Two Species of Realism

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Abstract

Different species of realism have been proposed in the scientific and philosophical literature. Two of these species are *direct realism* and *causal pattern realism*. Direct realism is a form of perceptual realism proposed by ecological psychologists within cognitive science. Causal pattern realism has been proposed within the philosophy of model-based science. Both species are able to accommodate some of the main tenets and motivations of instrumentalism. The main aim of this paper is to explore the conceptual moves that make both direct realism and causal pattern realism tenable realist positions able to accommodate an instrumentalist stance. Such conceptual moves are (i) the rejection of *veritism* and (ii) the re-structuring of the phenomena of interest. We will then show that these conceptual moves are instances of the ones of a common realist genus we name *pragmatist realism*.

Keywords: philosophy of science; philosophy of cognitive science; realism; instrumentalism; direct realism; causal patterns

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1. Introduction

If you were to go to the street and ask someone whether they think what they see is real, you will likely get an affirmative answer. Yes, this is a real tree. Yes, that approaching car is real. Yes, the building I am getting into is a real building. Someone might say something like "no, this is not real, we live in the Matrix", but even that person is probably joking and would move from the path of the approaching car to avoid being hit. Similarly, many people would claim the objects, processes, and mechanisms that feature in our scientific theories and models are real objects, processes, and mechanisms one can find in the world. Black holes are out there, with their singularity, their event horizon, and their ergosphere. The same goes for action potentials in neurons, with their voltage-gated ion channels, or for the decoding activities that produce proteins out of the genetic information in the DNA. Realism about perception and science–i.e., the idea that both our perception and our scientific theories and models offer a true characterization of the world–is just the standard position in our everyday lives.

Realism is not, however, as dominant in academic settings. Many philosophers and scientists defend different forms of nuanced realism or anti-realism regarding both perception and scientific theories and models. In the cognitive sciences, for instance, realist theories of perception are scarce. The most common position on perception is that it involves the construction of an internal model (i.e., a representation) of the external environment that may or may not reflect its real features (Shea, 2018). The challenge to perceptual realism entailed by this position goes all the way from *fictionalism* concerning the phenomenal details of perceptual experience–e.g., the colors we perceive are not out there in the environment–to the characterization of the whole perceptual experience as a kind of hallucination, as it often occurs in the predictive processing literature (e.g., Clark, 2015; Seth, 2021). Also, perceptual illusions are used to support the claim that perceptual experience is the product of a process of mental construction based on belief and expectations and that, therefore, it does not reflect the real world as it is out there but only as we perceive it (e.g., Smith, 2002). The dominant paradigm of the contemporary cognitive sciences is thus generally anti-realist regarding perception.

The situation in the literature on scientific realism is not as extreme as in the case of perceptual realism. With regard to scientific theories and models, realism is still the go-to position for the majority of scientists and philosophers although such realism is usually nuanced. It is not just *naive* realism. It is a form of scientific realism that acknowledges scientific theories and models usually contain abstractions, fictions, idealizations, etc., that make them unlike mirrors reflecting the real world. Scientific theories and models are just approximately true about the target phenomena they aim to explain. In this context, some of the objects, processes, and mechanisms featured in scientific theories and models are approximately representing real objects, processes, and mechanisms of the world. Contrary to this form of nuanced scientific realism, an anti-realist position, *instrumentalism*, can also be found in the literature. According to the proponents of instrumentalism, scientific theories and models are mere instruments scientists use to achieve whichever their research goals are but do not need to (or aim to) be true of the objects, processes, and mechanisms of the world. An example of the quarrel between nuanced scientific realism and instrumentalism may be found in contemporary discussions within the philosophy of biology and the cognitive sciences. Bayesian and predictive models used in theoretical biology and theoretical neuroscience, for instance, are interpreted both as mere scientific instruments agnostic of ontological commitments (Andrews, 2021; van Es, 2020) and as providing true descriptions of the components and processes of metabolic and cognitive activities of living organisms (Kirchhoff et al., 2022). Both positions are indeed still a matter of discussion within the philosophy of the life sciences.

Both when it comes to perception and to scientific practice, the general debate between realism and anti-realism (e.g., fictionalism, instrumentalism) is based on the opposition between two relatively simple observations relating to success and failure. On the one hand, we seem to deal very well with our shared environment on a daily basis. This fact points to the success of our perceptual capacities to capture the real properties of the world. Similarly, we are very successful in predicting and explaining different aspects of the world when using our scientific theories and models. Again, this fact seems to entail these theories and models capture real objects, processes, and mechanisms. On the other hand, perception is not always accurate and, more importantly, seems to vary from subject to subject in non-trivial ways. For instance, we sometimes misjudge distances and shapes, seem to be differently affected by illusions, and often perceive colors in different ways even when no pathology is involved. Additionally, we can suffer from perceptual hallucinations under different conditions. All these events seem to support the idea of perception as the mental construction of a model that is not always veridical of the real world. Similarly, the history of science shows that scientific theories and models that at some point in time are considered to capture the real objects, processes, and mechanisms of the world are systematically substituted by more successful theories that posit different sets of objects, processes, and mechanisms. In these cases, the substituted theory comes to be considered no longer as veridical as it was once supposed to be, and it's abandoned in favor of a seemingly more veridical new one. In addition to this fact, it is not difficult to find different models of the same target phenomenon that, even at the same moment of history, enjoy equivalent predictive and explanatory success despite positing different objects, processes, and mechanisms. Together, these observations suggest that scientific theories and models do not represent the real world but are mere instruments used by different scientists to pursue their different scientific aims at different times or even the same moment in history. The debate is therefore framed as a quarrel between acknowledging the success of perception and scientific theories and models—and thus endorsing some form of realism—or acknowledging the epistemic fallibility and variability of perception and scientific theories and models—and thus endorsing some form of anti-realism (e.g., fictionalism or instrumentalism). Such is the seemingly unsolvable dichotomy. Epistemic success or fallibility. Stability or variability. This paper stands against these dichotomies. Despite their pervasiveness in the literature both on perception and on scientific modeling, we contend it is possible to reconcile them. In other words, it is possible to accept and to understand both success and fallibility, both stability and variability. They are not opposed poles. One is not the negation of the other. It is possible to be a realist, and therefore acknowledge that we deal with our environment quite well on a daily basis and that our scientific theories capture reality, while accepting the fallibility and variability of our perception and scientific theories and models. *Pragmatist realists* make the conceptual moves needed for this, and both *direct realism* and *causal patterns realism* are instances that illustrate those moves. They are species of the pragmatist realism genus.

Our main aim in the following sections is to show that, although naive realism is *tout court* incompatible with all anti-realist positions, the core conceptual moves of these species of realism allow for fully accommodating the observations that classically led to fictionalism or instrumentalism. Thus, accepting them would effectively resolve the tension between realism and anti-realism regarding both perception and scientific theories and models. As just noted, one kind of realism able to do so is the *direct realism* favored by ecological psychology in the context of perception (Gibson, 1966, 1979). Direct realism offers a general realist framework that takes perception to deal with real properties and events of the environment while making room for different, and even incompatible, perceptual experiences within the same situation. This is possible thanks to two of the basic conceptual moves of ecological psychology: (a) the substitution of the notion of perceptual content by the notion of lawful specification and (b) the distinction between perceptual states and perceptual judgments. In the case of scientific theories and models, a kind of realism able to accommodate anti-realist observations is known as *causal pattern realism* (Potochnik, 2023a, 2023b). This kind of realism stems from the recognition of instrumentalism as a tenable position and, more concretely, from acknowledging the crucial role of idealization in scientific modeling. As in the case of direct realism, causal pattern realism is possible due to two fundamental conceptual moves: (c) the rejection of veritism as the central aim of science and (d) the distinction between the target phenomenon and the object of knowledge in the context of scientific modeling.

In the rest of the paper, we evaluate the four conceptual moves needed to endorse *direct realism* (section 2), on the one hand, and *causal pattern realism* (section 3), on the other. As will become evident, the two pairs of conceptual moves respectively attributed to direct realism and causal pattern realism can be interpreted as two instances of the same conceptual pair. The first component of this pair is the rejection of truth as the central foundation for realism. The second one is the distinction between phenomena as we talk about them and the different kinds of structures/patterns embodied by those phenomena. Given this, section 4 will explore and argue in favor of *pragmatist realism*. The conceptual moves provided by pragmatist realism are the reason why we are in the position to reject the dichotomy between realism and instrumentalism. To be clear, our argument is not aimed at convincing anti-realists in either domain (or both) to become realists in either (or both). Rather, our goal is to articulate the relation between the realism/anti-realism debate in the two domains (a relation that so far has remained largely unacknowledged), and, by clarifying the nature of what we see as promising versions of realism in both, to propose a general framework that should motivate those with realist sensibilities concerning either perception or science to find allies and support within the other domain. In this sense, and following a pragmatist inspiration, the "cash value" of this work is not so much to offer a (new) form of realism opposed or complementary to prominent realist claims in the philosophical literature (e.g., Chang, 2022; Massimi, 2022; Rice, 2021) but to identify the conceptual moves—or philosophical maneuvers, if you wish—that make these two current realist positions actually be realist. Once these conceptual moves are identified and the general pragmatist strategy that underlies them is made explicit, we will have set the conditions from which we can explore connections between different explanatory practices and from which we can compare the two species of pragmatist realism with other realist proposals in order to find analogies and disanalogies, compatibilities and differences, shared or not shared philosophical maneuvers, and so on. But that is a different story. In this work, we focus on the conceptual moves of direct realism and causal pattern realism.[1]

2. Perceptual Realism: Ecological Psychology

Ecological psychology is an approach to perception, action, and cognition that has been developed during the past five decades in the periphery of the dominant, information-processing paradigm in the cognitive sciences. Ecological psychology has its origins in the mid-20th century with the works of James and Eleanor Gibson and has generated a consistent output of empirical and theoretical results since its inception. In recent years, it has been regarded as one of the theoretical foundations of the 4E approach to the cognitive sciences, joining efforts with enactivism and other theoretical paradigms in order to provide an alternative to the information-processing one (Chemero, 2009; Di Paolo et al., 2017). Most important for the aims of our paper is that ecological psychologists defend *direct realism*, which is the most prominent realist take on perception we can find in contemporary cognitive science.[2]

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[1] We thank an anonymous reviewer for the suggestion of making explicit the "cash value" of this piece of work.

[2] Notice that the notion of direct realism we defend here is the one that comes directly from the ecological approach to perception and action in experimental psychology (Gibson, 1967a). We are aware notions of direct and indirect realism are also used in the field of analytical philosophy of mind. There might be analogies and disanalogies between the ecological notion of direct realism and the one used in the philosophy of mind. We will not explore these issues in this paper. All references to direct realism are references to the ecological notion.

In a philosophical paper, James Gibson (1967a) explicitly embraces direct realism in perception as the corollary of the ecological approach. Put simply, according to Gibson and ecological psychologists afterwards, perceptual information lies in the structure of the ambient energy arrays (e.g., light, air, etc.) that surround organisms. This structure is lawfully related to the layout of the environment these organisms inhabit and, thus, perceptual information is lawfully related to real environmental states. As perception is a function of perceptual information, it is lawfully related to those real environmental states. Thus, if the ecological view of perceptual information is accepted, perceptual realism is granted. In order to arrive at this conclusion, Gibson makes two conceptual moves that would become the core of ecological psychology and, consequently, the core of direct realism. We turn to them now.

2.1 Conceptual move A: Specification instead of content

In the theoretical context of ecological psychology, the notion of *specification* is the foundation of the lawful relationship between environmental states and perceptual information (see Segundo-Ortin et al., 2019). The first step to explain specification is to lay out the big picture of the ecological approach to perception. Its central tenet is that perception is direct (Chemero, 2009; Michaels and Carello, 1981; Turvey, 2018). This means, *contra* the information-processing paradigm, that perception is not the outcome of a process of enrichment and disambiguation of sensory stimulation. In other words, perception is not about constructing an internal model of the external environment by patching poor sensory stimulation with internal resources (e.g., memories, priors) of non-sensory, non-perceptual origin. Perception is not mediated by the construction of a mental representation of the external environment. In this sense, the case for anti-realism in perception weakens. The mediatory processes that make use of memories, inferences, expectations, priors, etc., and fuel anti-realism are just absent within the theoretical context of ecological psychology. But how is perception possible without all these processes? Here's where the notion of specification does its job.

Regarding perception, the alleged need for mediatory processes to build up an internal model of the environment rests on one single assumption: that whatever information we get through our senses is just not enough to support perception (and, by extension, intelligent behavior). This is often called *the poverty of stimulus argument* and was first attributed to Noam Chomsky in his critique of B. F. Skinner's *Verbal Behavior* (see Chemero, 2009). The argument goes like this: at any single point in time sensory stimulation is just too scarce and too ambiguous to be the sole basis of perception; thus, mediatory processes must construct an internal model of the environment that compensates for such scarcity and ambiguity of sensory stimulation. Ecological psychology rejects this argument. The works of the Gibsons and later ecological psychologists have consistently shown that sensory stimulation carries enough information for perception when properly described (see, e.g., Gibson and Gibson, 1955; Gibson, 1966, 1979; Lee, 2009; Turvey et al., 1981; Warren, 2021). The proper description of sensory stimulation in terms of perceptual information involves an ecological understanding of the ambient energy arrays surrounding organisms in a given environment.

One of these ambient energy arrays is, for instance, the ambient optic array. The ecological understanding of the ambient optic array is what Gibson named *ecological optics* and focuses on the structure of light in that array (Gibson, 1961; Tsao and Tsao, 2021). This structure depends on the sources of illumination (e.g., sun, lamps) and the surface layout of the environment: the difference in illumination (i.e., the structure of light) over and under my desktop depends on the position of the lamps in my office, the height of the desktop, the properties of the surfaces of the walls and the floor of the office, etc. Due to this dependence and the laws of optics, the structure of light in the ambient optic array is lawfully related with the layout of the environment. Therefore, at least some properties of this structure are *specific* to the properties of the environment: this specificity means that coming into contact with the structured light in this case is unambiguously and unequivocally informative, for the perceiving organism, about its environment.

Additionally, when organisms move around the environment, the structure of the ambient optic array available to them changes with their movement. This change is known as *optic flow* (Warren, 1998; Matthis et al., 2022). For the same reasons detailed in the case of ecological optics, some properties of optic flow are *specific* to the properties of the environment and the movement of the organisms in it: accordingly, patterns of change in optic flow are informative for the organism not only about the environment in general, but precisely about the nature of the organism's relation to it. Concretely, ecological psychologists claim that the properties of the optic flow that remain *invariant* under different transformations specify the layout of the environment, while some of the changes in the flow specify the movements of the organism. For example, when an organism engages in forward locomotion while looking ahead, the focus of expansion of its optic flow invariably specifies the place in the environment it is heading to, while the centrifugal expansion of the global optic flow from the focus of expansion specifies the locomotive movement itself; walking backwards, in contrast, generates a centripetal pattern in optic flow that is specific to (or lawfully related to) this way of moving in the environment. Within the ecological literature, perception is then defined not as, say, the internal representing and processing of information about the environment, but rather as the detection of the properties of the ambient energy arrays that specify the real properties of both the environment and the organism-environment interactions.

Ecological psychologists have provided a good amount of experimental support to the idea of specification and to the idea of perception as a function of specific perceptual information. We refer the reader to the ecological literature for more details on these issues as we will not further defend the ecological take on perception here (see, e.g., Gibson, 1966, 1979; Lee, 2009; Turvey et al., 1981; Warren, 2006, 2021; and references therein). We want, however, to point out one of the main conceptual moves as a consequence of accepting the ecological story regarding perception. As we have already noted, the information-processing paradigm typical of the cognitive sciences takes perception to involve the construction of an internal model of the environment. Such a process of construction is indeed the root of mainstream anti-realism (fictionalism, etc.) with regard to perception. And this is so because the constructed internal model can be *true or false* of the environment depending on the different elements from which it has been constructed. In other words, the *content* of the internal model may represent or misrepresent the real world and, in any case, it will never constitute a direct reflection of the properties of that world. It will always involve some degree of fiction as a consequence of its constructive nature.

An intuitive "realist" alternative would be to downplay the threat of misrepresentation and to hold, for instance, that the content of our internal models are (virtually) always accurate or true enough, thus guaranteeing that our perceptual states are reliable and trustworthy. But this is not the ecological version of direct realism. The ecological approach to perception, in contrast, does not relate perceptual states to environmental states in terms of truth or content (Segundo-Ortin et al., 2019). The relationship between the structure of the ambient energy arrays and the environment is not characterized in terms of truthfulness or falsehood, but in terms of lawfulness: a given property of the optic flow, for instance, is not true or false of the environment or the organism, but it just lawfully emerges from the organism-environment interactions. Similarly, perceptual states are functions of perceptual information but, crucially, they are not true or false of that perceptual information. According to ecological psychologists, perceivers detect ecological information by resonating or being attuned to it (Raja, 2018, 2019, 2021). They are more like a radio or a scanner tuning to the right signal than a device constructing a model of that signal. Attunement (or resonance) is obviously not cast in terms of truth-values: radios tune or not, but they are not true or false of a given radio station. Thus, ecological psychology effectively removes the notion of truth from the forefront of the theory of perception. While "naive realism" might be construed as a belief in the veridicality of perception, direct realism is not at all related to veridicality, instead construing perception as something that cannot have truth value—at least when it comes to traditional views of truth in terms of correspondence, representational accuracy and so on. This does not mean that the notion of truth must be completely abandoned, of course. In a deeply pragmatist vein, truth is not abandoned but reconceived when accepting direct realism. For particular contexts and descriptions, truth, correctness, and accuracy still apply to activities based on and guided by perceptual knowledge (see Section 2.2 and Section 4; see Raja and Chemero, 2020). They just do not apply to the concrete relationship of fundamental perceptual states and the environment. Perception gives us knowledge of some real properties of the environment without perceptual states being the sort of thing that can be true or false. But how can it be?

2.2. Conceptual move B: Separating perceptual states and perceptual judgments

Philosophy of perception and information-processing-based cognitive science share what can be called a *descriptive* view of perceptual states. In the case of philosophy of perception, perceptual states are often considered to be judgments about the environments—aka propositional attitudes (e.g., Byrne, 2005; McDowell, 1994). Perceptual states are of the form "that apple is red" or "this car is approaching". In other words, perceptual states are a form of categorical judgment that identify a subject of predication and predicate something about it. The content or meaning of these states is of course evaluated in terms of truth and falsehood. The case of information-processing-based cognitive science is similar. Although not always framed in terms of propositional attitudes, perceptual states are taken to be representations of objects and their properties (Hafri and Firestone, 2021; Shea, 2018). In this sense, perceptual states also involve a process of categorization (i.e., identifying an object and predicating something about it) and can be evaluated in terms of truth and falsehood as they can represent or misrepresent the target environmental state.

Ecological psychology frontally rejects the characterization of perceptual states as perceptual judgments or representations. As we have already noted, ecological psychologists take perceptual states to be functions of perceptual information. Perceivers detect perceptual information and that's the way they meaningfully relate to their environment. But, if perceptual states are not representations of the environment or categorical judgments, in what way are they meaningful? How do they provide cognitive access to the world? According to the ecological approach, perception is of *affordances* and they are the foundation of perceptual meaning (Heras-Escribano, 2019). Affordances are opportunities for interaction that organisms find in their environments: the edibility of an apple, the walk-ability of the ground, the step-ability of stairs, the grab-ability of a mug, etc. Perceptual information is specific to these opportunities for interaction and detecting it is perceiving an affordance. Importantly, perceiving an affordance is not based on a judgment about the existence of the affordance. For instance, when a goat perceives the jump-ability of a cliff, there is no perceptual state of the form "this cliff is jumpable" in the mind/brain of the goat. Indeed, there is no category of “cliff” in the goat to begin with. The goat meaningfully relates with its environment by a perceptual experience that—when properly tuned, in the radio metaphor described above—allows for a proper control of action. But that particular perceptual experience does not involve any kind of judgment or categorization. Even though we might describe the target phenomenon as a cliff being jumpable or not, the perceptual experience is just the function of the structure of light surrounding the goat and specific to a particular environmental state and the goat’s relation to it. Notice that this does not mean that we do not make categorical judgments or that we do not have categorical knowledge. To be clear, categorization is something we—and maybe other animals—do in many sociocultural contexts. And categorical judgments and categorical knowledge are perfectly compatible with direct realism. Ecological psychologists take the perception of affordances to be the fundamental perceptual process and, therefore, to be delivering the fundamental perceptual knowledge. Afterwards, this knowledge can inform categorization practices. For instance, affordances seem to inform linguistic categories and other forms of representations, as the empirical evidence in ecological psychology and other fields suggests (e.g., Wilford et al., 2022; Castellini et al., 2011; Snow & Culham, 2021). However, perception of affordances and categorization are not analogous.[3]

[3] An anonymous reviewer suggests a possible problem: by not paying due attention to perceptual judgments, direct realists are forced to abandon some of the traditional notions of perceptual knowledge. We agree with the anonymous reviewer that judgments involving categorization, such as “the computer is on the table”, are traditionally understood as a kind of perceptual knowledge. In the case of direct realism, however, they are seen as distinct cognitive activities informed by perceptual knowledge and constrained by other cognitive abilities, like learning, language, social skills, and so on. The key is that what direct realists—as opposed to the traditional theories of perception—are willing to call “perceptual knowledge” does not include non-perceptual abilities. Traditional theorists are willing to include non-perceptual resources in perception and, therefore, are willing to accept some form of *inference* that goes from non-categorical sensations to categorical judgments. An inference may involve memory, information-processing, construction of mental representations, filtering, edge detection, amodal completion, and so on. These processes are precisely the ones that lead to anti-realism in perception, as perceptual knowledge is taken to be the product of an

In the general case, the disanalogy between the perception of affordances and perceptual judgments or categorizations is explicitly discussed in a sidebar of Gibson's last book:

> To perceive an affordance is not to classify an object. The fact that a stone is a missile does not imply that it cannot be other things as well. It can be a paperweight, a bookend, a hammer, or a pendulum bob. It can be piled on another rock to make a cairn or a stone wall. These affordances are all consistent with one another. The differences between them are not clear-cut, and the arbitrary names by which they are called do not count for perception. If you know what can be done with a graspable detached object, what it can be used for, you can call it whatever you please… You do not have to classify and label things in order to perceive what they afford. (1979, p. 134).

The sidebar is illuminating for a fundamental reason: it frames affordances in opposition to fixed categories. By doing so, it recognizes the variability of perceptual experiences beyond our categorization practices. For instance, even when we classify a target situation as involving some specific object, like a stone, that does not mean that our perceptual experience is fixed. Our description of the target situation is not the object of experience. The objects of experience are affordances, and detecting perceptual information is perceiving them.

This is the last component of direct realism. Affordances are both objects of perceptual experience and real elements of the organism-environment interactions. The lawful and specifying character of

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event of subjective construction—or controlled *hallucination*, according to some (Seth, 2021). Direct realists do not accept such kind of inference in (at least the fundamental bits of) perceptual knowledge, securing a fundamentally realist access to the environment and a safe, realist foundation for further practices of categorization and other kinds of knowledge.

perceptual information is what ensures the reality of perceived affordances without the need for judgments, categorization, or evaluation in terms of truthfulness and falsehood. In this sense, direct realism is founded on the identification of the object of perception beyond our descriptions of the environment and the rejection of the evaluation of perception in terms of its veridicality. At the same time, as affordances are opportunities for interaction—and therefore concern the environment and the perceiver at the same time—direct realism ensures that similar situations (i.e., situations involving the same description) may provide different affordances to different organisms or to the same organisms at different moments in time. Thus, direct realism dissolves the tension between the stability emphasized by realism and the variability emphasized by anti-realism.

3. Scientific Realism: Causal Patterns

In philosophy of science, realism can be understood as an attitude toward the success of science, namely the perspective that the success of science stems from the truth of scientific theories. In particular, as it is often construed, the realist stance holds that it is because theories are true (at least approximately) that they can be used for generating successful predictions and explanations of phenomena in the world. Given this broad characterization, realism is traditionally tied to discussions concerning unobservable entities and processes posited by our theories: in contrast with the (anti-realist) instrumentalist view that empirical success does not warrant conclusions about truth, realists hold that successful theories are useful precisely because they are in fact true, because they actually (even if not completely accurately) capture what the world is like, including the entities and processes posited that are not subject to direct observation. This realist stance is neatly captured in the claim that "mature and genuinely successful scientific theories should be accepted as nearly true" (Psillos 1999, p. xv).

In her recent work, Angela Potochnik has offered an elegant and nuanced alternative version of scientific realism, one that takes seriously the success of science and realist intuitions about this success, but that reorients realist commitments so as to make them compatible with what might otherwise seem to be an anti-realist stance on scientific theories and models. In her 2017 book *Idealization and the Aims of*

Science, Potochnik emphasizes how idealization is "rampant and unchecked" in science: scientists routinely build and use models that differ, sometimes even grossly, from the phenomena of interest, not only simplifying and omitting detail, but also including in the model features known to be absent in the real-world phenomena. And not only is idealization widespread, but it's typically embraced by scientists as unproblematic, both as a general practice and as a characteristic of particular models. Different models that are seen as scientifically successful can work under different assumptions, they can model different aspects of the same target phenomenon, and they can even be totally incompatible—and still all of this does not undermine scientific realism. This is possible thanks to two key conceptual moves.

3.1 Conceptual move C: Understanding rather than truth

Potochnik's view can be interpreted as revealing how science succeeds through failure. As just described, models knowingly and often intentionally fail as representations of real-world systems and phenomena: models can be inaccurate, incomplete, and even outright wrong about their target phenomena in various respects—this means that, if judged in terms of their representational content, models knowingly and often intentionally fail to give us the truth about the world. And, with the support of examples from various cases of scientific practice, Potochnik further emphasizes that many of the best, most successful scientific theories and models are evaluated by scientists as being good and successful not despite idealization (i.e., a failure to be true in various respects) but because of it: scientists often treat idealizations as features that make models and theories more, rather than less, useful and successful. When confronted with such a puzzling observation—scientific success arising through failure with regard to truth—the philosopher has to decide whether to conclude that scientists are wrong or to conclude that philosophical conceptions about science need to be revised. Potochnik takes the latter path.

The key idea is to reconsider what we take the aims of science to be. "Idealizations cannot directly contribute to science's epistemic success in virtue of their truth," after all by definition they are not true (2017, p. 94). Instead, as Potochnik provocatively puts it, "science isn't after the truth": following Elgin

(2004, 2017) and others, she proposes that the fundamental epistemic achievement of science, and its main aim, is understanding rather than representational accuracy or truth.

For this to work, she explains, “understanding” must mean more than just the feeling of understanding. Sometimes, when confronted with a problem, people can mistakenly feel they’ve understood the situation and move on, only to later find out (or be told by someone else) that they had not in fact correctly understood what was going on. “Understanding” includes this psychological dimension, the felt experience that a tension has been resolved, a problematic situation has been addressed, and insight has been gained. But for it to be genuine, understanding must also include an epistemic dimension: you only achieve understanding when, in addition to feeling like you have grasped something, you did in fact successfully grasp it.

This “dual nature” of understanding, as both psychological and epistemic, is crucial in Potochnik’s account. Truth ticks one of the boxes: creating a true description constitutes an epistemic achievement, insofar as a true description succeeds in capturing what the thing described is actually like. But truth does not guarantee the psychological dimension of understanding, and it can even prevent it. A maximally comprehensive and accurate description of some system would by definition be true. But sometimes less is more. Excessive detail can in many cases be a source of confusion, with irrelevant truths getting in the way of intelligibility and insight by occluding what actually matters. And this is because, in science, “what matters” is not defined only in terms of the phenomena, but also of the people studying them. Science is not in the business of compiling truths about the world: science is something that humans do, and what scientists are after is understanding. And as limited beings grappling with a complex world, we have to simplify and idealize: “Science is tailored to human needs and thus human limitations, which leads to a focus on rather simple patterns that contribute to human understanding and influence” (Potochnik 2017, p. 57).

With its emphasis on truth, traditional realism seems out of touch with real-world scientific practice, especially in model-based research, where “less accurate explanations are sometimes better than more accurate alternatives” (Potochnik 2023a, p. 154). But the problem here is the assumption that a realist attitude toward the success of science must be committed to *veritism*, namely the assumption that truth is the fundamental epistemic achievement. Shifting our emphasis to understanding (in both its psychological and epistemic dimensions) allows us to embrace the role of idealization and still remain realists: by contributing to understanding, "idealizations contribute directly to the epistemic success of our scientific explanations" (2023a, p. 154). But how can this be?

3.2 Conceptual move D: Separating target phenomena and causal patterns

Scientific realism, we have seen, is a positive attitude about the success of science, and in particular, as traditionally construed, one in which science is seen as successful because, and to the extent to which, it truthfully represents how the world works. As an alternative, and to disentangle it from veritism, Potochnik offers the following broad characterization of what realism ultimately boils down to: "realism is the idea that *our best scientific accounts qualify as epistemic achievements and yield knowledge of the world*" (2023a, p. 10, italics original). Given this characterization, and given the shift to an emphasis on understanding that accommodates the contribution of idealizations, the question that arises, then, concerns *what we're realists about*, if not about the truth of scientific theories, models, explanations and accounts of the world. Potochnik explains:

> I think we should be realists about—that is, posit that we have scientific knowledge of—the objects of well-corroborated theoretical claims. But those objects are not unobservable entities, mechanisms, or even the phenomena under investigation. Rather, science's theoretical claims (when successful) often yield knowledge of causal patterns. (Potochnik 2023b, p. 4)

The key move here is that of distinguishing target phenomena from causal patterns. Put simply, causal patterns are regularities in dependence relations, that is, regularities in "how a shift in one thing changes another" (2017, p. 29). One and the same system or phenomenon embodies multiple causal patterns, while one and the same causal pattern can be, “perhaps with deviations and exceptions, embodied by some limited range of phenomena” (2017, p. 95). Consider, for instance, the causal pattern of predator-prey dynamics with their cycles of relative population fluctuation. This causal pattern was notoriously formalized in the Lotka-Volterra equations based on observations of fish populations in the Adriatic Sea, but it is clearly not limited to that particular context. The same causal pattern is also exhibited by many other biological populations in other places throughout the world, whether aquatic (such as phytoplankton and benthos in the San Francisco Bay: see, e.g., Dame and Prins, 1997) or terrestrial (say, polar bears and seals, or rabbits and foxes in their respective niches), and it appears also in non-biological systems, such as in the US and British economies (see, e.g., Goodwin, 1967, Desai 1984, Mohun and Veneziani, 2016). The same causal pattern is there to be found in many different real-world systems. At the same time, however, any of these real-world systems exhibits a practically endless number of different causal patterns beyond this particular one. In addition to the causal patterns of predator-prey dynamics just mentioned, and more famously so in philosophical circles, the San Francisco Bay also exhibits the fundamentally different hydraulic causal patterns modeled in the U.S. Army Corps of Engineers Bay Model, the scale model built in the 1950s for testing the viability of project for building a dam in the Bay area (Potochnik, Colombo & Wright, 2018). And similarly with the British economy, which besides embodying causal patterns characteristic of predator-prey relations, also exhibits distinct patterns of causal dependency between rates of taxation, savings, and investment in health care and education that are well-known in the philosophical literature for having been modeled with pipes and tanks in the Phillips machine (ibid). Examples like these are everywhere to be found. One and the same real-world system embodies a number of different causal patterns that can each be studied in their own right, whereas one and the same causal pattern might be present in a number of distinct and otherwise very different systems. The key idea at play here, then, is that scientists pursue and often achieve understanding *of target phenomena*, but this is not by means of aiming for, and succeeding in developing, true (even approximately) accounts of the phenomena, but rather by gaining knowledge of relevant *causal patterns* that the phenomena of interest embody.

The terms "relevant" and "of interest" in the previous sentence point to the psychological dimension of this version of scientific realism and the view of science it's built on. As we have seen, understanding is inherently agential: unlike the absolute truths of impersonal descriptions, it's always *someone* who understands or doesn't understand something. Accordingly, given the multiplicity of causal patterns embodied by phenomena, *which* causal pattern is relevant can vary with context and be different for different scientists and scientific projects: "a causal pattern's ability to explain (or, equivalently, to engender understanding) depends on the research interests of those seeking explanation" (2023b, p. 176). But this is still a realist position insofar as there is a fact of the matter concerning the existence (or not) of the causal pattern of interest. Both the causal pattern of predator-prey relations and the different causal patterns of water currents, sediment movement and so on really are present in the San Francisco Bay, but only the latter were directly relevant for researchers trying to answer the question "what would happen if we build a dam here?". Information about causal dependence and the scope of dependence is useful, illuminating and explanatory (or conducive to understanding) because it's "precisely the information needed to predict and intervene on our world: information about what factors influence a phenomenon, and in what circumstances" (Potochnik and Sanches de Oliveira 2021, p. 1314). And causal patterns are regularities that we can have actual, "full-fledged" knowledge of, as well as fail to—what's context dependent in scientific knowledge about causal patterns is not whether the causal pattern is real, but whether it is of interest, that is, "the cognitive value to the explainers or knowers" (Potochnik 2023b, p. 176).

The last point to be articulated concerns how idealization enters the picture—that is, how to link understanding of target phenomena through knowledge of causal patterns, on the one hand, and the way model-based research violates veritist expectations, on the other. And the key, quite simply, is that even while grossly differing from various aspects of the target phenomena, scientific models can contribute to understanding by successfully capturing the relevant causal patterns. Just as a given causal pattern can be present in different phenomena, so can *models* embody the same causal pattern, thereby enabling interventions that support insight into the phenomenon of interest. By embodying the relevant causal patterns in each case, the scale San Francisco Bay model, the Lotka-Volterra equations, and the Phillips machine all made it possible for researchers to gain understanding about the phenomena under investigation, despite the many obvious differences between the models and the real-world systems of interest.

The way in which models differ from target systems and phenomena is, of course, traditionally construed as the way in which models *misrepresent* those targets. The scale of the San Francisco Bay model is disproportional for width and depth compared to the actual bay, whereas real-life preys don't have unlimited access to food, and the British economy does not run on water and is subject to inflation, something that the Phillips machine didn't account for. These "sins of omission and commission" (Callender and Cohen 2006), or differences due to what models neglect and what they incorrectly posit, are typically described as ways in which models, as representations of their targets, are false about those targets. And although Potochnik sometimes talks about models along these lines, in representational terms (see, e.g., Potochnik 2017), her emphasis on real causal patterns embodied by phenomena *and* by models, on the one hand, and her emphasis on understanding as the central epistemic aim of science, on the other, are suggestive of the viability of an alternative interpretation in line with recent non-representational accounts of models as tools, artifacts and instruments, such as "radical artifactualism" (Sanches de Oliveira, 2022a; see also Sanches de Oliveira et al., 2021). A common representationalist assumption is that the epistemic value of model-based research is best understood in terms of representational relations between models and target phenomena. In contrast with accounts that adopt an artifactualist ontology (treating models as tools) but remain committed to this representationalist epistemology (holding that epistemic success is tied to representation), radical artifactualism proposes that the tool-like or instrumental nature of models suffices also to account for their epistemic value: a model can help "advance scientific understanding of some real-world system by being similar to that system in some action-relevant way," such as "when model-artifacts enable manipulations that are similar to manipulations of interest in some real-world system" (Sanches de Oliveira, 2022a, p. 26). Arguably, the interactions that models enable can be understood in terms of the causal patterns that models embody, some of which may be relevant and useful in the context of research targeting different phenomena: because the model embodies those causal patterns (e.g., literal water current and sediment movement patterns in the scale Bay model or abstract cyclic relative fluctuation patterns in predator-prey models), interacting with the model can be a means to gaining knowledge of the causal pattern and, accordingly, it can inspire similar interventions in other systems that also embody the same causal pattern; yet recognizing this does not necessitate ontologically or epistemologically interpreting the model (say, the scale Bay model or the Lotka-Volterra equations) in representational terms as a *description* or *depiction* of the target and its causal patterns, just as finding the same causal pattern in different real-world systems (say, predator-prey dynamics in different biological populations, or water current patterns in different bays) doesn't entail treating one system as a representation of the other. In this perspective, the so-called "target phenomena" aren't understood as targets that the model is supposed to represent, but rather as targets of investigation that provide the context in which building and operating with tools (i.e., models) that embody certain causal patterns can be epistemically useful because it leads to better understanding of those phenomena through knowledge of their causal patterns. And similarity with regard to the causal patterns that model and target both embody can be (and often are) exploited for making claims which may be true or false about the target, but the similarity itself has no truth value: similarity and dissimilarity between two things with regard to the causal patterns they embody can explain why engaging with one sometimes leads to a better understanding of the other, but the similarity and dissimilarity do not on their own make one a (better or worse) representation of the other. If this is right, then, by connecting to emerging views of models as tools while remaining neutral with regard to claims concerning representation, it seems that scientific realism based on causal patterns is even more attractive and generally applicable than Potochnik may have anticipated.

To conclude, in the realism about causal patterns explored here, the same target phenomenon can embody different causal patterns—not like objects embody Aristotelian forms, but more like time series embody trends or higher-order structures. Different models used in investigations of the same phenomena can differ from one another, and even be incompatible with each other, by targeting those different causal patterns. In the end, the epistemic value of models is not properly construed in terms of whether they are true or false about the target phenomena: rather, models contribute to the epistemic success of science because they capture, more or less well, causal patterns embodied by the phenomena, and through this, enable better understanding of those causal patterns. Which causal patterns of which phenomena are of interest depend on the goals of different scientific projects. But the causal patterns are real, both as aspects of the real-world phenomena and of the models. Causal pattern realism is scientific realism without veritism.

4. Two Species of Realism, One Genus

In principle, direct realism and causal pattern realism are independent from each other, and the fields where they apply–perception and science–are not necessarily connected (cf. Sanches de Oliveira et al., 2023). However, the two forms of realism share the same kind of conceptual moves, and, we propose, can be understood as two species of the same realist genus. To begin articulating this relation and correspondence between the two, a summary of the convergences discussed up to now is provided in Table 1.

	Direct Realism (Perception)	**Causal Pattern Realism (Science)**
Variability	One and the same object has potentially many different affordances, and different affordances can be more or less relevant for different people at a given point in time as well as for the same person at different points in time.	One and the same model and one and the same phenomenon embody potentially many different causal patterns, and different causal patterns can be more or less relevant for different scientists (or scientific projects) at the same time or for the same scientists (or scientific project) at different points in time.
Stability	Perceptual states specify, or are lawfully related to, organism-environment interaction, making them reliable guides to action through the detection of affordances.	Models that embody a causal pattern that is also embodied by some target system or phenomenon can be reliably used for interventions that generate understanding of that causal pattern and, through this, understanding of the target.
Epistemic success without veritism	Perceptual states can be used for categorization and to form judgments (which have truth value, that is, can be evaluated as true or false about aspects of	Models can be used to inform descriptions of target phenomena, and they may themselves be interpreted as representing the phenomena more or less accurately in some way or other

	the environment), but these are secondary; the primary aim of perception is the guidance of action through the detection of affordances.	(thus enabling evaluation in terms of truth or falsehood), but this is secondary; the primary aim of modeling is to engender understanding by enabling interventions that are relevant in the context of investigation about "target" phenomena.

Table 1. Convergences between direct realism and causal pattern realism that result from the analogous conceptual moves at play in the two forms of realism as described in sections 2 and 3 (i.e., *a* in direct realism alongside *c* in causal pattern realism, and *b* in direct realism alongside *d* in causal pattern realism).

Direct realism and causal pattern realism coincide in moving away from the emphasis on truth that, in each of their domains, tends to motivate the tension between realist and anti-realist perspectives. In the domain of perception, direct realism does this by abandoning the notion of perceptual content based on truth-values in favor of the notion of specification based on natural law (conceptual move *a*). And in the domain of science, causal pattern realism does this by rejecting veritism and, instead, construing (or rather, recognizing in scientific practice) the more fundamental role of understanding rather than truth as the primary epistemic aim of scientists (conceptual move *c*). In each case, the analogous move is made possible by the way in which direct realism and causal pattern realism both reframe the object of interest in their domains—another key respect in which the two coincide. For direct realism, moving away from the typical emphasis on truth is possible because in ecological psychology the object of interest is reframed by separating perceptual states from perceptual judgments (conceptual move *b*): in contrast with the common assumption that judgments are the starting point for perception, direct realism reverses this order, seeing judgments as enabled by, and potential products of, perceptual experience. And for causal pattern realism, moving away from the usual emphasis on truth is possible because the object of interest is reframed through a separation between causal patterns and target phenomena (conceptual move *d*): rather than assuming that the accumulation of truths about target phenomena is the primary measure of epistemic success, this variety of realism recognizes the more fundamental importance of causal patterns, and in particular, the goal of understanding the causal patterns embodied by target phenomena through investigation of other objects that embody the same causal patterns (i.e., models).

Through these analogous conceptual moves (i.e., *a* and *c*, *b* and *d*), direct realism and causal pattern realism both reject the emphasis on truth that is common in their respective contexts, yet this is not to say the two frameworks entirely abandon any notion of truth. Both have a role for truth, it's just not the role that is typically assumed in their domains.

In perception, as we have seen, truth (as traditionally conceived, in terms of representational accuracy or correspondence) is often considered important because perceptual content, categorizations and judgments are evaluated in terms of how true they are—e.g., how accurate the internal model is as a representation of the outside environment. But direct realism rejects the notion of perceptual content and, through this, it circumvents this supposedly foundational role of truth. Categorization or judgments can be evaluated in terms of truth or falsehood, but they are activities people engage in based on their perceptual experience rather than the other way around (i.e., rather than their perceptual states being the result of categorization or judgments). Still, some kind of normativity is still present in the direct realist picture which can, more broadly construed, be described and interpreted in terms of truth, especially when it comes to our descriptions of perceptual events and perceptual knowledge. A classic example in ecological psychology is a shark that relies on its ability to detect fishes' self-generated electromagnetic information to approach and hunt them (see Turvey et al., 1981). If some scientists use an electronic device to generate equivalent electromagnetic information in its environment, the shark will likely approach and try to hunt the electronic device. In this case, we can say that the shark was properly detecting perceptual information, even if its action of approaching and hunting was not properly informed by the *true* environment. Due to the artificiality of the environment, the available information was not specific in the same way that it is in the shark's typical environmental niche. Similarly, in the Ames Room—a room that, due to its shape, distorts the size relationships of the objects inside it when looked at from a particular point of view—we can say that the perceiver is not seeing the *true* environment even though her perceptual state is a function of the available perceptual information. The artificiality of the environment, this time combined with a restriction of the perceiver's movements that forces her to look at the Ames Room from just one point of view (see Runeson, 1988), is again what introduces an element worthy of an evaluation in terms of truth and falsehood. In both examples, the notion of truth can be applied when evaluating the whole situation and the *actions* of the perceiver in her environmental niche are taken into account. On one interpretation or manner of describing the situation, for instance, the electromagnetic pattern detected by the shark can be said to constitute a *false* signal, one that fails as a guide to action (namely, the action of hunting for food), yet this doesn't entail a failure of perception (e.g., the falsehood of the shark's perceptual content, or the inaccuracy of the shark's internal model): the shark's action *was* appropriate given the pattern—what was inappropriate was the artificial manipulation of that energy pattern by humans, violating the lawful relation that otherwise holds in the shark's niche. And the same applies to the Ames Room: given the subjective impression that common objects in the room have abnormal sizes, the perceiving subject's claim that one person is twice as tall as the other one is, of course, subject to evaluation in terms of truth values; and as for the perceptual state itself (rather than the judgment), although it could potentially be interpreted as evidence of a perceptual failure (e.g., the falsehood of the visual information), a different interpretation, favored in ecological psychology, is that, on the contrary, the subjective experience is evidence that the laws of ecological optics *do* hold and that only the imposition of artificial constraints, not typically part of the niche, (here, a restriction in movement, which is a major disruption of the usual organism-environment interaction) could make it seem otherwise. Truth is not at the forefront of perception, and therefore it does not apply to perceptual information or perceptual states in the traditional fashion, but it does apply to different activities that are constituted or at least crucially depend on perceptual knowledge.

Much the same happens, in the domain of science, where the tension between realism(s) and anti-realism(s) typically hinges on how optimistic or pessimistic one is about science's prospect of achieving truth in the way theories, models and explanations represent the world. Causal pattern realism avoids this tension by recognizing that the primary epistemic goal of scientists is understanding rather than truth. Yet this doesn't mean that truth never matters. The emphasis on understanding rather than truth, and on causal patterns rather than on target phenomena as a whole, does not preclude the existence of particular contexts in scientific practice where scientists care about truth about target phenomena. Accurately representing some biological or physical system, for instance, or linguistically describing that system in as much detail as possible, may well be important for some purposes in some contexts—and in those particular contexts, failure to deliver truth would be a significant shortcoming. No doubt, success in these cases is appropriately determined in terms of the truth value of the representations, descriptions, and so on. The observation motivating causal pattern realism is that these sorts of activities and goals are not the most fundamental activities and goals. When it comes to explanation-seeking investigation practices, especially in model-based research, scientists often willingly compromise on truth and accuracy broadly construed, thus revealing that these are subsidiary to what ultimately matters: understanding. And while representations, depictions and declarative sentences about real-world systems and phenomena *as statements of what is known* can be judged as better or worse in terms of how well they describe those systems and phenomena, it would be wrong to mistake these facts for the means by which knowledge was obtained. In many cases, the means to understanding was intervention on models that embody some causal patterns of interest but which, *if* evaluated in terms of overall accuracy in representing the target phenomenon as a whole, would be properly described as more false about the target than other competing models. The fact that scientists routinely prefer models that are representationally defective (or "false") indicates that interpretation of epistemic success in terms of representation with truth values (i.e., the "if" in the previous sentence), although popular in philosophical circles, is an external imposition, one that violates what scientists themselves see as constituting epistemic success. The mistake, that is, is to think that the domains where truth matters more than anything else are more fundamental, maybe even instrumental for understanding, and accordingly to interpret and evaluate the tools of science (e.g., models) in terms of truth value: as Potochnik compellingly argues, in many cases in science, and perhaps more often than not, understanding of causal patterns is the primary goal, and when truth about target phenomena in general gets in the way, it is willingly given up on.

Direct realism and causal pattern realism thus coincide in two key conceptual moves, first, coinciding in the fact that they depart from the emphasis on truth that is typical in their domains, and, second, coinciding in how they do this, namely by redescribing the object of interest in their domain. Having spelled out the similarity in more detail, we can now move to articulating the deeper connection we see between the two forms of realism. Our proposal is that these two classes of conceptual moves belong to a genus of realism—a genus we have named *pragmatist realism*. Pragmatist realism is a general realist attitude founded on the redescriptions of the general aims and targets of knowledge and of the role of truth in them.[4] When such redescriptions are in place with regard to perception, a species of direct realism emerges. When they are in place with regard to scientific models and theories, a species of causal pattern realism is developed. But why do we choose pragmatism to label this genus of realism? There are both historical and epistemological reasons to do so. Historically speaking, and specially through the works of John Dewey (1929), pragmatism is associated with the scientific instrumentalism that, subsequently, was the general theoretical framework in which some of the ideas supporting causal pattern realism emerged. At the same time, ecological psychology is a scientific project that directly emerges from William James' pragmatism and radical empiricism (Costall, 2023.; Heft, 2001; Segundo-Ortin and Raja, 2024). William James was the advisor of E. B. Holt, an American psychologist who was both a member of the self-proclaimed *new realists* (Charles, 2012) and the main influence of James Gibson's scientific training in psychology (Gibson, 1967b). This biographical connection furnishes all the aspects of direct realism.

The epistemological influence of pragmatism both on direct realism and on causal pattern realism is manifest in the conceptual moves explored in the previous two sections. Pragmatism is the source of the

[4] We choose this name to signal our proposal as different from other proposals that aim to tie pragmatism and realism together. An example of these proposals is *pragmatic realism* as defended by Roberto Torretti (2000) or Hasok Chang (2016), for instance. There are similarities between pragmatic and pragmatist realism that have to do mostly with their treatment of truth. We will not present these similarities here. There are as well differences that drive our divergence in naming. The main difference has to do with the restricted focus of pragmatic realism on the notion of truth. Although, as already noted, we also have explored the notion of truth, pragmatist realism is a wider conception of the influence of pragmatism in the presented realist views.

two re-descriptions at the basis of both kinds of realism. At the end of the day, James takes the scope of pragmatism to be "first, a method; and second, a genetic theory of what is meant by truth" (1907, p. 65-66; see also Sanches de Oliveira, 2022b). Regarding truth, pragmatists abandon the correspondence criterion (alluded to above) and defend a notion of truth tied to practice: "truth" is the name for what makes our practices successful—and, as causal pattern realism emphasizes, sometimes our practices are *more* successful if and when we work with what, under the narrower traditional rubric (in terms of correspondence, or representational accuracy), would be described as falsehoods. This pragmatist notion of truth is the one at play in direct realism and causal pattern realism. In both frameworks, truth gets reframed in such a way as to become entangled with particular practices—either scientific or behavioral—and their success. Truth (as correspondence) can be relevant for a concrete aim within a given scientific field and the practices associated to it just as it can be relevant for understanding what kind of practices (e.g., actions) in a given artificial environment, such as the Ames Room, are the right ones to not to be deceived; yet these cases fall under the umbrella of truth in the more general, pragmatist sense as practical success.

Effectively, the pragmatist notion of truth allows for a *plurality of truths* within the same world and situation depending on the practical contexts in which they are developed. In consonance with this line of thought, pragmatism is characterized as:

> The attitude of looking away from first things, principles, 'categories,' supposed necessities; and of looking towards last things, fruits, consequence, facts. (James, 1907, pp. 54-55).

The method of pragmatism is, therefore, a re-description (or perhaps a re-building, a re-construction) of the usual methods of classical epistemology. Pragmatism brings inquiry to the fruits and consequences of knowledge instead of its necessities and principles. This allows for philosophical and scientific theories to be instruments (see James, 1907, p. 53) and not reflections of the one and only true world. Indeed, as different practices may entail a diversity of consequences and fruits, a plurality of truths can coexist based on the different aims of the agents that engage in those practices—just like different perceptual states may emerge in similar environmental contexts depending on the actions of the organism and different scientific models of the same target phenomena can be more epistemically successful depending on the scientific aims of the researcher.

Pragmatism fully accommodates variability and plurality in knowledge. In this sense, pragmatism is compatible with instrumentalist ideas regarding both scientific modeling and cognition (e.g., Sanches de Oliveira et al., 2021). However, pragmatism makes this possible without necessarily falling into fictionalism or relativism. Although some neo-pragmatists, like Richard Rorty, openly embraced a form of relativism, pragmatism as such can be read in a realist way. James and Dewey, for example, thought that both the instruments used and the practices performed by agents to cope with their world are means to access real aspects of the latter. Moreover, both James and Dewey dismissed intellectualist theories and models that, according to them, were not able to capture the reality of their phenomena of interest–e.g., James' accusation of inferential theories of perception to be “pure mythology” in *The Principles of Psychology* (1890). Pragmatism and realism are compatible in different ways (see Torretti, 2000; Chang, 2016) and pragmatist realism is one result of this compatibility. Pragmatist realism allows for embracing both realism and instrumentalism at the same time while rejecting fictionalism and relativism regarding perception and/or scientific modeling: the opposite of pragmatist realism is not instrumentalism, but intellectualism and veritism (i.e., when narrowly construed—as it typically is—in terms of truth as correspondence or representational accuracy).

Direct realism and causal pattern realism are species of the genus of pragmatist realism, and they are such because their particular conceptual moves are instances of the more general conceptual moves of pragmatism. That said, it seems to be expected that accepting pragmatist realism entails the acceptance of both direct and causal pattern realism. Although this is possible (and, we think, attractive), it’s not necessary. One can accept direct realism without accepting causal pattern realism and vice versa. In other words, one can think we have direct perceptual access to real aspects of the world while rejecting such access from our scientific models and theories. And, conversely, one could accept causal pattern realism in the domain of scientific practice, while still holding onto intellectualist and veritist assumptions about perception, cognition, and mind. Still, the relationship between direct realism and causal pattern realism is interesting, and, although it's possible to accept one without the other, we want to highlight the benefits of connecting the two.

There are different ways of articulating this connection, with two directions of influence. On the one hand, we can think about ideas like the ones discussed in Section 2 (about perception) in light of the ideas from Section 3 (about science). Along these lines, it's possible to apply causal pattern realism to the philosophy of cognitive science and, for instance, based on ideas concerning science and the epistemic achievements of scientists in general, we can think of psychological science as research aiming at understanding mind and behavior through grasping causal patterns: in this sense, then, the differences between ecological psychology and computationalism/representationalism can be made sense of in terms of potentially different causal patterns and/or potentially different inquiry projects, with distinct aims with regard to understanding and explanation. Some aspects of this connection have been sketched in the recent literature (see, e.g., Sanches de Oliveira 2023), but many important details are still missing. Being clear on the relation between the two realisms, as we propose in this paper, could help drive progress on this front.

On the other hand, and conversely, we want to propose that it's also possible to think about the ideas from Section 3 (about science) in light of the ideas from Section 2 (about perception). This would constitute an extension of the ecological view, from the usual cases of perception-action in ordinary contexts, so as to account for the perception-action that humans engage in when doing science. Consider how, according to ecological psychology, in daily activities we resonate to informative patterns emerging in a dynamically unfolding organism-environment system: central to the ecological approach to explaining psychological phenomena, therefore, is the idea that we are sensitive to these informative patterns and that they constrain and enable behavior (see Raja and Anderson, 2021). The crucial point for the present discussion is that these informative ecological patterns are also causal patterns: and just as we resonate to causal patterns in daily activities (and as other animals also do), so do we resonate to causal patterns when doing science. This perspective echoes the well-known classical pragmatist idea that there is no fundamental discontinuity between "ordinary" practices and scientific practices. In both domains, coping successfully is what matters: questions about truth and the truth value of propositions we might make in the context of coping become of secondary interest because they are also ontologically secondary (or derivative) to direct perceptual attunement.

Summing up, we hope to have opened in this paper an alternative path that reconciles realism and instrumentalism in the general case. As we have pointed out, pragmatist realism is a realist alternative opposed just to intellectualism and veritism but not to instrumentalism. In this sense, pragmatist realism is a genus of realism that makes it possible to accommodate both realist and instrumentalist commitments in a coherent paradigm. The two species of realism reviewed here, direct realism and causal pattern realism, are instances of pragmatist realism in two different fields–perception and science. They illustrate the possibilities of pragmatist realism both in terms of understanding realism in different domains and in terms of providing a general framework to characterize and relate different species of realism.

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