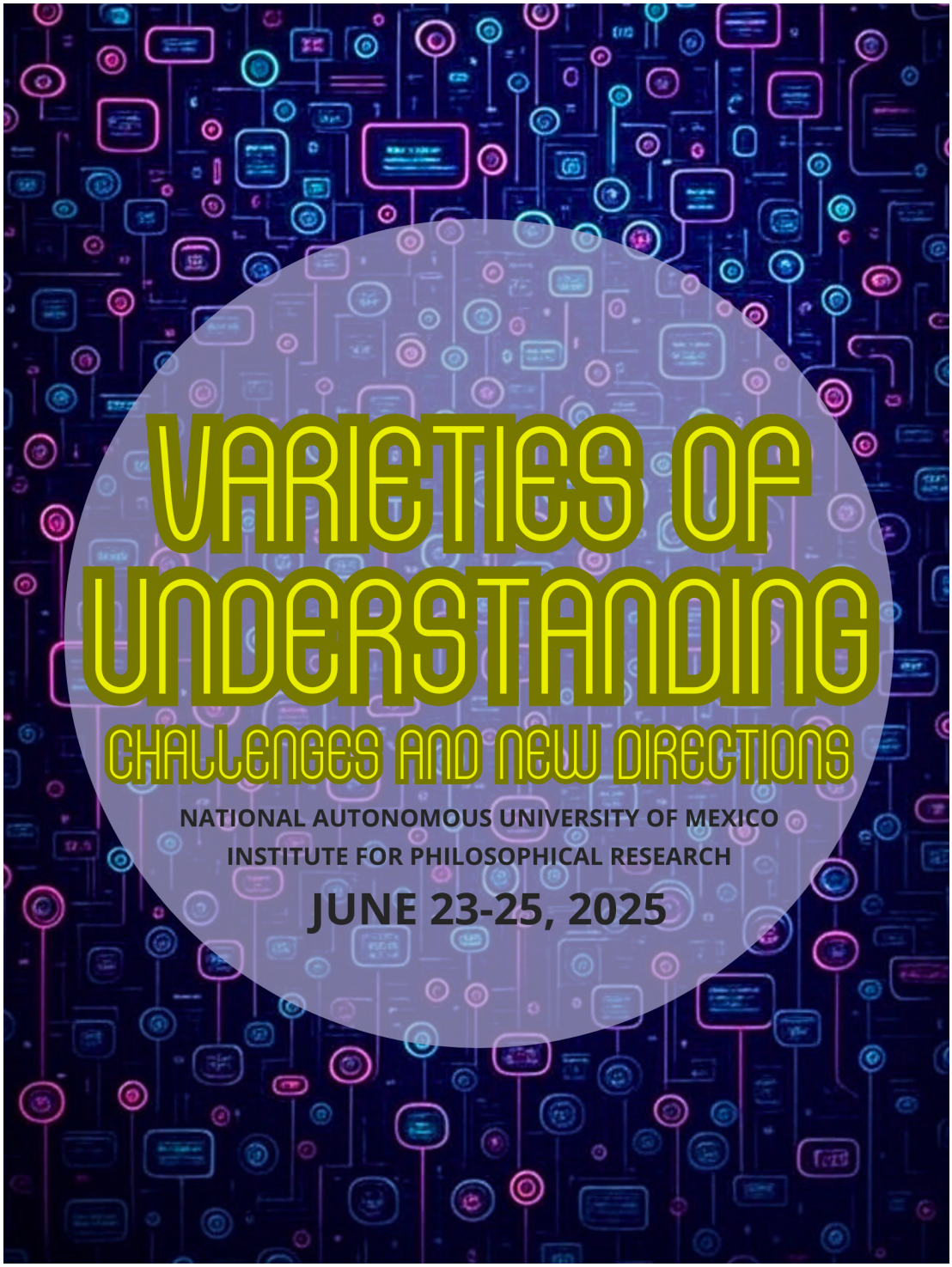
Varieties of Understanding:
Challenges and New Directions

BOOK OF ABSTRACTS


VARIETIES OF
UNDERSTANDING
CHALLENGES AND NEW DIRECTIONS
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The dawn of the XXI century saw the beginning of an explosion of interest in the nature of the precious cognitive achievement that goes by the ordinary name of "understanding". Two and a half decades later, the literature produced by epistemologists, philosophers of science, cognitive psychologists, has shed so much light on so many aspects and manifestations of the diverse forms that understanding can take, that it feels appropriate to ask where our understanding of understanding stands at the present, after all those contributions.

This conference aims to address that very general question by calling for papers that tackle any of the following more specific questions and related ones:

- What distinguishes understanding from knowledge, explanation, and interpretation?
- Is understanding an epistemically privileged cognitive state? what grounds this privilege?
- What are the theoretical vs. practical dimensions of understanding? How do they interact / inform each other?
- How can recent advances in cognitive science, AI, or data science challenge traditional views on understanding?
- What novel frameworks or theories offer promising directions for studying understanding in diverse contexts (scientific, social, ethical)?
- How does understanding vary across different disciplines, cultures, and historical contexts?
- Can diverse epistemic traditions contribute to a more pluralistic view of understanding?
- How do practical activities (like craftsmanship or performing arts) contribute to our understanding of complex concepts?
- What role should embodied, tacit, or skill-based knowledge play in our theoretical models of understanding?

Monday, June 23, 2025.

Chair: Miguel Ángel Fernández Vargas

[11:00-12:40] *Keynote Talk: "Notional Understanding vs. Real Understanding – in Human Beings, and in Artificial Intelligence"*
Stephen Grimm (Fortham University, USA)

[12:40-12:50] MINI-BREAK

[12:50-13:50] *"Is there a sense in which AI assistants can understand anything?"*
David Bourget (Western University, Canada)

[13:50-16:00] LUNCH BREAK

[16:00-17:00] *"How to Do Things with Propositions: Understanding-Why as Propositional Know-How"*
Jake Spinella (University of Illinois, Chicago, USA)

[17:00-17:10] MINI-BREAK

[17:10-18:50] *Keynote Talk: "Exclusive Understanding"*
Allan Hazlett (Washington University, St. Louis, USA)

Tuesday, June 24, 2025.

Chair: Pedro Stepanenko Gutiérrez

[11:00-12:40] *Keynote Talk "Machine Understanding"*
Tania Lombrozo (Princeton University, USA)

[12:40-12:50] MINI-BREAK

[12:50-13:50] *"Explanation and Understanding in Deep Neural Networks"*
Andrés Páez (Universidad de los Andes, Colombia)

[13:50-16:00] LUNCH BREAK

[16:00-17:00] *"Memory as a generative source of understanding"*
Jocelyn Wang (Rutgers Center for Cognitive Science, USA)

[17:00-18:00] *"Ch(A.I.)nging Our Minds"*
Martina Orlandi (Trent University Durham, Canada)

Wednesday, June 25, 2025.

Chair: Ana Rosa Pérez Ransanz

[11:00-12:00] *"Anti-intellectualism and Scientific Understanding"*
Bruno Malavolta (National Autonomous University of Mexico, Mexico)

[12:00-13:00] *"Structural Understanding: The Unity of Scientific Understanding"*
María del Rosario Martínez-Ordaz(National Autonomous University of Mexico, Mexico) and Moisés Macías-Bustos(University of Massachusetts-Amherst, USA)

[13:00-15:00] LUNCH BREAK

[15:00-16:00] *"Understanding and Explanation: Structure and Modality"*
Otávio Bueno (University of Miami, USA)

[16:00-17:40] *Keynote talk: "Problems and Possibilities: A Pragmatic View of Scientific Understanding"*
Soazig Le Bihan (Montana University, USA)

"Notional Understanding vs. Real Understanding – in Human Beings, and in Artificial Intelligence"

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This paper defends a distinction between notional understanding and real understanding (owing originally to John Henry Newman). Roughly, you have notional understanding of some linguistic expression if you can appropriately relate it to other expression (e.g., if you can give an English word a "dictionary definition" in terms of other English words), while you have real understanding of an item if you have had an experience of the referent of the expression. I argue that Newman's distinction illuminates a wide variety of phenomena, including the currently vexed question of whether Large Language Models such as ChatGPT really understand the words and sentences that they produce. A moderate claim is that they might possess notional understanding but lack real understanding, because they do not consciously experience the world. A stronger claim is that they lack any kind of linguistic understanding at all, because there is no notional understanding without some instances of real understanding. I defend the stronger claim here. No conscious experience, no linguistic understanding of any kind (notional or real).

“Is there a sense in which AI assistants can understand anything?”

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It is almost impossible to resist attributing understanding to today’s most advanced LLM-based AI assistants. However, there are also theoretical grounds for rejecting such attributions. In particular, understanding—at least as ordinarily conceived—is arguably tied to a subject’s capacity to experientially grasp certain contents, a capacity LLMs presumably lack. Taking these theoretical claims as background, I ask whether there is a diluted but still non-trivial and interesting sense in which LLM-based agents might be said to understand anything. I argue that Blockhead-style mechanisms demonstrate that any notion of understanding applicable to LLM-based assistants is equally applicable to systems that clearly do not understand. Thus, under the background assumptions adopted here, the claim that LLM-based AI assistants understand anything is either false or trivial.

"How to Do Things with Propositions: Understanding-Why as Propositional Know-How"

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There has been significant disagreement regarding the proper way to think about the relation between propositions, on the one hand, and understanding-why, on the other. Broadly speaking, there are two ways of theorizing their relation. The first is to treat understanding-why as a special kind of propositional knowledge, usually knowledge of causes or explanations. The second way is to treat understanding as a kind of ability that is different from propositional knowledge simpliciter.

The goal of this paper is to sketch a view that joins the latter in conceiving of understanding-why as at bottom a type of knowledge-how, rather than knowledge-that, but one that agrees with the former in giving an essential role for propositions in the account. Specifically, the core claim of this paper is that one possesses understanding-why with respect to a proposition when one can use it in skilled propositional performances, such as in the answering of wh-questions and in teaching.

On this view, understanding-why requires propositional capacities because, if the standard semantics of knowledge-wh attribution is on the right track, one cannot engage in skilled propositional performances such as answering why-questions or teaching without supplying a proposition. But, despite requiring propositional capacities, understanding-why does not reduce to knowing the right set of propositions, for two reasons. First, because knowing propositions is insufficient for skillfully deploying that knowledge in performance. Second, because one can understand-why without having knowledge—in many cases, mere belief in a proposition suffices for understanding-why.

There are at least three serious objections to this analysis of understanding-why. The first is that the standard semantics of knowledge-wh constructions—which unproblematically extends to understanding-wh—analyzes knowledge-wh as knowledge of propositions. If this is the case, then the invocation of the semantics of knowledge-wh ascriptions is either self-undermining or a red herring. As such, my

account looks dialectically unstable. This objection is too quick. What it ignores is the possibility of the view I am urging: that understanding-why is essentially propositional without it thereby reducing to knowledge of propositions simpliciter.

The second objection to my account concerns the idea that understanding-why requires being able to put it to work, so to speak. Intuitively, someone can understand why or how something works without being able to articulate that understanding in speech or performance. If this is true, then understanding-why cannot be grounded in know-how, as know-how is fundamentally performative in character. The reason to discount this objection is that it equivocates between two readings of the ability modals 'can' and 'able to.'

The final objection arises from a recent argument made by (Sullivan 2018). On this view, understanding-why is an intellectual ability. Such abilities are different in kind from practical abilities, such as making pottery, insofar as the former is centered on acquiring true beliefs in the form of propositional knowledge and the latter is focused on embodied activities. On such a view, it is a confusion to think of the ability to, say, understand why electrons repel protons as involving knowledge of how to do something. Rather, such cases of understanding-why involve "purely cognitive abilities" such as the ability to infer, reason, and judge, which are in no sense forms of know-how. I first note the possibly terminological nature of this objection, hinging as it does on a dispute over whether there are abilities that are not instances of know-how. I then reply in two ways: first, by observing that understanding even fairly technical subjects such as physics and philosophy comes with a certain set of technical abilities. This observation also reinforces my second point, which is that there is no distinction in kind between cognitive and practical abilities, as there are no such things as abilities that don't involve the capacity to give skilled performances, which is what Sullivan's cognitive abilities purport to be. What this suggests, pace objectors, is not that abilities can be practical or intellectual—all abilities are practical—but rather that the knowledge on which distinctively practical abilities are based can be practical or theoretical. If this is true, then the way is cleared for understanding-why to be what I claim it to be: a form of propositional know-how.

"Exclusive Understanding"

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Is there anything understandable that some people cannot in principle understand? Under what conditions is understanding, in that sense, exclusive? Given a sufficiently liberal conception of what is possible in principle, I doubt that differences in intelligence or cognitive ability generate cases of exclusive understanding: if Einstein can understand why the universe is expanding, then so can I – although it might take a lot of time and effort and training (and perhaps even neuroenhancement) for me to do it. However, you might think that differences in social location – differences of race, gender, or class – generate cases of exclusive understanding. A rich person, you might think, cannot understand what it is like to be poor. The intuitive explanation of this is that your social location can preclude your having certain experiences – e.g. the experience of being poor – that are necessary for the corresponding understanding. I'll argue, on the contrary, that differences in social location do not generate cases of exclusive understanding. Understanding what it is like to occupy a given social location does not require any particular course of experience. To put this another way, understanding what it is like to have an experience does not require having been acquainted with it.

"Machine Understanding"

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Large Language Models (LLMs) understand language? Do educational Artificial Intelligence (AI) agents understand the material they teach? Do therapeutic AI agents understand the people they work with? Asking and answering questions like these requires an account of "machine understanding": a theory of what constitutes understanding in an artificial system, and what counts as evidence for its attribution. In this talk I'll present ongoing work with my collaborators (Huili Chen, Stephen Grimm, and Olga Russakovsky) that aims to lay the conceptual foundations for claims about machine understanding. I'll begin by considering desiderata for an account of machine understanding, and defining the problem as one that involves evaluating claims of the form "S understands T," where S is some system and T is some target of understanding. I'll then consider how we can specify S, T, and "understands," spending most of my time on the "understands" relation. Specifically, I'll outline four families of approaches to understanding, and conclude with some implications for accounts of machine understanding and for current practices in AI.

"Explanation and Understanding in Deep Neural Networks"

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The concept of explanation has a long and variegated history in the philosophy of science. Starting with Hempel and Oppenheimer's (1948) logic-based approach, at least a dozen different analyses of the concept have been proposed. Given this rich theoretical repository, some philosophers have argued that the solution to the problem of specifying a meaning for "explanation" in the context of artificial intelligence (AI) is to adapt an extant account of scientific explanation to machine learning (ML) in general, and to deep neural networks (DNNs) in particular. Erasmus et al. (2021) offer the most developed account of this strategy. They examine four different accounts of explanation in the philosophy of science: the Deductive Nomological, Inductive Statistical, Causal Mechanical, and New Mechanist models. Their claim is that any of them is applicable to DNNs as it would to any scientific phenomenon. This claim derives from a more general principle that they call "the indefeasibility thesis" about explanation. The thesis states that explanations are invariant with respect to the complexity of both the explanans and the explanandum. There is no threshold of complexity beyond which a phenomenon becomes unexplainable. Therefore, despite their complexity, DNNs are scientifically explainable.

In this paper, I argue that the thesis that opaque ML systems are scientifically explainable is either trivial or false, and that it misrepresents the goals of explainable AI (XAI). It is trivial if an explanation is simply understood as the set of causes, entities or states that physically or computationally produce a prediction; not the linguistic or mathematical description of the known elements in the set, but the elements themselves, known or unknown. It is false if the claim is that it is always possible to offer an "explanatory text," a truthful description of the source of the prediction, thereby satisfying the factivity condition on scientific explanations (Páez, 2019). Most of the first part of the essay will be devoted to justifying the second claim. Now, if there are explanatory gaps in machine learning, and more specifically, if the predictions of DNNs cannot be scientifically explained, then the goal of explainable AI thus formulated will be unattainable. We should not insist on using a concept that cannot perform its desired function.

If the attempt to adapt an extant account of scientific explanation to ML is a hopeless endeavor, there are three remaining options: (i) either to adopt a consen-

sual or stipulative definition of "explanation" in ML; (ii) to abandon the factivity condition for explanation; or (iii) to abandon the idea that there is a unique way of understanding what an explanation is in the context of ML. The first option seems entirely unworkable and arbitrary. The second one is mostly associated with pragmatic theories of explanation. These theories have been fruitfully used to clarify the pragmatic context in which explanations are sought in AI (Miller, 2019, 2021). However, there is a tendency to analyze the concept in terms of its empirical usage, without much normative concern. In previous work I have defended the third option. I have argued that XAI ought to take a turn towards a more pragmatic approach in which the focus of attention shifts from the explanation to the understanding of ML systems. If we focus on the cognitive and practical needs of the different stakeholders involved in designing, implementing, and using a ML model, there will be a wide variety of options available to make the model and its outputs understandable. Whether one calls these paths to understanding "explanations" becomes largely irrelevant.

In the second part of the paper, I thus argue that understanding is better suited to play the central role often attributed to explanation. I analyze understanding as a success concept. Using the inferential conception of understanding set forth by Kuorikoski and Ylikoski (2015), I argue that the conditions of satisfaction for understanding either the output of an ML system or the system itself is the user's ability to draw inferences from it, to use it in all sorts of ways. More specifically, understanding can be equated "with the ability to draw correct counterfactual what-if inferences about the object of understanding. ... To understand a phenomenon is to be able to correctly situate it within a space of possibilities" (Kuorikoski, 2023, p. 218). In a similar vein, understandable AI should allow users to reason counterfactually, to put their knowledge of the system to use. Successfully putting one's knowledge to use is not limited to reasoning counterfactually and building mental models. Being able to fix or improve a system, to profit from it, or to game it, are examples of the many possible ways in which usage is a sign of understanding.

"Memory as a generative source of understanding"

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In this paper, I reject the traditional view that memory merely functions to preserve previously acquired information, such as information acquired through perception. I argue instead that one of the functions of memory is to improve our understanding of what is represented in the contents that we previously acquired. I provide this argument using empirical evidence about memory consolidation, a process that has been overlooked by most of the philosophy literature. The consolidation process improves the agent's ability to draw conclusions based on relationships between different contents, which are implicit in the information that they acquired before. I argue, moreover, that the fact that we intuitively ascribe understanding to each other when we acquire requisite mental representations through non-conscious consolidation processes poses a problem for many existing theories of understanding. I argue for my own positive view of understanding, according to which understanding requires not only the ability to draw the right conclusions in a variety of cases, but also that such conclusions must be drawn through transitions that transmit epistemic support.

"Ch(A.I.)nging Our Minds"

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Conspiracy theories are notoriously challenging to debunk. Recent work in psychology has shown that A.I. and ChatGPT in particular, can successfully change the minds of conspiracy theorists by presenting counterevidence, and this change seems to be durable (Costello et al. 2024). In this talk, I examine the philosophical import of this study and argue that insofar as abandoning conspiratorial beliefs is epistemically rational, A.I.-belief revision, as I call it, hinders the restorative benefits of trust that human-belief revision brings about when tackling conspiratorial beliefs. In particular, I suggest that when belief revision is initiated by an A.I., rather than a human, the revision of conspiratorial beliefs exacerbates the engagement crisis with experts, and it fails to restore trust in scientists. I conclude that while A.I.-belief revision might be epistemically beneficial, its risks invite caution.

"Anti-intellectualism and Scientific Understanding"

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paper addresses the connection between practical and theoretical understanding. It advances a unified approach for knowledge and understanding in terms of abilities and embodied cognition. More specifically, it suggests how anti-intellectualism might apply to contexts of scientific understanding. Intellectualism is the claim that epistemic standings must be guided by reflective second-order cognition. In contrast, anti-intellectualism claims that knowledge and understanding are achievements due to cognitive skills, which don't necessarily require reflexive justification (Carvalho 2018). Anti-intellectualism gets support from pragmatism and embodied accounts of cognition (Gibson 2015), and it stresses that embodied, skill-based achievements should play a fundamental role in our theoretical models of knowledge and understanding. I begin by presenting how anti-intellectualism is initially defensible, to then address contexts of scientific understanding.

Intellectualism about knowledge is illustrated by McDowell's (2011) account of perception. According to it, a non-defective episode of perception gives a factive reason that is reflectively accessible for the knower. A main motivation for this reflective requirement is that reflective reasoning can back up perceptual abilities to avoid environmental luck, and hence be knowledge (McDowell 2011, p. 23; also Sosa 2015, p. 87). In response, Carvalho argues that when the exercising of an ability requires environmental luck to succeed, it should not be counted as a genuine achievement. This, because abilities express competences that are indexed to relevant circumstances, as expressed by the ecological account of abilities: "being competent at ϕing is ... being good enough at ϕing with respect to some environment." (Millar, 2016, pp. 62-82). For instance, someone can be a competent archer by being skilled to shoot at targets in a clear whether, without having the ability to shoot in storms. Analogously, the exercising of perceptual abilities can be considered sufficient to generate safe beliefs, insofar as these abilities presume favorable environments to be exercised.

Regarding understanding, both Zagzebski and Pritchard assume a explainability requirement, according to which understanding requires the ability to explain what one intends to understand (Pritchard 2014; Zagzebski 2001, p. 246). Zagzebski motivates this requirement by invoking cases of propositional knowledge

that seem insufficient for the attribution of understanding: a person that knows Newton's Second Law, but doesn't understand it because is unable to explain it. However, if the person gradually learns more, it seems that the difference between knowledge and understanding depends on where the line for that threshold is drawn. Hence, even if a line is drawn at some point in the learning process, knowledge would still be a rudimentary form of understanding in terms of developed skills. In addition, the explainability requirement creates a potential regress: "If understanding required that one is able to explain a product, then it should be expected that one is also able to explain that explanation and so forth." (Carvalho 2018, p. 22).

Intellectualist requirements can be dispensed more easily in paradigmatic cases of practical knowledge and understanding. But Carvalho argues that the explainability requirement is dispensable even for propositional understanding. This is supported by Kuhn's claim that scientists learn a set of skills by being trained to assimilate the exemplars of a paradigm, rather than rigid methodological rules (Kuhn 2012). Scientists do not need to know how to explain why some explanations are good and others are not; they only need "to be able to tell them apart." (Carvalho 2018, p. 25).

While I defend the anti-intellectualist approach, it leaves open a relevant issue: even if epistemic achievements don't require reflexive explicability, what makes them reflectively opaque in each case? Why scientists wouldn't be able to explain their abilities and achievements?

I argue that one reason why practical knowledge and understanding might be opaque is that perception is based on the detection of local or incomplete invariants (Runeson, 1989; Gibson, 2015). On one hand, perceptual abilities might assume shielding conditions that are not necessarily aware for their agent, and the abilities of detection developed in experimental practices might be exercisable only within environments that maintain a structure of invariants. This is implied by the ecological account of abilities.

On the other, when scientists theorize about their practices, they create models or generalizations in attempt to identify such invariants. And for that they face a problem of external validity: how do we know that a detected invariant remains invariant under different contexts? Here, (factive) propositional understanding faces an inferential risk that is not faced by practical understanding, because only the former requires awareness of the shielding conditions. Bringing this to modeling contexts, abstractions might fail to specify local parameters that are required to sustain a modal structure. For instance, Newtonian Mechanics failed to specify that it is only applicable for classical contexts, and in so doing it made generalizations that are not universally true. More generally, I argue that this point is supported by the stability theories of scientific laws, which stress that generalizations become

lawful in virtue of their invariance under counterfactual conditions (Lange, 2009; Woodward, 2013; Cartwright, 1999; 2019; Mitchell, 2023).

"Structural Understanding: The Unity of Scientific Understanding"

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Here, we tackle the question of whether there is a shared ground for the varieties of scientific understanding. In recent decades, the concept of "scientific understanding" has been characterized in diverse and sometimes conflicting ways, leading to two possible conclusions: either there is no unified cognitive phenomenon underlying understanding (cf. Trout, 2017), or understanding is inherently pluralistic, encompassing multiple distinct types (cf. Hannon 2021).

We argue that this apparent plurality is misleading. Instead, we propose that (theoretical) scientific understanding is fundamentally structural (cf. Martinez-Ordaz and Macias-Bustos 2024; Macias-Bustos and Martinez-Ordaz 2023). At its core, understanding is a coherent relational phenomenon, meaning that it consists of grasping the inferential and other types of connections between elements of a theoretical framework/domain rather than tracking isolated facts. This perspective shifts the focus from piecemeal explanatory insights to the systematic organization of information that allows scientists to reason effectively within a given framework.

Building on this, our main thesis is that legitimate scientific understanding is, at its core, structural –as it depends on recognizing formal and inferential relations within theoretical representations rather than their truth conditions. Furthermore, we contend that the apparent plurality of understanding is reducible to structural grounds. We tackle the reducibility of holistic and explanatory understanding, and the fact that a structuralist take on understanding would be orthogonal to the debate over the factivity condition.

To do the above, we proceed in four steps:

- First, we summarize the discussions around the varieties of understanding.
- Second, we defend that scientific understanding is structural; scientists, including mathematicians, understand theories that are false (such as Newtonian mechanics), inconsistent (like Frege's Grundgesetze), or vague (such as high level theories where terms and predicates have borderline cases) in virtue of the fact that they understand the general structure of such theories

and what the world would be like if the whole theory or the consistent or precisified fragments of such theories were applied. We contend that the same would happen in cases with seemingly defective phenomena.

- Third, we explain how successful representation takes place, distinguishing structural understanding from mere coherence among propositions that lack a connection to independent domains. Here, we draw an analogy to structural realism, where epistemic success is determined not by a theory's ontological commitments, but by its ability to capture and preserve structural aspects of reality across theoretical change.

- Fourth, we address how structural understanding unifies diverse instances of scientific understanding under a single framework, explaining why even false, approximate, or idealized representations remain epistemically valuable. We focus on (a) showing that holistic understanding and explanatory understanding are two cases of structural understanding and, (b) demonstrating that a structuralist take on understanding is orthogonal to the debate over the satisfaction of the factivity condition – the question of whether understanding requires truth is independent of whether understanding is fundamentally structural.

"Understanding and Explanation: Structure and Modality"

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Scientific understanding is often, although not always, associated with scientific explanation. It is typically characterized as something that results from explanatory practices that increase intelligibility (see de Regt [2017]). Peter Lipton interestingly resists tying understanding and explanation, arguing that the former is broader and can emerge in the absence of the latter (Lipton [2009]). In this paper, I build up on Lipton's insight and argue that understanding can result from the transferring of structure among different domains, quite independently of any account of explanation involved (Bueno and French [2018]). I consider, in particular, the Lotka-Volterra equation and its use to represent phenomena as diverse as patterns in economic markets and relations among predators and preys. There are clearly mappings and transferring of structure among the models that describe the relevant phenomena, which result in understanding of the latter, given the recognition of structural patterns across diverse domains. It is not clear, however, that there is an explanation involved beyond the mere description of the events. I then argue that this, in turn, allows for a better account of the relations between understanding and modality, as the transfer of structure highlights what is possible or not in different domains (Bueno and Shalkowski [2009] and Bueno [2021]).

"Problems and Possibilities: A Pragmatic View of Scientific Understanding"

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Science is an astonishingly complex and diverse endeavor. What unifies the diverse scientific practices, from the axiomatization of quantum theory to the testing of medical treatments? I will argue that what unifies all of science is that it generates scientific understanding as conceived by the Problems and Possibilities View (PP View). The PP View provides a comprehensive and unified account of scientific understanding that is fit to unify science. It includes both explanatory and non-explanatory kinds of understanding. Under PP View, scientific understanding is generated when scientists competently engage in problem-solving activities and reflect on, compare, and evaluate possible solutions to scientific problems. In the talk, I will sketch the PP View and show how it captures and unifies a variety of scientific practices, from the most practical to the most theoretical.

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