

3.1 The Epistemological Implications of PEM

In order to carry out our inquiry, we will take into considerations (and try to answer) two questions, the first one which can be dubbed 'metaphysical', the second one which can be dubbed 'epistemological'. The first question is: Is PEM compatible with SR? The second question is: Which epistemological position fits better PEM?

For our purposes, we can here define SR as the metaphysical view according to which our best scientific theories are true, in the sense that they tell us precisely what exists in the world. For example, Ellis states that SR can be described as "a two-stage argument from the empirical success of science, to the truth, or approximate truth, of its dominant theories, to the reality of the things and processes that these theories appear to describe" (Ellis 2005, p. 372). Truth is normally intended by scientific realists as *correspondence*.[4] For example, Sankey states that: "correspondence theories which treat truth as a relation between language and reality are the only theories of truth compatible with realism" (Sankey 2008, p. 17). With regard to epistemology, we can here intend it in the broad sense of the philosophical inquiry on what makes some of our beliefs *knowledge*, i.e. justified, or true, or grounded.

3.2 Hohwy's Interpretation of PEM

According to Hohwy, PEM entails an internalist epistemological perspective. Internalism may be intended here in a broad sense as the epistemological view according to which what ultimately justifies any belief is some mental state of the epis-

[3] Cf. e.g. Rescorla 2015.

[4] Many positions have been elaborated on the issue of truth, and even if truth as correspondence seems to be the most widespread view among scientific realists, not every scientific realist adopts such view. For simplicity here we will focus on correspondence.

temic agent holding that belief (Pappas 2014).[5] Since according to PEM the totality of the brain activity can be accounted for in terms of Bayesian inferences, and since in this line of reasoning knowledge cannot but be conceived as related to the brain activity, the inferential nature of such activity is related to the way in which our knowledge can be considered justified. In other words, since the brain has no direct access to the world, and knowledge is produced by the brain, knowledge cannot but be ultimately justified by the brain's activity itself. According to PEM "the brain is isolated behind the veil of sensory input" (Hohwy 2013, p. 238), and the human mind "appears very indirectly related to the world" (Ibidem, p. 90). Indeed, "mental states do not extend into the environment, and the involvement of the body and of action in cognition can be described in wholly neuronal, internal, inferential terms" (Hohwy 2014, p. 24).

Briefly, Hohwy's argument runs as follows: we have to adopt an inferential conception of the mind, because otherwise we are not able to account for some very well known phenomena (e.g. binocular rivalry, see Hohwy 2013, chap. 1). If we adopt an inferential conception of the mind, we cannot avoid to adopt an internalist epistemological perspective, since we cannot eliminate the separateness that characterizes an inferential conception of the mind. Thus, we have to accept that we are in principle not able to avoid some radical skeptical challenge, such as Cartesian skepticism. This is the epistemological price to pay if we want to adopt PEM as a theory of the mind. Indeed, "PEM must necessarily rely on internal representations of hidden causes in the world (including the body itself) in order to predict the sensory input that they give rise to" (Hohwy 2014, p. 17).

As we have already seen, at any given time t we cannot have the certainty that our hypotheses will not be modified at time t+1. Moreover, it has to be stressed that even if the predicted hypothesis and the actual sensory input match, and even if this matching remains stable for a certain amount of time, this does not guarantee us that our hypothesis *truly* corresponds to the state of the world, and so that such hypothesis is true in a strong metaphysical sense. Indeed it could be possible that our sensory system and our internal model of the world both fail to detect and model some features of the world or some modifications of some detected features. Think to a modification that cannot be detected, because its magnitude is below the detectability threshold of our sensory system. In this case, the sensory input and the model would continue to match, while that modification would have nevertheless occurred. The fact is that in order to modify our hypothesis, we need to have some 'clues' that such hypothesis is incorrect. But it is not always easy to have an indication of the inadequacy of some of

[5] It may be objected that internalism is better described as the idea that justification requires awareness of the process that ultimately justifies a belief. But, in this context, such definition of internalism is equivalent to that given above. Indeed, according to PEM, what we can be really aware of are ultimately nothing but some mental states. So, even if the process that justifies a belief is an 'external' one, we will not be directly aware of such process. We will only be aware of the internal model of such process. So, if internalism is the view according to which justification requires awareness, and according to PEM we can be aware only of some mental states, then in this context internalism may be fairly defined as the view according to which a belief is justified by some mental state of the epistemic agent holding that belief. I wish to thank an anonymous reviewer for having raised this issue.

our hypothesis or recognize to which hypothesis a specific clue refers to. Indeed, perception solves "an *underdetermination problem*. The perceptual system estimates environmental conditions," and it "does so based upon *proximal stimulations* of sensory organs," but the proximal stimulations "underdetermine their environmental causes" (Rescorla 2015, p. 694). Thus, since the environmental causes are underdetermined, also the clues of inadequacy of our hypotheses, which are a subset of the environmental causes, are underdetermined.

The inferential nature of the mind, which makes us constantly prone to error and deception, but which, at the same time, ensures us the only possible way to effectively acting in the world, "should make us resist conceptions" according to which "the mind is in some fundamental way open or porous to the world" (Hohwy 2014, p. 1). If the mind were open to the world, the predictive machinery described by PEM would not be necessary. Indeed, PEM puts "the focus on the evidentiary boundary and the way it forces a clear distinction between internal states, where the prediction error minimization occurs, and hidden causes on the other side of the boundary, which must be inferred" (Ibidem, p. 7).

Moreover, PEM treats the inferential machinery of the mind in Bayesian terms. This means that the inferences that PEM deals with are *statistical* in character. But "any account that ties perceptual content to a statistical model within an evidentiary boundary will wedge apart the statistical model and the hidden causes it models" (Ibidem, p. 9). On this point Hohwy is very clear and states that:

> having access to rain samples and the mean of the rainfall is a very different thing from having access to the actual rainfall, even if the mean carries information about the rain. An explanation of this difference in the case of perceptual inference cannot soften the characterization of the hidden causes so they come to appear somehow unhidden.[6]

Thus, according to Hohwy, the three main tenets of PEM are deeply related: the "seclusion stems from the inferential component such that the upshot of the subpersonal processes is a probabilistically favoured statistical model" (Ibidem), and they jointly entail an internalist epistemological perspective.

This seems to mean that according to Hohwy's interpretation PEM is not compatible with SR. If scientific realists claim that the aim of science is truth, and usually adopt a non-epistemic conception of truth, according to which whether something is true does not depend on our mind, but depends exclusively on the way the world is,[7] this means that PEM cannot satisfy such a realist requirement. Indeed, according to PEM what we perceive or think cannot but ultimately rest on and be justified by our brain activity, and we cannot have any access to the way the world is independent from such kind of activity. As Hohwy states, we cannot "crawl outside of our own brains" (Ibidem, p. 7) in order to compare our model of the world to the world itself.

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[6] Hohwy 2014, p. 9.

[7] Cf. e.g. Sankey 2008, p. 112: "The realist conception of truth is a non-epistemic conception of truth, which enforces a sharp divide between truth and rational justification."

Thus, if we adopt PEM, we will never be able to assess whether a statement is true because it exactly corresponds to the way the world is independently from us. This is due to the fact that our mind works inferentially and the only things it can compare are homogeneous neuronal inputs. So, even if the realist conception of truth were the right one, if we adopt PEM we will be unable to judge whether we reached the truth, since we will be unable to claim that something is completely independent from our mind. But this contrasts with the fact that the great majority of the scientific realists refutes epistemic skepticism: realists claim that we *do* reach true theories and we *do* know that we have reached the truth. For example, Sankey states that the realist position is "a position of epistemic optimism, which holds against the sceptic that humans are able to acquire knowledge of the world" (Sankey 2008, 3). Since knowledge is usually intended by realists as related to the concept of truth,[8] it becomes clear that in this line of reasoning if we adopt PEM, we are unable to claim to have genuine knowledge. Since, on the contrary, PEM's supporters, and Hohwy among them, claim that we *do* have knowledge exactly through prediction error minimization, we have to conclude that PEM and SR are not compatible, at least because they rest on a different conception of knowledge.[9]

3.3 Clark's Interpretation of PEM

According to Clark's interpretation of PEM, it would be incorrect to interpret in the way suggested by Hohwy the indirectness of the link between the world which is modeled and our inner model of the world.

Indeed, Clark admits that following PEM our representations of the world have to be described as internal and may be in some sense deemed 'indirect': PEM "is a challenging vision, as it suggests that our expectations are in some important sense the primary source of all the contents of our perceptions" (Clark 2013b, p. 199). Nonetheless, Clark maintains that "we may still reject the bald claim that 'what we perceive is the brain's best hypothesis'," since "it remains correct to say that what we perceive is not some internal representation or hypothesis but (precisely) the world" (Ibidem).

We can affirm that we perceive 'precisely the world' because of "the brain's ability to latch on to how the world is" (Ibidem). If the brains were not able to adequately 'reflect' how the world really is, we would had not been able to survive. But we survived, so we can affirm that our representations are reliable. Indeed, "it is precisely by such means that biological beings are able to establish a truly tight mind-world linkage. Brains" can be construed as "statistical sponges structured [...] by individual

[8] Cf. e.g. Ibidem, p. 14, fn. 2: "the traditional justified true belief account of knowledge is a minimal condition for a realist conception of knowledge."

[9] It may be objected that if someone does not rely on the notion of truth, she is not speaking of knowledge properly, since knowledge requires truth. Thus, it would be nonsense to speak of knowledge without referring to truth. But that knowledge necessarily requires truth is exactly what has been disputed by some of those authors who are unsatisfied with the traditional accounts of knowledge (see below, sec. 6). Thus, if in their conception of knowledge does not figure any reference to the concept of truth, it seems unfair to conclude that they are not *really* speaking of 'knowledge', for the only reason that we *assume* that knowledge requires truth.

learning and evolutionary inheritance so as to reflect and register relevant aspects of the causal structure of the world itself" (Ibidem). The idea behind such view is that in order to survive the organisms have to produce *true* representations of the world, i.e. representations that 'correspond' to the way the world really is. Thus, it is the causal connection between the world and our brains that produces our internal representations of the world and it is our success in the survival that guarantees that those representations are adequate, i.e. that what is perceived is not just the brain's best hypothesis, but the actual world.

Clark seems to explicitly commit himself to the traditional correspondence view of truth. For example, he agrees with Karl Friston that the "hierarchical structure of the real world literally comes to be 'reflected' by the hierarchical architectures trying to minimize prediction error" (Friston 2002, p. 237, quoted in Clark 2013a, p. 492). PEM "delivers a genuine form [...] of 'openness to the world'," and thus might "be cast as a representationalist version of 'direct perception'" (Clark 2013a, p. 492).

According to Clark, even if PEM adopts an inferential conception of the mind that makes our perception not as direct as the supporters of the direct perception view maintain,[10] nevertheless the close causal relation that obtains between the world and the brain, and the evolutionary and developmental selective processes that shape our priors, consent us to define our perception at least as 'not-indirect'. Clark states that: "If a label is required, it has been suggested" that the metaphysical perspective implied by PEM "may most safely be dubbed 'not-indirect perception'" (Ibidem, p. 493). In this perspective the indirectness of the inferential nature of our mind is tempered by the 'directness' of the externalist justification of our hypotheses somehow measured in terms of success in dealing with the world.

Let's recapitulate the elements of Clark's interpretation of PEM analysed so far which suggest that Clark's view is very close to SR. Clark seems to adopt a correspondence view of truth, which is one of the most widely adopted conception of truth among scientific realists (see above, sec. 3.1). He also claims that we perceive the world as it really is and not just a hypothesis regarding the world. So he seems to subscribe to a non-epistemic view of truth, which is the view of truth usually adopted by scientific realists (see above, sec. 3.2). Moreover, Clark seems to justify his claim that we perceive the world as it really is in a way which is analogous to the way in which scientific realists justify their claim that our best theories are true, i.e. developing a 'success argument'. Since our hypotheses about the world are successful in making us surviving, the only plausible explanation for their success is that they are true, i.e. that they are able to reflect how the world really is. This kind of argument is clearly a variant of the 'No Miracle Argument', the argument traditionally used by the realists to support SR, according to which the only plausible explanation for the success of our best scientific theories is that they are true (see e.g. Psillos 1999).

It is worth noticing that in clarifying his view on PEM, Clark explicitly refers to Michael Rescorla's interpretation of the Bayesian approaches to the mind, which include PEM (2015). Rescorla's interpretation of the Bayesian approaches to the mind

[10] On the direct view of perception see Soldati 2012. See also Pappas 2014.

is straightforward realist. Rescorla explicitly claims to support a scientific realist perspective and advocates that success is a key element in epistemic justification:

> I assume a broadly scientific realist perspective: explanatory success is a *prima facie* guide to truth. From a scientific realist perspective, the explanatory success of Bayesian perceptual psychology provides *prima facie* reason to attribute representational content to perceptual states.[11]

According to Rescorla the Bayesian approaches describe the way in which we estimate the world, and to do this they assume, more or less implicitly, a realist and externalist epistemological point of view, i.e. an epistemological view according to which what ultimately justifies any belief is something other than some mental state:

> Accuracy of the percept depends upon accuracy of the individual estimates. By describing perceptual inference in this way, we type-identify perceptual states truth-conditionally. We individuate perceptual states partly through environmental conditions that must obtain for the states to be accurate.[12]

So Clark's interpretation seems to be committed to externalism. Externalism is considered to be the more adequate epistemological position to take in order to support a realist perspective, since it claims that a belief, which is 'internal', is justified by some 'external' element, which is independent from the subject.

For all these reasons, it seems fair to say that according to Clark's interpretation PEM should not be considered at odds with SR. Indeed, according to Clark, PEM gives us knowledge of the way the world really is, i.e. PEM gives us an account of our mind as able to produce *true* representations of world. Since the majority of the scientific realists adopts a conception of knowledge as justified true belief, or some variant of it, and Clark's interpretation of PEM claims that we do have knowledge and that knowledge is related to the truth, in this perspective PEM is compatible with SR.

4 Assessing Clark's and Hohwy's Interpretations of PEM

In order to assess Clark's and Hohwy's interpretations of PEM we will proceed as follows: we will derive some of the most relevant epistemological consequences from the three main tenets of PEM (sec. 4.1). It is important to stress that both Clark and Hohwy mostly agree on such tenets, so it seems fair to start from them. Then we will try to determine which epistemological position is more compatible with PEM (sec. 4.2). Finally, we will try to show whether such epistemological position fits better Clark's or Hohwy's interpretation of PEM (sec. 4.3).

[11] Rescorla 2015, p. 705.
[12] Ibidem, p. 702.

4.1 The Epistemological Implications of the Three Main Tenets of PEM

In what follows it will be argued that if we take into account all the three tenets of PEM described above (sec. 2), the more adequate epistemological position for PEM's supporters to take is infinitism. Let's see why. Take the first tenet: 'PEM adopts an *inferential* conception of the mind'. It is especially this inferential characterization of the mind that should lead PEM's supporters to prefer infinitism in epistemology.

This point can be clarified in two ways: by underlining the similarities between the challenges that both an inferential conception of the mind and infinitism have to face (we will take this way in this section); and by showing the incompatibility between what is implied by the three main tenets of PEM and what is implied by the other main epistemological positions (we will take this way in the next section).

With regard to the similarities between an inferential conception of the mind and infinitism, the most striking one is that they have both to face a similar skeptical regress problem. Indeed, as the skeptics deny that is possible to account for knowledge without ending in a regress, so "it seems we cannot explain perceptual inference at all, without ending in circularity or regress" (Hohwy 2013, p. 42). The problem is how to justify the claim that our perception is reliable, i.e. that we perform the correct inferences. As Hohwy states, if perception is an inferential process:

> either the inferential process is constrained or not. If it is not constrained, then there is no robust difference between right and wrong inference, and inference [...] remains unexplained. If it is constrained then the source of the constraints either is already engaged in correct perceptual inference or it isn't. If it is so engaged, then positing the source of the constraints as the explanation of perceptual inference [...] is circular or leads to a regress. If it is not so engaged, then again there is no difference between right and wrong inference.[13]

As in epistemology the main issue is how to connect justification to truth in order to secure knowledge from the skeptical challenge, so for an inferential conception of the mind the main issue is justify the claim that perception is reliable in representing the world even if the mind has no direct access to the world.

The problem is that according to the inferential conception of the mind, the mind can only make inferences in order to represent the world hidden behind 'the veil of perception': the mind cannot go out from what can be called the 'inferential circle'. Thus, according to this view of the mind, our relation to the world is not only possible but actual, but the relation between our representation of the world and the world itself can only be thought in terms of a potentially infinite process, since we can never 'crawl outside of our own brains' and compare our representation and the world in order to definitely state that a relation of correspondence obtains. This makes clear the similarity between such a view of the mind and infinitism. Indeed, infinitism denies the skeptical claim that we cannot have knowledge because we cannot justify our knowledge. According to infinitism knowledge is not only possible but actual, but the

[13] Hohwy 2013, p. 42.

justification of our beliefs has to be thought as a potentially infinite process, since we cannot go through the complete chains of reasons that justify our beliefs.

Thus, since PEM adopts an inferential conception of the mind, and such a conception of the mind represents cognition as a potentially unterminated inferential process, if a supporter of PEM tries to determine which epistemological conception fits better her favourite account of the mind, she would probably adopt infinitism.

4.2 Which Epistemological Position is more Compatible with PEM?

To better see the point made in the previous section, let's now turn to the second way of making clear why an inferential conception of the mind leads to infinitism. In order to show the difficulties of making compatible what is implied by the three main tenets of PEM and what is implied by the other main epistemological positions, we have to briefly consider the main alternatives to infinitism that are on the market.

Indeed, it has to be noticed here that both Clark and Hohwy seem to maintain a traditional attitude toward knowledge and justification, in the very minimal sense that they both refute skepticism, and thus have to defend the claims that we do have knowledge, and that knowledge is somehow related to the truth.

In a nutshell, skepticism claims that if we try to justify our beliefs we cannot but end in circularity, *petitio principii*, or infinite regress.[14] According to the skeptics, in any of those three cases we are unable to justify our beliefs. Since in all those three cases our beliefs would be unjustified, and being justified is a minimum (even if insufficient) requisite for a belief to be genuine knowledge, we should conclude that we cannot have knowledge.

On the contrary, those who refute skepticism maintain that knowledge is possible. In order to advocate for this position, epistemologists have negated that one or another of the above reported cases really prevent us to reach genuine knowledge, as skeptics maintain. Thus, traditionally the non-skeptical epistemological options are: *coherentism*, according to which circular patterns of justifications can enable knowledge; *finitism*, according to which finite patterns of justifications can enable knowledge; *infinitism*, according to which infinite patterns of justifications can enable knowledge (Turri and Klein 2014).

Let's briefly analyse them in order to see which one fits better the three main tenets of PEM. Consider coherentism first. The main problem with coherentism is that if we want to defend the claim that we have genuine knowledge and we consider knowledge as related to the truth, coherentism seems to be too permissive. As Klein and Warfield state: "coherence, *per se*, is not truth conducive" (Klein and Warfield 1994, p. 129). The fact is that not only true sets of propositions may be coherent. For example, Cellucci states that "the propositions of a fable form a systematically coherent whole, though being a fiction" (Cellucci 2014, p. 525). Moreover, if we allow repeating chains of reasons[15] in order to justify a given belief, we do not really *en-*

[14] See e.g. Floridi 1993.

[15] We refer here for simplicity to 'reasons' even if not every epistemological view requires 'reasons' in order to consider a belief to be justified. See Turri and Klein 2014.

hance the justification of that belief, because that very belief would figure in its own justification. Finally, consider coherentism in relation to the first main tenet of PEM, i.e. the inferential nature of the mind. The problem is that the coherence among our inferences would not suffice to assess whether they give us genuine knowledge, since those inferences may be internally coherent, but nevertheless be unreliable in representing the external world, which is the main issue at stake in this context[16].

Thus, it seems fair enough to say that if we adopt PEM we are left with two main epistemological options, i.e. finitism and infinitism. In order to determine which one fits better PEM, take now into consideration the second main tenet of PEM, i.e. the division between inner and outer is strict (seclusion). Consider finitism, i.e. the position according to which finite patterns of reasons can enable knowledge. To see the difficulty of combining finitism and PEM, recall that if we adopt PEM we subscribe to an inferential conception of the mind and that according to PEM the mind cannot have any direct access to the world. Since finitism implies that we should arrive at some *basic knowledge* which does not require justification at its turn, the question arises: How can the inferential circle be 'stopped'? In other words, how could we justify the claim that we have reached the end of an inferential chain where our representation of the world truly corresponds to the world, given the inferential functioning of our mind and that our mind cannot directly access the world?

Consider this issue in Bayesian terms. Since PEM models our mind as a 'Bayesian machine', in this framework the finitist's claim that we arrive at some basic knowledge which does not require to be justified at its turn would amount to know the exact distribution of probability of any possible case without the need of making any new hypothesis in that model. But, as Hohwy clearly states, the brain:

> cannot assess surprise directly from the sensory input because that would require knowing the relevant probability distribution as such. To do this it would need to, impossibly, average over *an infinite* number of copies of itself in all sorts of possible states in order to figure how much of a surprise a given sensory input might be.[17]

Thus, in order to claim to possess some basic knowledge, we should be able to actually go through an infinite inferential performance and assign the exact probability to any possible state of the world. Let's put aside, for the sake of the argument, the philosophical difficulty of making sense of the claim that we can know the exact dis-

[16] It may be objected that this is an unfair description of coherentism, since many coherentists usually require in their theories some additional constraint on coherence to account for the truth-conduciveness of coherence. But, as Olsson has clearly underlined, "these theories may be more fruitfully classified as versions of *weak foundationalism* than as pure coherence theories. An advocate of weak foundationalism typically holds that while coherence is incapable of justifying beliefs from scratch, it can provide justification for beliefs that already have some initial [...] degree of warrant" (Olsson 2014, Sect. 1). This means that for our purposes, weak foundationalism, as well as foundationalism, can be fairly considered a kind of *finitism*, since it has to be based on some kind of beliefs that have some basic form of justification, which cannot be accounted for in terms of coherence.

[17] Hohwy 2015, p. 3.

tribution of probability of all the possible states of the world. The main problem is that finitism has in common with skepticism the idea that it is impossible to actually perform infinite mental operations, given that humans are limited beings. It is exactly for this reason, i.e. to avoid infinite regress, that finitism claims that knowledge to be possible must rest on some basic knowledge. But if it is impossible for us to perform infinite operations, then in a Bayesian perspective we are not able to reach the basic knowledge required by finitism to claim to have genuine knowledge. Thus, we should conclude that we do not have knowledge. But PEM's supporters normally claim that we do have knowledge. So there is a clear tension between finitism and PEM.

Let's now consider the last main tenet of PEM: perceptual inferences have to be conceived as statistical inferences. PEM models perceptual inferences using the 'Bayesian decision theory' framework, which models decision-making under *uncertainty*. This choice is due to the fact that according to PEM it is impossible to know the exact distribution of probability of all the possible states of the world. If it were possible to know such exact distribution of probability, there would be no need to continuously update our hypotheses about those states. Rescorla states that:

> The core notion underlying Bayesian decision theory is *subjective probability*. Subjective probabilities reflect psychological facets of the individual or her subsystems, rather than 'objective' features of reality. To formalize probabilities, we introduce a *hypothesis space H* containing various hypotheses *h* [...]. A probability function *p* maps each hypothesis *h* to a real number *p*(*h*), reflecting the agent's subjective probabilities.[18]

This should make clear the divergence between PEM and finitism. When we model perception in Bayesian terms, we construe the hypothesis space's elements as perceptual *estimates*. The goal of PEM "is to describe a statistical inference over *estimates about the perceiver's environment*" (Rescorla 2015, p. 712). It is not easy to see how it could be defended the claim that some 'estimates' are such that they do not need any further justification, and so may be considered as basic knowledge.[19]

4.2.1 *A Naturalist Option for Finitism*

Let's briefly consider a 'naturalist' proposal which could be made in order to make finitism, PEM and SR compatible. It could be argued that, since priors are given by natural selection, the inferential circle is 'broken'. The world instills in us the correct priors, which are not inferential at their turn and are justified by the world itself, and this fact ends the regress.

The problem is that this *externalist* proposal, which is in line with Clark's approach, just begs the question on what justifies our beliefs. Indeed natural selection deals only with fitness, i.e. survival, and not directly with truth. If we try to connect

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[18] Rescorla 2015, p. 696.

[19] Cf. e.g. Hohwy 2014, pp. 2-5: "just as there is a schism between a statistical model and the modeled cause in statistical inference, there is a schism between the prediction-generating models of the brain and the modeled states of affairs in the world."

survival and truth we should adopt a sort of *reliabilism* and maintain an argument that could be roughly described as follows: since some beliefs have proved to be successful, they have been selected; selected beliefs are then reliable; reliability is a guide to the truth; natural selection gives us true beliefs. This is a very debated and controversial issue.[20] But reliabilism seems nevertheless to be inadequate to secure a realist *finitist* perspective mainly for two reasons: 1) reliabilism does not completely fill the gap between justification and truth; 2) reliabilism seems to many authors insufficient to account for *human* knowledge.

With regard to 1), it will suffice to recall the words of a realist champion as Psillos:

> In my (1999) [...] I argued that NMA proceeds within a broad naturalistic framework in which the charge of circularity loses its bite because what is sought is not justification of inferential methods [...] but their explanation and defence (in the epistemological externalist sense) [...]. I now think, however, that [...] [what] we should be after are *reasons to believe* that IBE is reliable (and not just an assertion to the effect that *if* indeed IBE is reliable, and we are externalists about justification, we are home and dry).[21]

With regard to 2), here it will suffice to recall the words of Ernest Sosa:

> Admittedly, there is a sense in which even a supermarket door 'knows' when someone approaches [...]. Human knowledge is on a higher plane of sophistication [...]. Pure reliabilism is questionable as an adequate epistemology for such knowledge.[22]

From what we just sketched above, it clearly appears that reliabilism in combination with finitism is at least not an easy option to take for PEM's supporters.

4.2.2 *PEM and Infinitism*

We discarded coherentism because repeating chains of reasons are objectionably question-begging, and finitism because finite chains of reasons are objectionably arbitrary at their terminus. Thus the only available epistemological option for PEM's supporters is infinitism. Since we have also shown some important convergences between PEM and infinitism, we can conclude that infinitism is the epistemological position that fits better PEM.

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[20] See e.g. Vlerick and Broadbent 2015.

[21] Psillos 2011, p. 26. Cf. also Klein 2015, Sect. 1: "reliabilist or externalist responses to philosophical skepticism constitute a change of subject. A belief could be reliably produced [...] but the reasons available for it could fail to satisfy the standards agreed upon by both the skeptics and their opponents."

[22] Sosa 1983, pp. 58-59.

4.3 Comparing Clark's and Hohwy's Interpretations of PEM

So far we have tried to answer the two questions raised in section 3.1, i.e. whether PEM is compatible with SR, and which epistemological position fits better PEM. We can sum up our inquiry as follows: Clark's interpretation of PEM involves an externalist perspective and is sympathetic to SR, while Hohwy's interpretation involves an internalist perspective and is less compatible with SR. As we have seen, this also means that Clark's view is more suited for a finitist epistemological perspective, while Hohwy's view seems more suited for an infinitist epistemological perspective. Indeed, it seems not easy to conciliate the realist claims that we do reach the truth and that truth is correspondence with the infinitist perspective on justification. Moreover, we have underlined how infinitists are dissatisfied with an externalist and reliabilist view of epistemic justification, which is exactly the position that characterizes Clark's interpretation of PEM. Then, since we have shown that to account for all the tree main tenets of PEM an infinitist perspective is the more adequate, Hohwy's interpretation of PEM seems to be preferred.

5 On Some Difficulties Still Afflicting Hohwy's Position

In this section we will sketch some of the difficulties still afflicting Hohwy's position: 1) how to model the formation of the hypotheses; 2) the difficulties deriving from infinitism.

With regard to 1), Hohwy says almost nothing on how to model the hypothesis formation process. We intend to refer here to the production of those hypotheses that are not 'innate'. Hohwy just takes for granted that hypotheses are produced and then updated. This is a crucial issue for all the Bayesian approaches to the mind, since Bayesian formalism does not account for knowledge ampliation, it is intended just to model the refinement of the probabilities of given hypotheses.

With regard to 2), first of all there is the question of how knowledge has to be conceived if we adopt PEM. Since Hohwy gives no peculiar account of knowledge, we may presume that he intends knowledge in the traditional sense, i.e. as related to the concept of truth. But we have seen that PEM conveys a view of the mind that may well be considered as taking an 'antirealist stance', given that we have judged it to be at odds with SR.[23] The problem is that there is a tension between the claim that we do have knowledge and that knowledge is related to the concept of truth, and an antirealist stance. Thus, if we adopt PEM the traditional conception of knowledge seems at least to be wanting. Secondly, there are the difficulties deriving from adopting

[23] Hohwy's view can be described as a sort of 'Kantian scientific antirealism', which particularly resembles Bas van Fraassen's scientific antirealism, especially on the issue of 'representation' (see van Fraassen 2008). Indeed, Hohwy's view of the relation between the internal model and the sensory input is similar to van Fraassen's view of the relation between theoretical models and data models. We can at most compare them and make them fit, but this does not guarantee us that they reflect the world itself, since we cannot directly confront our models and the world.

infinitism. Indeed, even if infinitism seems to be the best option when compared to coherentism and finitism, it nevertheless presents several problems. We will sketch just two of the main problems that arise in combining PEM and infinitism. First, if PEM's supporter adopts infinitism, then she has to address the main problem afflicting infinitism, i.e. that of giving some feature which is able to discriminate among chains of reasons without regress. Indeed, infinitism claims that infinite chains of reasons may justify our beliefs. But allowing infinite chains of reasons is insufficient. The problem is how to discriminate those infinite chains of reasons that justify a given belief from those infinite chains of reasons that do not justify that belief:

> The regress condition itself cannot explain the connection between justification and truth, but any additional feature that could explain this connection would undermine the rationale for the regress condition itself [...]. So infinitism must distinguish infinite sequences of propositions that are justification-affording – those upon which actual justified beliefs depend – from those that are not justification-affording, in a way that explains the relevant connection between justification and truth.[24]

Second, there is the problem of *reasoning*. Indeed, PEM deals basically with unconscious Bayesian inference, while infinitists, as we have seen, normally require reasoning, i.e. human conscious reasoning, for something to be qualified as genuine knowledge.

To sum up, in order to strengthen Hohwy's interpretation of PEM it seems urgent to address the following issues: 1) giving an account of the hypotheses formation process; 2) adopting a conception of knowledge more suited to PEM's 'scientific antirealism'; 3) elaborating an anti-skeptical position which is able to avoid the difficulties afflicting infinitism. In the next section, we will suggest that in order to address those issues it could be fruitful to take into consideration Carlo Cellucci's work.

6 The Heuristic View

For reasons of space, it is not possible here to give an exhaustive exposition of the Heuristic View (HV) developed by Carlo Cellucci (2015; 2014; 2013). In what follows, we will illustrate just the core tenets of Cellucci's position.

6.1 The Analytic Method as a Model of Hypothesis Production

According to HV, the method of philosophy, mathematics, and the natural sciences is the very same method, and it is the analytic method. The analytic method, which goes back to Hippocrates of Chios, Hippocrates of Cos, and Plato, may be described as follows:

[24] Cling 2004, p. 110.

> to solve a problem, one looks for some hypothesis that is a sufficient condition for solving it. The hypothesis is obtained from the problem, and possibly other data already available, by some non-deductive rule, and must be plausible […]. But the hypothesis is in its turn a problem that must be solved, and is solved in the same way […]. And so on, *ad infinitum*.[25]

According to HV, the axiomatic method is inadequate for giving a naturalistic account of how knowledge is pursued. Indeed, the axiomatic method is not able to account for the hypotheses production process, and so it is not able to show the real path that has been followed to reach a given result. On the contrary, the analytic method is the method used in the process of discovery. Indeed, since in order to solve a problem hypotheses are produced by non-deductive inferences, logic is essentially a logic of discovery.[26]

6.2 The Heuristic View and Knowledge

According to HV, the analytic method provides a model of knowledge ampliation. But how knowledge has to be conceived according to this perspective? If the method of philosophy, mathematics and the natural sciences is the analytic method, and the analytic method is essentially characterized by the use of ampliative inferences, i.e. inferences that are not truth-preserving,[27] the problem arises of how to conceive the relation between knowledge produced by means of the analytic method and truth. Indeed, usually scientific realists take the aim of science to be the truth. For example, Sankey states that "the aim of science is to discover the truth about the world" (Sankey 2004, p. 215). Contrary to this view, according to Cellucci the concept of truth has to be replaced with the concept of *plausibility*.[28] Indeed, since the traditional definitions of truth are not able to give us a criterion of truth, i.e. a non-algorithmic means to decide whether a statement is true, they cannot avoid the skeptical argument of the criterion (Cellucci 2014).[29] For example, Cellucci states that the concept of truth as correspondence is not adequate as a criterion of truth because, as Kant states:

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[25] Cellucci 2013, p. 55.

[26] The analytic method has not to be confused with the analytic-synthetic method. According to the analytic-synthetic method as stated by Aristotle, the search for a solution to a problem is a finite process, and once the prime premises have been found, "the only role which remains for analysis is to find deductions of given conclusions from prime premises" (Cellucci 2013, p. 75). On the contrary, in the analytic method there is no given prime premise, the path to find hypotheses is only 'ascending', and it has not to terminate.

[27] Hintikka and Sandu 2007, p. 13.

[28] For a plausibility test procedure, cf. Cellucci 2013, p. 56: "(1) Deduce conclusions from the hypothesis. (2) Compare the conclusions with each other, in order to see that the hypothesis does not lead to contradictions. (3) Compare the conclusions with other hypotheses already known to be plausible, and with results of observations or experiments, in order to see that the arguments for the hypothesis are stronger than those against it on the basis of experience."

[29] On the problem of the criterion of truth cf. e.g. Sextus Empiricus 1976, II.2.

> according to the correspondence conception, truth "consists in the agreement of cognition with its object," but "I can compare the object with my cognition" only "by cognizing it" (Kant 1992, 557). Then, "since the object is outside me, the cognition in me, all I can ever pass judgment on is whether my cognition of the object agrees" not with the object but only "with my cognition of the object" (557–58). Therefore, we cannot know whether a theory about the world is true in the [...] correspondence sense. This makes truth something that humans cannot reach, and makes the aim of science ultimately unachievable.[30]

Being truth such an *unrealistic* aim, Cellucci takes instead plausibility as the central concept of epistemology:

> the goal of science is plausibility. Scientific theories do not deal with the essence of natural substances, but only with some of their phenomenal properties, and deal with them on the basis of plausible hypotheses. Then a scientific theory is not a set of truths but rather a set of plausible hypotheses. Thus the goal of science is plausibility rather than truth.[31]

Thus, according to HV what we really do, and can do, is producing hypotheses by means of some non-deductive rule, and then assessing the arguments for and the arguments against any hypothesis and provisionally accept or refute such hypothesis.[32]

6.3 The Analytic Method as an Anti-Skeptical Option

Let's now compare HV with infinitism. HV may as well as infinitism be considered an anti-skeptical option, since it claims not only that we do have knowledge, but also that knowledge is necessary to survive. Moreover, HV and infinitism have in common the idea that the fact that knowledge acquisition may be a potential infinite process does not prevent us to consider genuine knowledge that portion of knowledge we reached so far. For example, Cellucci states that:

> Even if, by the finiteness of human capacities, we cannot go through an infinite series, this does not mean that the series of the premises cannot be infinite but only that, at each stage, we can only go through a finite initial segment of the series. And yet we can go through longer and longer finite initial segments.[33]

But HV and infinitism are nevertheless distinct positions. Indeed, infinitism retains the relation between knowledge and truth, and thus has to face the difficulty outlined above (sec. 6.2). As we have seen, infinitism *per se* is not really able to face the skeptical challenge and connect justification to truth. On the contrary, HV can safely maintain that knowledge acquisition is a potentially infinite process and that the

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[30] Cellucci 2015, pp. 217-218.
[31] Cellucci 2013, p. 154.
[32] This view is related to Aristotle's definition of *endoxa*, see Cellucci 2013, Sect. 5.7.
[33] Cellucci unpublished, Sect. 3.2.

knowledge produced so far is genuine knowledge, since HV conceives knowledge as plausible and provisional, and does not relate it to truth:

> if the series of the premises is infinite, there will be no immediately justified premises, so no knowledge will be definitive, all knowledge will always be in need of further consideration. But this does not mean that there can be no knowledge. There could be no knowledge only if the premises, or hypotheses, occurring in the infinite series were arbitrary. But they are not arbitrary since [...] they must be plausible, that is, such that the arguments for them must be stronger than those against them [...].[34, 35]

HV and infinitism diverge also with regard to the 'reasoning requirement' made by the infinitists to consider something as genuine knowledge. Indeed, Cellucci sees the production of knowledge essentially as a problem solving process, which is homogeneous throughout the biological realm. The way in which problems are solved is similar among all organisms, because "knowledge has a biological role, just like other capacities which ensure the survival of organisms [...] knowledge is essential for life" (Cellucci 2013, p. 250). Moreover, according to HV even unconscious inferences contribute to knowledge: "in the analytic method, some non-deductive inferences by which hypotheses are obtained may be unconscious" (Ibidem, p. 235). Thus, HV does not require reasoning in order to consider something as genuine knowledge.

7 Conclusion. The Heuristic View and PEM

From the exposition of Cellucci's proposal, it appears that HV could considerably strengthen Hohwy's position. Indeed, HV seems able to provide to those who follow Hohwy's interpretation of PEM: 1) a theoretical account of hypotheses formation, 2) a conception of knowledge decoupled from the concept of truth, and 3) an anti-skeptical position which is able to avoid the difficulties that afflict infinitism, but which at the same time displays those features that made us judge infinitism to be the position more compatible with PEM. Combining Cellucci's view with Hohwy's interpretation of PEM seems then to be a fruitful perspective worth of further investigations.

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[34] Ibidem.

[35] It is worth underlining that plausibility has not to be confused with probability (Cellucci 2013, Sect. 4.4). Plausibility involves a comparison between the arguments for and the arguments against, so it is not a mathematical concept. Conversely, probability is a mathematical concept.

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