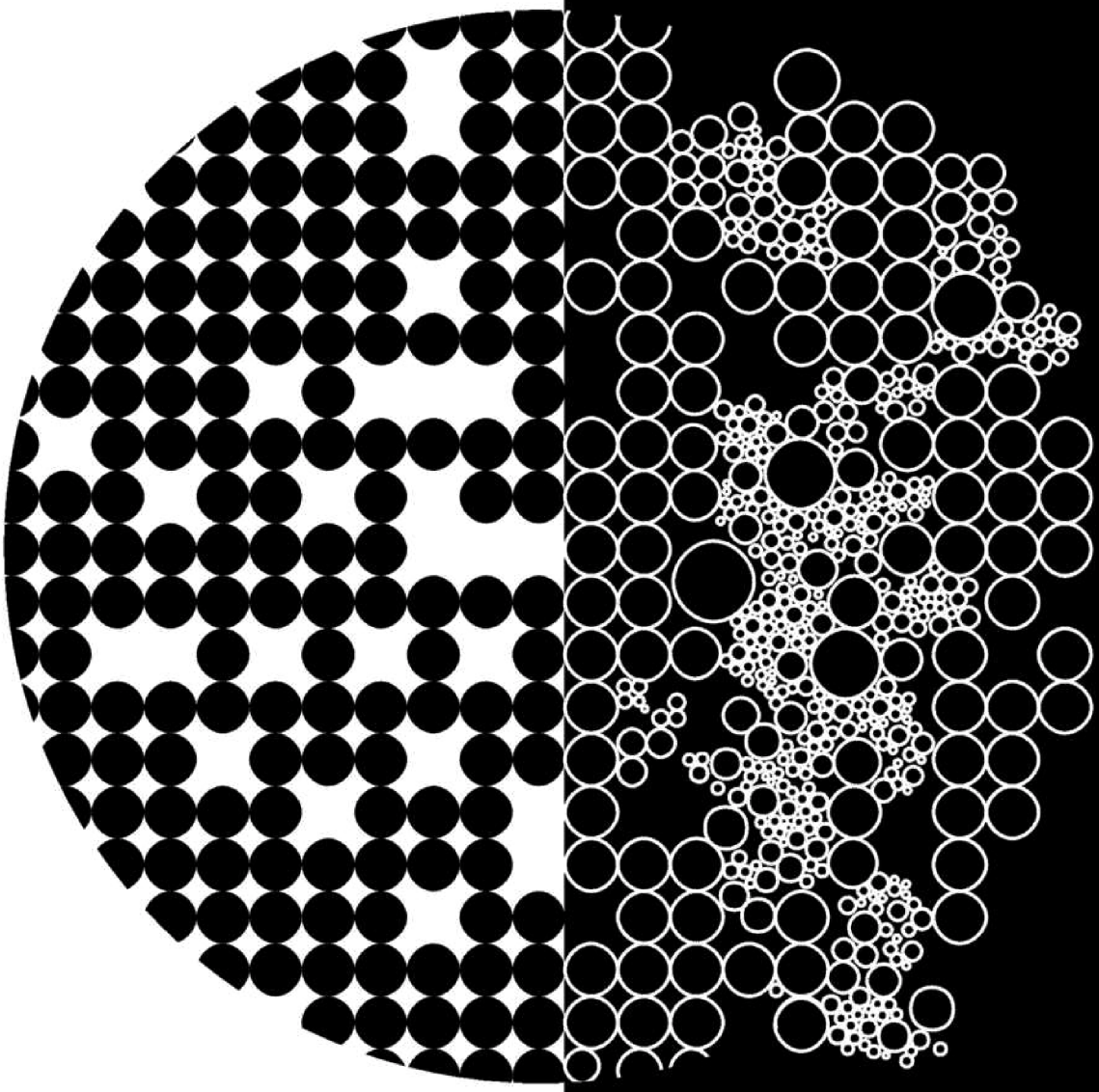

PULSE

A HISTORY, SOCIOLOGY & PHILOSOPHY OF SCIENCE JOURNAL

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Lucas Battich

Georgia Dearden

Luciano Nicolás García

Michele Luchetti

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Editor's Note

As always, the people who make a new issue possible are primarily the authors and reviewers. I'd like to thank the authors for entrusting us with their work and the reviewers for generously donating their time, expertise, and care. I'd like to thank the editorial board for all their hard-work. A special mention to Fani Cettl, for seamlessly managing the book reviews for this issue and to Conor Heaney for stepping in on several occasions to save the day. Thanks to Bloomsbury, University of Chicago Press, and Columbia University Press for supplying us with copies for review. A big thank you to Michela Massimi for taking the time to be interviewed for the issue, and to Michele Luchetti for carrying it out.

It is my great pleasure to announce that as of the publication of this issue, we will have two new Co-Editors of Pulse: Fani Cettl and Monika Bregovic. After two years as Editor and four years working for Pulse in total, I am delighted to be leaving the journal in such capable hands and am excited about what the future holds for Pulse under their leadership.

For my part, my aim when talking on the role of editor was to try and produce issues that placed varying styles of engagement with science next to one another in as roughly a coherent way as possible. In those two issues we've published articles covering topics in analytic metaphysics, philosophy of science, gender studies, new materialism, DIY biology, science & religion, continental science studies, STS, history of science and scientific publication, and so on. I think we went along towards meeting that aim and in doing so continuing to explore the interesting intersections that sit just at the edges of gerrymandered disciplinary boundaries. Working on the journal has introduced me to some fascinating topics and some wonderful people, and I am incredibly grateful to have fortuitously stumbled into the centre of such a fantastic project.

Matthew Baxendale

Contributors

Rosie Barron is a PhD candidate at the University of Glasgow. Her thesis focuses on the work of Samuel Beckett, assessing to what degree many examples of his prose, drama, and poetry can be considered as part of the travel writing genre. Her research interests also include literary modernism, motion studies, embodiment studies and object studies, interests which she has developed through conference papers presented at the '17th International Hemingway Conference' in Chicago (July 2016), resulting in an invitation to sit on a panel at their next conference in Paris 2018, the 'Crossroads V: Bodily Modernities. Comparing, Intersecting, Dismembering' conference (October 2016) and at the 'New Work in Modernist Studies symposium' (December 2016).

Lucas Battich is a Research MA student in Philosophy at Radboud University Nijmegen. He received a BA from the University of Dundee in Philosophy and Art. His thesis research focuses on joint attention, and its significance for communication. More broadly, his current interests are in philosophy of mind and cognition, and intersecting areas in philosophy of language, including social cognition, communication, and naturalist theories of mental content. He has also been active as an independent artist and curator, having exhibited his artistic work internationally

Georgia Dearden is an academic based in London, UK. She comes from a Fine Art background, and is on the advisory board for the independent publishers, Gordian Projects. Her academic work is focussed on the intersections of feminism, deconstruction and the biological body. She completed her MA Contemporary Art Theory at Goldsmiths, University of London in 2016 and plans to return in September 2017 to commence her PhD. She recently published a paper in the academic journal *Pyura Chilensis* dealing with the watery, feminine, subjectivities of cyberspace in relation to the VNS Matrix's *Cyberfeminist Manifesto*.

Luciano Nicolás García holds a Licenciatura in Psychology and a Doctorate in History, both from the Universidad de Buenos Aires (UBA). He works as an Assistant Researcher at the Consejo Nacional de Investigaciones Científicas y Técnicas, and as an Assistant Research Professor at the Faculty of Psychology, UBA. This article is part of a three-year research project, UBACyT 20020130200134BA, 'Psychological, psychiatric and psychoanalytical circulation, reception and transformation in Argentina (1900-1993)', directed by Dra. Florencia Macchioli and co-directed by the author. His main research interests are historical contextualizations of the mind and brain sciences, communist culture, and historiography. As a co-author with F. A. Macchioli and A. M. Talak, he published *Psicología, niño y familia en la Argentina (1900-1970). Perspectivas históricas y cruces disciplinares* (Buenos Aires: Biblos, 2014). As a co-editor with A. Yasnitski, R. van der Veer, and E. Aguilar he published *Vygotski revisitado: una historia crítica de su contexto y legado*. (Buenos Aires: Miño y Dávila, 2016). As an author he published *La psicología por asalto. Psiquiatría y cultura científica en el comunismo argentino (1935-1991)* (Buenos Aires: Edhasa, 2016).

Mattia Paganelli holds a joint post-doctoral research position at the Royal College of Art, Entanglement Cluster (London) and The University of the Applied Arts (Vienna) sponsored by the PEEK Grant. His doctoral research was supported by a full AHRC Studentship. He is also Associate Lecturer in the department of Visual Cultures, Goldsmiths University. His work covers the interdisciplinary terrain of contemporary art, philosophy and non-linear physics (chaos, complexity, diffraction). His investigation concentrates on the concept of *dimensionality*, where 'how the apparatus matters' becomes a dimension intrinsic to the emergence of sense. His work has appeared in peer review publications and has exhibited internationally.

Romén Reyes-Peschl received his PhD in 2016 from the University of Kent, where his work focused on the convoluted intersections between literature, philosophy, language, and the neurosciences. He has published articles on Don Quixote, Cameron McCabe, BS Johnson and detective fiction, while other recent research interests include Charlie Kaufman, Toby Litt and the history of anatomy and physiology. He is currently working on a monograph drawing on his doctoral research.

Niko Wolf has a B.A. in Philosophy and a B.Sc. in Physics from the Ludwig-Maximilians-University in Munich. This paper is based on the research he did for his Bachelor thesis, which he wrote on "Why are Causal Relations Time-Asymmetric?"

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Interview with Michela Massimi

By Michele Luchetti

On November 30th 2016 we interviewed Michela Massimi, Professor of Philosophy of Science at the University of Edinburgh. We met Prof. Massimi in Budapest, where she was invited as a guest of the Research & Publication workshop at Central European University in her role of Co-Editor-in-chief of the British Journal for Philosophy of Science, and as a guest speaker for the Department of Philosophy and the Science Studies program. We asked her questions concerning her career, work, and opinions on the relation between philosophy and science.

1) Last year the project "Perspectival Realism: Science, Knowledge and Truth from a Human Vantage Point", of which you are the main investigator, was awarded an important ERC grant. Can you give us an overview of the project?

This is an ERC Consolidator grant which started in January 2016, so we are now almost at the end of the first year out of five. It is a philosophy of science project, in which I am dealing with the question: "Can we be realist about science while also taking on board the fact that our knowledge is perspectival?". The notion of 'perspectival knowledge' — what it means for our knowledge to be perspectival — needs more clarification, but the overarching question that I am addressing is whether perspectivism can be made compatible with realism. I am looking at both scientific practice and the history of science, as well as philosophy of science.

The project is structured into five subprojects, one for each year. In the first two years, I will be looking at scientific practice, in particular at the role of models and modelling practices in making our knowledge perspectival while, at the same time, providing us with knowledge of the world as it is. I am looking at particle physics and cosmology because they are two fields in which it is particularly evident that there are limitations to our knowledge, due to the nature of our instruments and of the theories we endorse as best theories at the moment, the Standard Model in particle physics and

the Lambda-CDM model in cosmology. At the same time, however, we are on the verge of important scientific discoveries. For the past twenty years physicists have been looking for physics beyond the Standard Model, and collected evidence about the possible existence of dark matter and dark energy, so that now we have more reasons for believing there are such entities (Although we do not yet understand their nature). In the light of these changes, the question now becomes: how do we even go about looking for these new entities, and how can we be realist about them, once we take into account all the limitations of our theories and instruments? These are the issues that will be addressed in the first two years.

Year 3 and 4 will be concerned with more historical issues. I will ask the question about perspectival realism more from the point of view of the history of science. I am also interested in the origins of the idea of perspectival knowledge in the history of philosophy. When did it become important? Why does it still matter to us today? My take is that the question became important with the Enlightenment, and when Kant came up with the idea that knowledge is from a human vantage point. According to Kant, we should not ask questions about how our representations match a given world, but we should ask the opposite question: How is it that the world seems to respond so well and seems to be so congenial to what we learn about it? From the point of view of the history of science, I am interested in investigating questions about perspectivism in terms of controversies in science. I am looking at specific case studies, like the chemical revolution and the history of the electron, but I will also be looking at how scientists disagree because of coming from different perspectives in a broader sense, including technological and experimental perspectives, not just theoretical.

By the end of the fifth year, and thanks to insights from both scientific practice and the history of science, I will have made progress on my overarching question: How can we be realist about science despite the situated nature of our knowledge?

2) What is it like to be coordinating such a big project and pursuing research at the same time?

The structure of ERC grants is pretty unique. By contrast with many other grants, which are collaborative in that they involve a consortium of institutions, for example a

consortium of different universities, the ERC Consolidator grant is different. It is really about me, my project, and my team working for the project.

The team includes me and one post-doc, with a second post-doc joining us next year, plus two PhD students and one administrator. There is a certain amount of administrative work, and some effort is required to make sure that everyone is working towards the same goal.

3) What trajectory brought you to work on such a project?

Since the grant is called 'Consolidator', what the ERC expects is to consolidate my research to date. This is exactly what my project is about: in a way it brings together different strands of my research interests of the past fifteen years. I have always been working on the history of philosophy of physics, this is what my PhD thesis was about. I always had an interest in particle physics, and more recently in cosmology; I also did a MOOC[1] with the cosmologist John Peacock at the University of Edinburgh. However, the overarching question about realism and perspectivism is an old one, and one that has always been at the centre of my interests since I was a postdoc in Cambridge in 2003-4. I remember going to reading groups where we read Putnam and Kant. My interest for Kant actually dates back to my graduate times back in Italy. Of course, coming from Italy, I read Kant in all forms! I have always been interested in the question about the possibility of being realist, but from a human point of view. Attempts like Putnam's at developing internal realism, or pragmatist lines of thought are very congenial to the nature of my project. Having a five-year project allows me to investigate this question not as an armchair philosopher, but actually engaging with my other interests, making Kant interact with the history of science and with current scientific practice. I have eclectic interests, and this reflects in my idiosyncratic list of publications that span from Kant and Newton, to natural kinds, and simulations in high-energy physics, among other topics. What is great about the ERC grant is that it has given me a unique opportunity of further developing my interdisciplinary research to date, and take it in new directions.

[1] Massive Open Online Course

4) Speaking of interdisciplinarity, what is your view on the relationship between philosophy of science and the history of science?

I come from Italy, where there is a strong historically-oriented education. When I was an undergraduate student in philosophy I attended courses in the history of science, and my thesis was on the history of modern physics, in particular on the debate on the incompleteness of quantum mechanics. I have always been very interested in the history of science and the history of philosophy. When I moved to England, I was lucky to find other people that also had a general interest in certain ways of thinking about the history of science and philosophy, for example my colleague Hasok Chang. We were colleagues at UCL the year we started the integrated History and Philosophy of Science movement, in 2005. Steven French in Leeds, Hasok, and I decided to 'join forces' and have a little workshop that started as a UCL-Leeds initiative. After that, people contacted us from the other side of the Atlantic — John Norton in Pittsburgh and Don Howard in Notre Dame —suggesting to transform it into an international initiative. That was the beginning of the international committee for the History and Philosophy of Science (HPS), a committee that is still ongoing, and provides a network for people that think similarly about the relevance of the history and philosophy of science. There has indeed been a divide, which is mainly the consequence of what happened inside both philosophy and history. There has been an increasing specialisation in both disciplines, and the tendency towards specialisation has often been a wedge, so that people often cannot really see the relevance of history for philosophy or of philosophy for history. I am thinking of many areas within philosophy where asking historical questions is almost seen as second-class, since —as philosophers — one is expected to tackle questions from a purely logical point of view. And the opposite extreme has happened in the case of history, where there are people that are very interested in the social history or in the material culture, but — without denying the value of these traditions—often this approach leads to lose sight of the philosophical questions behind the history of science. Integrated HPS started as a way of overcoming those two opposite extremes that were pulling the two field fields in very different directions.

5) Do you think there is a sort of territorial aspect to some domains of philosophy and history?

Certainly integrated HPS is an attempt to overcome this gulf in the field; but there are perfectly good reasons both in philosophy and history as to why the disciplines got so far apart. In the case of history, it is fair to say that still in the 1940s and 50s there were people doing social history, intellectual history, and history of ideas. If you look at the panorama now, in terms of statistics, people doing intellectual history or history of ideas are just a handful. The vast majority of people in history of science today seem to be doing a certain kind of history of science that very often philosophers find a bit frustrating, because they think it does not have anything relevant to say to them. But the reverse is equally true: in philosophy sometimes we encounter very rarefied issues and logical expositions of topics without much engagement with the sciences or with the history of the discipline, which is frustrating for anyone with a historical sensitivity. Big topics like 'disagreement' or 'truth' in analytic philosophy are rarely asked with a historical sensitivity in mind. How did different communities in the past establish what it means to be true? Or how did they come to disagree? These questions are almost always asked in a very abstract and ahistorical way in philosophy. There is a lot of reliance on intuition and thought experiments. However, I think that gradually philosophers are coming to realise that it is important to look at scientific practice, at what scientists actually think and do.

6) Do you have yourself some 'heroes from the past' that inspire you in your attempt to integrate history and philosophy of science?

There are of course people, who introduced me to the field and played a role in leading me to think about these issues: first of all, my professors in Italy, Silvano Tagliagambe and Sandro Petruccioli. In terms of intellectual figures that inspired my trajectory, I would mention Alexandre Koyré, who carried out that sort of integration between history and philosophy of science I admire. His *From the closed world to the infinite Universe* is one of my favourite books, I remember studying it as an undergraduate student in Rome. I absolutely loved it.

Looking at philosophy and the history of philosophical ideas, I find inspiring also the generation of philosophers like Ludovico Geymonat in Italy, another example of scholars who were trying to bridge history and philosophy of science, or Émile Meyerson.

7) The relationship between science and philosophy has been at the centre of many debates ever since the category of 'science' acquired the meaning we still attribute to it. As a philosopher of science, what is your perspective on this relationship?

Also in this case, there are two extremes. There are philosophers who do not think much about philosophy of science, precisely because it is the part of philosophy that engages with empirical research, and as such is seen as not engaging with the purest philosophical reflection. I think one worrying aspect is that we see philosophy of science less represented in big philosophical meetings, such as the APA[2]. People systematically complain that philosophy of science is not much represented. The diagnosis is very simple: there are big portions of the philosophical community that think some philosophy of science has taken a trajectory that is not philosophical anymore, it does not really speak to mainstream philosophy.

In addition to that, there is a tendency to delegate philosophical questions to science, to make philosophy continuous to science, which can be a good thing, but also a bad thing. I think the naturalistic turn that philosophy experienced — the tendency to engage with the sciences and scientific practice —is absolutely important, because it avoids having to spin our wheels with logical paradoxes without engaging with what scientists are concerned with. But it is also true that there has also been a tendency in philosophy of science in recent years to get overspecialised. Fewer and fewer of us are working in general philosophy of science, and more and more are working in very specific topics. Within philosophy of physics, for example, it is not enough to say that one works in philosophy of physics. One has to specialise in a particular topic and publish more and more on that topic, in order to acquire a world-leading reputation in that field.

[2] The American Philosophical Association.

I think this is inevitable, to some extent, because it is part of what the field is like, and it is due to the fact that physics, economics, biology are very difficult disciplines to get acquainted with. If you want to be a very good philosopher of science in any of those fields, it requires a substantial amount of time to get trained, learn, and understand the subject. There is a growing tendency to get a reputation and publications for becoming an expert on particular topics, or for coming from a particular school that works on a certain topic.

On the other hand, I think we should try to bring philosophy of science back to philosophy, because it would be sad if philosophy of science becomes just a footnote at the end of a theorem. Sometimes I have this feeling when I see excellent pieces in some fields, but the philosophical discussion is very thin. It is a hard judgment to make, because it is the way the field is evolving, so there is no point in clinging back to the way philosophy of science was at the time of Popper or the logical empiricists, but I think it is a very delicate balance. When colleagues in mainstream philosophy complain about philosophy of science, they have a point, and the point is that certain kinds of super-specialised topics do not speak anymore to them.

8) What recommendation would you give to your students and young graduates in philosophy of science with respect to navigating this tendency to 'over-specialise' while still keeping their own interests to pursue as philosophers?

When I was a first-year undergraduate student in Rome, I remember my first class with Prof. Tullio De Mauro, who was a linguist and the head of the degree program in Rome. He came to class and said "I know you are not here because you want to make money or do business". It was a very honest thing to say. People study philosophy because that's what they like. I think it is important to follow one's own intuitions and passions. There is going to be some reality check as you go along. You start with an idea of what philosophy is and then, when you start studying it, you might realise that probably it is not exactly what you thought it was going to be like. In my case that realisation came at one point during my training. Still, doing something you have the passion for is crucial. That is the most difficult thing to do. As an undergraduate student or a PhD student, we all approach the field with our own ideas and preconceptions, but then the reality check

is going to come at some point. That is a crucial moment, when rather than giving up, the key thing is to take the lesson on board and try to get the best you can out of it.

9) What is your impression of the current state of 'health' of Science Studies, and of the prospects of current graduate students in the field? How has the scenario changed in the past two decades?

Before taking my current position at the University of Edinburgh, I was for seven years at the Science and Technology Studies unit at UCL. Even though I consider myself more an HPS person than an STS person, beyond the labels I have to say that STS as a field in general has done terribly well in recent years. Many new units have been founded, and what is distinctive about them is that they are highly interdisciplinary research they produce. There is not just history and philosophy of science, but also sociology and science communication. A few decades ago there were just a few units, like the Edinburgh school with David Bloor, but now there are many more at the international level. STS units sit in between the humanities and the sciences in a way that philosophers of science do not normally do. At UCL I was part of a unit at the intersection with the faculties of mathematics and natural sciences: there were students coming from mathematics and natural sciences, so we would teach students with a scientific background. Science studies bridge the gap between the sciences and the humanities and this is the reason behind their success in recent times. The division between disciplines becomes very blurred and there is more room for doing genuine interdisciplinary research.

As for the prospects of graduate students in Science Studies, I think they are very good and healthy prospects. We see an increasing number of students from science studies programs in American universities, for example, applying for jobs in Europe, and you can see that Science Studies programs produce very high-quality students that get jobs in top universities. It is a very positive indication that the field is healthy. Obviously it is not a huge field, but I think we will see a change in the future.

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How Can We Explain Time-Asymmetric Processes?

A Critical Analysis of David Albert and Barry Loewer's Mentaculus Theory

Niko Wolf[1]

Abstract

There are plenty of irreversible thermodynamic and causal macroscopic processes, yet the fundamental physical laws are completely time-symmetric. How can this be explained? In my paper, I will analyse David Albert and Barry Loewer's theory, which claims that only the distribution of matter in the universe is fundamental. They defend the "Best System Account" for laws, by which these are the strongest and simplest systematisation of scientific truths but have no modal force, i.e. they are a true description of the mosaic but do not necessitate any part of it. Albert and Loewer believe there are three main elements of these laws, which they call the Mentaculus: the fundamental laws of dynamics, the "Past Hypothesis" that the entropy was very small at the Big Bang and a uniform probability distribution over all possible states at the beginning of the universe. I will address four main questions: Why should there be a uniform probability distribution over all possible states at the beginning of the universe (as is postulated by the Mentaculus theory)? How can this theory explain the thermodynamic behaviour of isolated systems? Can all laws be reduced to the few principles of the Mentaculus? Is it even possible to develop laws that fulfil the requirements of the Best System Account?

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1. Introduction and physical background

In our surrounding macroscopic world, we experience many time-asymmetric phenomena, so-called irreversible processes. These can be understood intuitively as the following: if they were to be filmed and then watched in rewind, it would be easy to distinguish the "past to future" sequence from the "future to past" sequence. If an egg falls down and bursts apart, it will never recompose itself spontaneously. If a drop of red ink is diluted in a water basin, the drop will not form itself once again at any point. An example of a reversible process would be shooting two billiard balls at each other - the film and its time-reversal cannot be told apart. They will of course show different movements, but it will be impossible to know which one goes "from past to future" and which one goes "from future to past".

Reversible and irreversible processes are described by Thermodynamics, whose 2nd Law states that, for any isolated system, the entropy will always increase or remain the same (if it is in an equilibrium). Entropy can be conceived as a measure for the typicality of the distribution of entities in a system. For example, when ink is dropped into a glass of water, all ink particles are grouped in one small region of the glass, a very untypical distribution that has low entropy. Over time, the ink particles will diffuse until they reach a very typical state in which they are uniformly distributed throughout the water. This process of moving from an untypical towards a typical state constitutes an increase in entropy. It goes on until an equilibrium has been reached, from which point on the entropy will remain constant. Mathematically, entropy can be characterised by the Boltzmann equation $S = k \cdot \ln(W)$, where S is the entropy and W the number of distinct microscopic states available to the system given the macroscopic constraints (k being a constant named the Boltzmann constant in honour of its discoverer). This characteristic of thermodynamic behaviour shows that there is an intrinsic asymmetry in our macroscopic laws that has to be explained in some way. It should be noted that the 2nd Law of Thermodynamics is a statistical law, i.e. that entropy decreasing states are in fact not impossible, but merely highly improbable. Taking the example of the drop of ink once again: there is a probability (that can be calculated) that the atoms of the ink form a single drop some time after diffusion, but it is so small that it will never be observed.

As the behaviour of macroscopic systems is believed to supervene on the microscopic laws that rule its elementary components, we would expect the latter to

reflect the same asymmetry. However, the fundamental laws of physics are time-invariant, i.e. for every physically allowable sequence of events, the inverse sequence of time-reversed states is also allowable. Whether it is Newton's laws or Schrödinger's equation, both are symmetric regarding time. The Standard Model of particle physics recognises the so-called CPT-symmetry: it says that any physical object is invariant under a simultaneous transformation of charge, parity and time. A universe in which all matter is replaced by antimatter (corresponding to a charge inversion), all objects have their positions reflected by an arbitrary plane (corresponding to a parity inversion) and all momenta are reversed (corresponding to a time inversion) would be a "mirror image" of our own and would be subject to the exact same physical laws. It is only this combined symmetry that is valid, not time inversion alone, though. In fact, the decay of the neutral kaon (one of the particles the Standard Model predicts) breaks the time-symmetry and is thus a microscopic irreversible reaction. This kaon decay could be a microscopic explanation for time-asymmetry but it is a very rare reaction and not involved in any of the known macroscopic irreversible processes. It is a further hint at the existence of an intrinsic time-asymmetry rather than an explanation of it. Thus, the fundamental physical laws do not seem sufficient to explain irreversible processes.

Another possible source of explanation could be the time formalism that underlies our physical laws. The Theory of Special Relativity postulates the four-dimensional Minkowski space-time, in which time is considered a dimension similar to the three spatial dimensions. This is another drawback as spatial dimensions are completely symmetric - there are no irreversible processes in space. If an object is moved across space, its movement can't be distinguished from that of an object that has the exact inverse movement. However, the Theory of Special Relativity establishes that nothing can travel faster than the speed of light, thus limiting the space-time regions with which interaction is possible. These regions are called light-cones. Minkowski space-time is orientable, i.e. we can distinguish those light cones from which a given object can receive information from those to which it can send information. These could be identified respectively as "past" and "future" light cones, but nothing in the formalism compels us to do so. Our experience of irreversible processes is thus compatible with the mathematical formalism of space-time, which is a first necessary feature but not sufficient to explain time-asymmetry.

If we come back to Boltzmann's definition of entropy, a further problem arises. The mathematical formalism of entropy knows no objective distinction of past and future. In fact, if we started "retrodicting" the past from our present state, we would reach the conclusion that entropy will increase towards the past in exactly the same way as we predict it to increase towards the future. Thus, if we look at a cube of ice in the sun, we will predict that it will melt (increasing entropy towards the future), but at the same time we must posit that it was created spontaneously out of melted water (increasing entropy towards the past). Boltzmann's definition entails that entropy was greater both in the past and in the future, which is absurd since it would mean that every present moment is an entropy maximum in the history of the universe. This could be understood if the universe was at equilibrium and the entropy would remain at an equal level throughout time, but no experimental findings suggest this is the case. This effect is called the "reversibility paradox" and is precisely due to the fact that fundamental physical laws are time-symmetric and have no intrinsic distinction of future and past. In practice, no one tries to "retrodict" what will happen, because there are accounts of the past and not of the future. If a meteorologist was to "retrodict" the weather of yesterday, no one would listen to him because everyone knows how the weather was yesterday. This asymmetry of records and why "retrodicting" the past makes no sense will also have to be addressed by any theory that wishes to explain irreversible processes.

2. The Humean reductionist ontology in the conception of David Albert and Barry Loewer

Barry Loewer's paper "Two accounts of law and time" and David Albert's book *Time and Chance* present a Humean reductionist ontology in the footsteps of David Lewis. They claim that only the distribution of properties through space-time is a fundamental ontological entity. In this section, I will outline this ontology and its conception of time, laws and causation.

Humean metaphysics receives its name from the 18th century Scottish philosopher David Hume who was the first to "eschew fundamental nomological modalities",[2] denying that there are any necessary connections in nature. Contemporary Humean reductionists hold that "the totality of the universe consists

[2] Loewer (2012), p. 116.

of the distribution of fundamental categorical properties / quantities and relations instantiated by fundamental entities (particles, fields, etc.) throughout all of space-time", which they call the "Humean mosaic".[3] This means that the only fundamental truth of the world is the distribution of properties throughout space-time, the only thing an omniscient being would need to fully characterise our universe. This distribution is determined in past, present and future. Loewer thus defends a so-called block universe view, a term coined by Huw Price as "regarding reality as a single entity of which time is an ingredient, rather than as a changeable reality set in time"[4]. In this block, there is a space-time distribution of properties that is fully determined at the beginning of the universe. The change that we experience comes from moving across this distribution, no new states are produced at any time.

Therefore, physical laws are no ontological primitives for Loewer - they are explained instead by Lewis's Best System Account (BSA). This Best System is the scientific systematisation of fundamental truths that best combines "simplicity and strength".[5] It is the set of true propositions that best renders the regularities of the Humean mosaic, explaining the most features with the least complex foundation. These L-laws (as Loewer calls them in acknowledgement of Lewis's role in their development) explain regularities among the Humean mosaic and thus depend on the distribution of fundamental facts in the mosaic. However, they are no mere instruments to help us navigate through our surroundings: Lewis, Albert and Loewer stress that the BSA is the *true* account of the regularities of the Humean Mosaic.

According to Albert and Loewer, L-laws can be either deterministic or probabilistic. This is surprising at first, since Loewer stresses at the same time that the Humean Mosaic is deterministic. Yet, probabilistic descriptions can be much more informative while losing insignificant simplicity compared to a deterministic theory. An example of that would be the theory of radioactive decay - it is a fundamental fact about the Humean mosaic when precisely a certain particle will decay, but in absence of that knowledge a probabilistic theory explains the statistical behaviour of numerous particles best.

[3] Loewer (2012), p. 116.
[4] Price (1996), pp. 12-13.
[5] Lewis (1994), p. 478.

David Albert spells out what the ingredients of such a BSA theory of the world are according to him (and to Loewer):

I. The fundamental dynamic laws.

II. The claim that the initial macro state is M(0) and that the entropy of M(0) is very tiny. He calls this the "Past Hypothesis".

III. The Statistical Postulate specifying a uniform probability over the micro states that realise M(0).[6]

"These three ingredients provide a kind of probability map of the universe since they entail a probability distribution over the set of all possible micro-histories of the universe compatible with M(0)"; Loewer calls it the "Mentaculus".[7] It explains how our universe has evolved from the big bang until now. It started as a macrostate of low entropy M(0) with all compatible micro states having equal probability. All later states have to be compatible with the Past Hypothesis and its low-entropy postulate - this allows Albert and Loewer to avoid the reversibility paradox. A state is for Loewer the position and momenta of all elements of the Humean mosaic at a given time[8], The fundamental laws then explain the regularities of the Humean mosaic.

Speaking of "initial state" and "past" requires an account of the passage of time. Loewer believes that time passes, but not that there is a fundamental arrow of time. He thinks that the arrow can be reduced to other phenomena, for which the entropy gradient seems most promising.[9] The 2nd Law of Thermodynamics postulates that for an isolated system (what we suppose our universe to be) the entropy statistically increases or remains the same (if it is in an equilibrium). As our universe is not in an equilibrium for all we can tell, the entropy gradient of the universe as a whole always points in the same direction, which Albert and Loewer define as the future.[10]

Therefore, the only fundamental entity of the Humean reductionist account is the Humean mosaic, the distribution of properties in space-time. Laws explain how these properties change, but have no modal strength, i.e. they do not have any influence on the mosaic. Time passes, but its arrow can be reduced to the entropy gradient and causation is conceived as counterfactual dependency. In the next

[6] Albert (2000), p. 96.
[7] Loewer (2012), p. 124.
[8] Loewer (2012), p. 122.
[9] Loewer (2012), p. 121.
[10] cf. Loewer (2012), p. 126.

sections, I will address several problematic issues of the Mentaculus and the Best System Account in general.

3. Criticisms of the Mentaculus

In the following, I will analyse the Mentaculus as a proposal for a Best System Account (BSA) more closely and discuss several of its postulates that I find inaccurate. In 3.1, I will argue that there is little reason to suppose a uniform probability over the micro states realising M(0), in 3.2 that the Past Hypothesis fails to explain changes in entropy in isolated systems and in 3.3 that a reduction of all laws to the Mentaculus is implausible.

3.1. Why assume a uniform probability over the micro states that realise M(0) at the beginning of the universe?

One of the main objectives of the Mentaculus is to give an account of how fundamental probabilities can be compatible with a deterministic Humean mosaic. Albert explains this by claiming that the Fundamental Postulate of Statistical Physics holds at the beginning of the universe.[11] This Statistical Postulate states that for an isolated system with an exactly known energy and exactly known composition, the system can be found with equal probability in any micro state consistent with that determination.[12] This is viewed as the axiomatic foundation of the three thermodynamic ensembles and forms the basis of any statistical mechanics calculation. Being a fundamental postulate, it cannot be explained by anything else; but the powerful and intuitively evident principle of indifference justifies it. The principle states that in absence of any further knowledge, we can assign equal probabilities to every compatible situation.

Albert holds that the Statistical Postulate is valid only in the beginning of the universe, at which point the Mentaculus is determined for the rest of its duration. In chapter 4 of his book *Time and Change*, he motivates this as follows. If we looked at the physical state of the universe ten minutes ago and assumed the Statistical Postulate to be correct, we could convincingly explain and predict how our universe evolved from this state to its present state with increasing entropy. However, if we

[11] Albert (2000), p. 85.
[12] Tolman (1938), pp. 59-61.

tried to "retrodict" from the state ten minutes ago to the beginning of the universe, we would face the reversibility paradox highlighted in the introduction. Albert's strategy is that, if we want to eliminate the reversibility paradox, we have to move our point of reference so far back in the past that no "retrodiction" is possible, so essentially to the big bang.[13] Therefore, by establishing that the Statistical Postulate holds at the beginning of the universe and no other point, he manages to introduce objective probabilities compatible with a deterministic Humean mosaic and at the same time circumvents the reversibility paradox.

I will bring forward three arguments against this view. Firstly, it is doubtful that the beginning of the universe would satisfy the condition for application of the Statistical Postulate. Secondly, it remains unclear what exactly the postulated probabilities are supposed to be. Thirdly, one can question why Albert chooses a uniform probability distribution as it is the one that fits the actual single micro state worst.

There are still many open questions as to how exactly our universe came into existence, but it is generally assumed that the big bang was a space-time singularity. Yet, in order to be applicable, the Statistical Postulate requires a system to have an exactly known energy and exactly known composition, a criterion that our current knowledge of the beginning of the universe can definitely not satisfy. Unfortunately, Albert does not address this issue as assuming the Statistical Postulate at the big bang seems to be unproblematic for him. One option that Albert could pursue is to justify the use of the Statistical Postulate because it fits our calculations and can accommodate fundamental probabilities with the Humean mosaic and eliminate the reversibility paradox. But Albert refuses to introduce any kind of epistemic justification as he does not think that our knowledge (or rather lack of knowledge) of the Humean mosaic should be of any relevance to its best system of laws,[14] so this does not seem a viable option. Loewer is more subtle on that point, suggesting to apply the Statistical Postulate not necessarily at the precise beginning of the universe, but "soon after"[15]. The term is vague, but for our purposes we assume Loewer means by "soon after" a time at which the composition and energy of the universe can be known precisely enough to apply the Statistical Postulate. However, this brings us back to the problem of "retrodiction" between this "beginning of the

[13] Albert (2000), pp. 93-96
[14] Albert (2000), p. 64.
[15] Loewer (2007), p. 311.

Mentaculus" and the actual beginning of the universe. As Albert argues, if we consider anything other than the "entirety of the universe at nothing later than its beginning", we fall back into our reversibility paradox.[16] An option to circumvent this issue might be to define "soon after" as a limit but the implications of this would have to be analysed in further details. Another path could be to argue that the meaning of entropy in the context of the very early universe is unclear in itself. The reversibility paradox might then not be problem, but how this should exactly work remains an open question.

Independently of the external conditions for the Statistical Postulate that might not be fulfilled, it also remains unclear how exactly Albert & Loewer want to define their probability distribution. According to them, the initial probabilities are objective attributions of chances of a microstate at the beginning of the universe. This is the only time when there are probabilities, since once the microstate is fixed, the Humean mosaic unfolds and determines every subsequent state.[17] Frigg & Hoefer point out that "postulating a probability distribution for […] the only probabilistic event ever seems conceptually problematic".[18] As there is nothing chancy about the initial condition, the distribution seems only to reflect our ignorance of the system's actual micro-condition[19]. However, Albert refuses any kind of epistemic probabilities, claiming that it is absurd that behaviours of actual physical systems should in any way be explained by our judgments.[20] Yet, relative frequencies or propensities are also not an option as there is only one actual macro condition and the beginning of the universe is the only probabilistic event ever. The argument of Albert and Loewer seems to be that these objective probabilities are a fundamental feature of the world that cannot be explained any further, but this does not clarify at all of what the probabilities actually are.

The fact that there is only one actual microstate brings up a further problem: any other probability distribution than a uniform one will fit the real situation better. The best fit would be provided by a Dirac-distribution peaked at the actual microstate, so this would be much more informative at equal simplicity and should

[16] Albert (2000), p. 85.
[17] Loewer (2007), p. 316
[18] Frigg & Hoefer (2013), pp. 570-571.
[19] Frigg (2008), p. 679
[20] Albert (2000), pp. 64-65.

be favoured by a BSA account of laws.[21] Unfortunately, Albert and Loewer don't explicitly argue for why they prefer the uniform probability distribution over other distributions. It would be the distribution that the principle of indifference would commend for epistemic probabilities, but Albert and Loewer refuse this interpretation outright.

Therefore, the supposition that the Statistical Postulate holds at the beginning of the universe is constructed on an uncertain basis. The condition that the energy and composition is known does not apply at the beginning of the universe so there is no reason for it to hold. Furthermore, it is unclear how Albert and Loewer define their probabilities and why they choose a uniform distribution.

3.2. Can the Mentaculus explain the behaviour of energetically quasi-isolated sub-systems of the universe?

David Albert avoids the "reversibility paradox" in his *Time and Change* by positing that the Statistical Postulate only holds at the beginning of the universe and everything else unfolds through the fundamental laws. He believes that this, together with the Past Hypothesis, suffices to explain all changes in the Humean mosaic. In this section, I will discuss a criticism made by Eric Winsberg in his paper "Can conditioning on the "Past Hypothesis" militate against the reversibility objections?", namely that Albert's theory cannot avoid the "reversibility paradox" in small quasi-isolated sub-systems.

In order to illustrate this, we look at a Coleman cooler filled with lukewarm water in which we put a block of ice. The cooler with the water is in interaction with the rest of the universe until a certain point in time S, when the ice is added and the lid of the cooler is closed. The system is now energetically isolated from the rest of the universe and we expect the ice to melt slowly and the water to cool down until a state of equilibrium is reached where all ice is molten and the water has a uniform temperature (that will lie at some point between 0°C and the initial water temperature). The final temperature will depend on the initial masses of ice and water as well as the water's initial temperature; the entropy of the system will increase until the equilibrium is reached from when on it remains constant. This is a reaction that has been observed over and over again and that is well understood and described by physical laws. If it is to be accepted as a Best System Account, the

[21] Frigg (2008), pp. 678-679.

Mentaculus must be able to explain the thermodynamic behaviour of this quasi-isolated sub-system.

How can the Mentaculus account for this? Unfortunately, neither Albert nor Loewer discuss this example, but Winsberg outlines an argument that seems plausible. First of all, the Past Hypothesis only counts for the universe of the whole and cannot be applied to this sub-system that is extremely small in comparison to the size and age of the universe. Yet, it must be assumed that this small system behaves in the same way as the universe as a whole for the Mentaculus to be able to explain its thermodynamic behaviour. There is no purely mathematical reason to do so - the entropy of the cooler could go as wild as it wants, it would never have any influence on the entropy development of the universe as a whole because of its negligible size. Therefore, Albert must postulate that any subset of the universe (including those that are isolated) has a uniform probability distribution like the universe as a whole.[22] At first sight, this seems plausible: after all, why should any sub-system behave significantly different from the universe in total if the same laws apply? Even if there is no way to prove this postulate, we might be willing to accept it nonetheless.

However, if we refer to the cooler once again, at some time after it has been closed but before it has reached equilibrium (some ice has molten and the temperature of the water has decreased, but both water and ice still coexist), a problem arises. At this moment (as at any other moment), the cooler has to be in a microstate compatible with the past hypothesis, i. e. that its entropy was small at the beginning of the universe. The problem is that this poses no constraint at all on our sub-system (except if it had been isolated since the beginning of the universe, which is typically not the case for Coleman coolers). Its entropy is so small in comparison with that of the whole universe that it is impossible for any state of the cooler to be in conflict with the Past Hypothesis. This would mean that if we look at our cooler in an intermediary state (some ice has already molten, but some is still there) it would be highly probable that the entropy increases both towards the past and the future - we are back at our initial reversibility paradox. Clearly, the Past Hypothesis at the beginning of the universe is not sufficient to explain the thermodynamic behaviour of small quasi-isolated systems because their influence on the entropy of the whole universe is utterly negligible.

[22] Winsberg,(2004a), pp. 500-501.

One answer to this objection would be to postulate that the Past Hypothesis and the Statistical Postulate hold not only at the beginning of the universe but also in any quasi-isolated system at the moment it is separated from external influences. This so-called branch system is advocated by Eric Winsberg in his paper "Laws and Statistics"[23] but was developed earlier by Hans Reichenbach and Paul Davies.[24] It would eliminate the reversibility paradox and allow us to explain the thermodynamic behaviour of quasi-isolated systems. However, Albert explicitly rejects this strategy for two different reasons. On the one hand, he thinks it "sheer madness" to try to determine what exactly constitutes the quasi-isolated system (the content of the cooler, the cooler and its content, the room in which the cooler is, …) and which is the precise moment it enters isolation - that knowledge is necessary in order to determine when to apply the Past Hypothesis. On the other hand, he thinks it unnecessary and illegitimate to assume the Statistical Postulate at other times than the beginning of the universe.[25] The second point is rejected by our example of the Coleman cooler as it is clearly not sufficient to postulate the Past Hypothesis at the beginning of the universe.

The first objection is to be taken seriously, though: Davies characterises branch systems as "regions of the world which separate off from the main environment and exist thereafter as quasi-isolated systems"[26]. Basically, these are systems that separate energetically from the universe at some point to become independent (and usually merge again with the rest of the universe at some later point) and have their own Past Hypothesis at the moment of separation. This is problematic if we consider that both Albert and Loewer's objective is to reduce the arrow of time to the arrow of entropy: this branch system would entail that each separate branch has its own time system that is created upon separation. In fact, Lawrence Sklar points out in his book *Physics and Chance* that the branch theory only works under the assumption that all systems are exhibiting time evolution in the same direction.[27] Winsberg does not even attempt to counter the argument, claiming that his goal is not to provide "an explanation of the origin of asymmetries in time" but only to "explain how time-symmetric micro laws can be compatible with time-asymmetric macro laws", acknowledging that he can "readily admit that we are

[23] Winsberg (2004b), pp. 709-712.
[24] cf. Reichenbach (1956) and Davies (1977) for their proposals of branch systems
[25] Albert (2000), pp. 88-89.
[26] Davies (1977), p. 69.
[27] Sklar (1993), p. 328.

helping ourselves to some other arrow that is already out there".[28] Winsberg makes no comment about what this arrow might be, except that it might be related to the causal structure. This is incompatible with Albert and Loewer's proposal that the arrow of time can be reduced to the gradient of entropy.

Thus, the Mentaculus faces an important obstacle. It cannot explain the thermodynamic behaviour of quasi-isolated systems because it has no way to get rid of the reversibility paradox in these systems. The branch system offers a possible solution but requires an independent arrow of time, making it at odds with what Loewer and Albert specific projects.

3.3. Is the reduction of all laws on the Mentaculus plausible?

The Humean Reductionist ontology defended by Albert and Loewer claims that the Mentaculus and it alone is the Best System Account (BSA) of laws of the universe. In this section I will argue that while the Mentaculus should definitely be part of the BSA, a much stronger and informative system can be achieved if other non-fundamental laws are included in it. Albert and Loewer defend a strong reductionist position: they claim that all laws and regularities that we observe can be inferred deductively from the fundamental physical laws. I will tackle this position and try to explain why non-fundamental laws cannot be reduced to the Mentaculus but should still be included in the BSA.

In our scientific practice, postulating the existence of laws is by no means a prerogative of physics - both other natural sciences and social sciences claim to discover laws that reign their respective fields. Reducing all these laws to one physical "theory of everything" is a long standing hope, but until now there are few hints that we might be successful in that enterprise one day. The most prominent example is probably mental states, which many have tried to reduce to brain states of neuroscience - until now to no avail. Similarly, while it is obvious that the laws of genetics for example have a certain connection to fundamental physical laws (they definitely obey them) they have never been proven to follow deductively from them. Maybe one day scientists will achieve that reduction or maybe they will prove it is impossible, but for now the evidence is too scarce to postulate that every scientific law follows from the Mentaculus.

[28] Winsberg (2004b), p. 711.

So, if non-fundamental laws cannot be deduced from the Mentaculus, should they be included in the BSA? In order to judge this, we have to take a closer look at the criteria of evaluation. Lewis essentially points out two features that have to be weighed against each other: simplicity and informativeness.[29] These are vague concepts, but it seems intuitively clear: we want a theory that can explain as many phenomena as possible while keeping the number of postulated entities and the complexity of the calculations to a minimum. Adding non-fundamental laws decreases the system's simplicity but that is compensated by the superior informativeness. If we look at the spectrum of scientific research nowadays, plenty of research is done in the field of non-fundamental laws; every special science develops its own set of laws. It seems that a cluster of different BSAs for each science would reflect best how research is actually done. This is a promising approach: by restricting every system to its domain of application, we can ensure that it is most simple and informative for this particular science.

Frigg & Hoefer present another objection that must be dealt with: most of the laws of biology are limited to what happens on planet earth and those of medicine and the social sciences even to what happens to human beings. Would it not be preposterous to include laws about things that are confined to a minuscule part of the universe?[30] Frigg & Hoefer's answer to this objection is twofold. Firstly, they emphasise that a system's strength is determined not only by the number of tokens covered but also by the number of types. If these non-fundamental laws can explain biological features that would otherwise be inaccessible, the number of types the system explains is increased significantly. Secondly, the BSA was developed to be a "guide to life for epistemically limited agents",[31] so it is normal that the focus would be on the space-time regions of the universe that concern us directly. While the first is plausible, the second is highly contentious and would definitely not be supported by Albert and Loewer - I will discuss it in detail in section 4.

In summary, the Mentaculus provides a basis for a BSA but can by no means be a complete account: deducing all non-fundamental laws from the Mentaculus remains out of reach for the moment and non-fundamental laws are needed to explain many features of the world around us. Ignoring them would make the system considerably less informative.

[29] Lewis (1994), p. 478
[30] Frigg & Hoefer (2013), pp. 564-565.
[31] Frigg & Hoefer (2013), pp. 567-568

In section 3, I have presented several of the challenges the Mentaculus has to overcome, as well as answers of some other Humean reductionists, although quite a few of them would be incompatible with Albert and Loewer's conception. In the next section, I will point out issues of the Best System Account in general and why it might be impossible to find laws that can meet its standards.

4. Can there be laws that fulfil the requirements of the Best System Account?

The Best System Account (BSA) has the difficult task of working with laws that have no modal force but should have more strength than mere instruments. On the one hand, Humean reductionists believe the only fundamental ontological entity is the Humean mosaic and that laws only identify regularities in the mosaic but do not influence the latter in any way. On the other hand, they stress that the laws are a systematisation of fundamental truths and not only instruments we use in order to make experimental predictions. Without looking at the specificities of the Mentaculus, I will outline why finding this middle ground might be an impossible task.

It is an important issue that we only have access to a certain part of the Humean mosaic, namely the one that is in our past light cone, but the Best System Account is to be applied to the entire mosaic. The task of the BSA is thus to find the most simple and informative systematisation of truths about something to which it has only partial access. This is a difficult task by itself, but in addition to it we have absolutely no reason to suppose the Humean mosaic outside of our past light cone should behave in the same way as the one we know. After all, the laws have no influence whatsoever on the composition of the mosaic. If we are instrumentalists, this is not a problem: we only want laws to predict the outcome of our experiments, so the fact that they might not be valid in space-time regions we have no access to is irrelevant. If it is the laws that produce future states there is now problem either, because by definition the states will have to be compatible with the laws. That does not mean we might not believe in the wrong laws, but if we get them right, we are safe. For the BSA, which wants to be on a middle ground, neither of the two strategies work. So it seems an overly ambitious project to want to identify the best systematisation for the whole Humean mosaic while only having access to one part of it.

Frigg & Hoefer point out a second issue in their paper "Best Humean System for Statistical Mechanics": it is possible that our universe will "have an infinitely long future "heat death" state in which, basically, nothing happens". That is one of many scenarios envisaged by astrophysicists, and for such a universe the Best System would be something like "nothing happens but minor quantum fluctuations in an otherwise cold, dead, slowly expanding space". However, this kind of BSA would be of no avail at all to our scientific research, which naturally concentrates on what surrounds us. The two authors thus reject the argument by claiming that the BSA should be a "guide to life for epistemically limited agents - agents for whom […] one corner of the Humean mosaic is going to be more relevant and important than the vast regions with which they have no contact".[32] It is true that laws are only relevant for epistemically limited agents - after all omniscient beings could know the entire Humean mosaic. Yet, the postulate that the BSA is a "guide to life" should not be made light-heartedly, especially if like in our case it is in direct conflict with the other two virtues, simplicity and informativeness. This would change the BSA's scope from being the "best scientific systematisation of the totality of fundamental truths of the world",[33] to be the best scientific systematisation of the truths that we have access to and that are relevant for us. It is obvious that we can't know anything about the parts of the Humean mosaic we have no access to. However, claiming that the scope of the laws is to guide us goes pretty far down the road of instrumentalism. After all, the only difference that would remain is that a BSA has some claim to truth, but if relevance for us becomes a main criterion for the choice laws, that is an important blow to the strength of that claim as well. Anyway, it is extremely doubtful that Albert and Loewer would agree to Frigg & Hoefer's proposal as they refuse any justification for the Mentaculus based on our limited knowledge. Albert describes the suggestion that the probabilities of the Mentaculus might be of epistemic nature as "insane"[34] because he sees no reason why our knowledge (or rather lack of knowledge) of the Humean mosaic should be of any relevance to its best system of laws - he would most definitely present the same argument against any "guide-to-life-BSA". Yet, they don't give any hints to how they would respond to the "heat-death" argument.

[32] Frigg & Hoefer (2013), p. 564-565.
[33] Loewer (2012), p. 119.
[34] Albert (2000), p. 64.

The Best System Account is thus in a difficult position: it has to find an explanation of laws that have no modal force but are more than just instruments to predict the outcome of experiments. These laws further have to be the best systematisation of a Humean mosaic we only know partially. Frigg & Hoefer suggest including a third criterion of evaluation for a best system, namely that it helps explain the questions with which we are confronted. This view, however, leans strongly towards instrumentalism and would be refused by Albert and Loewer.

5. Conclusion

In this paper, I have pointed out several problematic issues of the Mentaculus: using the Statistical Postulate at the beginning of the universe, the explanation of small, isolated systems and the attempt to reduce all laws on the Mentaculus. Furthermore, I pointed out the difficulty for the Best System Account to develop laws that satisfy its criteria but are neither mere instruments nor have a modal force. I hope the outlined issues can be of use in the further development of theories to achieve a better explanation of time-asymmetric processes.

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6. References

Albert, David (2000), *Time and Change*, Harvard University Press: Cambridge, MA.

Davies, Paul (1977), *The Physics of Time Asymmetry*, University of California Press: Berkeley.

Frigg, Roman (2008), "Chance in Boltzmannian Statistical Mechanics", in *Philosophy of Science*, 75, pp. 670-681.

Frigg, Roman & Hoefer, Carl (2013), "The Best Humean System for Statistical Mechanics", in *Erkenntnis,* Volume 80 (2015) , Supplement 3, pp. 551-574 (published online 16 October 2013).

Lewis, David (1994), "Humean supervenience debugged", in *Mind*, 103, pp. 473-49.

Loewer, Barry (2007), "Counterfactuals and the Second Law" in Price, Huw & Corry, Richard (2007, eds.), *Causation, Physics and the Constitution of Reality,* Clarendon Press: Oxford, pp. 304-337.

Loewer, Barry (2012), "Two accounts of law and time", in *Philosophical Studies* 160, Issue 1, pp. 115-137.

Price, Huw (1996), *Time's Arrow and Archimedes' Point,* Oxford University Press: Oxford.

Reichenbach, Hans (1956), *The Direction of Time*, University of California Press: Berkeley.

Russell, Bertrand (1912/1913), "On the Notion of Cause", in *Proceedings of the Aristotelian Society,* 1912/1913, pp. 1-26.

Sklar, Lawrence (1993), *Physics and Chance: Philosophical Issues in the Foundations of Statistical Mechanics*, Cambridge University Press: New York and Cambridge.

Tolman, Richard (1938). *The Principles of Statistical Mechanics.* Dover Publications: Mineola.

Winsberg, Eric (2004a), "Can conditioning on the "Past Hypothesis" militate against the reversibility objections", in *Philosophy of Science,* 71, pp. 489-504.

Winsberg, Eric (2004b), "Laws and Statistical Mechanics", in *Philosophy of Science,* 71, pp. 707-718.

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On Scientific Knowledge and its Circulation:
Reception Aesthetics and Standpoint Theory as Resources for a Historical Epistemology

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Abstract

This short essay proposes a combined framework of Reception Aesthetics and feminist Standpoint Theory as an approach to the circulation of scientific knowledge and to a Historical Epistemology. The article argues that Reception Aesthetics provides intellectual tools to examine how ideas were appropriated at each conjuncture and made productive. Standpoint Theory focuses on how local agents can be scientific and epistemically productive and relevant, and how scientific labour is divided according to cultural, economic, and geographical factors. Here it is argued that the articulation of both outlooks can be fruitful for elucidating how the production of scientific knowledge with its normative criteria are distributed, how the dynamics of contemporary circuits of scientific exchange can be conceptualized, how the possibilities and limits to making past knowledge productive can be discussed, and how a normative stance can be built from the relationship between epistemic values, non-epistemic values, and historical conditions.

Introduction

In an well-known article, Secord (2004) concluded that although conceiving of the history of science as a form of contextualization has been an advancement for the field overall, it ended by equating "context" and "history", and confusing the approach itself due to

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imprecisions in the definition of objects and frameworks (p. 659). He called for a new, "foundational" way of understanding historicity in science as "an act of communication, with receivers, producers, and modes and conventions of transmission", oriented towards "eradicating the distinction between the making and the communicating of knowledge […] [and] thinking about statements as vectors with a direction and a medium and the possibility of response." (p. 661). This implies not only the study of the circuits, media and mechanisms of circulation of knowledge, a line of analysis pointed out by transnational history (Heilbron, Guihot & Jeanpierre, 2008; Turchetti, Herran & Boudia, 2012) but also an investigation into who produces knowledge and how it is modified in the process. That is to say, a conception in which the role of production of knowledge, and the role of appropriation and reconfiguration of knowledge, are two modalities of the same process — the producer is already a receiver, and the receiver can be considered a producer.

What is at stake here is not only a renewed way of thinking about history of science, but also an epistemological statement: scientific theories, methods, evidence, discussions and consensus are a result of the circulation of knowledge. That is to say, scientific production is not merely spread from one point to another but inherently distributed through different spaces and times. This description, which may seem trivial, is still not often taken as a starting point to conceive how scientists have been thinking and working through different times and places. Scientific knowledge's situatedness is not thinkable without taking into account its mobility, through time and across geographies. In this respect, both scientific outcomes and criteria for theorizing and obtaining evidence demand that a Historical Epistemology (HE) reconstructs and appraises scientific evolution.

This short essay aims to provide some intellectual tools, derived from my own research on the reception of Soviet and communist psychology in Argentina (García, 2014a, 2014b, 2016a, 2016b), for a historical epistemology of the sciences, in line with Secord's call, but with a different approach that highlights not just the communication in science, but stresses how situated agents appropriate and make circulating knowledge productive. The idea that epistemology and philosophy of science requires a historical basis is not new (e.g. Fleck, 1935/1979; Bachelard, 1938/2004; Metzger, 1987), but in recent years that demand has gained new attention and many versions of such a reconsideration have been proposed (e.g. Daston, 1994; Renn, 1996; Galison, 2008; Rehinberger, 2010). HE, as well as its companion, Epistemological History, remains a very imprecise field, however; agreements are rare and there are many terminological and conceptual juxtapositions that still require elucidation (e.g. Sturm, 2011). Nevertheless, this state of

indeterminacy broadens the search for intellectual and methodological tools. The approach to an HE proposed here is not normative; it does not offer criteria for deciding which knowledge is more accurate or consistent, and is not proposed as a closed or complete model.

Instead, it offers an outline of the ways one might deepen an examination of where, when, how, by whom, and for whom knowledges have been produced. This allows for a consideration of science as an endeavor that results from combined conjunctures, as an historical outcome *tout court*. This strong emphasis on historicity is still not incompatible with analytical and normative approaches; nevertheless, it obliges one to consider both contemporary and past epistemological norms, their situatedness and interaction. The aim, therefore, is to search for a historical reflexivity that provides information not only about specific knowledges and their contexts, but also about the epistemological frameworks used or presupposed by historical figures and contemporary historians and scientists, in an informed and productive recovery of the past.

In order to do so, this article offers an outline for the possibilities of a combined framework of Reception Aesthetics (RA), proposed in the German tradition of literary theory, and Standpoint Theories (ST), formulated in the feminist philosophy of science, as historiographical and epistemological resources for the history of sciences. RA is considered to have been a renovating outlook for the study of the circulation and changes in cultural production (e.g. Hohendahl, 1977; Dotti, Blanco, Plotkin, Vezzetti & García, 2008). What RA provides is not a proper historiographical framework, but a strategy for analyzing historical sources without a previously defined goal. This open-ended feature allows for diverse articulations with several other historiographical tools and approaches (e.g. Vezzetti, 1996; Wieviorka, Burguière, Chartier, Farge & Vigarello, 1998; Woessner, 2010). Here an articulation with ST is offered; this philosophical approach is proposed by their advocates as a renewed starting point for scientific thinking, and as such it is normatively driven. However, in contrast to the mainstream philosophy of science, ST considers that historical factors are constitutive of such normativity, and allows for an exploration of how scientific knowledge, and the scientists as agents, have been historically determined, both in the past and in the present.

This brings many challenging conceptual and methodological issues to the forefront, such as the possibility of using the past to establish normative criteria for the present, and vice-versa. While RA and ST are not new approaches, they have not been systematically articulated before; this brief essay proposes that a combined framework can be a fruitful historiographical strategy to highlight the entanglement of objects and

processes, impossible to attain by a single approach. In particular, RA and ST have features that can be useful to illuminate the production, circulation and embedding of scientific knowledge. I propose here that the articulation of both approaches is useful for an accurate historical analysis of the specificities of conditions of production and circulation of scientific knowledge, as well as the capabilities of scientists as local agents.

Circulation through geographies and history: Some features of Rezeptionsäesthetik

The main innovation of RA – contrary to what the word "reception" may suggest – was to locate the reader as a productive agent of a literary work, differentiating him or her from the reader presupposed by the author as an intended public. The variation of readers over moments of time and geography allowed for the introduction of the historical-aesthetic problems of how an oeuvre can retain its value across time, how a network of readers can develop, and how each reader and context for reading can have an impact on the consideration of that oeuvre. According to H. R. Jauss (1970/2000), consecutive readings are those that "concretize" and give historical life to each work. The value of a text depends on this evocative potentiality in different readers, derived from the intersection between the "horizons of expectation" created by a work and the expectations of the reader. The reader is reinstated as an agent who due to his or her historical placing, can make a reading effective and enhances the text through successive readings. From this stance, the reader as historical agent also has an epistemic role: it is through the act of reading, in the permanently updated historical relationship among author, work, and reader that the productivity and historicity of literary activity resides. Literary history is not a mere sequence of events, but the recognition of inherent change in any literary production due to the updating of readings. The task of history is thus the reconstruction of the mediations that allow the contact of the past (of a work) with the present (of a reading). This outlook opens the possibility of making historical studies to characterize specific readers – those expected by an author, those who read in practice, and the distance between them – which results in a history of the activity and skills of reading in itself and a history of the dissemination, publishing process and marketing of books. A solid tradition already exists in this area of historical studies (e.g. Darnton, 1982; Chartier, 1994; Moretti, 2006), yet scientific texts are still scarcely addressed in such perspective.[2]

[2] As RA is focused on the appropriation of circulating knowledge, it is mostly dependent on published texts. Yet correspondence, outlines, notebooks, unfinished manuscripts and other "private" and never published texts can be meaningful for reconstructing the genesis and development of scientific ideas (e. g. Holmes,

According to Eagleton (1983/2011), literature should not be restricted to a specific genre, given that genres are mutable and the same text might belong to several of them. It can even be said that "[t]here is therefore always the possibility of a vacillation of meaning, a chording of significance, that will break through generic constraints, whether the genre be that of poem, drama, novel, scientific paper" (Beer, 1990, p. 91). If this stance is admitted, scientific texts can be analyzed from the framework of reception, as they are also a kind of mutable literature. Yet, linguistic or aesthetic analysis should not overshadow the fact that scientific texts have peculiarities that cannot be merely considered to be part of a "genre" and need specific considerations. As a result of actions by the reader, the dissemination and reception of a scientific text is modulated by a series of characteristics that are considered to be scientific in specific moments and places. First of all, scientific texts intend to reveal the effective and material features of reality, so they aim for a clear and distinctive writing and vocabulary, and tend to minimize literary devices such as metaphors, unless they are suitable to acknowledge the available empirical evidence. Secondly, their technical vocabulary defines the circuits of dissemination; the reader is usually another scientist or student of science, and the texts refers to specific practices and methodological procedures.[3] This is a crucial aspect of scientific literature, as it must explicitly state the methodology used for obtaining data, so that such procedures could be replicated or altered by other scientists. In this way, scientific literature can generate more knowledge and guarantee its objectivity. Thirdly, from this perspective, objectivity depends on the circulation of scientific knowledge and practices in different contexts, and this epistemic aspect is tied to the usual expectation that science should be an international enterprise. That conjunction between objectivity and internationalism imposes the homogenization of practices and vocabularies for the communication of results and replication of procedures.[4] In that way, as opposed to other kinds of literature, scientific texts do not prioritize local specificities, but rather tend to diminish, if not eliminate them.

There is another aspect to consider. Scientific knowledge changes (grows, advances, develops) as new theories and evidence displace, refute or discredit previous ideas. In this sense, the recovery of knowledge from the past by a current reader always implies some kind of epistemological criteria with which to establish the pertinence, productivity, and

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Renn, & Rheinberger, 2003). RA does not exclude *per se* the analysis of these kinds of materials, as they may be helpful in establishing the distance between the actual work of research and the way the results were later communicated. However, as they are accessible to only a few specialists, their value for studying reception processes in different publics is limited.

[3] In order to define a clear subject in this article, I will not consider "popular science" literature, directed toward lay people. On this topic, see Vincent (2003).

[4] In fact, this perspective is one of the basis of Vienna Circle program (cf. Hahn, Carnap, Neurath, 1929/1996, p. 316).

relevance of that "old" knowledge for the present state of the art. Lucian of Samosata might always be productive for fiction and poetry; Claudius Ptolemy, however, is not equally productive – if at all – for current astronomy and geometry. The circulation, reception and re-updating of scientific knowledge thus works in specific ways.

Here is where ST can be useful for historical and epistemological ways of thinking about science.

Situatedness as agency: Some features of Standpoint Theory

Proposed by Anglo-Saxon feminists in the late 1970s, ST draws on the thesis postulated by Marx and Engels in *The German Ideology* (1846/1998) and by György Lukács in his essay "Reification and the Consciousness of the Proletariat" (1971). Stated briefly, ST claims that the gendered division of labor and the specific conditions of women's socialization generate a material and structural position different from that of men, from which the world can be known and experienced in a differentiated way. This would allow for the creation of specific knowledge and practices critical of the masculine ones that perpetuate gender inequality and oppressive practices towards women, which would lead to a challenge of the *status quo* in the pursuit of women's emancipation (Hartsock, 1985). This proposal had a considerable impact on the constitution of a new scientific epistemology in feminism, yet it also had its problems. The early version of ST assumed the masculine/feminine opposition as central, and therefore considered women as a unified subject that experiences the same vital and economic conditions in every place, leaving out other dimensions as race, culture and sexuality that introduce many important differences in women's experiences. When these dimensions were incorporated to the economic and relational facets of the ST, they broadened its scope without losing its central tenet: the primacy of situated experiences as knowledge is produced within material conditions and contingent relations. Such embeddedness allows for the consideration of different perspectives about phenomena and enables the emergence of new agents of knowledge, which include, but are not limited to, women who are feminists (Hartsock, 1997).

Mainstream philosophies of science do not thematize the international division of scientific labor, and thus they do not consider the incidence of race, gender, geographies, and class biases in the production of knowledge (Harding, 1986, 2006). The economic dimension is particularly important not only in local conditions for knowledge production but also on its international dissemination. Past and current internationalism in science have worked as the imposition of research agendas to the periphery by some centers –

mainly the North-Atlantic ones – based on important economic, political and military differences between the two that define the international distribution of labor (e.g. Kreimer, 2010; Raj, 2013). ST enables the consideration of the issues of periphery, culture, gender, economy, and other historical and social aspects within the normative analysis of science, and so it opposes the imposition of an "abstract masculinity" as it considers crucial aspects of reality not considered by such central, androcentric, Caucasian, bourgeois, and western rationality.

Material conditions and systems of relations affect the formation of the scientist and define the research agenda. But this does not imply the acceptance of a relativist stance without proper norms to decide which knowledge is better or worse; on the contrary, when knowledge is materialized in its specific conjunctures, it avoids assuming that it belongs to a universal, ahistorical realm that is valid *per se* for every place and time. ST as a philosophy of science seeks the procurement of more objective knowledge because of its reflection on the historical situations of conception and development, and in doing so it provides sources for knowledge that may be disdained or inaccessible from other stances. ST looks for new grounds, such as marginalized agents, conceptions, problems and events, from which to establish a "strong objectivity" and "robust reflexivity" against philosophies of science that do not consider the historical embeddedness of scientific production, and thus only account for justification criteria that are offered as universal norms immediately applicable in any setting. For ST, such an approach is less objective, less productive and even ideological, because it offers restricted criteria and systematic biases without tools for reflexivity (Harding, 1996b). ST avers that "it is the perspectives of economically, politically, and socially oppressed groups that can bring valuably novel insights to research projects" (Harding, 2015, p. 35). In this regard, the inclusion of alternative or dismissed perspectives that may provide new hypothesis and evidence would allow for the revision of the scope and biases of current methods and theories.

Accordingly, ST does not endorse any kind of value neutrality. Knowledge provided by the new situated agents might introduce different realities that affect ethical and political values. The regular distinction in history of science between epistemic and non-epistemic values cannot be defended if that analytical distinction implies only the epistemic ones are relevant to scientists (e.g. Kuhn, 1983). The former cannot be understood without the latter, and that does not suppose that the rationality of epistemic values necessarily have to be degraded. Epistemic values are more justifiable and productive insofar as they are considered along with non-epistemic values (Anderson, 2004; Kinkaid, Dupré &Wylie, 2007). This also contributes to a better historical understanding of the ideas and choices

scientists made in the past and a more sophisticated reflexivity on what it takes to produce scientific knowledge.

Distributed scientific thinking through embedded agents: Possible articulations between RA and ST

What science considers well-established knowledge has changed historically, and it is clear that a given idea or theory would not have been considered scientific at a different historical moment. Even if scientific limits are variable because they change with evidence and debates, several types of demarcation criteria have been proposed to settle what kind of knowledge is scientific and what kind is not. It is thus possible to give historical accounts of how such criteria have been defined and disseminated in different scenarios. For RA, the re-contextualization of received knowledge does not imply that they are mere copies, even less distorted ones, but that their productivity is renewed in each crossing of "horizons of expectation" which results in novel and specific "concretizations". Furthermore, it allows for novel opportunities for contrast between theories, practices and evidence, as well as the examinations of epistemic norms.[5]

ST aims to examine which social formations enable or constitute theoretical questions and answers. Thus, its framework includes the historical conditions that fostered the emergence and reproduction of epistemic and non-epistemic values in science, in particular those associated with "abstract masculinity". Therefore, it is possible to reflect on how those values can be challenged, updated or changed. Also, this allows for the detection and rescuing of "subjugated" knowledge with critical and normative perspectives, how it could be appropriated and modified, and its significance for the present. While ST keeps its focus in the present, RA can open the past in the search for neglected knowledge, as the problem of the recovery of the past in the present is a central part in hermeneutics, the tradition from which it has developed.[6] This opens up the possibility for two

[5] It can be argued that knowledge does not travel alone, but with its criteria of elaboration and justification. It should be noted, however, that knowledge is often appropriated with different criteria than those used in its initial production. Darwin's and Lamarck's evolutionary theories could be a case in point (Miranda y Vallejo, 2005; Engels & Glick, 2008; Gissis & Jablonka, 2011). This implies that, although normative criteria are always present, the relevant epistemic norm has to be defined in each case. This also opens up the possibility of considering how the same evidence, methods and theories could be accepted by different, even opposing, epistemologies depending on their geographical and historical circulation.

[6] See Bernstein (2002, pp. 270-275) for a brief exposition on this, following discussions of "difference" by Gadamer and Habermas. For this topic, Marxist philosophy also serves as a connection between RA and ST;

operations; first, the extension of loci, objects and agents for historical inquiry, which involves a critical decentering of disciplinary canons – still the main references in history of sciences, in any of their approaches.

It allows for a reconstruction of how sciences are and were made "from below" by non-canonical figures, such as middle range researchers and research teams, visiting researchers, scientists from peripheral contexts, immigrants, women, specific populations under study, and an array of intermediaries, from journalistic outlets and publishing houses in different languages to managers of international institutions. This centering of groups and communities emphasizes how they interact and communicate through geographies and time, focusing particularly on who put specific scientific knowledges into circulation and in what way, as well as how the circuits and mediators have been historically defined. Second, it sets a limit to an overly intellectual approach to history, as it demands the examination of social and material aspects that define how and by whom evidence is obtained and considered "objective".[7] This would avoid histories too centred in local controversies around the ideas of canonical figures, from which conclusions are usually too swiftly extended to several locations at the same time, or they are used to represent the rationale of dilated periods. As such, this articulation between RA and ST can be useful to both diachronic – the thorough reconstruction of knowledge in a specific time in the past or in the present – and synchronic – the changes and itineraries through time of theories, philosophical criteria, methodologies, agents and practices – approaches in studies of science. In fact, such outlook would preclude a sole strategy in history of science. It suggests that the aim is not a grand unified framework for history of sciences, but rather the more achievable objective of the necessity for a broad and reflexive approach to agents, problems and knowledges.

As has already been mentioned, historical and geographical re-appropriation deserves a careful analysis with respect to science. It is possible to allege that authors are not completely subordinate to reading operations, and that texts are part of their agency

RA has roots and connections with Marx's ideas on classic art (1857/1993), and the ideas on history of Walter Benjamin (1969) and Karel Kosik (1963/1976). For the sake of intellectual honesty, it must also be acknowledged that Jauss explicitly rejected literary theories based on the ideas of Lukács (Jauss, 1975). This is worthy of consideration for the debates between literary critics from Democratic and Federal Germany, but does not seem relevant for current philosophy of sciences and its feminist approaches (cf. Jameson, 1988/2004).

[7] About this specific issue, see Peter Dear's and Matthew Jones' objections to the mainly philosophical argumentation posed by Daston and Galison for a historical approach of objectivity (Dear, Hacking, Jones, Daston & Galison, 2012, pp. 13-15, 28-29). Daston and Galison warned of historical simplifications at the "macro" and "micro" level, where an overreaching context (e.g. capitalism, modernity, patriarchy) directly "explains" the specific ideas and practices of scientists, or where the insistence on local specificities keeps the analysis blind to global patterns and structures (2007, pp. 197, 205; 47-48). But this warning, albeit reasonable, only calls for specific approaches able to track and assess the historical sources. The articulation has to be shown, not merely inferred; the approach presented here is useful for such reconstruction.

(Thompson, 1993). Scientific authors impose their ideas, authorship and authority in a different manner from literary authors; they have their own ways of defining limits on how their work can be read or how their practices should be emulated based on their legitimacy for producing knowledge or the technical possibilities of their context. This sets standards on truth claims derived from the results of the research, and on the technological means required for their replication and confirmation. In a way, scientific texts are open to the extent that certain procedures and rules of knowledge production are followed.

Certainly, this does not mean that different readings cannot be carried out, but that they depend on the evaluation of procedures that lead to relevant evidence. Considering this, it could be argued that one of the limitations of RA is that it is restricted to key readers, individuals or specific groups. This may not be a shortcoming in itself, but it may reveal that the analysis of massive and/or non-differentiated audiences requires a specific approach with different methodological tools. On the other hand, Harding affirmed that standpoints "are not to be conceptualized only as perspectives. Everyone has perspectives on the world, but standpoints are intellectual and political achievements in that a group has to work together to figure out how to arrive at them" (2011, p. 19). Just as RA does not refer to massive audiences, ST is not meant to refer to solitary individuals or large undifferentiated groups. RA and ST are compatible in this respect, allowing for more historiographical precision in defining processes and actors.

In that respect, ST, due to its emphasis on the contexts of discovery and production, can resituate the problem of epistemic norms within the conjuncture that produced them. The problem becomes one of how and why the reader and the author have the same criteria for producing and evaluating knowledge (Ruetsche, 2004). That is to say, instead of assuming the preexistence of common norms beyond the circulation of knowledge, the establishment of shared norms in different conjunctures is what has to be historically examined. ST thus calls for research on the politics of dissemination of scientific knowledge, the internationalization of its production conditions, and the distribution of scientific work. Many lines of inquiry could be opened up by such a perspective, such as how scientific knowledge is accepted where technical means, or even the object itself, are missing, but where there nevertheless exists a scientific community that is authorized by it.[8] In addition, one could investigate how such a scientific community produces new knowledge from the knowledge it receives, without the possibility of

[8] See, for example, the use of Pavlov's physiology in psychiatry outside U.S.S.R., in contexts where laboratories conditions and research were completely different – if there were any –, and psychiatric practices were done with very different trainings and settings (Harris, 1995, Gao, 2015; García, 2015, Ruiz y Sánches, 2016; Lambe, 2017). For detailed account on Pavlov's laboratory and research, see Todes (2000, 2014).

replicating this previous research. ST sheds light not only on the dissemination of knowledge, but also on the implantation of biases in science. The members of a scientific community have multiple subjective positions that overdetermine – or multidetermine – their readings and appropriations, which results in different modalities of reception. This implies that evaluation stances diverge, converge or contradict each other and cannot be limited to epistemic criteria, even when the latter is necessary. Appropriation and rejection of knowledge in science is a process that potentially includes the whole range of scientists' experiences.

A brief example: Pedagogy and communism in Latin America.

Taken from my own research, the following is an example of the kinds of figures and processes for which this combined framework would be suitable. Berta Perelstein de Braslavsky (1913-2008) was born into a Jewish immigrant family. Her parents decided she would be a schoolteacher, a standard job for females and a feminized profession in the 1930s. Her studies were interrupted in 1936 when a ministerial decree expelled her from the Instituto del Profesorado Secundario [Secondary Professorate Institute] due to her involvement with the Communist Youth Federation, which gave rise to public scandal, both because of the presence of communism in public education and because she was a young "free" woman (Braslavsky, 1996, 2008). Braslavsky managed to continue her studies at the University of Buenos Aires (UBA). Though she did not consider herself a feminist, she nonetheless rejected religious and family values, choosing to live with her partner, himself from a traditional Jewish family, without immediately getting married. Once she graduated, unable to work in a public institution, she opened the Instituto de Argentino de Reeducación (IAR) [Argentinian Institute of Reeducation] in 1944 with the psychiatrist and comrade Julio Peluffo, where she would study and give treatment to around 60 children with mild developmental and learning disorders. This specific demographic combined education, child rearing and health attention, all subjects strongly associated with female roles. She remained a full-time activist, and in 1948 she spoke in representation of Argentina at the Second Women's International Congress in Budapest on the imperialist economy, the inequality of wage for women, the poor working conditions of female industrial workers and peasants, the excess of work in the domestic sphere, and the lack of proper laws for maternity (Women's International Democratic Federation, 1949, pp. 333-338). Before returning to Argentina, she spent four months at the Laboratoire de psychobiologie de l'enfant in Paris [Laboratory of child psychobiology], led by the communist psychologist and politician Henri Wallon. There she learned developmental

theories and testing procedures that defined the work at the IAR. After her return, while still working at the IAR, she wrote a book in which she proposed dialectical and historical materialism as a philosophical surpassing of positivism and antipositivism and a basis for scientific thinking, in line with the communist stance at that time (Braslavsky, 1952).

In her role of communist intellectual and international activist, in 1954 she became the general secretary of the Instituto de Relaciones Culturales Argentina-U.R.S.S. (IRCAU) [Soviet-Argentinian institute for cultural relationships], an institution officially recognized by the Argentinian government. In 1957 Braskavky was able to teach again and entered the UBA as professor. That same year, she got the support of the Consejo Nacional de Educación [National Council of Education] to conduct a series of research projects on the methodology of teaching, reading and writing in children with learning disadvantages, particularly dyslexia. The results of those inquiries were synthesized in the book *La querella de los métodos de enseñanza de la lectura* [*The Quarrel over Reading Teaching Methods*] (1962/1992), a book that gave her recognition in Latin America and was republished many times. There she proposed a developmental psychology and neurophysiology that mixed the ideas of Ivan Pavlov, Alexander Luria, Alexei Leontiev, Sergei Rubinstein, Wallon, René Zazzo and Jean Piaget – excluding the latter, all of them were standard communist references for the psychological sciences. Braslavsky combined their ideas – something not done in Europe, where those authors tried to differentiate from each other – to support a holistic and environmental idea of language functions as social products that preexist the child, who "internalizes" them though cultural transmission, and that determine the whole of cognition, behavior, and personality by means of functional modifications in the anatomy of the nervous system. The school is one of the most important spaces of socialization, reading, and writing, and does not just endow children with cognitive abilities, but more importantly gives them the tools for a whole cultural and social existence. Braslavsky discussed the current approaches to reading and writing education, and dismissed them for not being founded in scientific psychologies. In her view, the problem with methods contributed to the indiscriminate diagnosis of dyslexia, a disorder then blamed for failures by the educational institution.

The specialists on the issue – mostly physicians, still by then a predominantly masculine profession – recommended special schooling, with different teachers, programs and buildings, and medical attention for children with this pathology. Braslavsky rejected all teaching and diagnostic methods that reduced child psychology to internal factors, and criticized special schooling as "the dyslexic disorder is manifested, if not produced, in an essentially pedagogical situation such as the school environment" (p. 156). The pathology

was therefore not independent from teaching methods, so special education and medical treatments were not the solution; even worse, they hampered the socialization of the child. Her positions led to an open polemic in 1963 with Julio Bernaldo de Quirós, by then president of Argentine Speech-Language and Hearing Therapy Association and director of its specialist journal *Fonoaudiológica*, during the in the First Seminar on Dyslexia in Montevideo, Uruguay. There Quirós stated that statistics proved that "heredity seems to be an important factor, much more important than environment"; Braslavky, replied that "reading is an acquisition, not an innate possibility" (Grompone, et al., 1965, pp. 28, 140). In that dispute she represented the stance of teachers, still a feminized profession linked to the humanities, against that of physicians, a mainly masculine profession that was considered fully scientific (Barrancos, 2010, 220-224). Braslavsky's communist ideals of social justice and readings of leftist psychology and physiology were the basis of her stance. Her researched intertwined her political commitment with applied research, taking into account the work of Soviet and French Communist scholars without assuming their thesis *a priori*, as she employed her own methods and ideas, and searched for intellectual tools and data from non-communist authors. Her ideology set out problems, references, and certain hypothesis, but that did not imply an orthodox or partisan closure in her actual research, as is usually attributed to communist scientists. Political values lead her ideas on psychology and pedagogy, but evidence and problems were not collapsed into ideological limits.

After some years of full time teaching at the UBA and the Universidad Nacional de La Plata, the 1976 *coup d'état* drove her to exile in Venezuela, where she became a consultant for the local ministry of education, for Mexican and Cuban programs and for UNESCO. When the military dictatorship ended, she went back to Argentina and in 1986 was appointed as the director of the new department of Education Sciences of the UBA. In this position she promoted the pedagogical ideas of Vygotsky with specific graduate and postgraduate courses, and organized a four-year research program on methods of reading and writing for the Buenos Aires city council to design the first-grade curriculum in public schools. The results of this research were implemented in the schools and published in the book *La escuela puede* [*The school is able*] (1991). Although Braslavsky had left the Communist Party by then because of its conciliatory position toward the dictatorship, she still drew on Vygotsky's ideas on cognition and development; in fact, this research was the first in the country to apply the Soviet psychologist's theories on concrete public school practices.

This overview of Braslavsky's ideas, work, and life shows that a history of her knowledge and practices cannot be understood without at the same time taking into

account that she was Argentine, communist, and a woman. As such, she occupied a triply peripheral position: from the Western academic centers, from the political liberalism and conservatism of South America, and from a feminized profession not considered a "hard" science. In this example, RA would explore how political, psychological, pedagogical, and physiological ideas arrived from Western and Eastern Europe, while ST would account for how Braslavsky's own position in the social field and stance toward leftist values and ideologies provided a specific position from which to conduct research with a defined population and condition, and produce a scientific interpretation of data to discuss with local and international authors. From that characterization, her figure leads to the history of pedagogy in Latin America, the communist dissemination of scientific ideas, the roles assigned to women in society, and the capabilities and problems of an individual to produce knowledge from that setting. The combined approach of RA and ST allows for this kind of systematic and intertwined examination of the agent, the knowledges involved and means of circulation, and the specific political and social conditions of different contexts. Though she was not a figure of the disciplinary canon, Braslavsky's position as a peripheral middle range researcher who was nonetheless influential in Latin America provides an example in which the combined framework of RA and ST would give a thorough description of her conditions and activities for producing knowledge, as well as a novel starting point for histories of science, based on the circulation of knowledge, the disputes for legitimation of knowledge, and the possibilities of "marginal" agents and contexts for the production of scientific knowledge.

Conclusions

This short essay tried to show some articulation between two different frameworks to propose a historiographical outlook that is sensitive to the circulation and embeddedness of scientific knowledge, and the changes that this process implies. RA can offer a solid historical approach to ST, and the latter can in turn introduce epistemological issues into the reception process of scientific production. The historization of scientific knowledge and their epistemic norms can offer new insights into how current knowledge is generated and justified. The combined framework proposed here is suitable for the inquiry and assessment of knowledge production, both for the history and philosophy of science, and for science in general: it permits an informed recuperation of past knowledges, problems and failures; it provides criteria with which to advance historical studies and obtain evidence for a critical examination of the means for production and dissemination of

science; and it opposes ahistorical epistemologies that attempt to exert normative dominance based in an explicit or tacit universal rationality. All of this adds epistemic and philosophical value to the history of science.

Knowledge agents are active constructors in the process of reception, and so there is always some form of normativity with which they can read, evaluate and make received knowledge productive. Reception Aesthetics enables this level of analysis and provides the specific means by which to carry it out, introducing a historicity that is impeded by the usual overgeneralizations of mainstream philosophical approaches. Correspondingly, Standpoint Theory is open to such historicization and provides intellectual tools and approaches to analyze the production of knowledge from the specific experiences of the agents involved.

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References

Anderson, E. (2004). Uses of Value Judgements in Feminist Social Science: A Case Study of Research on Divorce. *Hypatia, 19*(1), 1-24. doi: http://dx.doi.org/10.1111/j.1527-2001.2004.tb01266.x

Bachelard, G. (1938/2002). *The Formation of the Scientific Mind*. Manchester: Clinamen.

Barrancos, D. (2010). *Mujeres en la sociedad Argentina. Una historia de cinco siglos*. Buenos Aires: Sudamericana.

Beer, G. (1990). Translation or Transformation? The Relations of Literature and Science. *Notes and Records of the Royal Society of London, 44*(1), 81-99. Retrieved from http://www.jstor.org/stable/531587

Benjamin, W. (1969). *Illuminations. Essays and Reflections*. New York, NY: Schocken.

Bernstein, R. J. (2002). The constellation of Hermeneutics, Critical Theory and Deconstruction. In R. Dostal (Ed) *The Cambridge Companion to Gadamer* (pp. 267-282). New York, NY: Cambridge University Press.

Braslavsky, B. (1952). *Positivismo y antipositivismo en la Argentina*. Buenos Aires: Procyon.

Braslavsky, B. (1962/1992). *La querella de los métodos de enseñanza de la lectura*. Buenos Aires: Kapeluz. (Original work published 1962)

Braslavsky, B. (1991). *La escuela puede. Una perspectiva didáctica*. Buenos Aires: Aiqué.

Braslavsky, B. (1996). *Testimonios para la experiencia para enseñar*. Buenos Aires: Secretaría de Cultura y Bienestar Universitario de la Facultad de Psicología, Universidad de Buenos Aires.

Braslavsky, B. (2008). *La educación achica las diferencias*. Buenos Aires: Capital Intelectual.

Chartier, R. (1994). *The Order of Books: Readers, Authors, and Libraries in Europe Between the 14th and 18th Centuries*. Stanford, CA: Stanford University Press.

Darnton, R. (1982). What Is the History of Books? *Daedalus, 111*(3), 65-83. Retrieved from http://www.jstor.org/stable/20024803

Daston, L. (1994). Historical epistemology. In J. Chandler, A. I. Davidson, & H. Harootunian (Eds.), *Questions of evidence* (pp. 282-289). Chicago, IL: University of Chicago Press.

Daston, L. & Galison, P. (2007). *Objectivity*, New York: Zone Books.

Dear, P.; Hacking, I.; Jones, M., Daston, L. & Galison, P. (2012). Objectivity in historical perspective. *Metascience, 21*(1):11-39. doi: http://dx.doi.org/10.1086/587536

Dotti, J., Blanco, A., Plotkin, M. Vezzetti, H. & García, L. I. (2008). Dossier: La Historia Intelectual y el problema de la recepción. *Políticas de la memoria, 8/9*, 98-109. Retrieved from http://www.cedinci.org/PDF/PM/PM_8-9%20compilada.pdf

Eagleton, T. (1983/2011). *Literary Theory: An Introduction. 2nd Revised Edition*. London: Wiley-Blackwell.

Engels, E-M. & Glick, T. (Eds.) (2008). *The Reception of Charles Darwin in Europe. Volume I*. London: Continuum.

Fleck, L. (1935/1979). *The Genesis and Development of a Scientific Fact*. Chicago, IL: University of Chicago Press.

Galison, P. (2008). Ten problems in history and philosophy of science. *Isis, 99*(1), 111-124. doi: http://dx.doi.org/10.1086/587536

Gao, Z. (2015). Pavlovianism in China: Politics and differentiation across scientific disciplines in the Maoist era. *History of Science, 53*(1) 57-85. doi: http://dx.doi.org/10.1177/0073275314567436

García, L. N. (2014a). Biologising psychoanalysis. Konstantin Gavrilov and freudopavlovism in Argentina (1942-1960). Psychoanalysis and History, 16(2), 215-236; doi: http://dx.doi.org/10.3366/pah.2014.0151

García, L. N. (2014b). Henri Wallon en castellano: jalones argentinos de un itinerario transnacional (1935-1976). *Universitas Psychologica, 13*(5), 1835-1845. doi:

http://dx.doi.org/10.11144/Javeriana.upsy13-5.hwcj

García, L. N. (2015). La psiquiatría comunista argentina y las psicoterapias pavlovianas: propuestas y disputas (1949-1965). *Trashumante. Revista Americana de Historia Social, 3*(5), 220-243. doi: http://dx.doi.org/10.17533/udea.trahs.n5a11

García, L. N. (2016a). Before the "boom": Readings and uses of Vygotsky in Argentina (1935-1974). *History of Psychology, 19*(4), 298-313. doi: http://dx.doi.org/10.1037/hop0000046

García, L. N. (2016b). *La psicología por asalto. Psiquiatría y cultura científica en el comunismo argentino (1935-1991)*. Buenos Aires: Edhasa.

Grompone, M., Guadalupe, E., Quiros, J., Della Cella, M., Escuder, E., Lorenzo, E., . . . Tuana, E. (1965). *Actas y trabajos sobre el I seminario sobre dislexia*. Montevideo: Sociedad de Dislexia del Uruguay.

Hahn, H., Carnap, R. & Neurath, O. (1929/1996). The Scientific Conception of the World. In S. Sarkar (Ed.) *The Emergence of Logical Empiricism: From 1900 to the Vienna Circle* (pp. 312-340). New York, NY: Garland.

Harding, S. (1986). *The Science Question in Feminism*. Ithaca, NY: Cornell University Press.

Harding, S. (1996). Rethinking Standpoint Epistemology: What is 'Strong Objectivity'? In E. Fox Keller & H. Longino (Eds.) *Feminism & Science* (pp. 235-248), New York, NY: Oxford University Press.

Harding, S. (2006). *Science and social inequality. Feminist and Postcolonial Issues*, Chicago, IL: University of Illinois Press.

Harding, S. (2011). Introduction. Beyond Postcolonial Theory: Two Undertheorized Perspectives on Science and Technology. In S. Harding (Ed.) *The Postcolonial Science and Technology Studies Reader* (pp. 1-31). Durham, NC: Duke University Press.

Harding, S. (2015). *Objectivity and Diversity. Another Logic of Scientific Research*. Chicago, IL: University of Chicago Press.

Harris, B. (1995). The Benjamin Rush Society and Marxist psychiatry in the United States (1944-1951). *History of Psychiatry, 6*(23), 302-331 http://dx.doi.org/10.1177/0957154X9500602303

Hartsock, N. (1985). *Money, sex and power. Toward a feminist historical materialism*. Boston, MA: Northeastern University Press.

Hartsock, N. (1997). *The Feminist Standpoint Revisited and Other Essays*. Boulder, CO: Westview Press.

Heilbron, J., Guihot, N., & Jeanpierre, L. (2008). Toward a Transnational History of the Human Sciences. *Journal of the History of the Behavioral Sciences, 44*(2), 146-160. doi:

http://dx.doi.org/10.1002/jhbs.20302

Hohendahl, P. U. (1977). Introduction to Reception Aesthetics. *New German Critique, 10*, 29-63. doi: http://dx.doi.org/10.2307/487671

Holmes, F. L., Renn, J. & Rheinberger, H. (2003). *Reworking the Bench: Research Notebooks in the History of Science*. Dordrecht. Kluwer Academic Publishers.

Gissis, S. &. Jablonka, E. (Eds.) (2011). *Transformations of Lamarckism. From Subtle Fluids to Molecular Biology*. Cambridge, MA: The MIT Press.

Jameson, F. (1988/2004). *History and Class Consciousness* as an "unfinished project". In S. Harding (Ed.) *The Feminist Standpoint Theory Reader: Intellectual and Political Controversies* (pp. 143-151). New York, NY: Routledge.

Jauss, H. R. (1970/2000). *Historia de la literatura como provocación*. Barcelona: Península.

Jauss, H. R. (1975). The Idealist Embarrassment: Observations on Marxist Aesthetics. *New Literary History, 7*(1), 191-208. doi: http://dx.doi.org/10.2307/468285

Kincaid, H., Dupré, J. & Wylie, A. (Eds.) (2007). *Value free science? Ideals and illusions.* New York, NY: Oxford University Press.

Kosik, K. (1963/1976). *Dialectics of the Concrete: A Study on Problems of Man and World.* Dordrecht-Boston: D. Reidel.

Kreimer, P. (2010). *Ciencia y Periferia. Nacimiento, muerte y resurrección de la biología molecular en la Argentina*. Buenos Aires: Eudeba.

Kuhn, T. (1983). Rationality and Theory Choice. *The Journal of Philosophy, 80*(10), 563-570.

Lambe, J. L. (2017). Revolutionizing Cuban Psychiatry: The Freud Wars, 1955-1970. *Bulletin of the History of Medicine, 91*(1), 62-93. doi: http://dx.doi.org/10.1353/bhm.2017.0003

Lukács, G (1971). *History and Class Consciousness: Studies in Marxist Dialectics*. Cambridge, MA: The MIT Press.

Marx, K. (1857/1993). *Grundrisse. Foundations of the Critique of Political Economy*. London: Penguin.

Marx, K. & Engels, F. (1846/1998). *The German Ideology*. Amherst, NY: Prometheus.

Miranda, M. & Vallejo, G. (Comps.) (2005). *Darwinismo social y eugenesia en el mundo latino*. Buenos Aires: Siglo XXI.

Metzger, H. (1987). *La méthode philosophique en histoire des sciences. Textes 1914-1939*. Paris: Fayard.

Moretti, F. (Ed.) (2006). *The Novel. History, Geography, and Culture*. Princeton, NJ: Princeton University Press.

Raj, K. (2013). Beyond Postcolonialism… and Postpositivism: Circulation and the Global History of Science. *Isis, 104*(2), 337-347. doi: http://dx.doi.org/10.1086/670951

Renn, J. (1996). *Historical epistemology and the advancement of science*. Berlin: Max-Planck-Institut für Wissenschaftsgeschichte. Retrieved from http://www.mpiwg-berlin.mpg.de/Preprints/P36.PDF

Rheinberger, H. (2010). *On Historicizing epistemology: an Essay*. Standford: Stanford University Press.

Ruetsche, L. (2004). Virtue and Contingent History: Possibilities for Feminist Epistemology. *Hypatia*, 19(1), 73-101. doi: http://dx.doi.org/10.1111/j.1527-2001.2004.tb01269.x

Ruiz, G. & Sánchez, N. (2016). W. Horsley Gantt, Nick, and the Pavlovian Science at Phipps Clinic. *The Spanish Journal of Psychology, 19*, 1–14. doi: http://dx.doi.org/10.1017/sjp.2016.73

Secord, J. (2004). Knowledge in transit. *Isis, 95*(4), 654-72. doi: http://dx.doi.org/10.1086/430657

Sturm, T. (2011). Historical Epistemology or History of Epistemology? The Case of the Relation between Perception and Judgment. *Erkenntnis, 75*(3), 303-324. doi: http://dx.doi.org/10.1007/s10670-011-9338-3

Thompson, M. (1993). Reception Theory and the Interpretation of Historical Meaning. *History and Theory, 32*(3), 248-272. doi: http://dx.doi.org/10.2307/2505525

Todes, D. (2000). *Ivan Pavlov. Exploring the animal machine*. New York, NY: Oxford University Press.

Todes, D. (2014). *Ivan Pavlov. A Russian Life in Science*. New York, NY: Oxford University Press.

Turchetti, S., Herran, N. & Boudia, S. (2012). Introduction: have we ever been 'transnational'? Towards a history of science across a beyond borders. *The British Journal for the History of Science, 45*(3), 319-336. doi: http://dx.doi.org/10.1017/S0007087412000349

Vezzetti, H. (1996). *Aventuras de Freud en el país de los argentinos*. Buenos Aires: Paidós.

Vincent, B (2003). In the Name of Science. In J. Krige & D. Pestre (Eds.) *Companion to Science in the Twentieth Century* (pp. 319-338). London: Routledge.

Wieviorka, M, Burguière, A., Chartier, R., Farge, A. & Vigarello, G. (1998). The work of Norbert Elias: Its contents and its reception. *Thesis Eleven, 54*(1), 89-103. doi: http://dx.doi.org/10.1177/0725513698054000008

Woessner, M. (2011). *Heidegger in America*. New York, NY: Cambridge University Press.

Women's International Democratic Federation (1949). *Second Women's International Congress*. Paris: Women's International Democratic Federation.

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Ontology Interrupted:
Prigogine, Stengers and the Abdication of Physics

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Abstract

The work of physicist Ilya Prigogine has exposed a radical asymmetry at the heart of physics: different mathematical conceptualisations of the same problem produce *equally valid but not equivalent* representations of matter and the universe. This article examines the philosophical implications of this asymmetry, proposing that the impact of Prigogine's methodological innovation cannot be constrained within the epistemological perimeter but explodes into an ontological problem that brings a challenge to the image of philosophy in its entirety. The argument departs from Isabelle Stengers' position, who – both as Prigogine's collaborator and independently – has interpreted this non-equivalence of the syntax of physics' formulations via the Deleuzean notion of counter-actualisation, and has entrusted philosophy with the task of speculating upon this epistemological divergence as an ontological problem. It will suggest instead that the local asymmetry shown by Prigogine's inside the practice of physics bars the convergence of physics and philosophy onto one onto-epistemological ultimate. It will show in detail how these impossibility and finitude cannot be considered as the object of ontological investigation, but have instead an impact on ontology's very logic. That is, they radically disrupt the hierarchy still implied in the distinction between language and matter, demanding that philosophy abandons any claim of acting as a meta-discourse for science and instead conceives of itself and of its task as a practice.

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Prigogine and Stengers

The study of dissipative structures developed by physicist Ilya Prigogine, exposes a radical *asymmetry* at the heart of physics. Seeking to reconcile the incompatibility of dynamics with the second law of thermodynamics, through a reconceptualisation of the problem via statistical mechanics, Prigogine demonstrated that the symmetry between the present and the boundary conditions, as inherited from the formulations of Newton and Hamilton, is the product of an arbitrary idealization.[2] The discovery that large dynamic systems are *non-integrable* (that is, irreducible to a finite set of independent and self-sufficient elements from which the evolution of the system could be predicted) makes them open to more than one possible solution for the same initial conditions and therefore temporally asymmetric.[3] This bars any form of reducibility of the present to an initial state, and raises questions for the epistemological abstraction towards the intelligible unity of the real, as well as the transition towards the image of an ontological ultimate.

Prigogine addressed this problem in collaboration with Isabelle Stengers.[4] The question they raise revolves around the epistemological presuppositions

[2] For a detailed and technical exposition of dissipative structures and self-organisation Cf. Grégoire Nicolis and Ilya Prigogine, *Exploring Complexity; an Introduction*, (New York, NY: Freeman and Company, 1998).

[3] Prigogine developed the notion of non-integrability, which was first formulated by Henri Poincaré regarding the calculation of the famous 'three-body problem'. From this, Prigogine built his problem articulating the interpretation of entropy and temporality through a statistical formulation, instead of accepting the notion of a finite and weak observer that was adduced to explain them within the classical framework.

[4] Ilya Prigogine and Isabelle Stengers co-authored two major works on the reconceptualization of physics that leads to complexity theory: *Order out of Chaos, Man new Dialogue with Nature* (London: Harper-Collins, 1984) and *Entre le Temps et l'Éternité*, (Paris: Fayard, 1988), (Between Time and Eternity). It must be noted that *Order out of Chaos* (originally titled *La Nouvelle Alliance*, 1979) was considerably reworked by the authors in occasion of the English translation, to update the conclusions to the new findings at both theoretical and experimental level. The version referred to here is the English translation. *Entre le Temps et l'Éternité* instead has not been translated into English. The article refers to the Italian translation: Cf. Ilya Prigogine and Isabelle Stengers *Tra il Tempo e L'Eternità*, trans. Carlo Tatasciore (Torino: Bollati Boringhieri, 2014). A considerably reworked version of this text, reflecting the "important progress in the mathematical formulation of our approach" was published in English authored by Prigogine alone (Stengers appears only as a collaborator), Cf. Ilya Prigogine, *The End of Certainty, Time, Chaos and the New Laws of Nature* (New

implicit in the mathematical formulations at play in structuring the world as represented by equivalences, thus taking the question to the root of the image that physics has projected of matter, nature, and of itself.[5]

The problem this poses is twofold. On the one hand, non-integrability reveals an empirical impossibility internal to physics. Prigogine demonstrated that in systems far from equilibrium there exist conditions where chronological reducibility – albeit ideal – is not possible and the idealised trajectory of dynamics must be replaced for probability as the primary unit of physics (in fact this is the case for most systems). This amounts to the impossibility of *convergence* onto one totalising description, leading to an epistemological impasse that coincides with the demise of the a priori space of consistency shown by Gödel's incompleteness.[6] On the other, this marks a much broader and more disruptive asymmetry. Crucially, as Stengers emphasises, the fact that the demonstration of non-integrability is built by adopting an alternative mathematical model (statistical mechanics) exposes a *divergence* at

York, NY: The Free Press, 1996), VII. Since *Entre le Temps et l'Éternité* highlights epistemological issues that in the *End of Certainty* leave the precedence to more technical, but no less important information: both texts appear here as separate works. Comparing the French and the English versions of Stengers' *Cosmopolitics,* it becomes evident that this work has also undergone the same process of manipulation while translated from French to English, reflecting the evolution and refinement of Stengers' thought. The differences, however, are minor and do not justify referring to both versions. The article will therefore refer only to the English translation. Cf. Isabelle Stengers, *Cosmopolitics*, Vol.1 and 2, trans. Robert Bononno (Minneapolis, MN: University of Minnesota Press, 2010).

[5] This equivalence, they claim, is intrinsic to the mathematical syntax adopted in the conceptualisation of natural processes. In the formulation of mechanics that Hamilton developed from Newton, the boundary conditions and the present were conceptualised as the two terms of an equation balancing on the "=" equal sign. This implied that any moment or point in the evolution of the system had to be equivalent and therefore reducible to the initial boundary conditions, thus making the process reversible and producing a clash with the necessity of entropy stated by the second law of thermodynamics. Temporality, organization, as well as life and knowledge, would be nothing but the by-products of finite approximations - illusions. A perfect measurement instead, albeit only ideal, would in principle allow both logical and temporal reversibility. Cf. Stengers, "In The Name of The Arrow of Time: Prigogine's Challenge," *Cosmopolitics*, Vol.2, 105-204.
Moreover, for Prigogine this problem is not limited to dynamics but persists also in quantum mechanics: "From the point of view defended by Ilya Prigogine, dynamics and quantum mechanics are both equally unsatisfactory, for one reduces the difference between past and future to the imperfection of our understanding, and the other to the act of measurement, or the act of awareness." The reconceptualisation proposed by Prigogine involves both branches of physics and shows that temporal irreversibility is intrinsic to matter at both levels. Cf. Stengers, *Cosmopolitics*, Vol.2, 101.

[6] Cf. Kurt Gödel, *On Formally Undecidable Propositions of Principia Mathematica and Related Systems*, trans. B. Meltzer (Mineola, NY: Dover Publications, 1992); and Ernest Nagel and James R. Newman, *Gödel's Proof* (New York, NY: New York University Press, 1986).

ontological level: different mathematical formulations of the same problem produce *equally valid but not equivalent* representations of reality.[7] This divergence turns the binary paradigm that shapes the question of knowledge along the dimensions of an object 'in itself' versus to an object 'for us' inside out, bringing to the fore an ontological asymmetry that pivots on the relevance of the methodology adopted for the conceptualisation of the problem and the syntax through which it is formulated.

For Stengers, this non-equivalence challenges certainty and the absolute legitimacy of scientific claims, in favour of more delicate claims of *validity*.[8] Indeed, in Prigogine's work physics is found grappling with diverging images of matter, where different conceptualizations can coexist.[9] While this does not entail a dualistic opposition but recasts the problem in terms of compatibility between heterogeneous models, nevertheless the authority that universality lends to the claims of physics becomes precarious. As Stengers points out, Prigogine's work has left science in a *fragile* state where with universality also the paradigm of certainty, the principle of identity and determinism have lost the authority necessary to support truth claims.[10] The non-equivalence deriving from Prigogine's reconceptualisation therefore becomes an ontological problem that forces physics to *abdicate* and to *withdraw* the universal claims it attaches to its objects. Indeed, this fragility goes as far as to affect the continuity postulated by ontology between the present and the ultimate. In other words, as certainty is the epistemological expression of the absolute, fragility is the epistemological expression of incompleteness, the irreducibility to the *same* of incommensurable descriptions produced by the very syntax of representation.

Stengers addresses this ontological asymmetry following Deleuze and Guattari. Developing a new concept for the problem of non-equivalence emerging

[7] Cf. Prigogine and Stengers, "The Identification of the Real," in *Order out of Chaos*, 57-78 and Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1, 1-83.

[8] A position closer to contemporary physics than absolute certainty and able to include quantum mechanics would be d'Espagnat's notion of "weak objectivity," which nevertheless remains within the perimeter of the possibility of thinking an ultimate object of knowledge that is challenged here. Cf. Bernard d'Espagnat, *On Physics and Philosophy,* (Princeton: Princeton University Press, 2006), 320-323; and Stengers, Cosmopolitics, Vol.2, 142-159 and 427n6.

[9] Cf. Grégoire Nicolis and Ilya Prigogine, "Prologue: Science in an Age of Transition," in *Exploring Complexity*, 1-3.

[10] Cf. Stengers, *Cosmopolitics*, Vol.1, 1-13.

from the *practice* of physics – she suggests – is the *speculative* task of philosophy.[11] This article wants to pause Stengers' interpretation and focus instead on the tension between the local impossibility exposed by non-integrability and the general openness of non-equivalence. It will look at the consequences that the demise of an absolute language (mathematic or otherwise) has for the relationship between physics and ontology and the position they claim. This seems all the more relevant as the speculative path chosen by Stengers appears at risk of contradicting her very admonition against seeking a universal meta-language able to represent the heterogeneity of contingent and historical events. To understand how this problem unfolds in Prigogine and Stengers' work, it is necessary to unravel some folds of their argument in detail.

Not a new universality

The demonstration of non-integrability operated by Prigogine does not introduce a new truth. Irreversibility does not constitute a new universal, and irreducibility must not be grasped as a fundamental truth regarding the real.[12] The heterogeneity of chaotic behaviours studied by Prigogine cannot be unified into a continuous and homogeneous ontological description.[13] The universe is instead open and plural (some regions of the universe are reversible and symmetric, while most are not).[14] The openness that Prigogine revealed results from a demonstration of impossibility where the image of physics is undone without being rebuilt in any new solid way. This crucial point pivots on the fact that the demonstration is developed inside physics, rather than from a third Archimedean point external and neutral. This has an immediate effect also for ontology: Prigogine and Stengers emphasize how "there is no longer any universally valid law from which the overall behaviour of the

[11] For the task of philosophy referred to here Stengers follows closely the discussion of science and philosophy proposed in *What Is Philosophy*. Cf. Isabelle Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki* 10 no. 2 (2005): 151-167.

[12] Cf. Prigogine and Stengers *Order out of Chaos*, 285; and Prigogine and Stengers, *Tra il Tempo e L'Eternità*, 139.

[13] Prigogine was very clear about this: "the fact that there are bifurcations everywhere does not constitute a continuity." Cf. 22nd *Solvay Conference* held in Delphi, Greece, November 24-29, 2001. Last modified April 29, 2011, accessed on June 6, 2016, https://www.youtube.com/watch?v=MnD0IlBvgO4.

[14] Cf. Prigogine and Stengers, *Order out of Chaos*, 257.

system can be deduced. Each system is a separated case."[15] This loss constitutes a severance with the modern paradigm of thought. Eliminating the three key concepts of *universality*, *law* and *deduction,* which upheld a linear image of ontology, drags identity as well as the authority of concept (as the definition and a priori perimeter of the present) into the collapse and leaves an open gap in the boundary of the system. In fact, the processes of emergence described by Prigogine cannot be idealised outside their local heterogeneity or be thought without the openness of their temporal horizon. Not only the law emerges as local and heterogeneous, but its emergence also requires site-specific forms of negotiation to assert itself where conditions allow it. Yet, these conditions are unable to necessitate the event of emergence. Thus the last victim of Prigogine's reconceptualisation is the notion of *necessity* associated with the notion of law.[16] Fragility undermines the image of physics as the model with which all other forms of knowledge should comply. The scientific fact displays a peculiar form of coherence, a truth that does not "transcend history," but one that can only be constructed "within history." Physicists, Stengers writes, "have lost any theoretical argument for claiming any privilege, whether of *extraterritoriality* or precedence;" that is, any privileged access to truth.[17]

Non-equivalence as Counter-actualisation

Then, one should ask what did Prigogine and Stengers demonstrate if their results do not constitute a new universal truth. Fragility must not be grasped as a failing of physics overcome by relativism. Stengers interprets the problem of non-equivalence through a Deleuzean prism. The loss of absolute legitimacy marks a movement of *counter-actualisation*: the divergence from the state of affairs accepted as real in conjunction with the emergence of the possibility of other models for thought and other methods that allow matter to speak. This casts the epistemological problem of representation in the light of the actual-virtual regime proposed by Deleuze (the

[15] Cf. Prigogine and Stengers, *Order out of Chaos,* 144-145.

[16] On this loss of *necessity* of the law Cf. John Holland, "Closing," in *Emergence, from Chaos to Order* (New York: Basic Books, 1998), 221-248; and Stengers, "The Law of Chaos?" in *Cosmopolitics*, Vol.2, 176-191.

[17] Cf. Stengers, *Cosmopolitics*, Vol.1, 3.

syntax of the conceptualisation acts as a differentiator for the ontological horizon of the possible).[18]

What is more, for Stengers, the rationality that sciences deploy as their absolute authority is established "polemically," projecting as the other of science, not only myth and the dogma of religion, but also, most importantly, other possible methods of measurement able to claim that their facts are also valid. In this sense for Stengers there is no distinction between physics and other sciences, as they all present themselves as the true language that can speak on behalf of nature and condemn the rest as opinion. In this light, for Stengers, the experiment that confers authority to physics through the invention of the mathematical representation of matter and its behaviours is an *event* where the possibility of measurement "brings a new Being into existence."[19] Not only is it the case that truth claims are dependent on the syntax that pronounces them, but the practice of physics expresses an intrinsic creativity where the epistemological problem of method becomes an ontological question of existence.[20] Stengers describes this event as a *factish*; not a fact nor illegitimate like a fetish, but the "truth of the relative" (which is not the same as the relativity of truth) championed by the new figure of the "non relativist

[18] Stengers refers directly to Deleuze and to Deleuze and Guattari, in particular to the figure, or psycho-social type, of the "idiot" (Dostoyevsky's *Idiot*) and the move to counter-effectuate the order of things that this type engenders; Cf. Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki*, 151-167. Cf. also Deleuze's analysis of Melville's character *Bartelby*, Cf. Gilles Deleuze, "Bartelby, Or The Formula," in *Essays Critical and Clinical*, trans. Daniel W. Smith and Michael A. Greco (London: Verso, 1998), 68-90. For the concept of actualisation and counter-actualisation at the centre of Deleuze's thought, Cf. Gilles Deleuze, "Twenty-First Series of the Event," in *The Logic of Sense*, ed. Constantin V. Boundas, trans. Mark Lester and Charles Stivale (London: Continuum, 2004), 169-175; and Gilles Deleuze and Felix Guattari, *What Is Philosophy*, trans. Graham Burchell and Hugh Tomlison (London: Verso, 2011). It must be noted that Stengers had developed a dialogue with Deleuze and Deleuze and Guattari's thought throughout her career. The Deleuzean notion of event provided the conceptual key for the organization of *Tra il Tempo e l'Eternità*, *The Invention of Modern Science* and *Power and Inventions*. In turn, Deleuze and Guattari in *What is Philosophy* make direct reference to the notion of chaos as presented in Prigogine and Stengers' *Tra il Tempo e l'Eternità*. Lastly, the interpretation of chaos as ontological horizon put forth in *What is Philosophy* is again adopted by Stengers in *Cosmopolitics*.

[19] Cf. Stengers, *Cosmopolitics*, Vol.1, 32; and Isabelle Stengers, "Construction," Science Under the Sign of the Event," in *The Invention of Modern Science*, trans. Daniel W. Smith (Minneapolis: University of Minnesota Press, 2000), 555-108.

[20] Cf. Stengers, "Scientific Passions" and "Culturing the Pharmakon," in *Cosmopolitics*, Vol.1, 1-13 and 28-41. It must be noted that as this issue is one of method rather than degrees of precision, it is no longer simply a Newtonian problems of approximations, but it both includes quantum mechanics and extends from physics to the entirety of science.

sophist."[21] This expresses a *constructive* logic that for Stengers replaces both determinism and relativism.[22] Accepting that the factish is true only within the domain of validity of the method of measurement that has brought it into existence (instead of expecting a universal language that can represent absolute reality) is the counter-actualisation of the image of science that Stengers sees in Prigogine's reconceptualisation.

Indeed, introducing Stengers' work Bruno Latour emphasises that her focus is ontology, rather than an argument developed within the limits of philosophy of science.[23] It is, however, a peculiar path into ontology because it stems from the obstacles encountered by physics in picturing the world according to one paradigm whose image is the homogeneity of universal convergence. The asymmetry discovered by Prigogine is the expression of a finitude intrinsic to the unit of measurement and marks an impossibility internal to physics and its mathematical models that impacts on representation in general. This is why Latour emphasises that for Stengers the non-homogeneity of the image of nature encountered by physics is a direct ontological problem. As he explains, the problem is not the epistemological opposition between a good and a bad practice of science, that of a language or a method that has misinterpreted the real, rather it stems from the intrinsic limits of the measurement that produces the scientific fact. Limits that do not simply frame the object of knowledge as the conditions of experience for the Kantian phenomenon (space and time), but structure both the object and the questions it can pose. Indeed, casting the problem of the legitimacy of truth statements including the socio-political reception of such claims (as Stengers does following Latour) the problem of knowledge is no longer unfolding between an object 'in itself' and an object 'for us,' rather it becomes the question of an argument, or event, "able to dictate its own reasons;" one which moves from the syntax of the practice (or "middle", as Stengers writes, echoing Deleuze and

[21] The source of the notion of *factish* is Bruno Latour. Stengers develops it emphasising a materiality in the syntax and the practice of science, whose relevance for the production of knowledge becomes pivotal. Cf. Bruno Latour, "On the Cult of the Factish Gods," in *On The Modern Cult of The Factish Gods*, trans. Catherine Porter and Heather MacLean (Durham, NC: Duke University Press, 2010), 1-66.

[22] How this construction is not a solipsistic projection but a coherent logic is the focus of the entire first book of *Cosmopolitics*; Cf. Stengers, "The Science Wars," in *Cosmopolitics*, Vol.1. 1-83.

[23] Cf. Bruno Latour, "Foreword," in Isabelle Stengers, *Power and Inventions; Situating Science*, trans. Paul Bains (Minneapolis, MN: University of Minnesota Press, 1997), vii-xix.

Guattari), rather than the extremes (observer or the object).[24] It is legitimized not by the vertical roots of proper names between language and objects, but thanks to the horizontal links established in the circulation among other scientists. Nevertheless, this does not entail the collapse of epistemology entrusting the validity of scientific claims to mere sociological relations. Instead, the question shifts from one of representation and truth, to one regarding the relevance of truth claims and their methods.

This alternative brought a challenge to the notion of the universality of mathematical representation, nevertheless, Prigogine's theory -in spite of being rewarded with the Nobel Prize in 1977- has not been embraced by physicists. Physics has continued to operate inside the existing paradigm of ideal intelligibility undisturbed, disqualifying Prigogine's demonstration as an invalid method.[25] The counter-actualisation of the unique and universal method of measurement then for Stengers becomes an act of *resistance* against the rule of one interpretation (or indeed actualisation) that imposes itself not as the most successful but as the only rational one.[26] With the non-equivalence of practices the problem has shifted from questioning the truth of a claim to the authority that can support the claim. In this light, non-equivalence for Stengers will require an "ecology of practices," a "parliament" populated by "diplomats" that do not attempt to foreclose problems by imposing a universal convergence onto a uniform truth, disqualifying other possibilities as irrational and therefore non-scientific, but keeping the possibility of counter-actualisation open.[27] However, and this is the delicate but crucial point this article wants to highlight, Stengers entrusts this counter-actualising move of resistance to philosophy only, as the discipline which alone can create concepts, thus giving philosophy the task to articulate this epistemological divergence through

[24] Cf. Stengers, in "Science Under the Sign of the Event," in *The Invention of Modern Science*, 71-88; and Stengers, "Deleuze and Guattari's Last Enigmatic Message," *Angelaki*, 151-167.

[25] Stengers comments that the scientific community has remained indifferent to Prigogine's proposal. The incorporation of probability in the fundamental description of dynamics, Stengers says, can be welcomed only among "friends" who would already be disposed to listen. Cf. Stengers, "The Arrow of Time," *Cosmopolitics*, Vol.2, 116-122.

[26] Cf. Stengers, *Cosmopolitics*, Vol.1, 1-13; and Isabelle Stengers "Wondering About Materialism," in Levi Bryant, Graham Harman, and Nick Srnicek eds. *The Speculative Turn, Continental Materialism and Realism*, (Melbourne: re.press, 2011), 368-380.

[27] Cf. Stengers, "The Curse of Tolerance," in *Cosmopolitics*, Vol.2, 303-416.

an ontological speculation.[28] This makes her argument vulnerable to be recaptured by metaphysics. If the practice of physics is opaque and the conceptualisations it constructs creative rather than purely representational, thought on the other hand is still endowed with the ability to transcend the heterogeneity of the practice of science and act as a meta-language, the discourse that can see and name the real in all its kaleidoscopic manifestations. This risks hollowing the practice of science and the very move that Stengers proposes, obscuring the relevance of its syntax and expropriating it of the products of its creativity. Instead, as will be seen next, the tension between incompleteness and non-equivalence complicates counter-actualisation, pushing it towards a stalling point.

Finitude

The initial claim of Prigogine and Stengers had played within the traditional paradigm of positive science, announcing the discovery of a new theory that, if it did not want to claim the status of a new universal law, was nevertheless a new conceptualization that aspired to replace the image that physics, modelled on the integrability of dynamics, presented of itself and of matter. Indeed, the possibility shown by Prigogine of another platform for conceptualising physics introduces an irremediable fissure in the accepted homogeneity of the claims of science, a non-equivalence where the "laws of physics" are not the same as the "laws of nature."[29] The law, the phenomena it rules, and the image it dictates are in fact built on what Stengers describes as a physico-mathematical fiction.[30] However, the demonstration of non-integrability via statistical mechanics constitutes a peculiar kind of proof. In fact, it is just the proof of the existence of an alternative possibility, a *there exists at least one instance* ('∃' in formal language) where dynamics is not integrable, and therefore not reversible and not representational. It is this proof of existence, or proof of possibility where the symmetry of dynamics' reversible processes is shown as a special case in an asymmetrical and irreversible universe. However, the

[28] Cf. Stengers, "Deleuze and Guattari Last Enigmatic Message," 151-167.
[29] Cf. Stengers, *Cosmopolitics,* Vol.2, 201.
[30] Cf. Stengers, "The Laws of Chaos?" in *Cosmopolitics, Vol.2*, 160-175.

demonstration that there exists at least one instance where the universal statement is not the case is not an encounter with an external barrier, a perimeter that defines what is possible and what is not possible, but a positive affirmation generated inside the system. That is, while the new claim is not pronounced absolutely, it marks the emergence of a new set of constraints that define the dimensions along which the system can evolve.

In other words, the impossibility to integrate that leads to irreducibility is not obtained through a demonstration of *reductio ad absurdum*, which would still imply the knowledge of an a priori totality where all options but one are barred. It is a demonstration that undoes the authority of certainty, rather than proving a new certainty. Both Gödel's incompleteness and Prigogine's non-integrability express a finitude that could be overcome with a greater expenditure of information/energy.[31] But if consistency in Gödel's case can be proved only on the ground of a more powerful system (that is externally), therefore entering a regression to infinity (another more powerful system would be necessary to ground the first one, and so on), with non-equivalence, as Stengers highlights, such finitude is revealed as intrinsically creative; it marks the pattern upon which the coherence of the system is possible. The openness of non-equivalence allows the emergence of alternative and yet compatible possibilities where statistical mechanics does not provide a firmer ground, sublating the current system and linearly expanding the existing space of consistency. Rather, it generates an 'elsewhere' outside the linearity still implicit in Gödel's problem, departing from the issue of identity altogether.

It is particularly important to grasp the import of the source of the impossibility demonstrated by Prigogine. It is by proving non-integrability from *inside* dynamics, rather than bringing a new counter-factual proof from a position external to the discourse it is acting upon, that Prigogine induces the counter-actualisation of the very discourse of dynamics. Indeed, what is relevant in Prigogine's work is a demonstration in a way more modest than the heroic claims about the universe being *thus*. Prigogine simply shows that *something else is also possible*; that is, the current order is not absolute. This claim is gentle and yet it constitutes a counter-actualisation of the possibility of claiming absolute truth. At the same time this is a somewhat secularised form of counter-actualisation. One less interested in

[31] Cf. Gödel, *On formally Undecidable Propositions*; and Prigogine and Stengers, "Irreversibility – The Entropy Barrier," in *Order Out of Chaos*, 257-290.

engaging with the metaphysical problem of reaching the ontological horizon or virtual limit (as Stengers' adoption of Deleuzean counter-actualisation implies) and concerned instead with the materiality and potential relevance of local choices of syntax.

A strictly scientific problem of compatibility between two theories (dynamics and thermodynamics) has exploded, shattering the boundaries of science and the frame of epistemology, to impose itself as an unavoidable ontological question. Absolute or universal claims are impossible, only finite configurations are admissible. The continuity required by ontology between the present and the ultimate is interrupted. The present is finite. Ontology is finite. Possibilities may be infinite, but cannot be unified in a continuity that would create a new ground or horizon; all configurations are local and heterogeneous, and no ultimate is possible.

Finitude is stated twice. Prigogine's reconceptualisation implies a move that is both passive and active. The impossibility of a local affirmation (incompleteness) implies the possibility of a multiplicity of positive alternatives in other incommensurable but compatible directions (ontological asymmetry), which requires a radically different approach to the problem of truth claims. One argument concerns the *object of physics*, the non-integrability of dynamic systems, and it is internal to the practice. The second, instead, concerns physics as a discourse and as an *ontological model*, and has an effect on the image that physics presents to the rest of the world, to the other discourses and practices, of linear rationality as the coherence that keeps the world together (or logic of sense). It is on the basis of this second argument that Stengers can build her interpretation of the fact of science as a constructivist event (or factish) that sees the object of science and the theory that describes it emerging simultaneously in a regime of "reciprocal capture."[32] However, this second onto-epistemological argument would not have been possible without the withdrawal imposed onto physics' universal claims by the possibility opened by the different mathematical representation developed by Prigogine.

Finitude, therefore, has a double fold: the possibility of a local plurality exposes the impossibility of a total unity; or, affirming the non-universality of the proof within physics exposes the counter-actualisation of epistemology and ontology. On the one hand, it prevents the image of an absolute object of

[32] Cf. Stengers, "Constraints" in *Cosmopolitics,* Vol.1, 42-55; and also *Cosmopolitics,* Vol.2, 196.

knowledge or thought from reaching a conclusion or being totalised; on the other, it does not allow language to claim the authority necessary for any form of absolute representation of such an object. The reductionist paradigm is thus under a double line of attack that prevents any form of ontological continuity towards the ultimate (whether as a reduction, abstraction, or state transition identifying the limit as a virtual horizon). Here lies the crux of the argument. This double fold complicates the counter-actualisation proposed by Stengers to the point of stalling, and effectively interrupting, its transition towards the plane of immanence of ontological difference. The fact that another conceptualisation is possible cannot and must not be ontologised as a new matrix for the emergence of sense. Any such attempts would amount to nothing but a new form of ultimate reduction posing divergence as the new ontological model.

Abdication and Withdrawal

It is necessary to pause here and listen to what fragility and finitude imply for the image of physics and its relation to ontology. As Prigogine and Stengers have explained, the heterogeneity and locality of chaotic behaviours demand that physics abstain from any claims of universal extraterritoriality.[33] The relevance of this point cannot be overemphasised. Prigogine's new proposal is a demonstration that does not *impose itself* but instead *exposes* a radical openness of physics and thought when concerning ontological claims. Yet, this is not to be interpreted as vulnerability; and certainly not as a subjective weakness of epistemological nature (a finite observer and the weak hermeneutics of approximation). Rather, it must be grasped as *metastability*, or metastable equilibrium of dissipative structures, whereby the transcendental is reinterpreted as a system that is open and whose boundaries are out of focus and flexible.[34] In other words, fragility means that physics is forced to withdraw the claims that capture all territories of knowledge and practices as

[33] "We believe that the epoch of certainties and absolute oppositions is over. Physicists have no privilege whatsoever to any kinds of extraterritoriality." Cf. Prigogine and Stengers, *Order out of Chaos*, 299.

[34] Metastable equilibrium is the logic of coherence of the *dissipative structures* that Prigogine had studied in thermodynamics. These are assemblages without a priori identity that last as long as an external flow of energy permits their internal processes to repeat. Cf. Grégoire Nicolis and Ilya Prigogine, *Exploring Complexity* Prigogine and Stengers, "The Science of Complexity," in *Order Out of Chaos*, 103-209.

deducible from dynamics. It is the notion of physics as the model science that loses its authority.[35] This amounts to an *abdication*. Yet, not in the sense of an impossibility of knowledge, rather this abdication concerns the *domain of validity* of physics and of each specific theory. It concerns the claim of totality that would supply a scientific support for idealisation both in and of ontology. Glancing at the long-range consequences of this reconceptualisation, it is possible to say that identity itself is metastable.

One of the arguments that runs through Stengers' *Cosmopolitics* is that physics is projected as the foundation for all sciences, thereby implying a linear reducibility of the macroscopic to the microscopic and implicitly demanding that the practice of other sciences not only do not contradict, but also be deducible from, physics. This axiomatic image of the laws of mechanics was also at the root of the problem of idealisation that Prigogine individuated between dynamics and thermodynamics, demanding that the latter comply with the former. At the same time, this reflects the notion of consistency that had provided a paradigm and a requirement for logic until Gödel disproved its universality. There is a parallel between this reduction of science to physics and proposing that ontology sits at the core of philosophy as the logic of *being qua being* (as abstracted and pure existence). Physics and ontology operate inside the same conceptual space. They are parallel in as much as they express the same logic of convergence, but this logic necessarily demands that they also converge onto the same ultimate, a vertex –moreover- towards which they would have a privileged access with respect to other scientific and philosophical questions. In turn this special position confers to their relationship an equally privileged status as the disciplines that can pose the ultimate question. Complexity brings a radical challenge to this convergence that ontology auspicates for itself and expects of physics, going as far as demanding a renegotiation of those critiques that already hoped to overcome a priori identity, as those moved by Heidegger and Deleuze, with particular emphasis on the re-interpretation the latter makes of sufficient reason.[36] This challenge, however, is not

[35] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 62-64. This non-deducibility of macroscopic sciences from Physics becomes particularly relevant for the notion of emergence in biology and is emphasised –for instance- by Stuart Kauffman's work on the notion of emergence in evolutionary biology. Cf. Stuart A. Kauffman, "The Nonreducibility of Biology to Physics," in *Reinventing the Sacred: A New View of Science, Reason, and Religion* (New York: Basic Books, 2010), 31-43.

an active attack to ontology's presuppositions; it does not aim at replacing the existing paradigm. Rather its passivity constitutes a *withdrawal*: physics pulls back, denies its participation; it no longer participates in ontology's essentialist logic of transition towards the ultimate. This is particularly relevant when reduction takes place in the subtlest manner, as when the undecidability encountered by quantum mechanics becomes the inspiration or the reference for the loss of foundations or ontological difference.

With non-integrability ontology becomes twice orphaned: first as the vertex on which they should both converge is deserted by physics, then of the legitimacy and authority that this overall convergence onto the ultimate would have provided. That is, first with regard to a smooth reduction of all events to fundamental elements (material or logical axioms); then, by being deprived of physics as its twin in the discourse of reduction. There, where ontology expects a confirmation or a partner for the transition to the ultimate, physics is no longer available for support; it does not converge with ontology onto a common sense. By challenging convergence as the site of their relationship, the fragility of science becomes also the fragility of ontology. With Prigogine's alternative possibility, physics de-territorialises the geography that the ontological paradigm of consistency and commensurability had laid out for it. This withdrawal of physics leaves ontology exposed to the irreducibility of the present. Ontology cannot expect a transition to the ultimate if physics multiplies its images of matter on the basis of the syntax of its conceptualisations. Finitude cannot be empirical without being at the same time onto-epistemological. That is, there cannot be a finite object if the discourse, concept, or language that describes it is still absolute. In fact, the very existence of a finite object undoes the universality of language (mathematic or otherwise). Given Stengers' argument on the polemical aspect of scientific truth, assuming that there is one language that can express its object absolutely implies the disqualification of all other languages as unable to convey information correctly. Likewise, if there exists an absolute object that is supposed to be expressible, then there must be an absolute language that expresses it immediately and in a pure manner without gain

[36] Cf. Heidegger, *Identity and Difference,* trans. Joan Stambaugh (Chicago, IL: University of Chicago Press, 2002); and Martin Heidegger, "The Question Concerning Technology," and "The Age of the World Picture," in *The Question Concerning Technology and Other Essays*, ed. and trans. William Lovitt (New York, NY: Harper, 1977), 3-35, 115-154. Cf. also Deleuze, "Difference in Itself" and "The Image of Thought" in *Difference and Repetition,* 36-89 and 164-213.

or loss of information. For languages less pure than absolute representation, different formulations would be expected to converge by representing compatible portions of the same truth, totalisable into one continuity. However, with the non-equivalence presented by Prigogine and Stengers, the absolute representational value of such language vanishes and with it the possibility of a homogeneous object (or concept) also crumbles as yet another arbitrary idealisation. What is disproved is not the absolute as such but, much more relevantly, the possibility of an absolute language.

What is relevant in Prigogine's work is *not what science does*, but *what it can no longer do*. Physics has abdicated. It has withdrawn the claims of extra-territoriality that demanded that its fundamental laws be satisfied at all levels of magnification and complexity as well as by all other laws.[37] Physics can no longer act as the axiom of which other sciences would be theorems. In other words, what Prigogine manages to do neither imposes a new claim as universal, nor induces a plain abdication that would allow relativism to take over (the weakness of subjective opinion). Rather, as Stengers shows, it is the demonstration that a logic exists, for without a logic there would be no coherence, and yet it is no longer possible to claim the universality or the homogeneity of such logic.[38] The laws of chaos, Prigogine repeats, emerge heterogeneously and locally.[39] The science of complexity comes upon a radical dichotomy where it is possible to describe the *necessary* conditions that permit chaotic behaviours to emerge, while it is impossible to predict when these will be *sufficient* to engender emergence.[40] Prigogine stated this

[37] Cf. Prigogine and Stengers, *Order out of Chaos*, 299.

[38] This is the fundamental tenet of Stengers' re-elaboration of the notion of coherence following Prigogine's work. Cf. Stengers, "In the Name of the Arrow of Time: Prigogine's Challenge," *Cosmopolitics*, Vol.2, 105-204. Also for Stengers' claim Cf. "Scientific Passions," *Cosmopolitics*, Vol.1, 1-13.

[39] Prigogine insists that chance cannot be interpreted as a replacement of causality, a faceless cause, or a Deleuzean quasi-cause, because it is impossible to predict when it will present itself and cause further bifurcations and divergences. Cf. Alvin Toffler, "Foreword: Science and Change," in Prigogine and Stengers, *Order out of Chaos,* xi-xxvi. A similar interpretation is instead found in Monod's notion of chance. Cf. Jacques Monod, *Chance and Necessity*; *An Essay on the Natural Philosophy of Modern Biology*, trans. Austryn Wainhouse (London: Collins, 1972). Monod, however, makes chance into something separate and potentially opposite to order, which is not the case with complexity.

[40] Cf. J Holland, "Closing", in *Emergence*, 221-248.

very clearly: non-integrability and emergence constitutes "a return to realism [away from idealisation] but emphatically not a return to determinism."[41]

What has been destroyed by the heterogeneity of the laws of chaos is precisely the notion of the ultimate as the root of ontology and, correlatively, the notion of the surface as something that lacks the legitimacy for supporting itself, its reasons, and its relevance; that is, the contingency of the present. No other problem had yet hit representation so close to its core. The transcendental, the Heideggerian groundless, Gödel's undecidability all stopped short of removing the ultimate. At best, they took place inside the space opened by the event of the ultimate, even if this is no longer complete or total; that is, in the wake of its disappearance.[42] However, to remain within the spatial metaphors favoured by ontology, if the transition to the ground or groundless would be linear, the actualised present keeps an infinitesimally tangent point of contact with its virtual horizon. Both retain access to the ultimate and the ability to cover the ontological distance that separates it from the present, or -in the case of the virtual- the proximity of intensity and extension. With complexity instead, the ultimate faces a radical challenge and is replaced by the metastable coherence of the present, abandoning all expectations of a legitimising transition for the temporal and ephemeral emergence of coherence of open systems. Even before being negated, the ultimate becomes irrelevant for the present.

It is in the refusal of a new universal truth that the counter-actualisation reveals the extent and the shift introduced by Prigogine's demonstration of impossibility. Only on the basis of the incompleteness that this exposes, is it possible to have real creative practices: *making* sense, rather than *representing* a priori identity. Deleuze had exposed recognition as the even economy of a priori causality within a concluded perimeter defined by identity. Incompleteness instead permits both change and creativity. Yet, this is not enough. Openness is related to possibility in different terms to the ontological possible that Stengers interprets

[41] Cf. Prigogine, *The End of Certainty*, 131.

[42] Deleuze is the thinker that has gone the furthest to break out of the linearity of this transition. His view that ground and groundless, or transcendent and transcendental, represent a false alternative because they both reflect the same image of thought is a very important step forward. Cf. Deleuze, "Series 15 of Singularities," in *The Logic of Sense*, 116-123. Stengers makes great use of the image of the "nomadic singularity" that Deleuze introduces here to explain the non-necessary emergence of the law of chaos. See for instance the metaphor of the emergence of the wave in the ocean. Cf. Stengers, "The Laws of Chaos," in *Cosmopolitics*, Vol.2, 176-191.

through Deleuze's virtual. Indeed, openness is finitude without ontological boundary; that is, without image. It has conditions (as Stengers puts it) that replace the concepts of identity, but these conditions do not have any kind of existence when they are not actual, rather they become relevant retroactively;[43] thus partially moving away from Deleuze, who poses the distinction between the present and the possible as the virtual, which is real but not actual. In other words, openness does not have an ontological status; it names the absence of identity boundaries without for this being identified as a threshold. Rather, and more simply, more and less become possible in the process; that is positively, rather than fulfilling a lack, following a trajectory, or denoting a co-existent field of potentiality tangent to the present. In fact, what denotes openness is a passage from actual to actual. Conditions emerge *as* conditions when specific patterns of the present are implemented in further iterations acquiring necessity a posteriori.

In this light, the work of Prigogine and Stengers is particularly refreshing. The withdrawal of physics does not leave the same structure in place, a vacant throne waiting to be occupied by a regent in the absence of the monarch. A regency ontology would only bring upon complexity the restoration proposed by the Speculative Realists (in fact, one should wonder why this reaction did not take place sooner).[44] Rather, the withdrawal of dynamics leaves behind a terrain that is not smooth, or in need of a new ruler, but a territory free from the capture of a universal paradigm,[45] which in this case is not simply a de-territorialized territory as Deleuze and Guattari would understand it, but is marked, striated, patterned with

[43] Cf. Prigogine and Stengers, *Tra il Tempo e l'Eternità*, 62-64.

[44] In fact, the notion of active matter that Prigogine and Stengers propose instead of the inert matter of classic mechanics has already been reinterpreted as autonomous and not in need of human participation. See for instance the neutrino as the *ancestral object* in Meillassoux and Harmann, or the notion of *vibrant matter* proposed by Jane Bennett. While the former take an absolutist stance on the existence the thing in itself, Bennett proposes an ecology that nevertheless does not overcome a binary interpretation of ontology. Cf. Jane Bennett, *Vibrant Matter: a Political Ecology of Things*, (Durham: Duke University Press, 2010); Quentin Meillassoux, *After Finitude, an Essay on the Necessity of Contingency*, trans. Ray Brassier (London: Continuum, 2009); and Graham Harman, *The Quadruple Object* (Winchester: Zero Books, 2011).

[45] Isabelle Stengers writes of a colonization of practices by the practice of idealisation and universalisation, that is ontology, as that which organises and sets a hierarchy both arbitrarily and in its own favour; the same illegitimacy of the idealisation in linear dynamics. Cf. Stengers "Wondering About Materialism," in *The Speculative Turn,* 368-380. For the notion of smooth terrain and space Cf. Gilles Deleuze and Felix Guattari, "1440, The Smooth and the Striated," in *A Thousand Plateaus: Capitalism and Schizophrenia,* trans. Brian Massumi, (Minneapolis: University of Minneapolis Press, 2005), 474-500.

the history of development of ideas and technologies, of shifts and changes or genealogies.[46] That is, the withdrawal from the claims of homogeneity and universality, and the censorship these imposed via approximation, leaves behind a *roughness* whose pattern constitutes the dimensions of possibility of the present; its creative potential. No metaphysical possible is needed for it to operate meaningfully and produce coherence and sense. No quasi-metaphysical virtual can provide a space and a guide for it; its present organisation-distribution is sufficient. This sheds the last residues of dualism still echoing in the relation between the actual object and its virtual image. In the explanation of processes growing upon chaotic bifurcations Prigogine makes ample use of the fractal fugues described by Mandelbrot, where results become parameters for the next iteration of the system. That is, the recursive interpolations of feedback loops that take place in complex processes adopt history as their material. The matter of the present is built of genealogies rather than upon fundamental elements.[47] Here entropy produces a form of *augmentation of causality* where information increases at each iteration, thus making the present much larger than any initial boundary conditions.[48] The notion of active matter that Prigogine and Stengers propose is a feedback loop that also involves what for classic physics was the observer. Their view is not that of a matter free from its inert image, but a constructive logic that cannot conceive of matter and observers as existing separately. Not reciprocally transcendental but emerging in simultaneity, structured by the intrinsic limitations of the unit and method of measurement. On this rough terrain left behind by the withdrawal of claims of universality (of physics or ontology), patterns and genealogies no longer organised by the *Same* constitute an *all that there is* without any possibility of thinking of either its opposite (all that is not) or its ultimate. This points to a logic where coherence is both historical and metastable.

[46] The notion of *genealogy* adopted here differs from the linear trajectory of deduction from identity that Deleuze and Guattari distance themselves from and follows Foucault's interpretation. Cf. Michel Foucault, "Introduction" and "The Discursive Regularities," in *The Archaeology of Knowledge*, trans. Tavistok Publication (London: Routledge, 2004), 3-22 and 23-88; and Gilles Deleuze and Felix Guattari, "Rhizome," in *A Thousand Plateaus; Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis, MN: University of Minnesota Press, 2005), 3-25.

[47] For this fractal recursiveness Cf. Benoit Mandelbrot, *The Fractal Geometry of Nature* (New York, NY: Freeman, 1983). Cf. Prigogine, *The End of Certainty* 38-44; and Prigogine and Stengers, *Tra il Tempo e L'Eternità*, 72-75.

[48] Cf. Prigogine and Stengers, *Tra Tempo e Eternità*, 59.

The *scientist* claims that irreversibility is a problem generated at macroscopic level by a weak observer with limited capabilities, who is forced to approximate; while idealization permits thinking or recognising chronological reversibility as the ultimate logic or truth. The *epistemologist* individuates idealization as the problem behind reversibility and reducibility. The *philosopher* instead should ask why idealization, abstraction or transition to the limit seem so inevitable; why the reduction to the ultimate (Being or difference) constantly returns as the broadest structure that enframes thought posing ontology as the fundamental line of enquiry. This seems an image of thought ingrained to such a degree that it cannot be escaped when asking philosophical questions.

All point to the fact that the onto-theo-logical syntax, as the dimension of thought decried by Heidegger, is still with us.[49] Indeed, as long as philosophy looks at the findings of physics for reference or inspiration, it is actually blindly entering a circularity. This is not a matter of seeking proof where none can be found, for it is obvious that philosophy cannot seek proof in science without resigning to an empirical materialism, thereby also resigning autonomy and entrusting all authority to science. The problem is more insidious and far more dangerous. In fact by referring to physics in such a manner, philosophy is still referring to the image of fundamentals; it is still applying, that is, a model of reducibility which either looks at the fundamentals of matter as parallel to the axioms of logic, or looks at the transition to the limit seeking an elemental behaviour of things, which would be revealed in the projection to infinity, so that the system, the universe or logic, would reveal its real truth and essential nature; even when this is a logic of divergence towards infinite difference. With Prigogine instead, it is dynamics that had to declare that its discoveries and practice can no longer be expanded to reach all forms of contingent and historical existence (the psycho-chemical or socio-economical organizations for instance). It is physics that is forced to declare its inability to offer a continuous explanation from microscopic to macroscopic states, which can be based solely on the microscopic. Finally, it is physics that by withdrawing from the ultimate convergence with ontology tells philosophy that philosophy has misused or at least misinterpreted; that it can no longer act as its example or axiom; and that the continuity between mechanics and the coherence of

[49] Martin Heidegger, "The Onto-theo-logical Constitution of Metaphysics" in *Identity and Difference*, 42-74.

the present has been interrupted. Physics, that is, is not imposing a new truth replacing the existing one; rather it remains silent precisely there where it used to speak the loudest.

Philosophy as a Practice

The argument presented here has examined how a problem encountered inside physics raises epistemological questions that challenge the very image of ontology, that is, both its expectations and its authority. The tension between non-integrability and non-equivalence constitutes a leap from a local incompleteness to a general openness that cannot be interpreted as a new ontological model. Indeed, the contingent impossibility at local level interrupts any passage to an abstract or unitary logic able to support sense universally and homogeneously, while non-equivalence undoes the possibility of an absolute language of representation.

Ontology displays an essential *continuity* between the present and the ultimate, which has remained unquestioned from the conservation of causality assumed by sufficient reason to the transition to the difference at the limit proposed by postmodern ontology. In this smooth passage to the ultimate, all interpretations (classic essence, modern totality, the ground and the groundless, the limit or the virtual) share the same *transitive* property: a spatialised image of thought that conceives the present and the ultimate as ontologically *simultaneous*, discussing the forms this transition may take but never questioning the continuity in itself. In this light, a "thought without image," as Deleuze invoked in *Difference and Repetition*, does not overcome the logic of transition to the ultimate, but only removes the a priori status of identity. Indeed, while identity for Deleuze is a continuous production and evaluation rather than a fixed a priori point, actual objects and their virtual images remain in a relationship where the actual is located by and points to the virtual. Here too, the transition to the ontologically ultimate as the logic that supports sense is retained. Instead, Prigogine's reconceptualisation has shown how, in the approximations necessary for the transition to an ontological horizon, the heterogeneity of each specific present is not explained but destroyed. What is more, what is idealised as a pure state is not the epistemological image of the unity of nature or the ontological ground, but rather the assumption of a smooth transition to this horizon.

The conclusions then should come in the form of an exhortation not to think or seek the ultimate; a warning against the risks of re-ontologising the non-equivalence of practices as a matrix for the emergence of sense. An exhortation, that is, to protect the heterogeneous creativity of the practice, not to rush to abstract (and therefore, foreclose) its problems and questions into one disembodied and unitary logic. Indeed, if the practice has the incredible power of bringing a new Being into existence -as Stengers wrote- it is also exposed and vulnerable to the incursions, capture and expropriation of a thought that believes it possible to think the possibility of existence independently from its contingent instantiations.

Prigogine and Stengers have built their argument on the fact that measurement is intrinsic to physics – constitutive of any observation. It is not possible to think of reality – let alone addressing it – as transcending the heterogeneous and finite determinations of the methodology and unit of measurement adopted to observe it. However, the possibility of alternative methods of measurement does not amount to a horizon of possibility from which to draw actualised events. Attempting to explain away with one homogeneous logic (counter-actualisation) the heterogeneous and contingent activities of non-equivalent practices is as arbitrary a move of idealisation as the approximations towards the boundary conditions of classic physics. Prigogine and Stengers have presented a practice of science that *constructs* its object rather than describes or represents it. As was seen, this turns inside out the ontological paradigm that shapes the question along the dimensions of an object 'in itself' versus an object 'for us'. They have shown that the pure question of the logic of existence (how there can be *something rather than nothing*) cannot be posed or thought without the radical finitude of the question regarding how can *things be organised thus rather than otherwise*. Non-equivalence shows that the hinge of presence and sense is the pattern of the heterogeneous forms of finitude of the thus/otherwise question, rather than the unique and pure event of the passage from nothing to something.[50] Indeed, in Stengers' thought, the syntax of mathematics acquires a radical relevance without, for this, demanding that this relevance assume the hierarchical position of a meta-

[50] On this notion of unique event or *eventum tantum* Cf. Deleuze, "Twenty-First Series of The Event," in *The Logic of Sense*, 169-175.

language that envelops matter and the universe externally.[51] On the contrary, the pattern of this syntax constitutes an irreducible degree of roughness beyond which there is no smoothness but only silence.

However, entrusting philosophy with the task of speculating about the concept of non-equivalence – as Stengers had suggested following Deleuze and Guattari - reduces it to the object of ontology and leaves ontology's position untouched. Yet, the critique of the universal at the centre of Stengers' project cannot be upheld if the finite determinations of local behaviours are still addressed through a more powerful and abstract language. In fact, this move obscures the relevance of the leap exposed by Prigogine's reconceptualisation, leaving the hierarchy between thought and practice intact. Yet, this is neither a necessary nor an inevitable choice. Instead, emphasising the positive finitude expressed by the silence of physics concerning absolute claims –this is the problem this article wanted to highlight- the non-equivalence of practices exposed by Prigogine's reconceptualisation is both *less* and *more* than counter-actualisation. *Less*, because non-integrability marks a contingent and practical impossibility inside the practice of physics, where the alternative mathematical syntax adopted by Prigogine produces a chronological irreversibility. Yet this does not need to reach a purer or more abstract form of undoing, a pure horizon of possibility that is, but simply remains open. *More*, because non-equivalence marks an asymmetry that concerns ontology not as its *object* but as its *logic*. Ontology does not speak of the counter-actualisation of physics, but rather is itself counter-actualised. In other words, counter-actualisation cannot be pronounced as an ontological affirmation concerning being/sense in general –as non-integrability forbids it- but remains an epistemological problem, which in turn voids the relevance of the notion of the ontological ultimate and shifts all questions of sense and its legitimacy onto the relevance of the methodology with which they are formulated. It is in this light that ontology too loses its privileged position, its primacy as the logic of pure existence and –therefore- also its right to pronounce statements with the authority of a logic that transcends and is independent of all practices, as the thought able to speculate upon the problems of the practice, and must instead consider itself as practice as well.

[51] Cf. Isabelle Stengers, "The Cosmopolitical Proposal," in Bruno Latour and Peter Weibel eds. *Making Things Public*, trans. Liz Carey-Libbrecht (Cambridge, MA: MIT Press, 2005), 994-1003.

This challenge invests the authority of ontology in its entirety, stepping outside the alternatives offered by transcendent and transcendental, or ground and groundless, as well as virtual models, to question instead the very privileged role that ontology awards to itself as the ultimate philosophical question. That is, non-equivalence amounts to more than counter-actualisation, because by being an internal and local interruption, rather than a negation imposed externally (which would inevitably imply a totalising viewpoint), it challenges the hierarchy that locates ontology in a position that enables it to speak on behalf of practices, giving it the privilege of naming the possible and of marking the dimensions along which this can become actual. And again, less because the resistance that Stengers invokes against a universal convergence is an eminently materialist move that exhorts us to "stay with the problem" of the practice, avoiding any logic of the same.[52] The problem, as it has emerged here, is that by entrusting philosophy with the task to carry out the move of resistance (counter-actualisation), rather than dispelling the actualised enframing of universality of the modern, the structure of abstraction of the heterogeneity of specific practices is retained. This amounts to a re-ontologisation of the problem, or in fact a return to metaphysics; a purification that cleanses the question of the very roughness that gives it specificity and relevance in the first place.

The groundbreaking innovation brought by Prigogine and Stengers' onto-epistemological asymmetry is to have voided the privileged position that the relation of ontology and physics held with reference to the real as their special object. For a truth that is constructed as a factish, there is no longer any interest or relevance in the ultimate. What is more, without ultimate, the hierarchy of the languages and practices that aim to it also vanishes. However, in this ecological regime constructive truth hollows any language of the power of making absolute claims, but not of the power of *making sense*. The task that now opens in front of the philosopher as well as the physicist is to ask how it may be possible to formulate the question of the coherence of sense without the privilege afforded to ontology and physics by their arbitrary nearness to the ultimate and without the mutually supportive relationship this has generated.

[52] Cf. Isabelle Stengers, "The Cosmopolitical Proposal," in Latour and Weibel, *Making Things Public*, 994-1003; and Stengers, "Wondering About Materialism," in *The Speculative Turn*, 368-380.

Here, Karen Barad's notion of *diffraction* (does a claim matter? how? for whom?) seems more apt to navigate non-equivalence than the quasi-binary logic of counter-actualisation, as it offers a less metaphysical and more pragmatic key than the speculation indicated by Stengers.[53] Showing that relevance names materiality as *that which matters*, Barad reframes the question in terms of the conditions of experience. The irreducible degree of roughness of the factish constitutes a basic ontological unit – she claims – where discourse and matter constitute a continuum. However, this new ontological interpretation of the factish as a phenomenon follows Bohr rather than Kant, thus abandoning the a priori universality of the conditions of experience, but – crucially – retaining the notion of conditions as necessary for existence; hence positive finitude as constructive and creative.[54] This new understanding of the phenomenon as irreducible roughness folds into one question - not only the ontological and epistemological problems of philosophy with the practical problems of physics - but also the ethical, as well as the aesthetic and political aspects of sense. Johnny Golding names this entangled and irreducible genealogy of the present "radical matter."[55] In this light, diffraction will require to be negotiated each time, specifically orienting all philosophical questions forward; towards a future, which itself is freed from teleological tracks and attuned to the questions: what matters, how does this matter, for whom does it matter? As the conditions, or indeed the *dimensions* of the emergence of sense.

[53] Cf. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and The Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007).

[54] Cf. Barad, "Part II: Intra-Actions Matter," in *Meeting the Universe Halfway,*" 97-187.

[55] The concept of *radical matter* was first developed by Johnny Golding in a series of meditations on new materialities, aesthetics and war. Cf. Johnny Golding, "A Deleuzean 'something': n-1 (or the techne of curved line drawing)," *Issues in Contemporary Culture and Aesthetics*, Vol.2 (2004), 59-66; "Raw / Hide: WWW III, the prequel," in T. Barlow ed., *Positions: The War Issue*, (Durham, NC: Duke University Press, 2005), 263-283; and "The Assassination of Time (or the birth of zeta-Physics)," in Hanjo Beressem and Leyla Haferkamp eds., *Deleuzean Events: Writing | History* (Berlin: Lit Verlag, 2009), 132-145. Radical matter then became one of the central concepts of the PHD Research Methods Seminar (Centre for Fine Art Research, Birmingham School of Art – BCU), led by Professor Golding.

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Are Non-Human Primates Gricean?

Intentional Communication in Language Evolution

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Abstract

The field of language evolution has recently made Gricean pragmatics central to its task, particularly within comparative studies between human and non-human primate communication. The standard model of Gricean communication requires a set of complex cognitive abilities, such as belief attribution and understanding nested higher-order mental states. On this model, non-human primate communication is then of a radically different kind to ours. Moreover, the cognitive demands in the standard view are also too high for human infants, who nevertheless do engage in communication. In this paper I critically assess the standard view and contrast it with an alternative, minimal model of Gricean communication recently advanced by Richard Moore. I then raise two objections to the minimal model. The upshot is that this model is conceptually unstable and fails to constitute a suitable alternative as a middle ground between full-fledged human communication and simpler forms of non-human animal communication.

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Introduction

Primatologist Frans de Waal has argued throughout his career that for any ability put forward as uniquely and exceptionally human, there is at least one species, and often several, that display this same ability. This goes for tool-use, social dominance alliances, empathy and fairness, and the transmission of habits and learned skills through generations (De Waal 2016; 2013). But even De Waal acknowledges that human language does set us apart:

> "We honestly have no evidence for symbolic communication, equally rich and multifunctional as ours, outside our species." (De Waal 2016, p. 106)

Current research in language evolution is thus concerned with the question: what makes human communication different from communication in other species, and how did it evolve? One current approach taken by several leading theorists to help tackle this question is the Gricean pragmatics approach to communication. On this view, part of the task of an evolutionary theory resides in explaining the emergence of the cognitive abilities that support a Gricean communication model of human language. Comparative studies between human and non-human primate communication can shed light on this evolutionary story.

The core notion for pragmatics, first advanced by Paul Grice, is that human communication involves the expression and recognition of intentions (Grice 1959, 1969, 1975; Bach & Harnish 1979; Sperber & Wilson 1995). In this paper I will concentrate on the role of this special kind of Gricean communicative intention in the phylogeny of language. One pervasive view is that non-human primates are incapable of entertaining communicative intentions (Tomasello *et al.,* 2005; Hurford, 2007; Bar-On, 2013; Scott-Phillips, 2014, 2015, 2016). This can be termed the *strong* view of Gricean communication. A different, *minimal* view allows for the possibility of a weaker form of Gricean communication, in which non-human primates are capable of engaging (Gómez 2007; Moore 2015, 2017; Townsend *et al.* 2016). In the first section I will review Scott-Phillips' (2014, 2015) position, as exemplary of the strong view of Gricean communication in the language evolution literature. I will

identify three related theses or assumptions that ground the strong view. This will help to clarify the points with which a minimal view of Gricean communication disagrees.

I will then examine the feasibility of a weaker model, as expounded in the work of Richard Moore (2015, 2016). Finally, I raise two objections for the minimal model of Gricean communication. The upshot is that the weak model is unstable. One the one hand, it collapses into non-Gricean forms of communication, and on the other hand it does not fully explain how it can support the development of a stronger Gricean model.

Standard interpretation of Gricean communication

In order to best consider the merits of the strong and minimal views of Gricean communication, is it helpful to contrast them, as Scott-Phillips himself does, with a third model of communication, usually termed the *code model* (Sperber & Wilson 1995, p. 3-15). In the code model, communication occurs when a sender encodes a message according to the rules of a shared code and sends it to the receiver, who then decodes the message. A defining feature of the code model is that of a twofold association. First, signallers associate certain states of the world with a particular signal. Second, receivers associate such signal with a particular behaviour (Scott-Phillips 2014, p. 21). It should be noted that a code-based model of communication may simply involve manipulative behaviours that impose little or no cognitive demands at all. Honeybee communication, for example, can be explained on this model. Upon returning to the hive, scout bees perform a waggle dance that can encode information about the direction, distance, and odour of the food, which forager bees then successfully decode in order to locate the food source.

As noted in the introduction, in the Gricean model communication is achieved not by the transmission of information and association of the linguistic code, but rather by the expression and inferences of intentions. The pragmatic or Gricean model starts from the fact that in human communication the meaning of an utterance is *underdetermined* by the syntactic and semantic rules of the language. For example, in saying the sentence "Thank you" I can express gratitude, or I could show disdain at your action, or annoyance. Even the degree of gratitude that I am expressing, and that I intend you infer, can vary widely depending of factors outside

the literal sentence "Thank you". This feature of human communication is widely known as the linguistic underdeterminacy thesis (Huang 2014, p. 7).

It highlights the gap between the literal meaning of a sentence and the proposition intended to be communicated by uttering said sentence. This gap cannot be filled by attending to the meaning of words alone, but, according to Gricean pragmatics, by attending to the intentions of the speaker.

Here I adopt a version of the Gricean model which slightly departs from Grice's original, after the refinements and modifications by Neale (1992), and Sperber and Wilson (1995, 2002), but which is largely taken as a starting point for the strong/minimal debate (Scott-Phillips 2014; Moore 2017). For a speaker *S* to mean something by uttering (or gesturing) *x* the Gricean model requires that, by uttering *x*:

(1) *S* intends to induce a response *r* in hearer *H*
(2) *S* intends that *H* recognizes that *S* has intention (1)
(3) *S* does not aim to deceive *H* regarding (1) and (2)[2]

Mainly following the work of Sperber and Wilson (1995), intention (1) has also been termed *informative intention*, and intention (2) *communicative intention*. For ease of exposition I will follow this convention, although it is necessary to be aware that these are defined technical terms, and can be somewhat misleading. In using the term *informative intention,* it should be noted that the communicative act may not be one of informing. Grice (1982) already was aware that though his exposition used indicative informative intentions as examples, this did not preclude intentions other than informative. [3] This is an important point, to which I will come back later when assessing the minimal Gricean model.

As Scott-Phillips (2014, p. 26) puts it, an informative intention (clause 1) is the intention that the audience recognizes *what* one wants to communicate. Yet this

[2] This formulation of the third clause is from Neale (1992), supplanting Grice's original formulation after several criticisms (e.g. Strawson 1964). The nuances of this clause will not concern us here. In what follows it will be assumed that S is acting with honest intent, and that clauses (1) and (2) suffice for Gricean communication.

[3] In fact, for Grice (1967) one (communicative) intention encompasses the whole complex of intentions (1), (2) and (3). Thus, the communicative act is one which has an underlying complex intention. I will follow Sperber's and Wilson's (1995) use of the term *communicative intention* exclusively to identify intention (2), as much of the debate necessitates to identify intentions (1) and (2) as functionally separate though related intentions.

intention alone, even if successful, does not necessarily result in communication. To illustrate: suppose I am a guest at your party, and I would like to refill my glass. I can achieve this by conspicuously placing my glass in a spot you will notice.
This action will count as an informative intention, that is, that I intend to produce a certain response in you by my actions. However, in this scenario, it can easily be the case that you don't recognize that I have such intentions, and also that I don't intend that you should (as when you don't know it was me who put the empty glass there). I will still accomplish my goal, but this would not be a case of communication. For communication to take place, it should be overtly manifest to you that I have the intention to get a refill, *and* that I want you to be aware of such intention. In other words, the audience must recognize not just *what* one wants to communicate, but also *that* one wants to communicate. Communicative intentions (clause 2 above) show that the speaker is trying to communicate at all.

Scott-Phillips relies on three closely related theses that will later help elucidate the points on which a weak view of Gricean communication will differ. The first thesis is that *informative intentions are intentions to affect mental states*. In other words, an informative intention is an intention to affect the audience behaviour *by virtue of* affecting their mental states:

> "An *informative intention* is a signaller's intention that the receiver change their representation of the world in response to the signaller's behaviour." (2014, p. 25)

Thus, both the expression and recognition of first-order intentions in the communicative act require that communicators be able to attribute mental-states to others, particularly states of beliefs.

The second, related, thesis is that *a communicative intention is a higher-order intention meant to affect the audience mental states*. A higher-order mental state is one whose object or representation is another mental state. A communicative intention is a higher-order state with a nested structure, as its object is the informative intention: *S* intends to create in *H* a mental representation of the fact that *S* has the intention to produce a response *r* in *H* (Scott-Phillips 2014 2015; Sperber & Wilson 1995, ch.1).

Combined with the first thesis, this nested structure of communicative intentions can be spelled out as follows (Sperber 2000):

> *S* intends that
> *H* should believe that
> *S* intends that
> *H* should believe that *p*

For this reason, Gricean communication requires the ability to entertain and understand higher order representations of such sophisticated structure. This brings us to the third thesis, which assumes that *both intentions are present in the same communicative action*, that is, the same signal (Scott-Phillips 2014, p. 105). To express and recognize a communicative intention is, then, to simultaneously express and recognize an informative intention.

Under this interpretation of Gricean communication, communicative intentions require a sophisticated ability for mental-state attribution and the expression and recognition of higher-order intentionally. Scott-Philips admits that there are currently no empirical studies directly targeting the comprehension of communicative intentions in non-human primates. Yet he remains sceptical of whether they might succeed. For, although there is evidence that some non-human primates are capable of tracking the goals and perceptual states of others, and perhaps entertain first-order representations, there is so far a broad consensus that they are not capable of entertaining a concept of belief, including false beliefs, and neither engage in complex nested higher-order mental states (see Call & Tomasello 2008 for an overview; cf. Tomasello et al. 1997). Scott-Phillips concludes that non-human primates are incapable of Gricean communicative intentions. Ape communication is instead a sophisticated code-based communication model, modelled by code-based associations, and possibly augmented by the flexibility of gestural signals (Scott-Phillips 2015, p. 64).

In conclusion, the communication systems used by apes and humans are different in kind and not in degree, and thus have different cognitive requirements.

The upshot is that the origin of language in hominins must have occurred by an evolutionary increase in the cognitive abilities required for Gricean communication: mental-state attribution, particularly of belief-like states (also termed "mind-reading" or "theory of mind"), and inference of complex higher-order intentions.[4]

However, there are some pressing concerns with the emphasis on these cognitive abilities, particularly on mind-reading and the understanding of higher-order intentions. In particular, there are two worries with this emphasis. The first is that it may put the bar too high not only for great apes, but for human infants as well, who will likewise fail to communicate on a pragmatic model under the standard reading (Liddle & Nettle 2006; Townsend et al,. 2016). On the hypothesis that communication itself plays some role in the development of cognitive abilities, particularly in belief-attribution and in entertaining higher-order mental states, Scott-Phillips' view will lead to a problematic circularity, since those same abilities have been singled out as necessary for communication in the first place (Breheny 2006; cf. Davidson 1975; Dennett 1996). Secondly, it is not clear how our hominin ancestor developed the abilities of mind-reading without engaging in some level of (proto)Gricean communication. The strong Gricean model account will have to explain how our pre-linguistic ancestors came to possess all the cognitive abilities for Gricean propositional thoughts. This task seems no less demanding than explaining language evolution itself (see Bar-On 2013b for a similar point). Given the high cognitive demands imposed by standard Gricean communication, it then seems dubious whether the pragmatic-first approach is the best explanatory approach to the evolution of human language communication.

Minimal model of Gricean communication

Given these problems with the strong view, there is no lack of motivation to explore a suitable alternative. Richard Moore (2015, 2017; see also Townsend et al. 2016) has recently advanced a minimal model of Gricean communication in which the prerequisite cognitive abilities are weaker, and thus may lead to the development of the complex abilities outlined in the previous section.

[4] Although comparisons between humans and contemporary non-human primates do not necessarily carry over to comparisons with extinct species of non-human animals in our evolutionary line, nor to humans' and contemporary primates' last common ancestor (see Bar-On 2013a).

In brief, Moore's model challenges the three theses identified above. I will first consider the arguments against the first thesis in detail. This thesis claims that an informative intention requires affecting *H*'s mental states and in particular, *H*'s beliefs. This is the standard idea (shared among others, by Bach & Harnish 1979; Dennett 1983; Sperber & Wilson 2002; Hurford 2007) that Gricean communication requires a concept of belief, and the understanding of false beliefs. A reply to the belief thesis can start with the claim that, in some cases, the observed *behaviour* of communicators can be described without appeal to beliefs at all. Which are these cases? Here it should be recalled that *informative* intentions, despite the terminology used, is a technical term which only singles out the first clause in the Gricean structure: *what* the utterer intends to accomplish with the utterance. Informative intentions need not be confined only to acts of conveying information. It is helpful to differentiate between informative acts and directive acts (already noted in Grice 1957). The intention to affect others' beliefs may surely be necessary for complex communicative acts, such as eliciting information about third parties, for example. However, Moore suggests that in acts of communication involving a simple range of directives, (e.g. "look here", "give me the food", "go away", etc.), communicators need not comprehend the actions of others in terms of beliefs. When the speaker's goal is to directly affect the audience's behaviour, beliefs and the understanding of false beliefs may play no functional role. In such cases, since the object of the first-order informative intention is to produce a behavioural response *r* in *H*, there is no reason to suppose that this must be only done by first affecting *H*'s beliefs. Instead, we can rethink the Gricean "informative" intention as an intention to produce a response in *H*, by virtue of affecting *H*'s goals or goal-directed behaviour.

Nevertheless, this intention will require some comprehension that the addressee is an agent, capable of responding to the utterance. Specifically, it requires that communicators possess an understanding of others as subjects who act in the world with their own goals. On this view, the intentions involved in the Gricean structure can be recast in terms of goals, and in having the ability to track the goal-directed actions of others. In a traditional conception of the intentions that underlie actions, including communication, to understand one's and others' intentions one must represent them as propositional attitudes, or as a combination of beliefs and desires (e.g. Davidson 1969), or as forming part of rational planning. On the other

hand, having goals and tracking the goals of others may not involve the representation of propositional attitudes.

This modest way of understanding others in terms of their goal-directed action will not require attribution of a complex psychology, nor an understanding of false beliefs (see Butterfill and Apperly 2013).[5] A creature with this minimal understanding of others will of course fail to comprehend communicative scenarios involving false beliefs. But, Moore (2017) suggests, they will be competent in many acts of communication which display a Gricean structure. In this manner, the (minimal) Gricean informative intention will not be captured in terms of beliefs, as:

S intends that *H* should believe that *p*

But rather as:

S intends that *H* should respond with behaviour *r*

In some cases, this minimal form of understanding others as agents may also require the ability to keep track of what others have and have not seen, and to understand that others' perceptions are different than one's own. There is mounting evidence that great apes, especially chimpanzees, appear capable of both abilities: understating the goals of others, and their perceptual perspectives (Call & Tomasello 2008; Tomasello 2008, ch.2). In short, Moore's reply to the first thesis of the strong view depends on three claims being true. First, that intentions can be suitably cashed out in terms of goals, which do not involve rational planning, nor representations of beliefs and desire. Second, that *S* has the ability to track the goals of others. Third, in some cases, that *S* has the ability to track others' perceptual states. A basic understanding of goal-directed action which does not require planning, nor representations of one's own and other's beliefs, is thus able to sustain a minimal form of intentional communication that retains the Gricean structure. In this manner, the assumption in the first thesis, that *informative intentions are intentions to affect mental states*, is dropped.

[5] When discussing Moore's minimal model in the remainder of this paper, the terms goals and intentions will be used interchangeably in this minimal sense, and without involving the understating of beliefs, desires or rational planning.

The second and third theses are challenged by a further innovation in Moore's model. He suggests that the two intentions constitutive of Gricean communication can be enacted in two separate actions.

To spell this out, lets first recall the Gricean schema:

(1) *S* intends to induce a response *r* in hearer *H*
(2) *S* intends that *H* recognizes that *S* has intention (1)

According to Moore, these two clauses are not necessarily always accomplished in the same action. Using Moore's terms, a behaviour of "sign production" enacts the first clause, and a (previous) "act of address" enacts the second clause. (2017, p. 316). This new frame directly challenges the third thesis identified above, that *both intentions are present in the same communicative action*. Moore admits this minimal model of separate behaviours is sufficiently but not necessarily Gricean, since it does not preclude that the same action can fulfil both clauses, as in the standard approach.

As Sperber and Wilson (2002, p. 16) note, an overt behaviour "manifestly intended to attract the other's attention" is a pre-requisite for engaging in Gricean communication. In Moore's view, an act of address is a functional pre-requisite towards accomplishing a communicative intention (2), since it signals that *S* has manifestly overt intentions, and that whatever follows is intended to be directed at *H*'s attention. An act of address may include attention-getting and persistence behaviours such as ostensive eye contact, name calling, slapping the ground or thumping the chest. Once *S* has *H*'s attention, a subsequent action will suffice to accomplish an informative intention (1). An act of address, by itself, is not necessarily communicative. But it will ensure that the subsequent action is sufficiently overt between the two subjects. The nested structure of higher-order states identified above can then be replaced as follows:

- *S* intends that
- *H* attend to *S*'s behaviour
- *S* intends that

- *H* respond with behaviour *r*

These intentions are both first order intentions, since each is elicited in two separate actions. In this model, the representational burden of entertaining nested higher-order intentions and beliefs is greatly reduced. Thus, the thesis that *a communicative intention is a higher-order intention meant to affect the audience mental states* is dropped.

To recap, Moore's weak model of Gricean communication makes several alterations to the standard reading. Both informative and communicative intentions are not made to affect the audience's mental states, but can be described as affecting behaviour without the need to do this *in virtue of* affecting mental representations. Informative and communicative intentions may not be both embedded in the same action or utterance. An act of address elicits a communicative intention, and the following signal production elicits an informative intention, in order to provoke a response in the audience. Communication on this minimal model will require a basic understanding of goal-directed action in others, and the ability to comprehend others' attentional states.

If Moore is right in dismissing the three theses of the strong model, a minimal model of Gricean communication may provide a suitable alternative for theorizing about the evolutionary development of full-blown Gricean communication and its sophisticated cognitive demands. However, I have some doubts that Moore's model succeeds.

Issues with a minimal Gricean framework

In this section I raise two objections for the minimal model just outlined. If these objections are on target, then the minimal model is conceptually unstable: either it collapses into a strong version of Gricean communication, or it remains too close to non-Gricean code-based communication, such that it is unable to explain the development of communicative acts beyond a fixed and limited set of directive actions.

The first objection starts from Scott-Phillips' (2015, p. 76) observation that a description of first-order intentions in terms of intentions to affect behaviour is too broad, in that it encompasses some behaviours that are clearly not communicative. To use an example of Scott-Phillips', suppose I say "Stop hitting me" and at the same time move away from you to a place where you cannot hit me. In this case

both actions can affect your behaviour, even though only the first is communicative. We can distinguish communication from different social behaviours only in terms of intentions to affect representational mental states. Scott-Phillips' objection relies on the assumption that understanding belief or belief-like states is a necessary condition of Gricean communication. This is the first thesis of the strong model and, as we have seen, a proponent of the minimal model can overcome this assumption by focusing on a limited set of directives, availing of the notion of goal-attribution, and appealing to the interplay of an act of address and an act of signal production. However, I think there is a way to recast Scott-Phillips' objection that meets the proponent of the minimal model on her own ground.

The problem arises from the minimal model's stipulation that the nested structure of communicative intentions can be broken down into separate acts. The key question is whether we can account for the connection between these acts in a way that can still allow us to distinguish communicative from non-communicative behaviours. For example, in trying to get you to stop hitting me, I could engage your attention through ostensive eye contact, and then move away to a place where you cannot hit me. Even if the informative intention, if there is actually one, is preceded by an act of address to engage the audience attention, this is not a case of communication. Yet it seems to satisfy the minimal Gricean view. The problem here is that there is no principled connection between the act of address and the subsequent behaviour meant to elicit an informative intention.

Attention-getting acts, including persistence and elaboration of a gesture by tracking the audience response, for example, may indicate that *S* understands that *H* is an agent with his or her own goals. But having the goal to get the audience's attention is not necessarily the same thing as having the goal to make it overt to the audience that one has an informative intention. Similarly, acts of address also do not guarantee that *H* will make the inference that the following signal is one of communication. It will be necessary to establish that both *S* and *H* can comprehend the connection between the two (or more) actions corresponding each to the expression of a communicative intention and the expression of an informative intention. In order to spell out a suitable connection between these acts, we can amend Moore's formulation above as follows:

S intends that

H should attend to *S*'s gesture *and thereby recognize (be able to track) that*
S intends that
H should respond with behaviour *r*

This formulation can capture the insight of the original Gricean schema while preserving some elements of Moore's minimal model. In this way, even if communicative and informative intentions are performed by different acts, both *H* and *S* should be aware of that these two acts are suitably connected. However, this requires reintroducing higher-order states in the picture. In short, the minimal model collapses back into a stronger version of Gricean communication, as it necessitates the more sophisticated cognitive capacities to express and infer higher-order states.

The second objection to the minimal model concerns the shift from mind-reading abilities to abilities of recognizing goal-oriented behaviour. The weak model of communicative intentionality does have the advantage that it posits lower cognitive requirements for communication which are perhaps shared by adult humans, infants and non-human apes, something which indicates that an evolutionary difference of degree may be at play in the phylogeny of language. The pressing difficulty, however, is that these proto-Gricean conditions, and lower cognitive requirements, might not be enough to support the minimal model of communication, as opposed to merely a code-base communication.

As noted, in the minimal model Gricean communication requires making inferences about a speaker's goals. One could hold that making inferences of complex communicative goals do require inferential knowledge of others' mental states (Tomasello 2008, ch.1; Bar-On 2013b). Moore replies to this objection by limiting the model's applicability to simple communicative goals. This limited range of simple goals can include basic directives: producing a signal to initiate play, request food or grooming.[6] Thus, the requisites for a minimal mode of Gricean communication are that communicators be able "entertain and identify in others only a limited range of goal-directed behaviours" (Moore 2017, p. 324). Moreover, according to Moore, a limited set communicative goals can only be used when utterances are used in fixed and predictable ways. The concern about a set of utterances that is fixed, predictable and limited to certain environmental conditions,

[6] Cf. Tomasello's observation that apes' gestural communication "is aimed exclusively at making demands/requests" (2008, p. 332).

is that an inflexible system is probably not a Gricean system, neither strong nor minimal, even when we do away with the requirement of belief attribution.

Liebal et al. (2013, p. 187) define functional flexibility of signals in the literature of non-human primate communication as "the production of a single signal across a variety of functional contexts and the production of several signals in the same functional context." Functional flexibility is one characteristic of human infant vocalizations (Tomasello et al. 2005; Oller et al. 2005).

Similarly, there is growing evidence and studies that show that some species of non-human primates display functional flexibility in communication (Liebal et al. 2013; Ackermann et al. 2014; Clay et al. 2015). This evidence suggests that non-human primates' communicative system is flexible when involving simple goals. The key question here is whether this limited functional flexibility implies that communicators make inferences according to the Gricean structure. I suggest that it does not.

We have seen that it is useful to distinguish between directive acts and informative acts in communication. Ideally, however, we should be able to sketch a Gricean framework that can encompass both, or at least account for the transition from directives to informative acts. The transition from simple goals involving a limited range of directives, to more complex ones involving intentional communicative goals to share information, is still to be explained. This transition is not as straightforward as it may seem at first.

In this respect, Tomasello (2014) makes a distinction between communication of demands, and the intentional communication of cooperative information. On this view, the transition from minimal to strong Gricean communication may be understood as a transition from simple goal-directed behaviour aimed to make requests and demands, to the complex behaviour of intentionally sharing cooperative information. In this transition, the attribution of communicative goals to others may not be a simple cognitive ability, as Moore seems to presuppose.

In order to share information, communicators will have to intentionally express their goals, and their audience will have to suitably infer not just what those goals are, but also what they are meant to inform. For example, suppose that *S* wants to communicate to *H* that there are tubers they can dig under a certain spot in the ground. In order achieve this goal, *S* can get *H*'s attention, via an act of address,

and then point (or perform any other suitable action, such as stumping her feet on the spot) to lead *H*'s perception toward the correct spot on the ground. Concerning *S* this situation could perhaps count as an instance of a minimal Gricean communicative act conveying information.[7] But it is not clear that *H* is a similar Gricean communicator. To count as one, *H* will have to infer that *S*'s goal is to look at the ground and infer that *S*'s goal is to make *H* realize that by looking at the ground *H* will understand that that there are tubers they can dig in that spot.
Moore seems to suggest that *H* need not understand that this is in fact *S*'s goal. It is only required that *H* be suitably affected to look at the correct spot in the ground. But the problem here is that, as there is no understanding of intentions involved, it is implausible to say that *H* understands what the reference of *S*'s signal is: the tubers under the ground. In this scenario, it suffices that *H*'s behaviour is manipulated by certain basic associations (stomping of feet, looking at that spot in the ground, etc.). These associations do not necessarily involve grasping *S*'s communicative goal, let alone *S*'s information that there are tubers under the ground. In contrast, *H*'s role may be equally accounted for in terms of a sophisticated code-based communication model.

In short, a minimal Gricean framework will have to provide a richer account of the cognitive requirements for communicative goal-attribution and inference. However, this seems to put us back where we left Scott-Phillips: the worry is that the cognitive demands of Gricean communication are such that it is hard to see how they evolved from a code-based system.

Conclusion

In the strong view of Gricean communication, three assumptions can be identified. First, informative intentions involve affecting mental states, particularly beliefs, and thus require a sophisticated ability of attributing mental states to others. Second, communicative intentions are higher-order intentions. Third, informative and communicative intentions are understood as united within a sole complex intention present in a single communicative action. In contrast, a weak framework of communicative intentions does away with these three assumptions. Intentions are described in terms of goal-directed actions to affect the behaviours and goals of

[7] Assuming, for the sake of argument, that the first objection above does not hold.

others. Communicative intentions are performed by overt acts of address that serve to get the audience's attention and may be separate from the signal itself. I have argued that this separation of communicative and informative intentions as enacted in two different actions is problematic, unless communicators are able to grasp the connection between the acts in a principled manner. But this brings us back to a strong version of Gricean communication involving higher-order mental states.

One important feature in the minimal conception of Gricean communication is that expressing and inferring intentions involves only the tracking of goal-directed behaviour in oneself and others. Of course, such a shift brings its own problems.

At least on the current formulation of the minimal model, it is not clear that tracking goal-oriented behaviours can support pragmatic communicative acts and avoid collapsing into a version of the code model. If this difficulty holds, the minimal Gricean model is not a preferable alternative, and we are back at the problems that beset Scott-Phillips' strong Gricean model, including the need to explain the evolutionary gap between code-based systems and full-fledged Gricean systems.

We seem to be left with two options. We can accept something along the lines of Scott-Phillips' view, and admit that the best way forward is to identify the emergent development of sophisticated mind-reading competence without appealing to language-use. Or we can abandon the project of providing a pragmatic-first approach to the emergence of language in phylogeny. Instead, I will briefly suggest a third option. We can adopt some of the innovations of Moore's minimal model, such as the emphasis on the ability to understand the goals and perceptual states of others. This minimal understanding of other minds fails to support a Gricean communication system. Yet the analysis of intentions in terms of this minimal understanding is nevertheless compatible with non-Gricean alternatives to language development which take into account the cognitive import of expressive behaviours and affective cues (Bar-On 2013b; Green 2007). In fact, these accounts may be complementary, and a more pluralistic approach may constitute a third option for progress in language evolution.

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References

Ackermann, H., Hage, S.R. & Ziegler, W. (2014) "Brain mechanisms of acoustic communication in humans and nonhuman primates: an evolutionary perspective". *Behavioral and Brain Sciences* 37(06):529–546.

Bar-On, D. (2013a). "Expressive Communication and Continuity Skepticism". *The Journal of Philosophy*, *110*(6), 293–330.

Bar-On, D. (2013b). "Origins of Meaning: Must We 'Go Gricean'?" *Mind and Language* 28 (3):342-375.

Bach, K., & Harnish, R. M. (1979). *Linguistic Communication and Speech Acts*. Cambridge, MA: MIT Press.

Breheny, R. (2006). "Communication and Folk Psychology". *Mind and Language*, *21*(1), 74–107.

Butterfill, S. A., & Apperly, I. A. (2013). "How to Construct a Minimal Theory of Mind". *Mind and Language*, *28*(5).

Call, J., & Tomasello, M. (2008). "Does the Chimpanzee Have a Theory of Mind? 30 Years Later". *Trends in Cognitive Sciences*, *12*(5), 187–192.

Clay, Z., Archbold, J. & Zuberbühler, K. (2015) "Functional Flexibility in Wild Bonobo Vocal Behaviour". *PeerJ* 3:e1124.

Davidson, D. (1969). "Actions, Reasons, Causes". *Journal of Philosophy, 60*: 685–99.

Davidson, D. (1979). "Thought and Talk". In S. D. Guttenplan (ed.) 2004, *Inquiries into Truth and Interpretation* (pp. 342–342). Oxford: Clarendon Press.

Dennett, D. (1983). "Intentional Systems in Cognitive Ethology: the 'Panglossian Paradigm' Defended". *Behavioral and Brain Sciences, 6*(3), 343-355.

Dennett, D. (1996) *Kinds Of Minds: The Origins Of Consciousness*. New York: Basic Books.

De Waal, F.B.M. (2013) *The Bonobo and the Atheist: In Search of Humanism Among the Primates*. New York: W.W. Norton & Company.

De Waal, F.B.M. (2016) *Are We Smart Enough to Know How Smart Animals Are?* New York: W.W. Norton & Company.

Gómez, J.C. (2007), "Pointing Behaviours In Apes And Human Infants: A Balanced Interpretation", *Child Development*, 78/3: 729-734.

Green, M. S. (2007). *Self-Expression*. Oxford: Oxford University Press.

Grice, P. (1957) "Meaning." In P. Grice (1989) *Studies in the Way of Words*, 213-223. London: Harvard UP.

—— (1969) "Utterer's Meaning And Intention." In P. Grice (1989) *Studies in the Way of Words*, 86-116. London: Harvard UP.

—— (1975), "Logic and Conversation." In P. Cole and J. Morgan (eds.), *Syntax and Semantics*, vol. 3: Speech Acts, 41-58. New York: Academic Press.

—— (1982) "Meaning Revisited." In P. Grice (1989) *Studies in the Way of Words*, 283-292. London: Harvard UP.

Huang, Y. (2014) *Pragmatics*. Oxford: Oxford University Press.

Hurford, J. (2007) *The Origins of Meaning: Language in the Light of Evolution*. Oxford: Oxford University Press.

Liddle, B. & Nettle, D. (2006) "Higher-Order Theory of Mind And Social Competence In School-Age Children", *Journal Of Cultural And Evolutionary Psychology*, 4/3-4: 231-244.

Liebal K., Waller B.M., Burrows A.M., & Slocombe K.E. (2013) *Primate Communication: A Multimodal Approach*. Cambridge University Press, Cambridge

Moore, R. (2015). "Meaning and Ostension in Great Ape Gestural Communication." *Animal Cognition* 19(1):223–231.

—— (2017). "Gricean Communication and Cognitive Development." *Philosophical Quarterly*. 67(267): 303–326.

Neale, S. (1992) "Paul Grice and the Philosophy of Language", *Linguistics & Philosophy*, 15/5: 509-559.

Oller DK, Buder EH, Ramsdell HL,Warlaumont AS, Chorna L, Bakeman R. 2013. "Functional Flexibility of Infant Vocalization and the Emergence of Language". *Proceedings of the National Academy of Sciences of the United States of America* 110(16):6318–6323.

Scott-Phillips, T.C. (2014). *Speaking Our Minds*. London: Palgrave Macmillan.

—— (2015). "Non-human Primate Communication, Pragmatics and the Origins of Language." *Current Anthropology* 56: 72-73.

—— (2016). "Meaning in Great Ape Communication: Summarising the Debate." *Animal Cognition* 19: 233–238.

Sperber, D. (2000). Metarepresentations in an Evolutionary Perspective. In *Metarepresentations: A Multidisciplinary Perspective*, 117–146. Oxford: Oxford University Press.

Sperber, D, & Wilson, D. (1995) *Relevance: Communication and Cognition*, 2nd ed. Oxford: Blackwell.

—— (2002) "Pragmatics, Modularity and Mind-Reading", *Mind and Language*, 17: 3–23.

Tomasello, M. (2008) *Origins of Human Communication*. Cambridge, MA: Bradford Books/MIT Press.

Tomasello, M., Call, J., & Gluckman, A. (1997). Comprehension of Novel Communicative Signs by Apes and Human Children. *Child Development*, *68*(6), 1067–80.

Tomasello, M., Carpenter, M., Call, J., Behne, T. & Moll, H. (2005). "Understanding and sharing intentions: The origins of cultural cognition." *Behavioral and Brain Sciences* 28 (5):675-691.

Townsend, SW, Koski, SE, Byrne, RW, Slocombe, KE, Bickel, B, Boeckle, M, Braga Goncalves, I, Burkart, JM, Flower, T, Gaunet, F, Glock, HJ, Gruber, T, Jansen, D, Liebal, K, Linke, A, Miklósi, Á, Moore, R, van Schaik, CP, Stoll, S, Vail, A, Waller, BM, Wild, M, Zuberbühler, K & Manser, MB. (2016), "Exorcising Grice"s ghost: an empirical approach to studying intentional communication in animals." *Biological Reviews* 3.

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Modernism, Science, and Technology

Mark S. Morrisson

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Reviewed By

Rosie Emma Barron

Mark S. Morrisson takes on an impressive academic feat in this New Modernisms edition. Bringing attention to how new scientific approaches and technological advances reshaped popular thought and imagination, Morrisson highlights the "rampant boundary crossing" (44) between cultural, social and artistic spheres with the scientific. This crossing in many ways symbolised the twentieth century as a whole with its explosive tendency to create and destroy, impact and inhibit, transform and reform at a before unprecedented scale.

In the study of the twentieth century, technology and science have often been at the forefront of general and academic intrigue. Although at first it would appear that literature is largely distinct from the hard fact worlds of science and technology, in this new study Morrisson builds on more traditional approaches to modernism to stress its interconnectedness with the scientific developments in the later nineteenth and twentieth century. To do so, he brings seminal scientific approaches from the nineteenth century into a modernist context, an approach which holds unbound potential for future research.

This volume moves progressively from its introductory chapter, 'Modernist culture, modernist science' where it overviews the field and introduces key scientific and technological concerns in the period, to chapters two and three, 'The Physical Sciences and Mathematics' and 'The Life Sciences', which both draw on recent

scholarship and provide influential and critical debate on the three main themes of the volume. Chapter four and the Coda both engage with relatively new ground, particularly in regards to the human sciences (e.g. anthropology, sociology, and psychology) and the emerging field of disability studies.

The body has always been an intriguing, but nonetheless difficult point of study, both in science and literature. In the modernist period, technological and scientific advancements changed approaches to the body, redefining possibilities and potential, allowing for an extension of the senses – the ability to see more with the invention of the x-ray for example, and the ability to hear further with the increased technology of the telephone and film. The study of the disabled body in this period has the potential to redefine our approaches to the senses, through a study of their ability to adapt and improve other forms of perception and expression provided by new scientific advancements and discoveries.

Engaging with old debates within a relatively new critical cross-disciplinary framework, Morrisson provides a comprehensive survey of modernism in this fairly short volume. From the complexities of chemistry and hard sciences, to the conceptual difficulties that are inseparable from developments in subconscious thought theory and life sciences, Morrisson leads the student by the hand in this text, tying in key developments within the scientific and technological fields with notable literary trends and works from seminal modernist figures like James Joyce, Virginia Woolf, H. G. Wells, and Gertrude Stein. Modernism alone has elicited countless studies, ranging from grand scale, all-encompassing monographs, to more specific, narrow studies of specific authors, themes, and theories. What Morrisson embarks on here is something in-between.

Whether within the arts, or the scientific or technological fields, the twentieth century threw many things, once thought of as stable, known, and solid, up into the air, prompting, for example, the famous work from Marshall Berman, *All That Is Solid Melts into Air* (1982), which examines the conflicting relationship between the social and the economic during the modernist period, with modernist art and industrial capitalism often at odds. This ambiguity was felt throughout the twentieth century, provoking an intense feeling of anxiety and upheaval. Morrisson highlights that this turmoil was not just felt by the artists of the period, but scientists also, who found themselves adrift in the turbulence of modernism, torn between old and new science - for example with Einstein's epistemological crisis in 1905 as he

struggled to merge classical physics with evolving new sciences. Interestingly, however, scientists, like modernist artists, found a way to make themselves at home in the maelstrom of modernism, embracing its paradigm shifts with enthusiasm and resulting in many modern avenues, not just the arts, largely adhering to Ezra Pound's famous declaration: "Make it new".

Drawing attention to seminal works on modernism and technology, Morrisson stresses the fusion of the human with the machine, afforded by scientific and technological developments. In many ways a turn inwards towards the subconscious and the mind, and in others ways an outward focus on physical advancement, the modern body was repeatedly exposed to machine-culture, stretching to fit the new cultural demands that needed internal reflection and outer progression. As Morrisson himself notes early in his first chapter, "many of the developments that fuelled a growing modernist self-consciousness were precisely these rapidly paced technological and scientific changes" (2). He suggests that the similar adherence shared by artists and scientists to the remarkable effect of self-consciousness within the period creates an argument for the movement's description as not just modernism, but a "scientific and technological modernism" (7).

This was reflected in much of the literature of the time, including seminal writers like Woolf and Joyce, as Morrisson discusses with insightful reference to how both authors blended art and science to accommodate the new consciousness of the period (Woolf and thermodynamics, pp. 46-49; Joyce and new physics, pp. 73-76, 78-79). However, many modernist texts that incorporated scientific elements into their narrative techniques, plots, and styles, have been largely overlooked in this respect. Morrisson's work has the possibility to reimagine such works within the scope of science and technology through his detailed investigation into their parallel, and largely inseparable, developments. Although some work has already been embarked on (see Michael Davidson 2007; Yoshiki Tajiri 2007), there is room, if not a need, for a revision of several of Samuel Beckett's works within the scope of disability studies, particularly in the context of technological and scientific developments that Morrisson highlights. Through such revisions, many of his works would hold the potential for a more positive reading – one which views his attention to the embodied experience as an interest in new technologies, as opposed to the prevalent readings of negative body.

Despite this seemingly pleasant blend of discourse from different spheres, this is not an easy read. With terms like "non-Euclidean geometries" and "thermodynamics", this study may first appear intimidating to a student of modernist literature. Although dense in nature, the layout and progression of the book, with the glossary at the end, transform this text into an ideal companion for the study of the effect of science and technology on the modernist period. The Coda stands out as something that will be of great interest to a variety of readers. Merging old and new science, this final section impels further study, and in summary echoes the intention of the text as a whole. This intention was never to explain away all the complex revolutions that took place in science and technology in the twentieth century. Instead, what Morrisson does take on is a "will to cross disciplinary boundaries" (155). This will is emphasised in Morrisson's passion throughout this text, a passion that will no doubt prove invaluable to scholars in modernism, science and technology.

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Flight Ways: Life and Loss at the Edge of Extinction

Thom Van Dooren

New York: Columbia University Press, 2016.

Reviewed By

Georgia Dearden

Van Dooren opens the book with a story of perhaps the most infamously extinct bird – the Dodo. Very few stories of this bird remain in the 21st century aside from that of its extinction. Dodos were among the first species to be written about as having died out because of humans – specifically due to the destruction of their natural habitat by European colonial explorers. As the author states, this awareness allows us to understand our implication in the loss of species, the loss of ways of life. This publication acts as something of a eulogy for extinct and endangered birds. In chapter four, "Mourning Crows: Grief in a Shared World", Van Dooren states that he wishes this chapter to act as a narrative of mourning. The sad story of the Dodo ominously signals the uncertain futures of the birds whose stories we encounter in this book.

Situated between the environmental humanities, extinction studies, and the natural sciences, Van Dooren orchestrates a conversation around the particularities of a number of species of bird. Each chapter in this book focuses on the specific stories of a different bird currently threatened by extinction at the hands of human carelessness. Chapter 1 relays the stories of the Albatrosses of the Pacific. Van Dooren describes the increasing threat posed by plastic waste in our oceans, looming over these albatrosses and presenting a growing threat with each day. As

readers, we are asked to reconsider what is at stake in the messy entanglements of embodied temporalities (33) – ways of life shared over generations of birds, lifespans of seemingly immortal plastics, and our own human species. Van Dooren calls for greater attention to be paid to the temporal nuances of ways of life shared over generations and the threats posed to such ways of life by plastic waste. He argues that this might enable us to understand the significance of the ending ways of life, while drawing us into a closer connection with other species. Our waste has brought us into direct and profound contact with these birds and, Van Dooren states, humans have failed to adapt to current ecological conditions in such a way that will allow us to continue living together in multispecies communities on this planet. Reflecting wider developments within the field of extinction studies from thinkers such as Ursula Heise and Donna Haraway, Van Dooren argues for the importance of ecological storytelling. He states that such inter-species stories can reconnect us with the distant, ongoing impacts of our waste.

In Chapter 2, we are brought into contact with Indian Vultures. This chapter focuses on the dynamics of eating and being eaten in multispecies communities – the digestive entanglements of the dead and the living. Van Dooren tells us that vultures have traditionally been at the heart of life and death's transformative potential, twisting death back into life and providing an efficient means of disposing of the dead. But due to the increasing presence of the drug diclofenac in cattle, vulture numbers are rapidly declining. Where diclofenac has been used to treat a cow while it was alive, it stays in the flesh of the cow after its death and poisons vultures who feed upon it. This produces what Van Dooren calls a 'double death' (54). This is a condition within which dead bodies fail to nourish and instead poison, producing more and more death that cannot be twisted back into life. The author here questions how we can live well within the perpetually unequal patterns of amplified loss and suffering that are produced here and take on further significance as climate change increases.

Chapter 3 focuses on the tales of the Little Penguins of Sydney Harbour and their struggles to find their way home to the burrows they hatched in, which are now in the foundations of privately owned homes. In this chapter, Van Dooren argues for the importance of knowing the stories of other species, because although as humans we can never fully understand them, to know more enables us to see differently and be drawn into new kinds of relationships and ethical obligations. The

author draws us as readers into a confrontation with the ethical, ecological and philosophical weight of our actions. This is done not only through Van Dooren's detailed accounts of the homeless penguins – the text performs its call for more stories and relationships to extinction by successfully provoking the reader's empathy.

Chapter 4 discusses the rearing of Whooping Cranes in North America. In a discussion of captive breeding programmes, Van Dooren unpacks the violence implicit in the care of these birds. As Van Dooren tells us, the suffering that whooping cranes undergo in captivity positions them as something of a 'sacrificial' generation (91). These are the generations undergoing the debatably necessary suffering for the continuation of the larger species. The author argues that our ways of thinking around violent care need to be radically different, such that ways of living together in captive spaces might become more visible and imperative.

The final Chapter covers the mourning rituals of a number of birds, in particular the very nearly extinct Hawaiian Crow. Here Van Dooren laments the lack of popular interest in extinction and argues for the importance of empathy (136). Grief is here positioned as a process of transformation and learning to accommodate an altered reality. Van Dooren argues that the stories by which we live shape the world we live in and vice versa. He states that as they travel, stories breath new life into the dead, enabling them to haunt our lives and future possibilities. The narrative of mourning Van Doreen presents throughout this book is not one of putting to rest, but of learning to live with the dead in way that is sustainable – of learning to live with ghosts.

Van Dooren argues for the necessity of storied ways of co-living and dying in the world through telling the stories of a variety of birds. As readers, we become emotionally entangled with these birds. As I read about their various fates from Tex the Whooping Crane (97), to the homeless Penguins of Sydney Harbour (84), I felt very real pangs of sadness for them. This book not only offers an insight into the complex architecture of extinction, but also invites the reader into a relationship with these birds. The book is cleverly structured in that Van Dooren allows us to 'get to know' these birds - he takes the time in each chapter to give detailed specifics of their lives. But each chapter has a sorry tale to tell, and by the time the reader reaches the final chapter on grief and mourning, we are ourselves already mourning for the loss and suffering of the birds we have read about.

Van Dooren's call for more cultural scripts and stories around extinction is highly compelling. We are forced to hold ourselves accountable for our part in their suffering. In teaching us something of the mourning rituals of Crows, Van Doreen invites us to mourn together with these crows in a way that is generative – 'in choosing to grieve we choose life' (144).

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The Restless Clock: A History of the Centuries-Long Argument over What Makes Living Things Tick

Jessica Riskin

Chicago; London: University of Chicago Press, 2016.

Reviewed By

Romén Reyes-Peschl

Describing paradoxes can be inherently dangerous – how to avoid the very pitfall one is trying to describe? Historian of science Jessica Riskin sets forth nevertheless, and ultimately succeeds, precisely because of an avowed desire not to avoid paradox, but instead to investigate and (if needs be) to explode it from within; basically, to merrily embody it. To this writer's mind, her challenging and fascinating book treats 'The Restless Clock' of its title so well because it resembles a type of textual 'Restless Clock' itself.

First appearances are to the contrary, however, with Riskin taking a more standard chronological approach to structure. Her premise is to trace 'the origins and history of the principle banning agency from science and this principle's accompanying clockwork model of nature' (2). Riskin's point of departure is actual clockwork models of living beings, the surprisingly ubiquitous automata of medieval Europe, and gradually onwards into the global currency of robotics and AI. It is these early lifelike machines, she maintains, that inspired the philosophical discussions which in turn led to the inception of modern science itself.

Thus, developmental scientific debates sit alongside a material history of androids, life-mimicking machines and proto-robots. After the expository chapter on

Renaissance automata, Riskin patiently relates foundation-building chapters on Descartes, an assortment of 'natural theologians' and Cartesian detractors, and the nigh-universal employment on all sides of clockwork and telescope metaphors. These analyses also take in the strikingly life-imbued vicissitudes of now commonplace words such as 'machine' (150) and 'organization' (180).

All this sets the scene for a description of the rise and fall of Romantic science, and its fraught, equivocal influence upon Darwin. As the power of Darwin's ideas came to be recognized by peers, and later on by successors, such complex but fruitful ambiguity at their roots was not always readily accepted. Indeed, competing claimants to the most accurate interpretation of Darwin argued fiercely about the provenance of his influences (especially that of Lamarck), but when the dust eventually settled – the clock's pendulum swinging away once again – the net result was the utter repudiation of even the vaguest whiff of Romanticism, as encapsulated in the neo-Darwinism characterized by Riskin's villain of the piece, August Weismann.

But far from being solely descriptive, there is a prescriptive, almost political agenda lurking beneath Riskin's words. She urges that her 'major purpose […] has been to demonstrate the importance of historical understanding to current thinking about the sciences of life and mind' (10). If this somewhat lukewarm opening statement of intent demurs the point, the book then steadily builds to the crescendo of the forthright final chapter, unambiguously titled 'History Matters' (337) (and incorporating perhaps unintentionally polemical subtitles like 'Armies of Idiots' (339) and 'Heated Agreement' (347)).

Between these two poles of tepidity and fieriness, Riskin manages never to waver from her central argument by stoking it up slowly. Though chronological, the inner workings of each chapter tick-tock back and forth from one type of account of nature to another, very much in the manner of Leibnizian loan-term *Unruhe*, meaning 'restlessness'. These types of account can crudely be summarized as 'classical mechanist' vs 'self-propelling, agential or mystical'. Herein lies the paradox for Riskin: classical mechanism's ban on agency in scientific explanations silently imported an off-screen supernatural power to underwrite the mysteries of nature.

She identifies in the second, agential category a series of rigorously scientific yet disavowed figures who have been castigated by classical mechanists for just such misdemeanours as the mechanists themselves unwittingly commit. This

contradiction, according to Riskin, underpins the emergence of modern science, and continues to this day (hence the longstanding but bitter confusion of a 'Heated *Agreement*'). The solution, and why 'History Matters', of course, is to reverse the disavowal; that is to say, in the words of another of Riskin's late subtitles, the obvious treatment for the maladies of science is 'A Dose of History' (355).

The Restless Clock is an erudite, meticulously researched book, though Riskin takes care not to let her complex subject matter obstruct her lucid prose, keeping almost all secondary commentary to endnotes and an extensive bibliography – indeed, back matter comprises a third of the entire volume. Nonetheless, Riskin laudably maintains a sense of humour throughout, beginning right from her chosen cover image: a mechanical duck (in)famous for defecating, who 'also did other duckish things – flapping, splashing, ruffling – but its main attraction, drawing people from all over Europe to see it, was its final malodorous delivery' (133). Cutting-edge but dense research could more often do with just such a sprinkling of absurd, almost Pythonesque frivolity. Additionally, the many pictures and figures in this beautifully rendered volume help to vividly bolster the historical narrative as much as to keep one's attention.

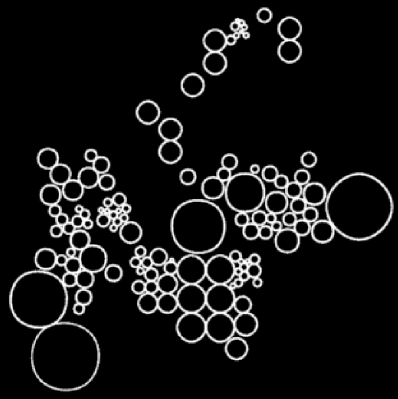
Almost inevitably given the book's subject, however, Riskin's greatest strength and weakness rest simultaneously on a paradox: the increasingly complicated yet correspondingly proselytizing nature of her take-home message. Later chapters, where layers of the agency/passive-mechanism debate pile up and become ever more fine-grained – not to mention impacted by constant technological advance – quickly get jargonistic and a fair bit harder to follow.

As mentioned, this is accompanied by the increased assertiveness of Riskin's voice, but just as she is becoming more confident and convincing, the opacity of the accrued historical palimpsest is given less space, rather than more as it deserves. This means that, though recent developments are no less important to Riskin than their historical precursors, she seems unable to give full expression to their ever-increasing volume and complexity. Closing sections on Cyberneticists and Schrödinger, for example, are thoroughly intriguing, yet somehow feel rushed by comparison with the languor and cohesion of mid-book sections on Leibniz, La Mettrie and Lamarck.

Nevertheless, Riskin's gambit – her 'dangerous idea', as philosopher Daniel Dennett attributes to Darwin – is to steadfastly defend history (and by extension, the

humanities) from the slings and arrows of an all-encompassing, reductive brute-mechanism. She does this by showing that such attacks actually undermine unadulterated, ahistorical mechanism itself. History, the humanities, agency, and even religion (heaven forbid) are built into just such aporia-ignoring scientific ad hominems, but are easily avoidable just by science knowing something more of its own history.

Convincingly establishing whether agency exists in nature or not might be a casualty of the sprint to the book's finish line, but this is perhaps not even the point. In a subtle gloss on the admittedly overplayed Two Cultures debate (itself preceded by the 19th century German schism described briefly on pp. 251–260), Riskin stubbornly reminds readers that the historical ban on agency cannot simply be used as a paradoxical excuse to ban history from debate itself. For this *Unruhe*-inspired insight, Riskin and her agency-riddled, restless clock of a book should be praised time and time again.



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