Ecological Perspectivism: Understanding Perspectival Realism through Ecological Psychology

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Abstract: Perspectival realism claims that scientific knowledge is always situated into a vantage point. We argue that ecological psychology offers a suitable framework to develop perspectival epistemologies. Ecological psychology stresses that perception is focused on *affordances*, i.e. the possibilities of interactions afforded by reality given the abilities of an organism. We call the integrating view as *ecological perspectivism.* It claims that science offers knowledge of reality in terms of affordances, which are relational to the instruments and abilities of scientific communities. Cognition is of affordances, and what a domain affords for scientists depends on which skills and technologies they avail. We connect this proposal with the main arguments for perspectivism. First, regarding instrumental detections, ecological perspectivism offers a realist account of perception that treats the use of instruments as tools that scaffold and extend embodied cognition. Second, regarding model pluralism, ecological perspectivism supports an artifactualist account of modelling as embodied cognition extended by tools. Such tools can be representational by receiving semantic interpretations that associate them with targets through the use of linguistic skills. Third, we promote Michella Massimi's account of Natural Kinds with a Human Face. It treats kinds as open-ended groupings of phenomena with salient nomological dependencies. However, ecological perspectivism suggests that the realist content of scientific perspectives must be cashed out in terms of affordances, thereby reinterpreting the metaphysical notion of 'phenomena'.

Keywords: Perspectival Realism; Ecological Psychology; Scientific Realism; Gibson; Massimi; Mitchell;

1. Introduction: Perspectival Realism as a Puzzling Middle Ground

Perspectivism is a family of views that employ the visual metaphor of vantage points to reconcile the mind-independence of reality with the cultural situatedness of knowledge (Cretu, 2020; Jacoby, 2023). Such views gained attention since Ronald Giere defended scientific perspectivism as a middle ground between scientific realism and social constructivism (Giere, 2006). A clear statement of perspectivism must specify how it differs from the traditional positions in the scientific realism debate. This matter has been controversial, as Giere defined perspectivism by means of two claims:

(1) Scientists have legitimate warrant to claim how the world *seems* to be according to their favored theories; but

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(2) They have no legitimate warrant to take a further step and claim unconditionally "this theory (or instrument) provides us with a literal and complete picture of the world itself" (Giere, 2006, pp. 5-6).

In these terms, perspectivism rejects the so-called "God's point of view", according to which "There is exactly one true and complete description of 'the way the world is'" (Putnam, 1981, p. 49). This view is centered on the idea of "utter objectivity": scientific representations are utterly objective in the sense that they "exhibit no dependence on users or potential users" (Elgin, 2010, p. 3), except for the linguistic conventions regarding how sentences or symbols express propositions. Giere's perspectivism stresses that scientific theories are not utterly objective, although they offer perspectives on how the world seems to be from certain vantage points. But defined in this way, perspectivism is too vague to constitute the middle-ground it is intended to be. It is not clear what separates perspectivism from a pyrrhonian skepticism, which accepts claims about how things *appear* to be, but suspends beliefs on how things *are*. As a result, both realist and anti-realists might accept perspectivism while disagreeing on the controversial issues of scientific realism.

In this conundrum, two interpretations of perspectivism emerge. On one hand, some perspectivists renounce the notion of truth as correspondence with reality. Instead, they take truth claims to be "relative to a perspective" (Giere, 2006, p. 81), "guides to an independently operating world" (Teller, 2011, p. 471), required for "a coherent activity (or system of practice)" (Chang, 2020, p. 14), or something like it. Critics object that, because perspectives are not clearly grounded into reality, these brands of perspectivism are too close to ontological relativism or epistemic instrumentalism (Chakravartty, 2010; Morrison, 2011; Votsis, 2012).

Alternatively, perspectivism is often treated as a form of scientific realism that situates knowers into their cultural background. Here perspectivism is taken primarily as an epistemic rather than metaphysical view (Hoefer and Martí, 2020; Mitchell, 2020; Massimi, 2022). In this direction, we defend an interpretation of perspectivism based on ecological psychology (Gibson, 2015). To do so, we show how ecological psychology can account for the main arguments that motivate perspectivism, while accommodating both realist and constructivist dimensions of it. The resulting view is what we call *ecological perspectivism*. It claims that scientific practices offer perspectival knowledge of reality by detecting *affordances*, i.e. the possibilities of interactions afforded by reality given the capacities of an organism. In what follows, section 2 offers an introduction to ecological psychology aimed to make sense of

ecological perspectivism. Sections 3 to 5 explain how ecological perspectivism can account for the three main arguments for perspectivism, namely, the arguments from instrumental detection, model pluralism, and theory change.

2. Ecological Psychology

James J. Gibson and Eleanor Gibson developed the ecological approach to perception in the sixties and seventies. This approach provides a radical new way to understand and investigate perception, departing from the stimulus-response scheme shared by behaviorism and classical cognitivism. According to these views, perception is a response to effective, punctate, and momentary stimuli. While behaviorism understands that response as behavioral — e.g. behavior that performs discrimination — and as happening immediately after the stimulation, cognitivism understands that response as mental and assumes an information-processing mechanism between the stimulus and the response. For cognitivism, sensory information processing is necessary to build the content of the perceptual response. Both approaches, however, assume that perception is sensory-based and mainly a passive and automatic process. There is no place for the first-person agency within the stimulus-response scheme shared by behaviorism and cognitivism.

According to the ecological approach, the starting point for perception is potential and distal stimuli structured over time and space. For instance, the ambient light at a point of observation comprises rays coming from different directions with different intensities. A set of adjacent points in space or successive points in time comprehends an optic array. When the optic array structure is lawfully related to some feature of the environment, such as a surface, it specifies that feature. Any change in the surface changes the optic array structure. In other words, that structure carries information *about* the surface. Gibson calls energy patterns — optical, mechanical, chemical — that specify a feature of the environment *ecological information* or *stimulus information*. Perception then is the process of picking up such information. It is not reactive but an active process. Perceiving is an act of the living observer (Gibson, 2015, p. 229). She needs to explore the ecological information spread over time and space to perceive what that information specifies. Because what matters is the structure of the stimuli, sensations are incidental to perception. In the ecological approach, perception is information-based.

The relation of specificity is necessary but not sufficient for information. In the ecological approach, the definition of information considers the organism and has three terms: an environmental factor, an energy pattern, and an organism. To be considered information an energy pattern must not only be detectable by an organism but must also be usable by it (Michaels and Carello, 1981, p. 46). Thus, patterns of ultraviolet wavelength might be information for honeybees but not for us. Not only because honeybees are sensitive to ultraviolet wavelengths but because this kind of radiation affords the collection of nectar to honeybees. Ecological information is as much about something as *for* someone. A consequence of this notion of information is that an energy pattern that is information for a species might not be for another. This variation is also present across individuals of the same species.

The claim that information is for someone emphasizes that information must be useful and meaningful for the organism. Although objects and events have physical magnitudes, these properties are insignificant for organisms. They are not what organisms initially perceive. According to Gibson, an organism perceives what an object or event affords, offers, or furnishes, in other words, what the organism can do with it. A handle affords to grasp, a cliff affords to fall off, a flat surface affords locomotion, and a cave affords to hide. The things that show up in the organism's perceptual experience are possibilities for action, such as grasping, falling off, and hiding. Gibson introduced the term *affordance* to refer to these possibilities (Gibson, 2015, p. 119). Affordances are relational in nature. They point both to the environment and the organism. Whether a surface affords to sit upon depends on its height. At the same time, it also depends on the organism. A stub that affords to sit on to an adult may not do so to a child. This variation occurs because the affordances available to an organism depend on its body properties and abilities. At this point, we can say that ecological information specifies not objects or events but their affordances. This formulation makes explicit both dimensions of information: that it is *about* something and *for* someone.

The hypothesis that we perceive affordances works in tandem with another idea that animates Gibson's information-based approach to perception. We are talking about mutualism, the thesis that the organism and the environment make an inseparable and complementary pair (Gibson, 2015, pp. 4, 129). An organism cannot exist without an environment. In the same way, an environment implies an organism to be surrounded. The physical world might exist without any organisms. However, one cannot conflate the environment with the physical world. The environment that matters for the organism is not the world described in physical terms but in ecological terms. Paths, places for hiding, shelters, predators, and preys constitute the

environment where organisms live. The same applies to ecological time. The events that make up the organism's environment are waking up, searching for food, hiding from predators, and nurturing the offspring. To be more precise, the environment of an organism is the set of affordances it is attuned to (Gibson, 2015, pp. 4, 120). Thus, when one describes the environment and the organism at the ecological scale, the "descriptions of the animal are always given in reference to the environment and those of the environment, in reference to the animal" (Shaw, Turvey and Mace, 1982, p. 198).

The mutuality thesis also implies the idea that the minimal unit of analysis is the organism-environment system. The attempt to understand one without the other, at least for psychological explanations, is destined to fail. For philosophy of science, this supports a pragmatist approach in which the metaphysics and the epistemology of science must be investigated together by focusing on scientific practices, that is, scientists in their niches realizing the cognitive tasks demanded by them. The abilities of scientists must be comprehended in relation to those niches, and vice-versa.

Another key idea for the ecological approach is that perception involves the education of attention (Gibson, 1968, p. 51). Although an organism is prepared from birth to perceive some affordances due to its selection history, it is through its development that the organism will become attuned and responsive to the majority of affordances it can perceive. The organism learns to perceive by becoming sensitive to ecological information not previously attuned to. By moving around and exploring its environment, the organism discovers the affordances specified by the new information.

As we will sustain in the following sections, the ecological approach to perception has interesting resources for articulating a version of perspectival realism:

Ecological Perspectivism: Scientific practices offer perspectival knowledge of reality by detecting affordances.

According to Gibson, the ecological approach to perception provides new reasons for realism (Gibson, 1967). First, perception is a process of information pickup that does not rely on representations or inferences. One directly perceives affordances by picking up information that specifies them. Second, affordances do not need to be perceived to exist. They are features of the environment. Because of that, ecological perspectivism is a realist attitude towards science: affordances are *real* relations. At the same time, since affordances point to the abilities

of an organism or a group of organisms, the existence of a particular environment depends on the organism's abilities, so to speak, its perspective in terms of what it can do. The same space-time region can comport different environments or niches. Because of that, ecological perspectivism is also a perspectival epistemology that treats knowledge as necessarily situated. The products of science are not *utterly* objective, because they are partially determined by the abilities of a scientific community. Thus, the relational character of affordances paves the way for articulating realism and situatedness as two sides of the same coin.

The connection between ecological psychology and scientific realism might be initially challenged in two ways. First, (as a reviewer points out), perception might seem to be a cognitive phenomenon of an individual, while science is a communitarian endeavor. We stress that this apparent gap is misleading. The view of perception as the active pick up of information and its openness to learning also turn perception potentially extensible through social practices (Carvalho, 2020). A whole system of coordination can sustain the use of local energy patterns as information about something for the members of a particular community. Thus, a postal system makes available for the members of the community the perception of a postbox as affording letter-mailing (Gibson, 2015, pp. 4; 131). People from a group without a postal system can see the postbox as affording support for an object but not letter-mailing. A consequence of these ideas about perceptual learning is that members of different groups can live, work and perceive different environments if they pick up different sets of affordances.

The social nature of human perception has also been formulated in connection with niche theory. According to it, evolutionary outcomes are constructed not only by natural selection imposed from the environment into the species, but also by organisms acting on their niche and thereby reshaping the environment that makes selective pressures (Laland et al, 2016). Cognitive scientists embraced this idea to spell out how certain cognitive processes might be facilitated by "loading off" information into the environment. Over time, the process of attuning with the environment is done not just by developing abilities "internally", but also by means of niche construction activity, which changes the environment to re-shape which affordances exist for the organism (Heras-Escribano, 2020). Attending to scientific knowledge, Rouse argues that it can be conceived in terms of discursive activities of niche construction, which modify the environment through the coordination of speech acts that reconfigure the space of reasons that next scientists can interact with (Rouse, 2015). This motivates an account of scientific practice in terms of ecological-enactive co-construction, such that reality

constrains the results of scientific experiments, while scientists construct a culture that reshape their environment (de Oliveira et al, 2023).

A second worry is that there might be a gap between ecological psychology and scientific realism because scientific knowledge is mediated by models. Gibson's reasons for realism regard the content of perception, stressing that we do not perceive mental representations, we perceive directly our environment. Still, scientists usually rely on models to represent and infer their conclusions. Sanchez de Oliveira (2016) argues that, because these models are autonomous tools to be engaged with, "the models are not descriptions of *what* the target organisms *are like*, but rather they are tools that are *like and unlike* the target organisms in contextually-relevant ways." (p. 1376). He concludes that "models do not yield representations of the target that we can be realists about—no description, that is, that can be *universally valid, independent from particular perspectives*" (de Oliveira 2016, p. 1377). More recently, Vicente Raja and Sanchez de Oliveira (2024) argue for what they call *pragmatist realism*. This form of realism drops veritism as the central aim of science. Instead, the understanding of phenomena is the aim of science, which can be achieved not through a true description of the target phenomena but by manipulating models that reveal the relevant causal patterns embodied in the phenomena of interest. For Raja and de Oliveira, giving up veritism makes room for a position that accommodates both realism and instrumentalism.

In this regard, ecological perspectivism is relevant not only to develop perspectival epistemologies in fleshing out how scientific knowledge is situated, but it is also relevant to show how ecological psychology might favor a more positive view towards scientific realism. Perspectival realists argue that when scientists are able to detect a phenomenon across multiple perspectives of investigation, there is warrant to believe that the relevant phenomenon is real and the cross-perspectival claims are true, since different perspectives offer non-circular ways to calibrate and prove the reliability of a particular perspective. This view assumes a realist conception of phenomena, as stable events that are modally robust in the sense that they can happen and be inferred in multiple ways (Massimi, 2022; Mitchell, 2023b).[4] Importantly, we'll

[4] Although all other authors explored the connections between ecological psychology and *scientific* realism, as far as we know, Sandra Mitchell (2023a; 2023b) has been the only one to suggest the development of *perspectival* realism through ecological psychology. As she highlights: "The affordances of real phenomena are what they offer the scientist, what they provide or furnish to experiment and representation. I (Mitchell) mean by it something that refers to both the causal properties in nature and the representational framework of the scientist. It implies the complementarity of both in establishing what is real." (Mitchell, 2023b, p. 288). Although we started

argue that phenomena should be interpreted as indexed to the domains of inquiry in which they are detected. This makes the reality of phenomena to be equivalent with the realist dimension of affordances. Ontologically, affordances have been interpreted as dispositional properties (Heras-Escribano, 2022). They express how a system would behave under the relevant interactions of an agent, but also, and more crucially, how a dispositional property manifests depends on the surrounding environment. Hence by investigating a phenomenon in certain environments one gets to know how such stable events manifest under these environments.

In what follows, we defend ecological perspectivism by showing how ecological psychology might sustain a form of situated realism in the contexts of the main arguments for perspectivism, regarding experimental detections, modeling practices, and the conceptualization of phenomena into kinds.

3. The Argument from Experimental Practices

Instrumental perspectivism claims that detection instruments do not simply reveal how the world is, but reveal how the world is *from a particular point of view* (Giere, 2006, pp. 31-40). Giere argues that "observation using instruments is perspectival in roughly the same ways that normal human color vision is perspectival" (2006, p. 41). Specifically, he claims that detection instruments are perspectival in two senses – *partiality* and *opacity*:

> First, like the human visual system, instruments are sensitive only to a particular kind of input. They are, so to speak, blind to everything else. Second, no instrument is perfectly transparent. That is, the output is a function of both the input and the internal constitution of the instrument (Giere, 2006, p. 14).

Each kind of detection instrument has a defined range of inputs, and responds according to its internal mechanisms. Consequently, different instruments can deliver complementary information about a target. For instance, brain imaging can be done through CAT scans (Computer Assisted Tomography) or PET scans (Positron Emission Tomography) among several other ways. A CAT scan uses multiple X-ray photographs to measure how dense is the

our investigations on independent grounds, our proposal of ecological perspectivism can be seen as a development of her suggestion. Specifically, we advance it by elaborating on how affordances are relative not only to "the causal properties in nature and the representational framework of the scientist", but also to the *abilities* of the scientist in terms of embodied cognition. Such abilities are acquired by scientists as they assimilate their exemplars of research, and configure a more comprehensive form of cognition that encompasses a greater diversity of affordances, potentially including non-representational forms of embodied cognition and know-how.

matter in each area of the brain, building an image that reveals the *structure* of brain tissues and surrounding bones. A PET scan uses gamma rays to measure neural activity in brain regions. The gamma rays are radiated from within the brain because a radioactive isotope is (typically) injected in the bloodstream of the subject. The intensity of radiation coming from each part of the brain reveals properties regarding the neural activity of those regions. Overall, the two instruments detect different kinds of input (X-rays and gamma rays) and create different kinds of images that model different kinds of information about the brain (Giere, 2006, pp. 49-58). Accordingly, the argument for instrumental perspectivism relies on the partiality and opacity of detection instruments to draw conclusions about their epistemic power (see Cretu, 2020, p. 4):

(1) Scientific knowledge generally depends on instrumental observation from experimental practices.

(2) Detection instruments are (to some extent) *partial* and *opaque*; that is, they are sensitive to a limited range of inputs; and their outputs might often contain artifacts fabricated by the internal constitution of the instrument.

(3) Since instruments are (to some extent) partial and opaque, the claims warranted by the use of instruments are perspectival.

(4) Hence, scientific knowledge is generally perspectival.

Instrumental perspectivism is supposed to offer a middle ground between realist and anti-realist epistemologies of experimentation. On Giere's approach, instruments are neither "windows into the unobservable" nor "engines for creating phenomena" (van Fraassen, 2008, pp. 100-104), but something in between. They help the elaboration of data models, but just as the greenness does not inhere in the grass and different animals might see the grass in different ways, data models don't show a purely objective reality. They show how it appears from a perspective. The truth-value of experimental claims is determined in relation to an instrumental perspective (Giere, 2006, p. 56). In this way, the epistemic power of detection instruments is assumed to be situated because of their partiality and opacity. However, both features are attacked as unable to show that situatedness is insurmountable.

Regarding partiality, Charkravartty argues that it is trivial that one might tell truths without telling the whole truth: "One might correctly describe the front of one's house, in a

way no doubt compatible with descriptions of its other sides. Et cetera." (Chakravartty, 2010, p. 407; also Lipton, 2007, p. 834). Because partial truths can be combined into a unified story, the fact that detectors are partial does not seem to make scientific knowledge perspectival in any controversial sense. This also seems to apply to scientific contexts where multiple causal ingredients are identified and then combined into a system, as in the Newtonian analysis of a total force through the vector addition of various forces, such as gravity and friction (Cartwright, 1983).

Regarding opacity, Baker argues that Giere's argument conflates "*what* is detected with the *means by which* things are detected" (Baker, 2020, p. 32). This is the same as conflating the medium with the content of a representation. Considering visual perception, light is the means by which we perceive objects. This does not imply that we perceive light rather than ordinary objects. Likewise, we detect galaxies *by means of* telescopes and gamma rays (Chakravartty, 2010, p. 408).

If neither partiality nor opacity motivate a relevant form of perspectivism, one might think that the argument from instruments loses its appeal (e.g. Chakravartty, 2010; Baker, 2020, p. 18). Giere's own solution was to abandon truth as correspondence with reality, claiming that truth-values are only determined in relation to a perspective (Giere, 2005, p. 154; 2006, pp. 64-5; 81; 2013, p. 55). Consequently, many questioned whether perspectival realism is realism indeed. Jacoby, for example, claims that perspectivism "require[s] a radical re-conception of what realism entails", and that "How reasonable it is for us to call [it] realist, therefore, will depend upon what one thinks a realist account should provide." (Jacoby, 2023, sec. 4c).

Ecological psychology helps us appreciate how instrumental perspectives can be in touch with reality while being humanly situated. On its lenses, instrumental perspectivism claims that the epistemic power of detection instruments is to *extend* our perception of affordances. Given that perception is the detection of ecological information and improves through learning, instruments might extend our perceptual powers. A telescope or a microscope can be used to magnify the structure of an optic array at a point of observation, facilitating the detection of information, and in some cases even turning it possible. One can become so skillful in using an instrument that the distinction between relying on them or on our sense organs to detect information collapses. In this case, one does not need to interpret the information detected, one can directly pick it up: "with a telescope or a microscope you could look for yourself" (Gibson, 2015, pp. 4; 247). This means that instrumental observation can give *direct*

perceptual knowledge of otherwise unobservable entities and their properties, without being mediated by representations or inferential processes. Scientists can see cells and distant galaxies with the same transparency that humans see tables and trees.

By treating instrumental detection in terms of direct perception, ecological perspectivism *rejects* the idea that detections are situated because they have opacity. In ecological psychology, cognitive *transparency* corresponds to the fact that perception detects invariants in terms of affordances. While detection instruments do have artifactual residues embedded in their outputs, perception is the ability to distinguish ecological information from residual noise. As Hacking illustrates, *practice* makes one able to see with a microscope. Through interaction, one develops the ability to distinguish which properties are invariants of the specimen and which things are artifacts created by particular types of microscope or preparation procedures (Hacking, 1983, chpt. 11). [5]

While we eschew the claim that detections are perspectival because of opacity, ecological perspectivism stresses that instrumental detections are situated because of their *partiality* and *embodiment*.

Regarding partiality, Sandra Mitchell argues arduously that it is sufficient to dissociate perspectivism from traditional forms of realism (2020; 2023a; 2023b). Although she accepts physicalism, the claim that the universe is composed of material objects (Mitchell, 2023b, p. 265), she opposes "physics-ism", the idea that all sciences must be reduced to a unified system of laws of physics where “the convergence of explanations down to simpler and simpler principles will eventually come to an end in a final theory” (Weinberg, 1993). Given the complexity of reality, such a final theory would not be navigable, just as Jorge Luis Borges' complete map of a city by means of an exact replica would not be a good map (Borges, 1975, p. 131). This is not an *a priori* claim, but a lesson to be learned from the non-reductive pluralism of our actual scientific practices (Dupré, 1993; Cartwright, 1999; Giere, 1999). The analyses of complex systems usually fail to generate a complete reduction into simpler and broader laws. Instead, the formulation of simpler laws requires idealizing an invariant structure from some confounding factors that might interfere in it. Hence, simpler laws tend to be less general in applications, being restricted to some shielded contexts presumed in *ceteris paribus* clauses.

[5] To be clear: perceptual transparency does not imply that we must reject the traditional distinction between data and phenomenon (Woodward, 1989). Instead, ecological perspectivism supports an epistemology of experimentation that treats data models as tools that have a role in *tuning our perception* of the phenomenon.

This shows that, even if it is metaphysically possible to exist a reality that follows a simple guidebook of natural laws, that is not our reality. Our universe is ungraspably complex (Dupré, 1993; Cartwright, 1999). In such a universe, looking for a global and unified physical theory is to commit the epistemic sin of Borges' geographers. Instead, we should aim for a plurality of partial perspectives that provide understanding through the salience of local invariants. An overly complex universe is at best understood as a dappled world that obeys different laws at different regions (Cartwright, 1999; Mitchell, 2023b).

The disunification of scientific laws also requires the postulation of emergent properties (Mitchell, 2023b). Traditional accounts of reduction invoke bridge-principles to translate higher-level and lower-level theories while preserving the content of lower-level generalizations (Nagel, 1961). Besides the traditional problems of multiple realizability, where terms such as "money" or "pain" cannot be reduced to a single kind of physical state, reductive strategies are unsuited for dealing with emergent properties (Mitchell, 2023b). Some properties of a system might be merely aggregative, just as the mass of a body results from the mass of its parts. But "strong emergence" exists when the properties of a complex system perform downward causation (O'Conner, 1994; Bedau, 1997). For instance, robustness is a system-level property by which a dynamic system maintains its functions stable in face of perturbations (Edelmen & Gally, 2001; Greenspan, 2001). Robustness has countless examples, such as neuronal reassignment in the brain as a response to traumatic injury; genetic expression that can be triggered by environmental conditions even after the relevant genes are knocked out; or regular protein folding. When dynamic systems exhibit any kind of strong emergent properties, these will not be scientifically explainable just through their constituent parts, because it is the other way around: it is the structural properties that determine component properties in downward causation (Stelling et al., 2004; Robinson et al., 2005; Fernald & Maruska, 2012; Sinha et al., 2020; Aerts et al., 2016).

So, given that scientific realism traditionally embraces the idea of *approximate* truth, how is perspectivism a non-trivial form of realism? The first difference is that perspectivism stresses that the partiality and situatedness of knowledge are *unsurmountable.* The reason why (some) realists consider partiality to be a trivial feature of knowledge is the expectation that partial truths can be integrated into the full history, just as different images of a house can integrate a complete picture of it (Chakravartty, 2010, p. 407; Lipton, 2007, p. 834). In this version of scientific realism, science aims at truth, and hence approximate truth is at best a

defective form of success to be overcome. The book containing the fundamental laws of nature does not contain approximate laws or non-reductive emergent properties. Several realists actually took this view (see Giere, 2006; Cassini, 2025). Alternatively, perspectivism stresses that scientific knowledge is situated in practices with local aims. The disunification of laws, and the appeal to emergent rather fundamental properties, they occur not because the complete theory is accidently out of reach, but because they enable scientists to focus on understanding the features of reality that they consider relevant, up to the degrees that are relevant for their purposes. Because 'scientific realism' is a label with countless interpretations, some scientific realists will claim that their position is compatible with the *unsurmountable* partiality of knowledge. For those, we are happy to accept that perspectival realism is a *form* of realism rather than an *alternative* to it. The epistemological relevance of perspectivism remains on making explicit the ways in which knowledge is situated as it has contingent focuses.

As perspectivism stresses the inevitable partiality of knowledge, *ecological* perspectivism stresses that detections are situated in being *embodied*. So far perspectivist epistemologies focused mostly on the *representational* knowledge established by *inferences* from data models to phenomena (Massimi, 2022; Mitchell, 2023a; 2023b). In the framework of ecological psychology, cognition is situated already in the perceptual and non-representational level, since it requires a material culture of technologies and techniques. As favored by anti-intellectualist epistemologies (Ryle, 1946), this practical knowledge is irreducible to the propositional knowledge obtained with models (Carvalho, 2018). Because instrumental detections enable knowledge of reality in terms of affordances, and affordances are essentially relational to the abilities of beings, the knowledge obtained from detections is necessarily situated into the abilities of a scientific community. Different communities might perceive different environments while interacting with the same kind of physical system, because it affords different things for each of them (vide Kuhn, 2012).

Embodiment, partiality and emergence should be put together in epistemological contexts. Embodiment expresses the idea that knowledge is situated on abilities, which enable an agent to detect affordances. And affordances themselves are emergent properties. In the weak or reductive sense of emergence, this follows immediately from the relational nature of affordances. In the strong or non-reductive sense of emergence, this is implied by Gibson's mutualism thesis. Organism and environment cannot be explained in complete isolation from one another, because the relationship between a living being and its environment is a different

kind of relationship than the one between an inanimate object and its surroundings. Hence, cognition and knowledge must be explained at the emerging level of the organism-environment dynamics. Accordingly, even if affordances can be initially reduced to the dispositions of a system in relation to abilities of agents (Heras-Escribano, 2022), such abilities are emergent in being constitutively situated within environments, and such worldly dispositions are also emergent in being an environmental structure that remains invariant under the relevant range of interactions that is meaningful for the organism. Notice that these dispositions or invariants are themselves a system-level property that is not reducible to fundamental properties, because affordances are local or incomplete invariants (Runeson, 1989). Thus a ground surface affords walking, but not if the plane is taking off. Elemental substances such as phosphorus or sulfur afford combustion at a stable temperature, but only if they are shielded from interfering parameters, such as anomalous pressure.

The resulting framework reflects Gibson's mutualism thesis: comprehending an organism's cognition requires comprehending its environment, and vice-versa. Scientific knowledge will look miraculous when abstracted from the environment of laboratories, just as laboratories will look mysterious places when abstracted from scientific culture. The epistemic success of science is partially explained by the fact that reality fits scientific representations, as suggested by Putnam's no miracles argument (1978). But scientific representations are not a direct product of reality. They are co-determined by social features in contingent ways. For this reason, explaining the success of science also requires comprehending how scientific knowledge is situated in experimental abilities (or instrumental perspectives) that build material environments to expand human cognition. In this way, ecological psychology helps to rehabilitate the instrumental argument for perspectivism.

4. The Argument from Modeling Practices

The most popular argument for perspectivism is based on model pluralism (Cretu, 2018, pp. 3-4; Jacoby, 2020; Frigg and Nguyen, 2020, ch. 5). Scientific models can present radically different characterizations of a target, without a comprehensible way of unifying them. If we take those models to be literal representations of their targets, a contradictory picture of reality seems to follow, which gets in tension with scientific realism. For instance, to explain how water flows and propagates, water is modeled as a continuous, incompressible medium. But in

explaining how chemical compounds diffuse in water, or in calculating the friction of a water flow along solid surfaces, water is modeled as a collection of discrete particles in thermal motion. How can water be both a continuous medium and discrete particles? (Morrison, 1999, pp. 53–60; Teller, 2001, pp. 401–9; Rueger, 2005, pp. 581–7). As a solution, a perspectival account explores the idea that each model offers a limited and complementary perspective of a target. Giere's account motivates the line of reasoning:

(1) *Inconsistent Model Pluralism*: Scientific practices often employ multiple models to investigate the same target system, ascribing contradictory properties to it.

(2) *Epistemic Scientific Realism:* Those models are epistemically successful.

(3) *Model Representationalism*: Epistemically successful models are accurate representations.

(4) *Reality as One:* There are no contradictory facts.

(5) Therefore, accurate representations cannot be taken as true where 'truth' is understood in a correspondence sense.

(6) *Perspectivism:* Instead, successful or accurate representations are true only in a perspectival sense.

On Giere's account, a scientific perspective is a hierarchy of models being compared with reality. On the bottom level, data models present the information gathered in experimental practices. Data models are already perspectival, because experimental practices are perspectival. On an intermediary level, representation models connect theoretical principles with data models. Giere takes models to represent by means of a 'theoretical hypothesis', i.e. statement of the form "the model (completely interpreted and specified) and the target resemble each other in these specified aspects (structural or otherwise)" (Giere, 2010, p. 271). Instead of correspondence truth, modeling aims for similarity: "the relevant relationship between models and reality is not a semantic relationship, like truth, but the similarity among two non-linguistic entities, the abstract model and the real system" (Giere, 1990, p. 20). Unlike truth, similarity is limited to certain aspects and degrees specified internally to a perspective. For instance, the ptolemaic model is still employed today for purposes of navigation, and might be regarded as accurate for these purposes (Kuhn, 2012, p. 38). Finally, at the top level, the fundamental principles and models of the theory might comprehend different representation models, e.g.

newtonian laws of motion orient the configuration of pendulum models, fall models, planetary models, and so on (Giere,1990; 1999; 2006; 2010).

Many wonder if the transition from "truth" to "similarity" is enough to accommodate both realism and pluralism. Margaret Morrison argues that, on one hand, it is trivial to claim that models rely on idealizations, because models can be de-idealized for applications (Morrison, 2015, p. 157). Where de-idealization is viable, the properties ascribed by different models might be integrated into a coherent picture, and premise (1) can be rejected. On the other hand, the key challenge from model pluralism is to understand *which aspects* of models should be treated as real. For instance, there are at least thirty different contemporary models for the atomic nucleus, making it difficult to specify whether it is like a shell, a liquid drop, point particles, probability waves, or what? (Morrison, 2015, p. 159-160). Perspectivism tries to accommodate different claims by indexing them into a perspective: "from the perspective of this model it looks like a shell, and from that model it looks like liquid drop". But the question persists: "is reality like this model represents?". If perspectivism says 'yes' to both models, inconsistency reappears. If it says no, then it seems that "perspectivism is simply a rebranded version of instrumentalism" (Morrison, 2011, p. 350). There would be no substantive difference between perspectivism and an anti-realist account that denies (2).

Likewise, Chakravartty argues for the rejection of (1) to avoid (5). He accounts for model pluralism by invoking *dispositional realism*: science might know the nature of things by knowing dispositional facts, that is, "how behavioral dispositions are manifested under different stimulus conditions" (Chakravartty, 2010, p. 410). Different models can capture the dispositions of a target under different sets of circumstances: water is something that has a disposition to behave as a continuum medium under some circumstances, and to behave as a collection of discrete particles under others. Both facts are relevant to understand what is water. But if it is true that "water behaves like a continuous fluid in wave propagation", then this is true in whatever context, and therefore dispositional facts are non-perspectival facts (Chakravartty, 2010, 412; also 2017, pp. 197-200).

After that, perspectivists came to agree that if perspectivism is not be an anti-realist variety of instrumentalism, it must safeguard the realist notion of correspondence with reality, and Giere's argument must be reformulated for that (Hoefer and Martí, 2020; Massimi, 2022; Mitchell, 2023b). Then the challenge becomes, once again, to show in which sense the knowledge of an independent reality is situated, which marks the relevance of perspectival

epistemology. For that, Michela Massimi deals with the challenge from inconsistent models by attacking its representationalist tenet, the claim (3) that what makes models successful is being an accurate representational map (Massimi, 2022, pp. 44-71). She relies on an inferentialist account of modeling (Suárez, 2004; 2009; 2015). It inverts the priority between explaining the representational role of models and explaining surrogate reasoning. For representationalists, models enable surrogate reasoning *because* they represent their target. Alternatively, inferentialists take as primitive the fact that models enable inferences about their targets, and argue that models can work as representational maps *because* (or in the same sense that) they allow for surrogate reasoning. If that is so, there is room for considering non-representational types of modeling activity that are inferential in other ways.[6] In this direction, Massimi stresses that scientific modeling is perspectival *not* because models are partial representations, but because of "its fulfilling a distinctively exploratory role in delivering scientific knowledge over time" (Massimi, 2022, p. 12). Exploratory models are not aimed to map an actual system, but rather to show what is *possible* in a domain.

Developing this proposal, Massimi characterizes models as *inferential blueprints* (Massimi, 2022, p. 143-6). As inferential tools, blueprints give us instructions that help us conceive scenarios, allowing us to infer *possibilities*. Such inferences can be expressed in the form of indicative conditionals - "if x is the case, y will be the case" – where the antecedent presents a physically conceivable scenario, and the consequent is translatable into modal allegations about what the system can do. Moreover, a blueprint might include multiple drawings of the same target. Such complementary perspectives allow us to identify distortions that arise from particular vantage points and distinguish non-perspectival features of the target: "it is only the plurality of perspectival models that can open a 'window on reality' to show its target" (Massimi, 2022, p. 144). Accordingly, an inference from data *to phenomena* (beyond mere possibilities) is justified by cross-perspectival identification:

> It is the ability of epistemic communities occupying a plurality of scientific perspectives to feed data into inferences licensed by perspectival models (where

[6] The proposal of non-representational modeling receives further support from *model artifactualism*. It claims that models are tools to be manipulated, and they support learning by enabling material engagement that scaffolds certain activities (de Oliveira, 2022, p. 10). *Hybrid* artifactualism comprehends models as *representational* tools, which are mediators in having a dynamic of their own: "what it means for a model to function autonomously is to function like a tool or instrument" (Morgan and Morrison, 1999, p. 11). Tarja Knuuttila develops this idea by defending that models are autonomous *because* of their materiality: "Without materiality mediation is empty" (Knuuttila, 2005, p. 1266; 2011; 2017). *Radical* artifactualism proposes to account for the epistemic relevance of models without relying on representationalism, treating them as non-representation tools that scaffold special types of action, thereby providing understanding based on the sensorimotor engagement with models and their action-relevant similarities with other domains (de Oliveira, 202; Rolla and Novaes, 2022, pp. 629–630).

> applicable) that justifiably underpins the reliability claim of a conditional "Given this data, then conclude this phenomenon is real" (Massimi, 2022, p. 194).

Although we endorse the main tenets of Massimi's perspectivism, we oppose her solution to the problem of inconsistent models by means of abandoning representationalism. We do so on two grounds. First, she relies on the inferentialist account of scientific representation. But the inferentialist account is questionable by itself. Suarez takes 'representational force' and 'capacity for surrogate reasoning' as *surface features* of the model, claiming that we should seek "no deeper features to representation other than its surface features", at least not in general terms because the means of representation can vary with context (Suarez, 2004, p. 771; 2015). This claim is utterly contentious, since it goes against a wide tradition of accounts of epistemic representation. Contessa, for instance, claims that it makes "the performance of valid surrogative inferences an activity as mysterious and unfathomable as soothsaying or divination." (Contessa, 2007, p. 61; for deeper discussion, see Nguyen and Frigg, 2022, p. 45).

Second, the main reason for adopting the inferentialist account is the problem of dissimilarity, where models are intended to be felicitous falsehoods (Elgin, 2007). The problem threatens representationalist accounts that are based on some kind of similarity between model and target (van Fraassen, 2007; Giere, 2010). But there are accounts of epistemic representation that are not based on similarity. On the DEKI account, *interpretation* is what makes something into a representation. An interpretation is a mapping between specified properties of a model-object and related properties of a target domain (Nguyen and Frigg, 2022, p. 56). Let $M = (O, I)$ be a model, where O is an object and I an interpretation. Let T be the target system. On the DEKI account, M represents T iff all of the following conditions are satisfied (Frigg and Nguyen, 2022, p. 62):

(i) *M denotes T* (and in some cases parts of *M* denote parts of *T*).

(ii) *M exemplifies* some specified *Z*-properties, where $Z = \{Z1, ..., Zn\}$

(iii) *M* comes with an interpretative *key K* associating the set $\{Z1, ..., Zn\}$ with a (possibly identical) set of properties $Y = \{Y1, ..., Yn\}$.

(iv) *M imputes* at least one of the properties *Z1, ..., Zn* to *T*.

First, an interpretation might presume that M *denotes* a target *T*. Accordingly, *representing T* is a factive expression (Nguyen and Frigg, 2022, p. 63). Second, representing involves *exemplification*. Some features of a representation are relevant, and others are not (e.g. points as extensionless bodies). Exemplification demarcates the features of the model that are representationally relevant, as those features become interpreted as examples of some Z-property. Third, epistemic representations require an interpretative *key*. As stressed by the problem of dissimilarity, the features exemplified by a model usually are not the same features we attribute to a target (Elgin, 2017). Such attribution requires a key, i.e. a translation manual to convert features exemplified by the model into features of the target. A key *K* associates the set *Z* with a set *Y = {Y1, ..., Yn}* of features, which are candidates for imputation after the model is de-idealized and adjusted for application. Developing a key requires local background knowledge, and "model users are aware that there is a blank to be filled, [...] they don't naïvely assume that reality is just like the model" (Nguyen and Frigg, 2022, p. 62). Notice that a key does not have to be precise, as the attributed properties can be made within an interval of magnitudes, and a model can be applied with different degrees of accuracy (Nguyen and Frigg, 2022, p. 65). Nor it has to be completely formalized or fixed in practice, as exploratory modeling might dynamically modify both the properties and the interpretation of a model to inquire in better ways. Being tools, models have a history, and some even have a genealogy of developments (Massimi, 2022). Finally, *imputation* is the process of ascribing *Y*-properties to the target, based on *Z*-properties and the key *K*. A model *M* is an accurate representation iff the target *T* has the attributed *Y*-properties.

The DEKI account allows to spell out how models can be representational tools without ceasing to be embodied. As the DEKI suggests, the use of representational tools initially requires interpretative conventions. But after the interpretative abilities are acquired, perception may tune with the affordances of a model and the functional similarities between model and target. At this point, interpretations can become tacit, and the model may be used without reflecting about an interpretation. For instance, one can see a location in a map, and point *to the map* and claim: *here* is station Etiopia. This is the phenomena in which one perceives *through* a model, and makes observational reports from model-based knowledge: one can *see that a substance is humanly toxic* in lab rats; and *see whether a bridge is viable* through calculus. This is different both from seeing lab rats and from seeing a calculus. On the ecological approach, this is not a figurative use of "seeing", but rather a perception instrumentally extended through models.

Regarding the problem of inconsistent models, ecological perspectivism aligns with answers that defuse the problem by denying (1). Integrative pluralism (Mitchell, 2023a; 2023b), dispositional realism (Chakravartty, 2017), and some defenses of perspectivism (Rueger, 2005; Giere, 2006) all stress that seemingly incompatible models are successful because they have different uses. On the traditional approach endorsed with the semantic view of scientific theories, models are interpreted as abstract structures that represent invariably according to their structural properties (via isomorphism or similarity). This implies that models with different structural properties will automatically have different representational contents. Moving past the semantic view, pragmatic accounts of scientific theories (Dutra, 2008) and representation (Nguyen & Frigg, 2022) acknowledge the autonomy of models as tools, taking representational value to depend on how the model is used inferentially or otherwise. Different models might present incompatible properties at their surfaces (the Z-properties), but in practice those properties are interpreted in compatible ways. As Chakravartty (2010) illustrates, the characterizations of water as a continuous medium and as discrete particles are used to represent different dispositions of water. Even in cases such as nuclear physics where tens of different models are employed, these models have different representational uses and might even apply to entirely different experimental data (see tables 1 and 2 in Morrison, 2011, p. 348).

There might still be cases in which models not only present incompatible images in their Z-properties, but also input incompatible Y-properties about the same target. In those cases, realism remains under threat. So the question of which Y-properties are real remains a challenge to be decided by case analysis and scientific reasoning, but not by a philosophical account of representation. This complies with the *localist* methodological attitude towards the scientific realism debate, which takes the truth of scientific claims to be judged on a local basis (Asay, 2019). Still, the DEKI account is helpful because it explicitly spells out that representational content is contextually determined by the interpretation and uses of the model, and hence seeming incompatible models might have compatible applications once they are situated in their practices and properly deidealized (Cassini, 2025).[7] When such applications

[7] Although other accounts of scientific representation have also embraced this pragmatic contextualism, recall that they either rely on isomorphism or similarity and end up facing the problem of dissimilarity (Elgin, 2017), or they try to deflate the notion of representation instead of offering a general substantive account (Hughes, 1997, p. 339; Suarez, 2015).

are accurate, they can be taken as true in correspondence with phenomena, but such representations and phenomena are indexed to the relevant environments of application.

5. The Argument from the History of Science

A final argument for perspectivism comes from the history of science. Many past scientific theories employed different concepts than contemporary theories, yet they were considered greatly successful in important aspects. This suggests that past theories offered a different perspective about reality, instead of being just false (Massimi, 2017). As Cretu (2018, pp. 4-5) puts it:

(1) Once we reflect on the succession of past scientific theories we are led to the conclusion that although many past theories proved to be false, some at least, got something right.

(2) Since many such theories have been abandoned, yet some claims were retained, it cannot be the case that science gives us true and complete images of the world.

(3) Instead, what history of science teaches us is that there are multiple different perspectives regarding the same phenomena.

(4) Thus, history of science yields perspectival knowledge of the world.

Giere also attributes this view to Kuhn (Giere, 2013) and Feyerabend (Giere, 2016). As we saw, Giere's approach abdicates from truth as correspondence. Alternatively, Massimi's perspectival realism accounts for theory change without compromising on truth. Instead she elaborates scientific ontology in terms of *phenomena*: "Phenomena are stable events indexed to a particular domain of inquiry, and modally robust across a variety of perspectival data-to-phenomena inferences" (Massimi, 2022, p. 207). This requires unpacking.

First, this is a realist (mind-independent) account of phenomena, given that phenomena are considered as *events*, not to be reduced to human experience or observability (cf. van Fraassen, 1980). Second, phenomena are *stable* events in the sense that "there is a lawlike dependency among relevant features of it", where "lawlikeness is a primitive relation of stable events in nature ... The natural world comes pre-packaged with stable events, because lawlike" (Massimi, 2022, p. 209). For instance, the stretching of an elastic spring is a stable event, as

there is a lawlike dependency between applied force and elastic displacement (vide Hooke's law), which persists regardless of the humidity, the metals involved, and so on. Lawlikeness can be semantically captured by *subjunctive* conditionals, expressing what *would* happen under specified conditions. Third, phenomena are indexed to a domain of inquiry. A stable event only becomes a phenomenon if it is included in the epistemic interests of a community (Massimi, 2022, p. 208). Fourth and last, phenomena are *modally robust*, being events that can happen and be inferred in various ways (Massimi, 2022, p. 211-6). The relation between data and phenomena is not straightforward, because data contains noise and must be filtered: "Detecting a phenomenon is like ... fiddling with a malfunctioning radio until one's favorite station finally comes through clearly" (Woodward, 1989, p. 438). To filter a phenomenon from noise, one needs multiple exploratory models to calibrate one another. As scientists progressively explore a domain from the multiple perspectives, they might identify the robustness of an event and infer its reality as a robust phenomenon:

> The correspondence theory of truth still applies, but ... The correspondence is instead between claims of knowledge that have been retained over time and across perspectives, on the one hand, and modally robust phenomena reliably inferred from data, on the other. (Massimi, 2022, p. 367).

This ontology of phenomena is also claimed to support the account of Natural Kinds with a Human Face. It defines *natural kinds* as: "(i) historically identified and open-ended groupings of modally robust phenomena, (ii) each displaying lawlike dependencies among relevant features, (iii) that enable truth-conducive conditionals supporting inferences over time." (Massimi, 2022 p. 16; 226). On this account, some kinds such as 'caloric' might be considered *empty kinds*, if they fail to be robust in sustaining cross-perspectival identification. Other kinds such as 'dark matter' are "*in-the-making kinds*", which are still being investigated to see if they are robust. But even after a kind shows its robustness, it is not to be taken as eternally accepted in the scientific lexicon, because it is still an "*evolving kind*".

Science might revise their definitions of evolving natural kinds *not* because they fail to identify phenomena and lawlike dependencies, but simply to open venues for other groupings of phenomena that facilitate scientific activity. For instance, the identification of elements as natural kinds requires the identification of multiple phenomena (atomic spectra, chemical reactions, melting and boiling points, oxidation, etc.), each of which configures a domain of inquiry (Massimi, 2022, p. 253). The classification of kinds is always evolving, because the set of phenomena that defines a kind is open-ended (Massimi, 2022, p. 289).

This antagonizes with natural kind essentialism, which identifies natural kinds by means of a fixed essence determined by microscopic properties: biological kinds like lemon are defined by a genetic code, chemical kinds are defined by their molecular composition, water is H2O, and so on (Putnam, 1975, p. 240; Kripke, 1980, p. 124). Against essentialism, nominalistic accounts of natural kinds argue that scientific classifications are partially determined by human decisions. For instance, LaPorte observes that scientists *stipulated* that deuterium oxide (D2O) is a kind of water with isotopic varieties (LaPorte, 2004). The way scientists identify water could have been different (Chang, 2012), just as metrology could have used different conventions for the measurement of temperature (Chang, 2004). But Massimi's account is not fully nominalistic, because it treats phenomena and nomological dependencies as real things that constrain our classifications of them.

Massimi's perspectivism is criticized for making situatedness too thin: "insofar as it's realist, Perspectival Realism isn't perspectival and insofar as it's perspectival, Perspectival Realisim isn't (necessarily) realist" (Panagiotatou and Psillos, 2023). The problem is, again, that once one specifies the phenomena and the lawlike dependencies known by a perspective, it is tempting to abstract those realist elements from the perspective in which they are situated. In result, a perspective opens a window into non-perspectival facts, which are to be taken as part of reality as it is (as if from God's point of view). Or else a perspective is situated into exploratory models that are directed at epistemic possibilities, and there is no realism in that.[8]

Ecological psychology and Massimi's perspectivism converge on many points. We fundamentally agree that scientific perspectives are historically situated in the sense of being situated within the cultures within a historical period. But ecological perspectivism spells this out in its own way: perspectival knowledge is situated in being *embodied* into certain abilities that might require instruments to scaffold them, and being *partial* into allowing the knowledge of a limited range of affordances. This implies a re-interpretation of the notion of 'phenomena' that cashes out 'nomological dependencies' in terms of affordances. On this view, a phenomenon is considered a *stable* event because what it affords is meaningful for us. The more it affords, the more robust it is.

[8] To be strict: Massimi's definition of 'phenomena' does claim that phenomena are "indexed to a domain of inquiry", but only in the extrinsic sense of being taken as events of interest for investigations (Massimi, 2022, p. 208). But this is not enough to make phenomena relational to perspectives. And she is adamant in stressing that: "Scientific perspectives do not offer perspectival facts. Nor should truth be understood in terms of perspectival truthmakers …, or as indexed to a perspective or relative to a perspective." (Massimi, 2022, p. 8).

Unlike nomological dependencies, affordances are essentially relational to organism and physical reality, and emerge within determined conditions of interaction between them. What an object affords is relative to context and to whom. In this sense, affordances are indexed to perspectives. For instance, the stretching of an elastic spring is a stable event, because it affords elastic displacement through applied force (vide Hooke's law), which remains invariant to several factors (the humidity, the metals involved, etc), but this stability is localized in expressing what *would* happen to an elastic spring under a limited range of interactions that are meaningful for us, while abstracting from uncountable other contexts (stresses beyond the elastic limit, high temperatures, springs under large deformations, viscoelastic materials, relativistic speeds, etc).

One might also understand affordances in terms of dispositional properties (Chakravartty, 2017), but a major caveat is needed. Dispositional properties manifest in different ways under different circumstances. Accordingly, affordances *qua* dispositional properties are indexed to background parameters that include the surrounding reality *and the organisms interacting with it*. Affordances are local (Runeson, 1989), and equate to dispositional facts that are indexed to the contexts of interaction that are relevant for us. Because of that, they remain perspectival facts. Besides the ordinary cases such as color perception, scientific examples abound in discussions about the external validity of experiments, such as analysis of placebo effects or the measurement problem in physics (Myrvold, 2022). While the problem of external validity is not necessarily insurmountable, we must recall that its solution comes from an integrated perspective that is more informative about the behavior of a system. But this is not an escape from situatedness, because the integrated perspective must remain partial, embodied and idealized to highlight the structures that enable understanding for us.

Even if ecological perspectivism indexes phenomena to the environments in which they emerge, the ecological notion of information supports the account of Natural Kinds with a Human Face. Because ecological information is always for an organism, it is expected that scientific classifications reflect the ways scientists can interact with a domain, as well as the interests entrenched in such interactions. At the same time, because information is about what reality affords, linguistic classifications are partly constrained by reality. Theoretical change might reflect both dimensions. Concepts such as ‘caloric’ were abandoned because they didn’t resist cross-perspectival identification, thus reality constrained scientific classifications. But

the decision to include the property of "having enough gravitational force to clean the neighborhood of its orbit" in the definition of 'planet' also reflected the research interests of the International Astronomical Union, and they could have defined 'planet' otherwise, thereby resulting in Pluto to remain as a 'planet' (Massimi, 2022, p. 226). By distinguishing these two dimensions of theory change (information being *about* something and *for* someone) one can appreciate that theory change (or conceptual revision) is not necessarily a sign that past theories failed epistemically.

6. Conclusion

Perspectival realism and ecological psychology are both aligned to a pragmatist stance in philosophy of science. Rather than approach scientific realism by analyzing scientific theories in terms of axiomatic systems, or in terms of abstract structures that can be accurate (Suppe, 1989) or empirically adequate representations (van Fraassen, 1980), pragmatic approaches treat scientific theories as system of practices in which model structures are contextually used to justify scientific claims, generating a plurality of perspectives that can be reliable for different purposes (Dutra, 2017; Cartwright et al., 2022; Massimi, 2022). Being an active account of cognition, ecological psychology supports the view that science is based on many kinds of practical knowledge that are irreducible to propositional knowledge. It is an immediate ally for pragmatist approaches to scientific realism.

In addition, perspectivism and ecological psychology both intend to account for cognition in a way that conciliates situatedness and realism. While perspectivist epistemologies have focused on several aspects of science to explain its situatedness, ecological perspectivism stresses the necessary embodiment and partiality of scientific knowledge. Cognition is of affordances, and what a domain affords for scientists depends on which skills and technologies they avail. This offers an active, realist and transparent account of perception that grounds experimental practices into reality, by treating the use of instruments as tools that scaffold and extend embodied cognition. It also supports an artifactualist account of modelling as embodied cognition extended by tools. Such tools can be representational by receiving semantic interpretations that associate them with targets through the use of linguistic skills.

Once the realist content of scientific perspectives (the nomological dependencies) are cashed out in terms of affordances, phenomena become indexed to certain contexts of

appearance. Metaphysical questions of "what is real?" must be addressed jointly with epistemological questions of "how we know it?", as prescribed by the pragmatist stance (Mitchell, 2023b, p. 263) and supported by the mutualism thesis: organism and environment must be analyzed as an inseparable pair (Gibson, 2015, pp. 4, 129).

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