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ORIGINAL RESEARCH

More than roots: revisiting Kantian elements in predictive processing

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Abstract
This paper explores recent suggestions of conceptual affinity between the Predictive Processing (PP) framework and Immanuel Kant's philosophy. We argue that Kant's layered cognitive architecture mirrors PP's hierarchy, particularly in its top-down processing and active construction of experience. Furthermore, both frameworks endorse a version of internalism that emphasizes the mind's representational mediation of reality rather than direct access to external objects. However, key differences remain, notably Kant's emphasis on a priori constraints and conscious judgment, contrasted with PP's probabilistic and subpersonal predictive mechanisms. By highlighting these convergences and tensions, we conclude that PP is not only largely compatible with Kantian themes but constitutes a contemporary variant of Kantianism, reanimating essential insights within a scientific framework.

Keywords Kant · Predictive processing · Internalism · Cognition

1 Introduction

Predictive Processing (PP) is a leading computational framework in the mind sciences—and popular within the philosophy of mind too—that unifies perception, cognition, and action under a common inferential mechanism. It posits that the brain operates as a prediction machine, continuously generating hypotheses/predictions about sensory inputs and striving to minimize the discrepancy between these predictions and actual sensory data. This process, known as prediction error minimization, is central to PP and underpins perception, action, and cognition.

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Prediction error minimization employs a hierarchical structure and top-down processing, in which higher-level states generate predictions about lower-level sensory inputs. These predictions are compared against incoming sensory signals, and any mismatch triggers prediction errors that update the higher-level states of the internal model (also called generative models, as they are used to generate the hypotheses). Hence, prediction errors actively inform the system to adjust its internal models. This process is governed by principles of Bayesian inference, where the brain integrates prior beliefs/hypotheses with incoming sensory evidence to update its estimations of the world. Over time, this continuous updating allows the brain to incrementally approximate a more accurate model of its environment.

A central feature of the hierarchical structure is that each level processes information at different spatial and temporal scales, with higher levels handling more abstract representations over longer timescales, and lower levels dealing with concrete, immediate data over shorter timescales. The highest levels of the hierarchy in perception include hyperpriors, deeply embedded constraints that shape perception and cognition across various contexts. This top-down processing allows for integrating abstract, context-dependent information (including what is traditionally considered cognitive/conceptual content) with more immediate, raw sensory data, facilitating the interpretation of complex stimuli by applying learned expectations.

PP extends beyond perception to encompass action through the mechanism of active inference. The brain not only updates its internal models to fit sensory data better but also acts on the environment to make sensory input conform to its predictions. By adjusting motor outputs, the organism minimizes prediction errors by altering external conditions that generate sensory input to match the internal model. This action-oriented nature of PP highlights the deep integration of perception and movement within a unified inferential process.

A critical feature of PP is environmental seclusion, the idea that cognition does not have direct access to the external world. Instead, the brain infers the structure of the environment through its generative models, relying solely on the sensory signals it receives. Perception is not a simple reflection of an objective world, but a constructive process shaped by the inferential constraints of the cognitive system.

According to Swanson (2016), the predictive processing framework has Kantian roots. Similar sentiments are expressed, for example, in Hohwy (2013), Friston (2019), and Wiese and Metzinger (2017). Two broad similarities between PP and Kant would be the top-down explication of the human cognitive system, and the idea of the mind tracking features of the environment without direct access to anything external to itself.

There are also notable differences, making it challenging to establish a link between the two frameworks that would be more than just a loose analogy. Swanson (2016, p. 6) mentions Kant's heavy focus on the a priori features of cognition instead of its empirical genesis. Others have hinted that the scientific realism about the brain and external world taken for granted in PP misses a crucial lesson in the Kantian line of thinking: namely, that the brain too is like any object of experience and hence a "representational construct" (Zahavi, 2018, pp. 53–54). Similarly, the kind of naturalism implied by PP might not be compatible with Kant's transcendental philosophy (Zahavi, 2018, 51n1; Moghadas & Taheri, 2023). The plausibility of the connection

between the two frameworks also depends heavily on how we understand PP itself—there is more than one way (Beni, 2018). Obviously, the same is true about Kant whose system allows many interpretations (who knows, maybe the most PP-compatible Kant-interpretation would have to be openly anachronistic or unorthodox). There are further issues, such as "neuroidealism" (Britten-Neish, 2024), or idealism more generally (Westerhoff, 2025; see also Schlicht, 2026), and skepticism looming in both PP and Kant (Christias, 2024).

While it is not possible to face all of these challenges in a single paper, our objective is to shed light on them by clarifying the connection between PP and Kant, thereby responding to Swanson's (2016, p. 11) appeal: "It is my hope that the links between PP and Kant […] even hint that further important insights might await those who embark on PP-savvy readings of Kant." As a result, we replace undermotivated and preliminary comparisons with a structured and textually informed account of the points at which Kant and PP genuinely converge, where they diverge, and what philosophical significance the surviving parallels may have. We do not attempt a full integration of the two frameworks; rather, we map the conceptual ground on which such integration would need to proceed. In doing so, we provide a principled basis for evaluating the legitimacy and limits of Kantian readings of PP and for identifying directions in which future, more detailed engagement may be productive.

To keep our contribution within reasonable bounds, we will limit our examination to the original works of Immanuel Kant. Thus, we will not engage with branches of neo-Kantianism, post-Kantianism, neo-neo-Kantianism, or "Kantianism", understood as a very broad notion covering all kinds of later philosophy that echoes Kant in one way or another. Moreover, we will limit our examination of PP to the interpretation we gave, sometimes called the cognitivist (Venter, 2021) or conservative version of PP (Piekarski, 2017). This choice is motivated by its (at least) apparent consistency with Kant's philosophical starting points. By contrast, alternative interpretations that emphasize active inference, and sometimes situate it within the context of enactivism and ecological perception, typically presuppose anti-representational or externalist assumptions that sharply depart from Kant's view that perception is essentially mediated by the mind's own representational structures.

We begin with the parallels Swanson identifies (Sect. 2), as his discussion remains the most detailed and systematic treatment of the commonalities between PP and Kant. In contrast, others have typically only remarked upon such connections without substantial explication. After revisiting these parallels and identifying which of them are well-supported, we employ them in discussing two essential features shared by both frameworks. The first one is the structural view of cognition (Sect. 3), where cognition is seen as hierarchically organized and actively constructive. The second is the internalist view of the human cognitive situation (Sect. 4). Because in this view perceptual contact with the world is mediated by representational structures internal to the cognitive system, and the mind cannot access the world beyond its own internal model, we call it "internalism." We argue that the relationship between Kant and PP involves more than points of convergence (despite some notable differences) and PP qualifies, in a restricted but philosophically meaningful sense, as a contemporary variant of Kantian theory of mind insofar as it instantiates—as it does—these two essential features.

2 A quick look at Swanson's findings

Swanson (2016) finds nine [1–9] commonalities in PP and Kant. He begins by [1] tracing the reverse-engineering and top-down analysis present in PP back to Kant's transcendental method of argument. However, rather than explicating Kant's method as such, Swanson lists rather anecdotal connections between Kant's legacy and PP. While these—Kant as the grandfather of cognitive science and so forth—may be true, they do little to advance our understanding of the purportedly Kantian dimension of PP.[1] More significantly, it remains unclear that Kant's transcendental method as such is akin to reverse-engineering and top-down analysis characteristic of PP. For one, Kant's transcendental method is inseparable from his aprioristic stance, which Swanson himself (2016, p. 6) finds at odds with PP. Furthermore, it is not evident that one can so straightforwardly attribute to Kant the probabilistic approach central to PP (*pace* Swanson, 2016, p. 3). As far as we know, Kant never describes cognition in such terms.

Swanson (2016, p. 3), following Anderson and Chemero (2013), describes [2] PP as a kind of "neo-neo Kantian" view that conceives the mind-world relation in the Kantian manner as "somehow indirect". Certainly, the Kantian idea that the things in themselves remain unknown to us aligns with PP, where one of the most basic ideas is that the mind must "account for sensory input […] from inside the confines of the skull" (Hohwy, 2013, p. 258). Although Kant does not speak of skulls and rarely about brains (but see, e.g., A484/B512; Kant, 2011, p. 286; AA 7:176), a more standing philosophical issue is that PP begins with a pre-established distinction between the mind and external world.[2] Such a starting point is similar to representative realism, according to which both the mind and extra-mental things are presupposed, though direct access from the former to the latter is denied. Kant would classify such a view as transcendental realism, which he deems untenable and leading to other untenable positions, such as empirical idealism (see, e.g., A371-2). In its place, Kant offers transcendental idealism, which he finds compatible with empirical realism (A371). As one already sees from this, although Kant's view is difficult to pin down, it is not idealism in any standard sense.

There is a further complication in the comparison between PP and Kant. The fundamental premise of PP says that the mind (brain) makes a constant attempt at tracking a causal structure of sensory input consisting of hidden causes of the world accessible only indirectly to the mind. Swanson (2016, p. 3) draws a rather direct connection between this idea and Kant. At a minimum, one would expect an explanation of how this view can be attributed to Kant. After all, Kant famously maintains that causality is a special kind of a priori concept that reflects the structure of the mind rather than a feature of the transcendent reality itself. Moreover, Kant thinks that such concepts cannot find cognitive application beyond the way the objects appear to the

[1] Andrew Brook (1994) has argued that Kant's influence on cognitive science has been immense. Kant has shaped the work of many scientists at the end of the 19th century and, through them, has had an indirect but lasting impact on the subsequent development of the mind sciences.

[2] 'A/B', followed by page numbers, refers to the two editions of the *Critique of Pure Reason* (1781/1787; Kant, 2000a). 'AA', followed by volume and page numbers, refers to Kant's *Gesammelte Schriften* (Kant, 1900). The English translations are from *The Cambridge Edition of the Works of Immanuel Kant*.

mind. Thus, Kant seems committed to rejecting both exogenous causal structure and, subsequently, PP's core premise. That said, Kant is committed to the idea that something extra-mental gives rise to the appearing objects—indeed, he explicitly refers to their "non-sensible cause" (A494/B522). According to a long-standing criticism (e.g., Schulze 1792), Kant contradicts himself at this point, but, as we will see below, maybe there is a way to lessen this tension.

Swanson regards PP as an [3] antithesis to traditional approaches "that assume that perception is a *passive* process by which features of objects in the environment are *detected* by the sense organs and encoded into the nervous system and assembled in a bottom-up fashion" (Swanson, 2016, p. 4). Kant does seem to abandon such a view in his critical philosophy, starting from the idea that the objects, as we cognize them, result from mind-based processes governed by space, time, and the categories. However minor this point may seem, one should keep in mind that in part the cognitive process is passive (receptive) for Kant too (e.g., A19/B33; A494/B522).

Swanson links the above antithetic to Kant's "Copernican Turn." The fundamental idea of the latter is that we need to switch from thinking that "all our cognition must conform [*richten*] to the objects" to "objects must conform to our cognition" (Bxvi). Again, Swanson does not provide much explanation, as if it were self-evident what Kant means. Contrary to Swanson's suggestion, it is also not evident that the issue concerns the activity of perception. In the original context, the central issue is the possibility of a priori cognition. What matters is not merely that the observer contributes to the cognitive process (which trivially suggests activity) but Kant's further premise that the basic features of this contribution are knowable independently of experience (Bxviii-ix).

Swanson finds further [4] similarity in the Kantian forms of space and time and the notion of hyperpriors familiar from PP. According to Clark, such priors "[embody] systemic expectations concerning very abstract (at times almost "Kantian") features of the world" (Clark, 2016, p. 174); hyperpriors are high-level constraints that guide lower-level processing across contexts by encoding very abstract expectations about the structure of the world. Swanson, in turn, asks whether there is anything in Kant fitting such a description, then quickly shifts to speak about "constraints", and soon concludes: "Kant's proposal that space and time are features of cognition that *form*, *constrain and restrict* possible perceptions of outer objects is echoed in PP" (Swanson, 2016, p. 6). Insofar as both hyperpriors and Kant's forms shape and limit the range of possible perceptual experiences, the comparison has initial plausibility. However, the analogy breaks down upon closer inspection. Hyperpriors, however stable, are empirical constructs: they arise through experience, can in principle be revised, and reflect learned regularities about the environment. In contrast, Kant's forms of space and time are necessary structures: they are the a priori conditions that make experience possible in the first place (i.e., they do not arise from experience). This contrasts with PP, where hyperpriors are products of experience-sensitive learning. For this reason, it might be more accurate to view space and time, in the Kantian framework, not as hyperpriors, but as fixed elements of the world-model that underlie any possible experience.

As mentioned before, Swanson has concerns regarding the notion of a priori when comparing PP to Kant. More specifically, the [5] key difference between the two

frameworks is that, unlike PP, Kant is not concerned about "the empirical acquisition of priors" or how they are "learned" (Swanson, 2016, p. 6; italics omitted). Indeed, if we identify the Kantian space and time as priors, the whole comparison is a non-starter, since Kant regards them as a priori, that is, *not* empirically acquired in the first place, as just stated. However, the issue is trickier than this: Swanson implies that for Kant the "priors" are innate, but this is incorrect. Not only did Kant not believe in innate ideas, as Leibniz and others did, but he never claimed that the forms are strictly innate (see esp. Kant 2002a, p. 312; AA 8:221).

Swanson begins his next comparison by pointing out how [6] Kantian schemata are analogous to generative models, which supposedly help us explain perceptual object recognition. As Swanson sees it, Kant's schematism is "a theory of perceptual object recognition and concept application" (Swanson, 2016, p. 7) that "concerns "[isolating] meaningful objects from noisy and chaotic perceptual scenes" (Swanson, 2016, p. 6). While the first characterization seems to be accurate, it is questionable whether Kant's schematism fits the second. The schematism chapter of the *Critique of Pure Reason* is, of course, notoriously difficult to encode and open to many interpretations (see, e.g., Pendlebury, 1995, esp. note 4), but it would require much more elaboration to get Swanson's comparison properly off the ground.

We have similar reservations with [7] "analysis-by-synthesis." Kant's notion of analysis does not seem to operate at the cognitive level suggested by Swanson. Instead of referring to the analysis of "incoming sensations" (Swanson, 2016, p. 9), Kant mainly refers to the analysis of concepts, which basically means a procedure of explicating what predicate-concepts are contained in the subject-concept (e.g., A7/B11; A716/B744), or the analysis of the faculty of understanding itself (A65/B90). That said, Kant does state that analysis (or dissolution, as he also calls it) presupposes the combination (synthesis) of representations (B103; B131). From this it is possible to draw the idea that the mind is a kind of back-and-forth processor of data, which ultimately always refers back to its synthetic activity.

We agree that the [8] central role of imagination in perception provides a good starting point for identifying significant connections between PP and Kant (Swanson, 2016, pp. 9–10). Kant's close link between imagination and associative synthesis may turn out particularly interesting. Kant also appears to find what cognitive scientists call offline processing as an ineliminable feature of the mind (see, e.g., Gładziejewski, 2016, p. 577). Indeed, Kant's aprioristic framework rests on the idea that the mind is not bound to empirical input.

Finally, Swanson (2016, p. 10) brings up PP's [9] intellectual debt to Helmholtz. While Helmholtz is undeniably a notable figure in the history of PP (Hohwy, 2013, pp. 5–6), this connection alone is insufficient to establish a fruitful link between the two theoretical frameworks, especially if one is to extend the link all the way back to Kant. It also appears that Kant was, as Swanson (2016, p. 7) himself affirmingly notes, critical towards a purely associationist view of the mind. Helmholtz, on the other hand, can be seen as emphasizing associationism (Hatfield, 1990, p. 204, 216). If this is so, there may be some irony in the story, one possible conclusion of which is that Helmholtz's theory was not necessarily an improvement of Kant, even if it was more "scientified." It could also turn out that some elements in Helmholtz's theory

are closer to PP, while other elements in it are further from PP than Kant's. However, as noted before, a Helmholtz-Kant comparison exceeds our present scope.[3]

As we have seen, Swanson identifies several points of contact between PP and Kant, offering a valuable starting point for examining connections between the two frameworks. However, many of these connections remain underdeveloped and deserve further clarification and systematic grounding. In what follows, we can only take up those themes that we regard as the most fruitful aspects for establishing further points of contact between PP and Kant. Section 3 reconstructs Kant's structural view of cognition, emphasizing the hierarchical interplay of sensibility, understanding, and reason ([1], [3], [8]). Section 4 explores the internalist commitments of Kant's philosophy and their relevance to the cognitive assumptions of PP ([2]).

3 Structural view of cognition

A crucial part of Kant's general philosophical project, in the *Critique of Pure Reason* in particular, was to lay out the formal structure of the mind and its fundamental cognitive operations. For Kant, the mind is basically a hierarchical collection of capacities that together make us the kind of cognitive agents we are, limiting our epistemic possibilities accordingly. The way we experience the world is characteristically determined by the cognitive structure imposing itself on the sensory input. The explication of these features directly entails several aspects of Kant's theory mentioned in the preceding section, aspects which simultaneously distinguish his position from earlier theories of mind.

Kant's cognitive architecture can be seen as employing a form of top-down analysis akin to PP [1].[4] Instead of starting from the empirical particulars of perception and building upwards, Kant's transcendental method asks what structural features must be in place for experience to be possible at all. In doing so, Kant anticipates the general explanatory strategy later characteristic of PP, where perceptual phenomena are accounted for by reference to internal principles and hierarchical organization rather than by assuming a simple bottom-up construction of experience. The active, constructive role of the faculties aligns with Kant's Copernican Turn [3], according to which objects must conform to our mode of cognition rather than the other way around. The mind's contribution is not merely supplementary but constitutive of experience itself, an idea echoed in PP's generative model of perception.[5]

Although both frameworks emphasize hierarchical organization, they differ in how they conceive the internal structure of cognition. PP envisions a continuous inferential hierarchy, lacking fundamental categorical distinctions between process-

[3] For an overview on Helmholtz in relation to Kantianism and neo-Kantianism, see Beiser, 2014, 196–205. See also Lenoir, 2006.

[4] To some extent at least Kant was driven by the same questions as Hohwy (2013, p. 1): namely, "how we manage to make sense of the manifold of sensory input that hits the senses, what happens when we get it wrong, what shapes our phenomenology, and what this tells us about the nature of the mind."

[5] Then again, PP frames this constructive role within an empiricist and naturalistic outlook, whereas Kant's Copernican Turn seeks to ground the very possibility of a priori cognition, not merely to describe mechanisms of perceptual construction.

ing stages. By contrast, Kant's account posits a clear internal division between distinct cognitive faculties, each with its own specific mode of operation (e.g., A130/B169; Kant 2000b, p. 83; AA 5:196-7; Kant, 2011, p. 251; AA 7:140-1).

At the base of Kant's cognitive architecture lies *sensibility* or receptivity, through which the mind receives representations in a way characterized by the very manner in which the objects affect the perceiver (A19/B33). The outcome of the affection itself is *sensation*, which is, roughly, an impression upon the senses or the representation thereof (Kant, 2000b, p. 198; AA 5:321; Kant, 2001, p. 187; AA 29:829; see also Kant, 2002b, pp. 78−9; AA 4:282). One might call this the sensory input that starts the cognitive process in a bottom-up fashion. However, how the mind ultimately perceives the object is also characterized by space, understood "as a mere form of sensibility in the mind" (A21/B36). Space is a kind of template imposed on sensory input, structuring the way the input is taken in by the mind, adding a top-down element to the cognitive process from the outset. Time receives a similar treatment.[6]

The basic type of representational content generated by sensibility is *intuition*, which, in this context, means an immediate non-conceptual representation of a particular object. Kant's general term for an object indicated by sensibility-originated representation is *appearance*.[7] If there is sensation involved, the representation is sense-based, or *a posteriori*. Otherwise, it is a priori, that is, independent of empirical input. All such representations are constrained by space and time.

Kant further distinguishes between sensibility and imagination [8], the basic function of which is to represent objects in their absence (B151).[8] The cognitive role of imagination is crucial whenever the mind needs to go through and grasp a manifold of appearances, and it also illustrates the active and constructive nature of the mind [3]. (Think, for example, of examining a house feature by feature.) Kant's technical term for this kind of operation is apprehension, which is a kind of synthesis that allows the mind to find organization in the sensory manifold (A98-100; B160; Kant 2000b, p. 135; AA 5:252). To apprehend in a coherent manner, the mind also needs to be able to refer to its past states. Kant calls this kind of connecting activity the synthesis of reproduction or recollection (A100-2; Kant, 2001, p. 252; AA 29:883). Since tracking and keeping previous perceptual states in mind requires the ability to

[6] Later in the *Critique*, in the Anticipations of Perception, it is further suggested that sensations enter the mind on a continuity (A169/B211), and that this continuity or "their property of having a degree can be cognized a priori" (A176/B218). This idea too underlines that the mind imposes a certain organization on the sensory input, partly anticipating the results of the cognitive process.

[7] It is a further question, and a debate on its own, both generally and in the Kantian context, what role concepts play in forming representational content. Some Kant interpreters think that the categories must be imposed on the appearance to represent any object in the first place, thus governing the cognitive process from the outset. Others would emphasize that while the appearance gives rise to the possibility of thinking an object under a concept, the appearance as such is conveyed non-conceptually to the mind, one consequence of which is that crucial steps in the cognitive process are independent of the intellect. (See, e.g., Allais, 2016) More generally speaking, the question is about how "intellectualistically" Kant should be interpreted—a theme not alien in PP either (see Hohwy, 2013, p. 5, 18; cf. Orlandi, 2018).

[8] We only provide a general, textually well-supported overview. Further details concerning the role of imagination in relation to the other faculties of the mind, its role in perception and other forms of representation, and its significance in Kant's philosophical project in general, are much discussed in Kant scholarship. For a recent, comprehensive analysis on the topic, see Matherne, 2024.

represent objects that are not actually perceived anymore, the syntheses of apprehension and reproduction tellingly show how synthetic activity stands on the capacity of imagination.

It is in this context that Kant explicitly refers to inference and prediction, the key theoretical elements of PP, and makes a further distinction between the reproductive and anticipatory use of imagination (Kant, 2001, p. 252; AA 29:883-4). In Kant's example regarding these backward- and forward-looking uses of imagination, the ringing of a bell evokes the thought of dinner time—an instance of reproductive imagination. What is also involved is the inference of what happens next: namely, that there will be a dinner. This is the work of anticipatory imagination. As Kant clarifies, the prediction involved in the inference can be conscious (in which case it is called *praesagitio* or "prescience") or unconscious (*praesensio* or "presentiment") (see also Kant, 2011, p. 295; AA 7:187). These operations follow the law of association (e.g., Kant, 2001, p. 375; AA 28:674; see also A100-102; Kant, 2001, p. 252; AA 29:883; Kant, 2011, 285-6; AA 7:176).[9]

What we do not find from Kant, however, is evidence that probability plays any specific explanatory role in the cognitive process. Of course, one might speculate, given the inductive character of experience (e.g., B3-4), that Kant should grant that probability plays a role in reproduction and anticipation. When encountering unfamiliar objects, or if something unexpected happens, the perceiver is actively engaging in comparing, reflecting, and abstracting from the given group of representations—as Kant describes the process of concept acquisition in the lectures (Kant, 2004, p. 592; AA 9:94−5)—and that some sort of estimation of likelihoods would have to be involved in the process. All the same, the probabilistic picture of PP is something that we cannot find in Kant in an explicit fashion.

Relatedly, although association is central to Kant's theory, Kant regards it as insufficient to establish objective representations of states of affairs (see esp. B142; A767/B795; see also A121-2; B5). In the first edition *Critique*, when Kant introduces the synthesis of reproduction (A103), he seems to want to emphasize how the conceptual recognition of objects requires a further step in the cognitive process: namely, the capacity to take the given representations as connected with each other in a unified or rule-like fashion. At this juncture, Kant focuses much on the so-called unity of apperception, which for the purposes of this paper should be sufficiently explicated as that function of the mind that brings representations together and connects them in a single consciousness.

When things are examined at this level, the basic notion for Kant is *judgment*, which suggests a conscious taking of the states of affairs in a certain way by the cognitive subject. In the hierarchy of the faculties, we would now be discussing *understanding*, the basic cognitive task of which is to think of appearances given in sensibility under some concept or another. Just as sensibility is restricted by the forms of space and time, thinking (that is, judging) is restricted by logical forms (e.g.,

[9] In his lectures on metaphysics, Kant used Baumgarten's *Metaphysica* as a handbook, and much of Kant's view, as presented here, is drawn from Baumgarten's theory of empirical psychology (see Baumgarten 1757/2013, esp. III.I.VIII and III.I.X).

"S is P", "If S, then P", etc.) and the categories, also known as the forms of thought (B150).

Understanding and the capacity to make judgments would also be the level at which Kant thinks error takes place:

> For truth and illusion are not in the object, insofar as it is intuited, but in the judgment about it insofar as it is thought. Thus it is correctly said that the senses do not err; yet not because they always judge correctly, but because they do not judge at all. (A293/B350)

Something similar can be found in predictive processing. In PP, sensory signals themselves are neither true nor false; they only provide input against which predictions are tested. What matters is the match or mismatch between the prediction and the actual input. In this sense, error lies not in the sensory input, but in the predictive model's interpretation of the causal regularities that the input is taken to reflect. This is similar to Kant's point that the senses do not err: In both cases, the cognitive system is responsible for how experience is organized and interpreted, and the possibility of error stems from this internal activity rather than from sensation itself.

The highest faculty in the cognitive hierarchy is *reason.* In the *Critique*, Kant focuses much on the fallacies human reasoning is susceptible to. This reflects his general agenda of showing how we cannot, *pace* traditional metaphysics, establish truths about reality through reason alone. On a more positive vein, Kant thinks that reason is the highest capacity that manifests the highest order unity in our thinking:

> All our cognition starts from the senses, goes from there to the understanding, and ends with reason, beyond which there is nothing higher to be found in us to work on the matter of intuition and bring it under the highest unity of thinking. (A298-299/B355)

Kant's examples of the unifying (regulative) function of reason are many (see A648-668/B676-696). The presupposition of the systematicity of nature is one (e.g., A651-2/B680-1). In thinking to this end, Kant proceeds roughly as follows: though we cannot ultimately establish through reason what kind of a systematic whole the world is (see A653/B681) reason nevertheless imposes the idea of systematicity on the appearances.

Reason also enables us to establish necessary truths about the world of appearances. An example of such a truth would be that every event has a cause. Such truths, or principles, need not be empirically verified, but they rather represent the transcendental conditions of the possibility of experience, which makes them synthetic a priori in Kant's terms [5]. This already reveals that apriority plays a dual role in Kant's theory: On one hand, the notion refers to actual cognitive processes beyond immediate empirical input—in this respect, Kant and PP are close relatives. On the other hand, the notion of a priori is essential in Kant's general method of establishing the necessary conditions that ground actual cognitive processes. While this may distance Kant from PP at first sight, his starting hypothesis for adopting the aprioristic method seems to bring the two frameworks back together: Although Kant maintained

that cognitive processing begins with experience, it does not follow that everything in the cognitive process is an outcome of experience, or reducible to sensory impressions (B1). This closely parallels PP's claim that perception is not passively received from the senses but actively constructed through prior models that are not themselves the product of occurrent sensory input.

Kant's cognitive architecture is thus distinctly layered: sensibility, understanding, and reason form separate levels, each characterized by its own specific mode of representation and functions. PP, in turn, posits a continuous inferential hierarchy without fundamental categorical distinctions between processing stages. Yet, as we see from the overview of Kant's position, although the three main capacities are distinct in principle, they are in many ways interlinked and restricted by one another. For the understanding to be of cognitively significant use, its representations must maintain a connection to appearances. Sensibility must furnish data for understanding, and though reason cannot gain cognitive access to transcendent reality beyond the sensibility-originated appearances, we saw how reason nevertheless has an important regulative function in the human cognitive makeup.

Another crucial part of Kant's view is that the mind can go beyond sensory input, the clearest examples of this being the uses of imagination and reason, as discussed above. While imagination still operates relative to sensibility, reason can transcend the senses altogether, for better or worse. This anticipates PP's insight that cognition involves offline simulation. In both frameworks, imagination plays a constructive role, enabling the mind to synthesize and project likely future states even in the absence of immediate sensory input. Thus, for both Kant and PP, much of cognition unfolds independently of sensory input.

Notably, as we climb up the cognitive hierarchy from sensory input to judgment, there is a corresponding increase in invariance (cf., e.g., Hohwy, 2013, pp. 29–30). The cognitive process starts with highly variant sensations (e.g., the shade of green as sensed under certain lighting conditions) and slightly less variant intuitions (e.g., a round object). Concepts are even less variant in that they are abstract kind of representations that always "[contain] only the common characteristic (leaving out what is particular)" (Kant 2000b, 345; AA 5:484). Ultimately, what takes place at the concrete perceptual level becomes more and more bracketed until we are reasoning in highly abstract terms. Yet, if we are not to exceed the boundaries of possible experience altogether, what happens at the most abstract level remains dependent on the feedback from less abstract levels and vice versa. This aspect of Kant's view—namely, the increasing level of abstractness and the corresponding decrease in variance at higher levels—can be seen as a direct consequence of his Copernican turn. It is likewise a central feature of PP, where it emerges from the hierarchical organization of the system and the top-down flow of predictions across levels of processing. However, it should be noted, to quote Schlicht (2026, 93; cf. Orlandi, 2018) that "although the balance between top-down and bottom-up processing is retained", being "structurally analogous" between PP and Kant, "it is interpreted differently and cashed out in the terminology of expectations or predictions and sensory signals or prediction errors."

A further thing we witness above is a gradual move from rather primitive perceptual and associative processes to making sense of the states of affairs and expressing them in a judgment. Though Kant allows for unconscious processes, he is ultimately

concerned with conscious cognition and belief. This may be something that distances Kant from PP, where unconscious inferential activity has been of primary concern and the term 'belief' is used in a much less demanding sense: In PP, the term refers to a probabilistic estimate represented by the brain's generative models, not to a consciously held propositional attitude. Belief updating in this context concerns automatic adjustments in the brain's internal predictions, not deliberate changes in what a subject consciously believes.

Relatedly, the Kantian hierarchy suggests that there are different *kinds* of representations. While this may again be something where Kant simply differs from PP, it could also become a valuable theme for further development within PP. After all, different levels in PP—for example, low sensory levels (e.g., edge detection) and high conceptual levels (e.g., object categorization)—seem to engage different types of representational operations, not just different degrees of variance and abstraction. Acknowledging such distinctions could refine PP's account of hierarchical processing, particularly in explaining cases where errors arise at the conceptual rather than the perceptual level (e.g., by reassessing the extent to which perception involves rational capacities; see Gładziejewski, 2021).

4 Internalist picture of the mind

We saw how Kant is also committed to the idea that there is something external to the mind that puts the cognitive process into motion. It is just that we do not exactly know anything about this something. Call this the Kantian epistemic humility (see Langton, 1998). Given this premise, which the conservative version of PP appears to largely share with Kant, one could argue that the long-standing issue about transcendent objects or the ontological status of the things in themselves need not detain us when locating fruitful connections between Kant and PP (cf. Zahavi, 2018). In the same spirit, mind-dependence can be understood in broadly realist terms in the Kantian context too, which should not come as a surprise since Kant insists that his system is compatible with empirical realism (e.g., A371, 375; Abela, 2002; cf. Hohwy, 2025). This means, among other things, that it is not in doubt that "to our outer intuitions there corresponds something real in space." (A375) Moreover, Kant added to the second edition of the *Critique* a section titled the Refutation of Idealism to emphasize that he is neither the problematic nor dogmatic idealist some may have portrayed him to be, but someone who in fact holds that objects exist in space independently of the perceiver (see B274-9). All in all, instead of questioning the existential status of things in any way (see esp. Kant 2002b, pp. 288-9; AA 4:293), Kant's so-called idealism may be understood as simply emphasizing the fact that the mind is responsible for the way we represent the world, as the mind embarks on "'spontaneous' interpretative activity" (Gładziejewski, 2016, p. 574). Against this background, Kant's view does not really suggest skepticism either (*pace* Christias, 2024).

The following issue seems less easily avoided. Is Kant's view nevertheless thoroughly internalist in insisting that the mind's access is confined to appearances? How does this commitment compare to PP's basic idea that the mind can only access its endogenous "model-surrogate of the external environment" (Gładziejewski, 2016, p.

571) or that "normal perception is nevertheless at one remove from the real world it is representing" (Hohwy, 2013, p. 138)? While "internalism" takes many forms, the relevant sense here is the view suggested by both Kant and PP that the mind cannot ever have access to the world beyond its own internal model of the world (cf. Gładziejewski, 2016; Hohwy, 2013). Also relevant here are the related worries (from Sect. 2) regarding transcendental realism and the extension of the concept of cause.

Let's start with the obvious. Kant thinks that the objects of experience are to be understood specifically as "sensibly conditioned" objects of the world of sense or appearances (A563/B591). The reason for this qualification can be seen as fundamentally epistemic (e.g., Allison, 2004). After all, the critical Kant appears to argue all along that we cannot gain knowledge beyond the world of sense. The approach is somewhat like Berkeley's attack against Locke, who claimed that ideas can resemble the extra-mental things in themselves in some respects (which Locke termed primary qualities, such as shape and number). To this Berkeley (1710/2003, I.8) responded, and justifiably so, that intra-mental ideas cannot resemble extra-mental non-ideas, and that the mind could not verify the resemblance in any case, given its dependence on its own ideas. Kant, by contrast, seems to grant this much yet think that idealism per se can be avoided and realism preserved (it is not the case that there is nothing beyond the world of sense, independently of the mind, even if it remains cognitively unreachable). This is apparently possible if we reject what he calls transcendental realism.

On the most straightforward reading, by transcendental realism Kant refers to "the commonsense pre-theoretic view that objects in space and time are 'things in themselves'" (Stang, 2016). The issue is more complex than this, however (Allison, 2004, pp. 20–34). To begin with, it is not only spatiotemporal objects but space and time themselves that Kant regards as *not* transcendentally real (A36/B53; A369). This already suggests that we should not only view the appearances themselves as modified by the mind, but that the world itself, in its spatiotemporal manifestation, depends on the mind. The transcendental realists would also accept that the mind's access to things is not neutral, yet they would still portray the human cognitive situation against the world as independent of the mind. Kant, by contrast, seeks to reject altogether the model of a pre-given external world paired with its mental representation. Instead, what we have got is the world of appearances, understood as the domain of spatially extended, temporally structured, and lawfully behaving objects—in a word, nature (see, e.g., Kant, 2002c, p. 183; AA 4:467; A125). On this view, one might promote relationalism (Allais, 2015) or even direct realism (Jansen, 2014), at least if one is ready to fully embrace the Kantian-Copernican turn. This is a tall order, of course, but maybe not too tall if we regard (following Allison, 2004 and others) Kant's view as fundamentally epistemic rather than metaphysical.

Moreover, one might well think that Kant only underlined the impossibility of establishing a mapping between appearances and things in themselves. The following passage is quite illuminating in this respect:

> [O]bjects in themselves are not known to us at all, and that what we call outer objects are nothing other than mere representations of our sensibility, whose form is space, but whose true correlate, i.e., the thing in itself, is not and cannot

> be cognized through them, but is also never asked after in experience. (A30/B45)

To some extent, PP seems to be aligned with Kant. At least it should be clear that in PP intra-mental objects are not confused with extra-mental objects, as apparently happens in transcendental realism (cf. Allison, 2004, pp. 22−3). The basic point of PP that there are "hidden variables" that we are unable to ascertain (Gładziejewski, 2016, pp. 571-2) already supports this distinction. Things appear even more Kantian when it is emphasized that "cognitive systems have no way of adopting a view from the 'outside' in order to directly ensure that the generative models they use structurally resemble the causal organization of the world" (Gładziejewski, 2016, p. 578).

At the same time, we can find transcendentally realist aspirations in PP. The first thing to note is that in PP what lies outside the mind is explicitly contrasted with what lies inside the mind without considering the ambiguity of "inside" and "outside" any further. For example, a spatial object may refer either to an object "in us", as it is represented by the mind as external, or the object as such "outside us", considered transcendentally beyond the representation of it (see Allison, 2004, p. 24). While PP appears to share the idea that the access to objects is necessarily conditioned by the mind, PP does not seem to share the epistemic limitation that Kant draws from this premise: namely, that the object in the transcendental sense remains cognitively inaccessible. PP's general idea of indirectness is telling in this respect: though the mind cannot *directly* access the world outside, it continually attempts to infer the world's causal structure (in the transcendental sense) by minimizing prediction error (see, e.g., Gładziejweski 2016, pp. 578-9). In effect, PP presupposes a structured external reality that is epistemically approachable via generative modeling and prediction error minimization. We can see a similar trend in the identification of the world-states with "external causes of the sensory signal, i.e. objects with their patterned interactions", which in turn entails a probabilistic mapping between the world in itself and the sensory system (Gładziejewski, 2016, p. 571).

In a sense, then, PP sees the mind as able to transcend itself in a way that Kant would probably attribute to a transcendental realist. As a result, PP appears less radical in its internalism. At the same time, while PP echoes some of Kant's strictures concerning epistemic humility, it ultimately remains committed to a form of representative realism that Kant would deem problematic. That said, it should be emphasized again that Kant also acknowledges that something external to the mind contributes to the way the mind can begin to make sense of the world: the sensibility-originated cognitive processes require that "we are affected by objects" (A19/B33). Accordingly, Kant too must accept that even if the mind regulated the world of sense (e.g., A125), the mind does not exert total control over its representations, nor are the objects indicated by representations mere intra-mental products, but also results of the aforesaid affection, at least in part.

Moreover, if confronted, Kant would likely have to concede that there are extra-mental indicators—some sort of accuracy conditions, even—for the proper use of cause and the rest of the categories (cf. A143-4/B183). The Kantian humility—or should we say minimalism—rather underscores that we must abandon viewing things as they are presented to us in relation to how they might be independently of the

cognitive process. This would explain Kant's insistence that the concept of cause is limited to the world of sense: the causal organization of the world can only be verifiably identified with the causal organization of the world of sense. However, if we regard this limitation as fundamentally epistemic, the point is not exactly that there cannot be causality beyond appearances, but that this would be something that our concept of cause has insufficient means to track. PP in turn can be seen as an attempt at overcoming this epistemic limitation through the idea of tracking probabilistic regularities between the world "out there" and its "model-surrogate." Even so, one might conclude that both frameworks are "noumenalistic" in the sense that the world "beyond" is not reachable *as such*, but PP would be the one keen on retaining a mapping or correspondence view (*pace* Westerhoff, 2025, pp. 977-8) between what Kant would call appearances and things in themselves.

5 Conclusions and prospects

In this paper, we have examined the often repeated but less explicated claim that PP, particularly in its conservative form, has Kantian roots. While this assertion appears in several places in the literature, it is frequently left without substantive elaboration. A notable exception is Swanson (2016), who offers the most systematic comparison to date. As discussed in Sect. 2, he identifies nine parallels between Kant's transcendental philosophy and PP. We argued that Swanson's findings are not as neatly separable as they may seem and that he also overlooks crucial features of Kant's view. However, some of these comparisons are more compelling, and his analysis plays the role he intends by being a springboard for further insights into the topic.

We focused on two themes. First, in Sect. 3, we reconstructed Kant's structural theory of cognition, where Kant's layered account of sensibility, understanding, and reason shows clear parallels to the hierarchical, top-down architecture of PP. Both frameworks share the idea that cognition proceeds through levels of increasing abstraction, with the mind actively shaping sensory input through its own formal constraints in a top-down manner. However, differences remain: PP relies explicitly on probabilistic inference, which is absent in Kant, and whereas Kant emphasizes conscious judgment, PP has thus far been primarily concerned with subpersonal and unconscious processes. We also proposed that more complex and highly abstract human cognitive achievements should be better addressed in PP, perhaps following Kant's idea that representations come in different kinds, especially those capable of abstracting away entirely from sensory input.

Second, in Sect. 4, we compared Kant and PP from the shared internalist picture of the mind and the standpoint of transcendental realism. While PP at times seems to rely on the epistemic commitments that appear too uncritical or too assumptive from the Kantian perspective—particularly regarding the tractability of external cause—it nevertheless does reinforce Kant's view that something external must affect the mind for cognition to begin, even if it remains unknowable itself. At the same time, the basic setting of PP can be used to underscore Kant's realist tendencies more openly.

Of course, everything we have said depends on how one interprets the complex philosophy of Kant in particular, but also on how one interprets PP. One might also

think that there should be some leeway in the Kant-PP comparison in any case, given that the two frameworks are historically quite far apart. Crucially, however, the aspects we discussed and that persisted under closer scrutiny are not contingent features of Kant's system but concern essential commitments of any Kantian theory of mind. As we have suggested, a theory of mind qualifies as Kantian when it posits (i) a hierarchically organized cognitive structure in which the mind actively shapes experience through constraints in a top-down manner, and (ii) a representation-dependent epistemology grounded in the limits of internal processing rather than direct acquaintance with external reality. Arguably, PP meets both conditions.

This understanding of PP as a Kantian theory of mind offers several prospects for developing the PP-Kant connections further, including the things that were found as requiring further clarification in Sect. 2. To illustrate these prospects, let us briefly consider Kant's hierarchical and aprioristic capacity view that implies certain features are being imposed onto the cognitive process, thereby shaping the latter from the outset. The mind does not so much anticipate the results of the cognitive process, or adapt itself to them, but lays down some of the structural features of the world of sense. Consequently, a cognitive agent like us tends to represent things in a certain way, given the mind-originated/dependent transcendental framework of space and time and the categories that pre-structure all possible representational content. For example, we simply represent worldly things as spatially extended concrete particulars with attributable properties. Told in Kantian terms, the mind intuits sensibility-originated appearances that are subsumed under the concept of substance and accident in judgments. In PP terms, this would be the most basic kind of world-model, or a combination of such models, that the mind possesses and employs when it deals with sensory input. Perhaps the main difference to PP would be that the model-like elements appear as fixed and unchangeable in the Kantian view. From the Kantian point of view, something like this simply needs to be in place; otherwise, the cognitive process would lack any coherent starting point. Whatever the role of models and hyperpriors thus is, they too need to have restrictions and restraints, and Kant's view could be seen as an attempt at tracking these cognitively foundational restrictions and restraints.

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