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THE ONTOLOGICAL AUTONOMY OF THE CHEMICAL
WORLD: A RESPONSE TO NEEDHAM

INTRODUCTION

In his comment to our article (*Foundations of Chemistry*, 7 (2005), 125–48), Paul Needham considers our proposal of an ontological pluralism as a radical alternative, not needed to deal with the problem of the relationship between chemistry and physics. Needham agrees with us that ontological reduction cannot be simply assumed; however, he decides to shift the burden of the proof to the ontological reductionist, and to wait for a coherent account of the thesis and for a convincing argument for it before going “so far” as us.

Of course, there is no ultimate and definitive position in science or in philosophy: we have learned from history that even the best arguments are good only in a relative sense. Moreover, science does not force an only “right” metaphysical view: metaphysics is underdetermined by scientific theories. Therefore, when ontological questions are discussed, there may always exist different philosophical positions, different ontological pictures to account for the world described by science. And the adoption of one of the pictures over the others strongly depends on the philosophical temperament of each author.

Nevertheless, this does not mean that there are not good reasons to defend a certain philosophical position. And a strong argument in favor of an ontological picture is its fruitfulness in the account of many different problems of the philosophy of science. It is precisely in this sense that, we think, ontological pluralism can be argued for: it supplies us a philosophical framework to deal with many puzzles arising

when the relationships between the worlds described by different theories are considered.

THE DISTINCTION BETWEEN EPISTEMOLOGICAL AND ONTOLOGICAL REDUCTION

Needham begins by bringing into question our distinction between epistemological and ontological reduction. By assuming an implicit agreement about both notions, perhaps we were not clear enough about this topic; so, this is the proper place to clarify the issue.

If we accept the distinction between subject and object in the epistemic relationship, linguistic and/or conceptual items (language, theories, laws, descriptions, concepts, names, predicates, etc.) correspond to the side of the subject, and ontological items (ontology, regularities, individual entities, properties, relations, events, etc.) correspond to the side of the object. On the basis of this distinction, it is usually accepted that epistemological reduction is a relationship between linguistic – or conceptual – items, in particular, theories, and ontological reduction is a relationship between ontological items, usually properties but also individual entities, events and nomological regularities. This means that, from the very beginning, epistemological reduction and ontological reduction are different concepts to the extent that they apply to items of a different nature.

However, when we try to decide about the effective application of these two forms of reduction, we have to face the following problem. We, as subjects of knowledge, have direct access to our linguistic or conceptual space; so, leaving aside technical difficulties, in principle there is no obstacle in deciding whether a certain relationship between two items belonging to that space holds or does not. However, we have no direct access to the whole ontological realm. It is not necessary to be an internalist realist to accept this fact: even a metaphysical realist should recognize that there are domains of the ontology that are unobservable and, therefore, not empirically accessible; as a consequence, ontological conclusions about those inaccessible

domains are necessarily indirect. Therefore, we do not always have an empirical basis to decide if a certain relationship between ontological items holds or does not.

Nevertheless, if we are realists in some sense, we conceive of linguistic or conceptual items as referring to ontological items; then, we consider that the relationship between two theories and their terms reflects a certain relationship between the ontological domains described and referred to by those theories. In particular, the epistemological reduction between two theories, if obtained, could lead us to believe that the corresponding ontological reduction holds. This means that epistemological reduction can count as an indirect argument for ontological reduction. In other words, we have to see what happens on the epistemological side in order to draw some conclusions about the ontological relationship of reduction. Up to this point, we hope to have been clear enough about how we understand the notions of ontological and epistemological reduction and the links between them.

In our article, we have considered the traditional, Nagelian concept of epistemological reduction, according to which the reduced theory can be deduced from the reducing theory plus some necessary definitions. This is an *eliminativist* position: since the linguistic items belonging to the reduced theory can be eliminated from the scientific discourse, we have no ontological commitment to their references. Then, if the epistemic reduction between two theories were established, one could have good reasons to support ontological reduction and to assume, on the basis of Occam's razor, that the ontology is populated exclusively by the items referred to by the reducing theory.

Needham seems not to agree with this conclusion. He considers the elimination of ontological items coherent or legitimate only in the case of theory change, like the case of the abandoned theory of caloric. According to Needham, "*Reduction preserves what it reduces*" (p. 3). But, in what sense does reduction preserve it? Of course, even under the strong Nagelian epistemological reduction we are entitled to use the reduced linguistic items for reasons of conciseness and

economy, but this does not imply that we believe in the existence of their references as different from the references of the reducing linguistic items.

Needham argues as if we were saying that there is absolutely *nothing* referred to by the reduced linguistic items. For this reason he appeals to the example of caloric, and claims that Hamilton's definition "*certainly doesn't eliminate the imaginary numbers themselves*" (p. 4). Also for this reason he recalls the case of non-referring expressions as 'the present king of France'. But our denial of the existence of the ontologically reduced items is not analogous to the problem of "subsistence" faced by Russell. In the case of epistemological reduction, the words of the reduced theory are not non-referring terms: they have *the same reference* as those in terms of which they were defined. This situation is analogous to the case of two names referring to the same individual: we do not say that there are two persons, one denoted by 'Lewis Carroll' and the other denoted by 'Charles Dodgson' when we have identified both names. In the same sense, under the assumption of epistemological reduction it is said that, since the term 'temperature' is defined by its identity with 'mean kinetic energy', both expressions refer to the same ontological item: 'temperature' does not have an independent referring character; temperature is nothing different than mean kinetic energy. In other words, we are not saying that temperature and imaginary numbers do not exist in the same way that the present king of France or caloric do not exist: we are claiming that they do not exist as ontological items different than those referred to by the reducing description. In this obvious sense we can agree with Needham that reduction "preserves" what it reduces: when we have an identity between two terms, ' $t_1 = t_2$ ', we cannot deny the existence of the ontological item referred to by t_1 without denying the existence of the ontological item referred to by t_2 . But this is certainly not the point of our discussion about the ontological autonomy of the chemical world, where the question consists in deciding if chemical items are something ontologically different than the items described by physical theories.¹

WHICH EPISTEMOLOGICAL REDUCTION?

The discussion of the previous paragraph would be more interesting if science contained relevant examples of epistemological reduction in Nagel's sense. However, this does not seem to be the case. As Primas claims, "*there exists not a single physically well founded and non-trivial example for theory reduction*" in the sense of Nagel (Primas, 1998, p. 83). But even if there were examples of successful application of such a notion of reduction in certain areas of science, there is a broad consensus among the philosophers of chemistry that this is not the case in chemistry: the epistemological reduction of chemistry to physics clearly fails. As we have said, since we have no direct access to all the domains of reality, we only can draw some conclusions about ontological reduction through the study of the relationships between theories. For this reason, if epistemological reduction were successful, we should have a good argument to believe in ontological reduction. But, when epistemological reduction fails, why should we insist on the defense of ontological reduction?

Given the failure of epistemological reduction conceived as a deductive relationship between theories, different strategies have been proposed: to understand the links between terms as bridge laws, to speak of the emergence of certain items, to posit a relationship of supervenience between two ontological realms, etc. Although abandoning the strong eliminativist position of the deductive view of epistemological reduction, all these strategies assume a certain ontological dependence of the ontological items belonging to a non-fundamental level of reality with respect to the ontological items belonging to the fundamental level. Needham seems to suggest that we have been not clear enough regarding the notion of ontological dependence. He even calls into question the coherence of this notion: "*Is this idea of second-class existence, in what the authors go on to describe as 'an ontologically inferior level of reality', coherent?*" (p. 3); for this reason he claims that "*What is needed to make the thesis clear is an acceptable notion of ontological dependence, in terms of which the ontology of the*

reduced theory can be said to be dependent on that of the reducing theory, but not vice versa" (p. 6).

We think that the notion of ontological dependence has a venerable history in the development of philosophy. In the Platonic relationship between Ideas and sensible things, or in the Aristotelian distinction between substance and attributes, there are certain ontological items – Ideas, substance – having ontological priority over the others in the sense that they do not need anything else to exist; the remaining items have a secondary existence since they require the primary items to exist – sensible things are mere “copies” of Ideas, attributes must be applied to a substance. In the Modern Age, ontological dependence appears as the relationship between primary qualities, endowed with ontological priority, and secondary qualities, that are merely subjective. In all these cases, it is not said that the secondary items do not exist in an absolute sense, but that they have a derived existence which depends on the existence of the primary ones.² It is in this sense that we talk of “ontological priority” or of “secondary entities endowed with a merely derived existence”: even if accepting the failure of epistemological reduction, many philosophers of chemistry insist on assuming the ontological dependence of the world of chemistry with respect to the world of physics.

Summing up, we consider that the notion of ontological dependence is philosophically clear and meaningful. But this does not mean that we accept it in the case of the ontologies described by theories not related by epistemological reduction. Ontological dependence is an asymmetric relationship between ontologies. According to ontological pluralism, on the contrary, ontologies are symmetrically related: even if ontologically linked, none of them depends on the others to exist. As Needham says, the issue can be posed “*in terms of counterfactuals, along the lines of ‘if the reducing ontology didn’t exist, then the reduced ontology wouldn’t exist’*” (Needham, p. 6). The difference between both positions is expressed by the true value assigned to this counterfactual: whereas according to the thesis of ontological dependence it is true, according to the thesis of ontological pluralism it is false.

Needham correctly points out the problems of determining the truth conditions for this kind of counterfactuals. But, once again, what happens in the epistemological side can help us to find good arguments to support conclusions in the ontological side. When translated into epistemological terms, the counterfactual sentence reads ‘If one theory were false – unsuccessful, inadequate, etc., – then the other theory would also be false’. In this case, the sentence loses much of its counterfactual character since we can decide about its truth value by studying science itself. It is precisely on the basis of scientific arguments that van Brakel considers that sentence as false when he claims that “*If quantum mechanics would turn out to be wrong, it would not affect all (or even any) chemical knowledge about molecules (bonding, structure, valence and so on). If molecular chemistry were to turn out to be wrong, it wouldn’t disqualify all (or even any) knowledge about, say, water*” (van Brakel, 2000, p. 177). Furthermore, the history of science shows us effective situations where the replacement of the supposedly primary theory did not affect the supposedly secondary or phenomenological theory: when classical statistical mechanics was replaced by quantum statistical mechanics, this fact did not modify macroscopic thermodynamics. Let us also remember that the first results in thermodynamics, proposed by Carnot, were obtained assuming the theory of caloric as the underlying description of phenomena.

If the fate of a “phenomenological” theory may be immune to the fate of the supposedly “fundamental” theory, we find no good philosophical reasons to assume the ontological dependence of the ontology described by the first on the ontology described by the second. If thermodynamic terms do not acquire their meanings through their relationship, reductive or not, with the terms of statistical mechanics, it is reasonable to accept that the existence of thermodynamic items does not ontologically depend on the existence of the ontological items described by statistical mechanics. In other words, temperature is not mean kinetic energy nor ontologically depends on mean kinetic energy: temperature is what thermodynamics describes as measured by thermometers, holding certain relations with

pressure and volume, etc., and these facts do not require an underlying ontology to exist.

Of course, conclusions grounded on epistemological considerations do not prove ontological thesis, but we think that they offer good arguments to defend ontological pluralism, a position considered by Needham as an unpalatable remedy for facing the problem of the secondary status of chemistry.

NOT AS UNPALATABLE AS IT SEEMS

In the first paragraph, Needham says that we view the different but equally theory-dependent ontologies “*as in some sense at odds with one another so that they can’t simply be amalgamated into one all-embracing ontology*” (p. 1). On the basis of our article, it seems quite clear that we reject the idea of an all-embracing ontology. But we would never say that those different ontologies are at odds with one another. Perhaps Needham is afraid of a certain kind of ontological schizophrenia, which would lead us to a disintegrated science where one description has nothing to do with another. But we think that the ghost of disintegration can be avoided when the thesis of ontological pluralism we defend is adequately interpreted.

Along the history of science, scientists have always sought the unification of different theories. Certainly, the conviction that reality is a harmonious whole and not an incoherent plurality lies behind this aim. We think that this is a completely reasonable ontological assumption, which should not be abandoned. It is true that, in the majority of the historical cases, such an assumption has been expressed in the ontologically reductionistic terms that we reject. But the ontological pluralism we propose does not give up the idea of unification: it supplies the picture of a *non-reductive unification*. In this picture, the autonomous ontologies are ontologically related by means of “vertical” interlevel links. Therefore, although there is not an all-embracing ontology, the different ontologies are not “at odds” with one another to the extent that they belong to the same structure. It is in this sense we say that ontological pluralism leads us to a diversified, but not disintegrated, reality.

For Needham this is a radical, unpalatable proposal, but we do not understand why. Perhaps he feels more comfortable in a reality with a single fundamental ontology and where the remaining ontologies are linked with that one by the asymmetric relationship of ontological dependence. Even if there is nothing incoherent in this metaphysical picture, Needham does not say us what its advantage or fruitfulness might be. We, on the contrary, prefer to live in a reality that spreads out in a multiplicity of objective levels, ontologically structured by symmetric nomological links. I, Olimpia, am really not comfortable with the conclusion that my daughter Lara or the chair where I'm sitting have an ontologically dependent existence because they are made of quarks: we are completely convinced that their objective existence goes very far beyond any description in terms of their microconstituents or some other all-embracing ontology.

Furthermore, we have argued that this philosophical framework is fruitful in facing some traditional problems in the philosophy of science. In particular, it can be applied to cases where two different descriptions assign incompatible or even contradictory properties to a system: (i) determinism and indeterminism in highly unstable systems, (ii) reversibility and irreversibility in classical statistical systems, (iii) quantum and classical features in quantum systems, (iv) reversibility and irreversibility in quantum systems described by time-asymmetric quantum mechanics (see references in our paper). In all these cases, the supposedly fundamental theory would deprive the system of a property whose objectivity can hardly be denied from a different descriptive level. Ontological pluralism, on the contrary, allows us to preserve the objective character of both apparently incompatible properties: they are not incompatible since they belong to different ontologies. On the other hand, we have argued elsewhere that ontological pluralism can overcome many conceptual difficulties that chemistry teachers have to face in the classroom, since it supplies them the philosophical support for their realistic position, usually adopted in a naive or pre-reflexive way (Lombardi and Labarca, 2006).

Of course, this does not mean that all the philosophical work has been already done. Internalist realism, as proposed by Putnam, still has certain shortcomings that cry out for a philosophically adequate solution. In particular, Putnam is not clear enough in the distinction between conceptual scheme and theory, and does not present a notion of truth acceptable from a realistic viewpoint. In this sense, we are working with Ana Rosa Pérez Ransanz (UNAM, Mexico) in the formulation of an ontological pluralism that supplies a clear characterization of the notion of conceptual scheme and that recovers certain basic realistic intuitions which cannot be easily accommodated in Putnam's original proposal. We hope that this work will contribute to a better understanding of our overall philosophical perspective.

CONCLUSIONS

Needham says that “*Any notion of ontological reduction implying either the second-rate, inferior existence of the reduced realm, or its total elimination, certainly can be denied*” (p. 5). We agree with Needham about rejecting any position that denies the existence of the items described by a successful scientific theory or that endows them with a secondary ontological status just because such a theory is not conceived as “fundamental”. The difference between his perspective and ours is the attitude to take on the basis of this rejection. Needham considers that the notions of ontological reduction and ontological dependence are not clear enough to be philosophically discussed and, therefore, he prefers to suspend the debate up to the moment that the ontological reductionist provides a coherent account of the thesis and a convincing argument for it. By contrast, we think that the notions of ontological reduction and ontological dependence are philosophically meaningful and that, for this reason, ontological reductionism has been widely adopted in the history of science up to the present. As a consequence, if we want to deny any form of ontological dependence we have to propose a positive philosophical framework sufficiently well

articulated to serve as an alternative to that strongly rooted assumption.

As we have admitted from the very beginning, there is no last word in science or in philosophy; however, this does not minimize the relevance of the debates. For this reason, we are very happy to have contributed with our article to reintroduce the discussions about ontology in the philosophy of chemistry.

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NOTES

1. We will not discuss here the issue of vitalism, since it was considered in our article only due to a comment by Luisi, who claims that strong emergence “*sounds like a kind of vitalistic principle*” (Luisi, 2002, p. 193).
2. In fact, in the substantialism-relationalism debate about the ontological status of space, the relationalist maintains the ontological dependence of space on bodies, whereas for the substantialist space exists by itself, that is, it does not need bodies to exist. The contrast between both positions subsists even in a universe with no bodies and no space because in a universe void of bodies the inexistence of space is a possible but not necessary situation for the substantialist, but it is a necessary consequence of the inexistence of bodies for the relationalist.

REFERENCES

- O. Lombardi and M. Labarca. The Ontological Autonomy of the Chemical World. *Foundations of Chemistry* 7: 125–148, 2005.
- O. Lombardi and M. Labarca. The Philosophy of Chemistry as a New Resource for Chemistry Education. *Journal of Chemical Education*, forthcoming.
- P.L. Luisi. Emergence in Chemistry: Chemistry as the Embodiment of Emergence. *Foundations of Chemistry* 4: 183–200, 2002.

- P. Needham. Ontological Reduction: A comment on Lombardi and Labarca. *Foundations of Chemistry*. doi 10.1007/s10698-005-9002-6.
- H. Primas. Emergence in Exact Natural Sciences, in G. Farre and T. Oksala (eds.), *Acta Polytechnica Scandinavica* 91: 83–98, 1998.
- J. van Brakel. The Nature of Chemical Substances. in N. Bhushan and S. Rosenfeld (eds.), *Of Minds and Molecules. New Philosophical Perspectives on Chemistry*, pp. 162–184. New York: Oxford University Press, 2000.

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