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Intuition and Awareness of Abstract Models: A Challenge for Realists

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Abstract: It is plausible to think that, in order to actively employ models in their inquiries, scientists should be aware of their existence. The question is especially puzzling for realists in the case of abstract models, since it is not obvious how this is possible. Interestingly, though, this question has drawn little attention in the relevant literature. Perhaps the most obvious choice for a realist is appealing to intuition. In this paper, I argue that if scientific models were abstract entities, one could not be aware of them intuitively. I deploy my argumentation by building on Chudnoff’s elaboration on intuitive awareness. Furthermore, I shortly discuss some other options to which realists could turn in order to address the question of awareness.

Keywords: intuition; awareness; scientific models; abstract objects; abstract models; intuitive awareness; tacit knowledge

1. Introduction

Several philosophers argue for a realistic understanding of scientific models, by claiming that they postulate abstract entities. While I do not intend to discuss this issue in detail here,¹ there is a point of particular interest that I would like to focus on. Instead of arguing about whether one is able to think of scientific models as abstract entities or not and how could it be possible, I focus on how one can become aware of their existence if they are abstract entities.

The issue of awareness emerges since it is plausible to think that one should become aware of an abstract entity in order to actively employ it in a scientific inquiry. I maintain that that the issue of awareness poses a challenge for any realistic approach to abstract models. For fairly obvious reasons, arguing for intuitive awareness of abstract objects seems more promising for a realist than arguing for their perceptual awareness.

The issue gains more interest, since intuition has been plausibly linked with what could be called “creative thinking”, a connection rooted a long time ago. For example, one could trace it back in Poincare [2]. Therefore, given the growing literature on the models-as-fictions approach,² in which the creative features of model-building are scrutinized, questions regarding intuition are legitimately raised. It is quite surprising, though, that the issue of intuitive awareness has not yet drawn much attention in the relevant literature.

Of course, one should not defy that it is confusing that the term intuition is used as a general label for varying forms of knowledge, processes and outcomes [8]. Most of these definitions agree that intuition is based on automatic processes that rely on knowledge structures acquired through different kinds of learning [8] (pp. 47–48).³ I maintain that appropriating such a broad understanding

¹ For detailed overview of the discussion about abstraction and abstract entities in philosophy, see [1].

² See, for example, [3–7]. This list is obviously non-exhaustive.

³ For a detailed discussion, see [9].

suffices for my current purposes. After all, different types of intuition make use of partly non-conscious processes, such as pattern recognition, memory traces and currently perceived information, and often the only awareness is of the result [8] (p. 53).

In this paper, I argue that if scientific models were abstract entities, one could not be aware of them intuitively. I deal with this issue by building on Chudnoff's insightful elaboration on the issue of awareness of abstract entities. Specifically, at first I concisely outline the ongoing philosophical discussion on scientific models. In the next section, I shortly discuss Chudnoff's view on intuitions as epistemically useful intellectual experiences. Then, I proceed by discussing his views on intuitive awareness of abstract objects and I argue that his elaboration is at least inapplicable in the case of scientific models, if they were abstract objects. Finally, I shortly discuss possible alternative approaches that could be endorsed by realists to account for the awareness of models as abstract entities, in which a place for intuition is retained.

2. An Outline of the Discussion on Scientific Models

In order to properly frame the main question that I am dealing with in this paper, a short outline of some aspects of the ongoing philosophical discussion on scientific models may be useful.

Due to the polysemy of the notion, it is not easy to define what a scientific model is; in fact, there is no unanimity on that even among philosophers of science who deal with the issue. This polysemy makes it difficult for one to investigate every aspect of their role and nature, and how they are employed in scientific reasoning and practice etc. Nevertheless, it is undisputed that modeling and scientists' interaction with models is one of the most important scientific activities. Scientists take advantage of the relation between a model and its target system—whatever this relation may be and arguably regardless of their success in properly identifying the target—in order to theorize about the latter by employing the findings of their studies on the former.

Much of the philosophical discussion on scientific models is about how they fulfill their epistemic function. While both realists and antirealists acknowledge that models are not identical to their targets, the discussion on models is orthogonal with the discussion on representation in science. Models are generally considered to facilitate both the route from experience to theory and our intervention in real processes which they represent (at least in certain degrees and respects) or stand for. In the last two decades, there is a growing number of philosophers who argue that models do not (or need not) represent and/or contest the view that representation presupposes (or is reduced to) a structural relation between the model and its target. According to them, the representational status of scientific models is not only dubious or ambiguous, but also unnecessary for the actual role that they play in scientific practice. These philosophers put emphasis on the epistemic function of models and tend to think of them as mediating artifacts, focusing either on their mediating role (i.e., [10]) or their artifactual character (i.e., [11]). An alternative approach is articulated in [12], in which I attempt to describe how models mediate scientific cognition by interlacing their artifactual character with a proper understanding of their representational status.

Regardless of which ones' favored stance on the several issues emerging in the relevant discussion is, there is consensus to the obvious fact that there are models which are not material, perhaps in many different senses. For example, no scientist can experiment on electrons which move in circular motion around the nucleus in an atomic model. Another example is the model of a simple pendulum, which contains no representation for friction, so any exact realization would be a perpetual motion machine which is universally regarded as being physically impossible [13] (p. 248).

Therefore, since several models need not to be physically realized in order to be employed in scientific inquiries, some philosophers prefer to treat them as fictional entities. According to Giere and other realists, on the contrary, non-concrete models are "abstract entities" [14] (p. 81), which are human constructions that should not to be identified with linguistic entities such as words or equations [15] (p. 747). According to Psillos, models, being products of idealization and abstraction, are not worldly systems; although what exactly models are may still be a matter of dispute, a central thought is that

models (or at least some models) are abstract entities [16] (p. 3). As Psillos explains, the claim that models are abstract entities is meant to imply that they are not concrete and that they are not causally efficacious, in the sense of Dummett's 'abstract physical objects' [17] (p. 300). Despite its arguable ambiguity, I choose to adopt this terminology, as a *locus communis* in the relevant discussion, without getting further engaged on whether what is modeled is an object, a structure, a relation, a property or something else.

As they perform their inquiries, scientists deal with models as if they were objects, aiming to make inferences about their targets. Indeed, as [18] argues, the manipulation of models is an essential part of the process of scientific investigation. However, one can manipulate something only if it exists or, at least, if s/he considers it to exist. Therefore, those invoking realist accounts on models ought to tell us a story about their existence as abstract entities; this point has already been raised in the relevant discussion. As I argue in this paper, they should also argue on how one becomes aware of their existence as abstract entities, if they are to be employed in actual scientific practice.

3. The Epistemic Role of Intellectual Experiences

In his [19], Chudnoff argues that intuitions are intellectual experiences playing an epistemic role parallel to the one of perceptual experiences. In particular, intellectual experience makes us aware of abstract objects; this awareness grounds knowledge of propositions made true by those objects, likewise perceptual experience makes us aware of concrete objects and this awareness in turn enables knowledge [20] (p. 105).

Furthermore, Chudnoff argues that a causal connection between objects of intuitive awareness and intellectual experience is not necessary in order to put us into epistemic contact with abstract objects. According to him, there is a metaphysical link between intuition experiences and abstract objects, so that an intellectual experience can be dependent on the relevant abstract object and it could serve to distinguish that object from others.

This is the core idea underlying Chudnoff's formulation of what he calls "Formal Naïve Realism": If S is intuitively aware of an abstract object o by having intuition experience e, then e depends on o, in that: in accordance with the essence of e, o is part of the principle of unity that e's (material) parts instantiate and thereby determines e's phenomenal character [19] (p. 223).

According to Chudnoff, an intuition experience is constituted by various mental episodes (i.e., of imagination, attention etc.), which are "material" parts to such an experience. The essence of a particular intuition experience making one aware of an abstract object demand that its parts be arranged in ways that are reflected in its phenomenology. The phenomenology required by the essence of the intuition should differentiate the relevant abstract object from others, so that parts of the particular experience enables the subject of experience to distinguish similarities (or resemblances) and differences between different abstract objects and to contrast the relevant abstract object from others.

As Witmer explains, one should take into account the explanatory role of essences in order to make out why these specific arrangements are possible, while others are not; the abstract object must be mentioned in stating what it is to be that particular event, since part of what it is to be that particular event is to be an experience the parts of which are arranged in a way that allow for differentiations enabling the subject to distinguish that abstract object from others [20] (p. 107).

4. Two Questions for Awareness

Chudnoff's [21] defends the view that some mathematical intuitions make their subjects aware of abstract objects. As he states, the awareness relation he is discussing about is close to Tye's "consciousness of things" [22] (p. 14): If a phenomenally conscious state of mine is such that it at least enables me to ask 'what is that?' with respect to some entity only on the basis of its phenomenal character, then I am conscious of that entity.

Chudnoff poses two questions that one should answer in order to argue for the awareness of an abstract object. The first question is the "Existence Question": If there are any experiences that we

(could) have, that make us aware of abstract objects. The second question is the “Grounding Question”: If there are such kinds of experiences, in virtue of what do they make their subjects aware of abstract objects when they do so.

In the rest of this section, I deal with each one of these questions, as they posed in Chudnoff’s [21], with respect to scientific models.

Let us begin with the “Existence Question”. Since the traditional view is that there are not sensory experiences that make us aware of the existence of abstract objects, it seems rational to think that such awareness occurs in intuition. This intuitive awareness is, in a sense, phenomenologically analogous to sensory awareness of concrete objects. By phenomenological analogy, Chudnoff argues that it is intuitive experiences that put their subjects in a position to know what intuitively seems true in them and make them (the subjects) aware of abstract objects.

If this is correct, then it is problematic to regard scientific models (or parts of them) as abstract entities, since the reason why they are employed in scientific inquiries is to grant cognitive access to previously unknown (or incomprehensible from the specific point of view) areas of reality. Therefore, it could not be the case that what intuitively seems true in them makes an agent aware of them, since the latter should rather be a prerequisite for the former, as long as the agent consciously builds or employs them.

Before dealing with the “Grounding Question” in detail, I should mention that, according to Chudnoff’s line of reasoning, it is pointless to pose it once the “Existence Question” is discarded. Nevertheless, even if, as I have argued, one cannot offer a positive answer to the “Existence Question” question in the case of scientific models, I will scrutinize it, as if it were an autonomous one.

Chudnoff, after a careful examination and convincing rejection of several other options, argues that there is only one way one could answer the “Grounding Question”. According to him, if an agent is intuitively aware of an abstract object by having an intuitive experience, then: (i) this experience depends on the object, and also; (ii) the phenomenology of this experience differentiates the object from its background.

Let us discuss this answer in terms of scientific models. Suppose that a scientific model A is an abstract object. Then, according to Chudnoff’s well-argued approach, our intuitive experience that made us aware of A’s existence should depend on A and the phenomenology of this experience differentiates A from its background. The first part seems unproblematic; there is arguably no plausible reason to counter-argue on that awareness of A’s existence depends on A itself. However, it is not obvious that one should also undoubtedly grant the second part. For, it is not plausible to isolate A from the context of any possible—and therefore any actual, too—scientific inquiry in which A is employed. In this sense, it could be argued that, in the case of scientific models, their background consists of the phenomenology of their purported intuitive experience.

Let me attempt to clarify this claim by an example. Suppose that A is a simple harmonic oscillator. How could one think of it outside the context of an actual oscillation? One could probably claim that it could simply be a momentarily non-oscillating oscillator. However, in the aforementioned context, this is not an acceptable answer, since, even in such a case, if it oscillated, our intuitive experience would be about the oscillation—which could easily be isolated from its actual background—and not the oscillator. Therefore, in a bizarre sense, one could argue that, from this point of view, such an oscillator could not oscillate!

Of course, there is no need to stretch Chudnoff’s line of reasoning to such an extent. Chudnoff argues that mathematical intuition is the only possible successful candidate to fulfill the requirements of the plausibility of his proposal. Therefore, since, in this paper, I refrain from going beyond Chudnoff’s argumentation, it suffices for my purposes to underscore that the aforementioned kind of purported awareness of A as an abstract object is not the kind of awareness that occurs in mathematical intuition, that Chudnoff argues for.

5. Alternatives for Realists

Thus far, by employing Chudnoff's line of reasoning, I have argued that, if scientific models were abstract objects, we could not be aware of them intuitively. Therefore, a realist should offer an alternative account for the awareness of models as abstract entities.

In such an alternative account, a special place for intuition could arguably be retained. For example, as Podnieks argues with regard to mathematical theories, in them we have the most elementary type of intuition—some unconscious “reasonable principles” ruling our reasoning. We can say, therefore, that a theory (or model) can be fixed not only due to some system of axioms, but also due to a specific intuition [23] (p. 50). I maintain that this understanding could be expanded with regard to scientific models in general. In this line of reasoning, it seems reasonable to claim that a model can be fixed due to a specific intuition.

Given the link between intuition, creative thinking and models-as-fictions traced in the introductory section of this paper, an attempt to proffer an alternative account could arguably be informed by a discussion of mindful awareness and intuition with regard to the question of abstract models in science. I will now proceed by outlining such an attempt.

Francisco Varela and his partners argue that the current science “holds a potential for the profound transformation of human awareness” [24] (p. 6). According to them, lack of awareness is not in itself a problem, but “the lack of discrimination and mindfulness of the habitual tendency to grasp”, of which an individual can become aware [8] (p. 60). In order to succeed in this, Varela and his partners emphasize five essential components to be aware of and to practice: contact between the mind and the object, a feeling tone of it, a discernment of it, an intention toward it and attention to it. Attention and intention interact such that intention directs consciousness and attention focuses as well as holds consciousness on the object.

This line of reasoning could arguably offer an alternative way of dealing with the question of awareness of abstract models. For example, it could be argued that abstract models are intellectual constructs yielding scientists the opportunity to interact with their field of study by manipulating them in an instrumental way. In such a case, one could arguably account for the five components on which Varela and his partners put emphasis. However, it is not clear if this alternative could be easily endorsed by a realist, for s/he should then face the challenge of the perennial question of how intellectual constructs find their counterparts in reality.

If a realist insists on appealing to intuition, another alternative could be inspired by Polanyi's view that intuition is connected with tacit knowledge [25]. Tacit knowledge, as Raami explains, is often formed alongside professional expertise over a long period of time [8] (p.60). It could be argued, then, that abstract models confer tacit knowledge, as the scientific community which is engaged with the given field of inquiry, constructs and employs them in scientific inquiries, has mastered what is already known about this given field.

As it has been argued, tacit knowledge is revealed through practice in a particular context and transmitted through social networks [26]. In our case, it could be argued that scientists employ an abstract model in their engagement with their specific field of inquiry, within the context of which they perform their work. This work, as well as its outcomes, is communicated with the relevant scientific community, which could be regarded as a social network.

On these grounds, intuition could be linked with professional expertise and tacit knowledge or, to put it otherwise, tacit knowledge could be regarded as expert-based intuition. Thus, instead of directly addressing the issue of intuitive awareness of abstract models, the realist could argue that scientists who construct abstract models intentionally access intuitive information. However, the realist should then focus on how tacit knowledge is conveyed by (or, should one prefers, embodied in) scientific models and account for it in a way that realistic ontological commitments underpin the epistemic role scientific models perform in actual scientific practice.

6. Envoi

In this paper, I have argued that any approach on models as abstract entities should account for their awareness. It seems that this question may be troublesome for realists. The problem may be more significant if, as I argue, intuitive awareness could not provide the answer.

Regardless of the success of my argumentation in this paper, I maintain that it turns out that the epistemic function of abstract scientific models is inevitably intertwined with their ontological status in any attempt to articulate a comprehensive realistic approach on the issue of awareness.

If this is correct, though, then the aforementioned problem posed to realists could become a great opportunity for them to become acquainted with views and elaborations deployed in other intellectual contexts in order to tackle it and even appropriate them for their causes. I have attempted to point to this direction with the two alternatives I outlined. In the course of such attempts, arguably the most interesting outcome would be to bring realism closer to the perspective endorsed by those who focus on social aspects of scientific cognition. As I have attempted to show, intuition could serve as the vehicle which will drive realists to this direction.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Coniglione, F. Between abstraction and idealization: Scientific practice and philosophical awareness. *Pozn. Stud. Philos. Sci. Humanit.* **2004**, *82*, 59–110.
2. Poincare, H. *Science et Method*; Ernst Flammarion: Paris, France, 1908.
3. Curry, G. Models as Fictions, Fictions as Models. *Monist* **2016**, *99*, 296–310. [[CrossRef](#)]
4. Frigg, R.; Nguyen, J. The Fiction View of Models Reloaded. *Monist* **2016**, *99*, 225–242. [[CrossRef](#)]
5. Levy, A. Models, Fictions and Realism: Two packages. *Philos. Sci.* **2012**, *79*, 738–748. [[CrossRef](#)]
6. Godfrey-Smith, P. Models and Fictions in Science. *Philos. Stud.* **2009**, *143*, 101–116. [[CrossRef](#)]
7. Woods, J. *Fictions and Models: New Essays*; Philosophia Verlag: Munich, Germany, 2010.
8. Raami, A. *Intuition Unleashed*; Aalto ARTS Books: Helsinki, Finland, 2015.
9. Glöckner, A.; Witteman, C. Foundations for tracing intuition: Models, findings, categorizations. In *Foundations for Tracing Intuition: Challenges and Methods*; Glöckner, A., Witteman, C., Eds.; Hove, East Sussex; Psychology Press & Routledge: New York, NY, USA, 2010; pp. 1–23.
10. Morrison, M.; Morgan, M. Models as Mediating Instruments. In *Models as Mediators. Perspectives on Natural and Social Science*; Morgan, M., Morrison, M., Eds.; Cambridge University Press: Cambridge, UK, 1999; pp. 10–37.
11. Knuuttila, T. Models, Representation, and Mediation. *Philos. Sci.* **2005**, *72*, 1260–1271. [[CrossRef](#)]
12. Kilakos, D. Ideality, Symbolic Mediation and Scientific Cognition: The Tool-Like Function of Scientific Representations. In *Model-Based Reasoning in Science and Technology: Logical, Epistemological, and Cognitive Issues (Studies in Applied Philosophy, Epistemology and Rational Ethics)*; Magnani, L., Casadio, C., Eds.; Springer: Cham, Switzerland, 2016; pp. 205–218.
13. Giere, R.N. Why Scientific Models should not be regarded as Works of Fiction. In *Fictions in Science. Philosophical Essays on Modelling and Idealization*; Suárez, M., Ed.; Routledge: London, UK, 2009; pp. 248–258.
14. Giere, R.N. *Explaining Science: A Cognitive Approach*; University of Chicago Press: Chicago, IL, USA, 1988.
15. Giere, R.N. How Models Are Used to Represent Reality. *Philos. Sci.* **2004**, *71*, 742–752. [[CrossRef](#)]
16. Psillos, S. Living with the abstract: Realism and models. *Synthese* **2011**, *180*, 3–17. [[CrossRef](#)]
17. Dummett, M. *Frege: Philosophy of Mathematics*; Duckworth: London, UK, 1999.
18. Morgan, M. Learning from Models. In *Models as Mediators. Perspectives on Natural and Social Science*; Morgan, M., Morrison, M., Eds.; Cambridge University Press: Cambridge, UK, 1999; pp. 347–388.
19. Chudnoff, E. *Intuition*; Oxford University Press: Oxford, UK, 2013.
20. Witmer, G. Chudnoff on the Awareness of Abstract Objects. *Fla. Philos. Soc.* **2016**, *XVI*, 105–116.
21. Chudnoff, E. Awareness of abstract objects. *NOUS* **2013**, *47*, 706–726. [[CrossRef](#)]
22. Tye, M. *Consciousness Revisited*; The MIT Press: Cambridge, MA, USA, 2010.

23. Podnieks, K.M. Platonism, Intuition and the Nature of Mathematics. In Proceedings of the Heyting'88, Summer School & Conference on Mathematical Logic, Chaika, Bulgaria, 13–23 September 1988; Bulgarian Academy of Sciences: Sofia, Bulgaria, 1988; pp. 50–51.
24. Varela, F.; Thompson, E.; Rosch, E. *The Embodied Mind: Cognitive Science and Human Experience*; MIT Press: Cambridge, MA, USA, 1991.
25. Polanyi, M. *Personal Knowledge: Towards a Post-Critical Philosophy*; University of Chicago Press: Chicago, IL, USA, 1958.
26. Goffin, K.; Koners, U. Tacit Knowledge, Lessons Learnt, and New Product Development. *J. Prod. Innov. Manag.* **2011**, *28*, 300–318. [[CrossRef](#)]



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