

VOLUMEN 17 • NÚMERO 32
NÚMERO ESPECIAL: FILOSOFÍA DE LA MEDICINA

*euph*Ψία

REVISTA DE FILOSOFÍA

PRESENTACIÓN

Introducción de los editores, Mario Gensollen y Alger Sans Pinillos

VARIA

La abducción en el razonamiento médico, Cristina Barés Gómez y Matthieu Fontaine

Jeopardizing Biomedical Epistemic Niches, Lorenzo Magnani

Revolución en los modelos sanitarios: diseño, complejidad e instituciones, Anna Estany

Challenges and Controversies of Generative AI in Medical Diagnosis, Jordi Vallverdú

El lugar de la cirugía en la filosofía de la medicina, Cecilia M. Calderón Aguilar

DISCUSIÓN

Ética de la innovación médica, Antonio Sitges-Serra

Análisis y definición de los conceptos de *salud y enfermedad*, Adreu Segura



ISSN 2683-2518

Jeopardizing Biomedical Epistemic Niches

Lorenzo Magnani

Department of Humanities

Philosophy Section and Computational Philosophy Laboratory

University of Pavia

lmagnani@unipv.it

Resumen

Este artículo explora el tema del descubrimiento y la creatividad abductiva en la cognición científica, centrándose en los desafíos enfrentados por las compañías biofarmacéuticas en su organización de I+D. El autor argumenta que estas compañías están generando “nichos epistémicos empobrecidos”, los cuales amenazan aspectos fundamentales de la ciencia moderna. El autor propone el concepto de *irresponsabilidad epistémica*, enfatizando la importancia del “conocimiento en movimiento” en la investigación científica multidisciplinaria, interdisciplinaria y transdisciplinaria. La creciente expansión de la mercantilización y comercialización de la ciencia, la comercialización de productos tecnocientíficos y el empobrecimiento de los nichos epistémicos parecen amenazar el florecimiento de la creatividad humana y la exitosa cognición creativa abductiva en la ciencia.

Palabras clave: compañías biofarmacéuticas; abducción creativa; nichos epistémicos; maximización de la apertura eco-cognitiva; optimización de la situacionalidad eco-cognitiva; investigación y

desarrollo; conocimiento en movimiento; comercialización de la ciencia biomédica.

Abstract

This article explores the issue of discoverability and abductive creativity in scientific cognition, focusing on the challenges faced by biopharmaceutical companies in their R&D organization. The author argues that these companies are generating “impoverished epistemic niches”, which threaten fundamental aspects of modern science. The author proposes the concept of epistemic irresponsibility, emphasizing the importance of “knowledge in motion” in multidisciplinary, interdisciplinary, and transdisciplinary scientific research. The increasing expansion of commodification and commercialization of science, marketing of technoscientific products, and the impoverishment of epistemic niches seem to already threaten the flourishing of human creativity and successful abductive creative cognition in science.

Key words: biopharmaceutical companies; creative abduction; epistemological niches; maximization of eco-cognitive openness; optimization of eco-cognitive situatedness; research and development; knowledge in motion; commercialization of biomedical science.

1. Abduction and the Optimization of Eco-Cognitive Situatedness Promote Discoverability

In my recent research I have argued that efficient strategies must be used in order to achieve selective or creative good abductive results —the word abduction characterizes all cognitive acts that lead to hypotheses— but it is also necessary to rely on an environment characterized by what I have dubbed *optimization of*

eco-cognitive situatedness, in which the “eco-cognitive openness” (Magnani, 2016) is the central requirement. Indeed, good creative and selective abduction reasoning strategies must not be “locked” in an externally constrained eco-cognitive environment, such as one with fixed definitory rules and finite material components (this is the case, for example, of the computer counterparts of games like Go or Chess), which obviously serve as cognitive mediators capable to limit agents’ reasoning.¹ The significant issues of *discoverability* and *diagnosticability* (Magnani, 2022), which are mostly ignored in the literature on abduction (and only briefly sketched by Charles Sanders Peirce himself, universally recognized as the “father” of abduction), can be fruitfully addressed by the concept of *optimization of eco-cognitive situatedness*.

Abductive cognition is also crucial in scientific reasoning for developing original and creative hypotheses. *Situatedness* is related to eco-cognitive aspects, where knowledge travels. *Maximizing* the richness of information flux is essential for solving inferential problems, especially in science and medical diagnosis. Hence, the primary quality of logical abductive inference is the *optimization of eco-cognitive situatedness* —and in science also its maximization— which surpasses other criteria like minimality, consistency, relevance, and plausibility, to produce the final result.

The optimization of eco-cognitive openness and situatedness in science is under threat due to the current precarious state of human abductive creative cognition, prompting increased attention. Chapter eight of my book (Magnani, 2017) highlights negative issues affecting human abductive cognition in science,

¹ More information on the function of locked and unlocked strategies in AI computational programs is provided in (Magnani, 2019).

including epistemic irresponsibility, commercialization, and depletion of epistemological niches. These issues threaten human creativity and fruitful abductive cognition in science, highlighting the need for urgent action. Biopharmaceutical companies are a prime example of impoverished *epistemic niches*² in contemporary science. This impoverishment generates the emergence of what I call *epistemic irresponsibility*, that threatens the epistemic integrity of science, because it jeopardizes the critical role of the optimization of eco-cognitive openness and situatedness in abductive cognition.

Indeed, some parts of scientific enterprise are being commodified and commercialized, leading to the marketing of technoscientific products and at the same time the depletion of the epistemic niches in which scientific cognition would have to flourish. *Knowledge in motion* is put in danger, a characteristic that is instead crucial in a multidisciplinary, interdisciplinary, and transdisciplinary productive research, capable to favor what we called optimization and situatedness of eco-cognitive openness. Interdisciplinary collaboration is essential to address epistemological issues, epistemic irresponsibility refers to the impoverishment of scientific research and encompasses eco-cognitive scenarios, including those connected to economic, political, and institutional spheres. I contend that the lack of epistemic responsibility can have serious consequences for society.

² In the following section the concept of epistemic niche will be clarified, in its relationship with the so-called cognitive niches.

2. Improving “Knowledge in Motion” by Encouraging Scientific Abduction via Eco-Cognitive Openness Maximization

We said that human abductive cognition plays a crucial role in research, and permits the individuation of the ethical and epistemological problems that are present in various fields like information technology, engineering, and biomedical sciences. This raises a new challenge for the philosophy of science, which now should be more socially relevant for the entire community of citizens. The philosophy of science can now address the issue of trust in the relationships between science and society, identifying instances where epistemic rigor is compromised, causing good scientific rationality to be destroyed or even “faked”. (Fernández Pinto, 2020) provides a deep analysis of the fact that research in science can be influenced by commercial interests, which can lead to untrustworthy results. For instance, patent incidents of scientific fraud or misconduct can cause doubt among policymakers and the public. Hence, commercialized science is considered the primary cause of the decline in public confidence in science. Commercial interests can encourage consensus or dissent that is beneficial to industry but unacceptable from an epistemological perspective. This can also result in limited reliability when industry asserts its research is trustworthy when it is not.

As I said above the exchange of ideas and scientific information is actively encouraged in the so-called *epistemic niches*, which are a special kind of *cognitive niches*. These are cognitive human acts that transform the physical world into a cognitive one. According to relatively recent research on the field of biosciences of evolution made by Odling-Smee, Laland, and Feldman (Odling-

Smee *et al.*, 2003; Laland and Sterelny, 2006; Laland and Brown, 2006), humans have created large cognitive niches, characterized by informational, cognitive, and computational processes, that of course are also related to the performance of high-level cognitive activity such as scientific rationality and reasoning. Since Galileo Galilei, in epistemic niches mindful dissent is promoted, and secrecy is abolished. Science is seen as a morally charged endeavor, with the moral commitment to adhere to accepted procedures, laws, and cognitive practices. Without these features, an epistemic niche is no longer epistemically characterized, as it is not committed to advancing scientific research in the best way. This perspective allows us to perceive science as a morally charged endeavor, with the moral and epistemic aspects being not strictly separable.

Moreover, scientific inquiry is facilitated by collectives that promote free exchange of ideas, as exemplified by John Stuart Mill. Broad individual freedom from restriction, as allowed in some communities, is also crucial for scientific creative abduction. As illustrated above, eco-cognitive openness, and the optimization of eco-cognitive situatedness, is essential for scientific creative abduction. However, this characteristic requires special care to be maintained and preserved in these communities, as it is essential for the advancement of scientific inquiry.

Biddle (Biddle, 2009) criticizes Longino (Longino, 2002: 159) for focusing on “unencumbered selves” and claiming it creates a false impression of freedom in science. However, he is mistaken in his view that creative abductive scientists must be open to everything and operate in a world where no claim or belief can be immune from criticism. In areas of scientific inquiry unrelated to creative abduction but to every day generic routines, people do not

necessarily need to be completely open-minded but belong to specific epistemic niches that offer pre-established guidelines, heuristics, methodologies, and evaluation standards. This highlights the importance of understanding the social context in which scientific inquiry occurs and balancing openness to new ideas with adherence to established practices.

In sum, scientists exist in social “epistemic niches” defined by established paradigms, research programs, and exemplars. These niches provide rigid rules and criteria that govern scientific cognitive processes. This highlights the importance of understanding the social context in which scientific inquiry occurs and the need for scientists to balance their openness to new ideas with their adherence to established scientific practices. This also highlights the need for critical analysis and questioning of beliefs as already illustrated by Kuhn (1962), Lakatos (1970), Feyerabend (1975) and by their enormous following. Without a doubt, it is reasonable to view certain scientists as “advocates for particular approaches, paradigms, or research programs” as Biddle says (2009: 622) —also Lakatos famously stressed the important role of “the rationality of a certain amount of dogmatism” (1970: 175)— but also as individuals who, when faced with the difficulty of learning new concepts, are receptive to everything.

Scientific research is crucial for maintaining discoverability, which involves optimizing and maximizing eco-cognitive openness and situatedness. The social, political, and economic environment in which research is embedded plays a significant role in facilitating scientific discoveries. The availability of resources and funding is essential for facilitating scientific breakthroughs. Collaboration among scientists from different disciplines and regions can lead to more comprehensive and

diverse research outcomes. A supportive environment that encourages open communication, funding, and collaboration is essential for scientific progress, ensuring that even the most talented scientists can make significant contributions to their respective fields.

The importance of the institutions and procedures for the creation and acquisition of knowledge has always been highlighted by social epistemologists (Longino, 1990; Kitcher, 1993). Also Reiss, who was specifically referring to biomedical research, stressed the significance of not limiting normative judgments about how to organize research to ethical aspects alone (such as discriminating against diseases that affect racial or ethnic minorities, the poor in Western societies, or diseases that affect the world's poor, etc.), but also to the epistemic components of research when, for example, epistemic decency is disrespected (Reiss, 2010). In particular scientific creative abduction faces challenges due to narrow specialization, which hinders the development of eco-cognitive openness.

Despite cross-disciplinary boundaries, such as in HIV/AIDS research, the cross-fertilization of ideas in a state of "knowledge in motion" is a key characteristic of this flourishing creative scientific research in the modern era. For example, research on HIV/AIDS has been gaining attention due to its multidisciplinary approach, highlighting the importance of maximizing eco-cognitive openness for abduction, as stressed in the article "Knowledge in motion: The evolution of HIV/AIDS research" (see (Adams and Light, 2014; Light and Adams, 2016)), Light and Adams' research programs on HIV/AIDS utilize scientometric computational techniques to illustrate the integration stages of disciplinarity, multidisciplinarity, and interdisciplinarity. These factors are

connected to a real optimization, aiming to maximize eco-cognitive openness, that distinguishes creative abductions in science.

Research in multidisciplinary fields involves specialization from various disciplines, promoting interdisciplinarity and transdisciplinary approaches, facilitating a comprehensive understanding of a single topic. Light and Adams (2016: 1229–1230) observe that the U.S. National Academy of Sciences emphasizes the importance of interdisciplinary research, which involves teams or individuals integrating information, data, techniques, tools, perspectives, concepts, and theories from multiple specialized knowledge fields to advance fundamental understanding or address issues beyond the purview of a single discipline. This approach, characterized by transdisciplinarity, has been extremely successful in HIV/AIDS research, demonstrating the dynamic nature of integration across disciplinary lines:

HIV/AIDS research appears to have grown more multidisciplinary also consistent with increased specialization, after an initial period of more interdisciplinary integration. In other words, after an initial period of high cross-fertilization and joint problem-solving, the researchers returned to their silos working on overlapping topics in a more disciplinary fashion. As evidenced by the case of HIV/AIDS research, integrated programs are dynamic and situate themselves into different states of organization (Light and Adams, 2016: 1245).

Research in interdisciplinary areas fosters cross-disciplinary collaboration, promoting comprehensive solutions to complex problems. Institutions should promote interdisciplinary research, fostering communication and collaboration among researchers. This approach benefits both the scientific community and society

by bringing together diverse perspectives and expertise, thereby favoring a dynamic and innovative approach. In the following section further details instead related to the current impoverishment of epistemic niches and related to the commercialization of science will be illustrated.

3. Technoscience Marketed

The United States was fostering epistemic responsibility through the HIV/AIDS studies, involving scientists and decision-making agents in creating appropriate artifacts, policies, attitudes, and intellectual habits. This responsibility is crucial in ensuring the development of social and economic institutions that promote responsible epistemic actions. Unfortunately, as reminded by Biddle (2011: 245–246), in 1964 0.8% of the whole U.S. R&D was funded by private industry, while 66.8% was funded by the federal government, however, the relationship had already reversed in 2004: the federal government funded 29.9% of national R&D, while private enterprise funded 63.8% of it. In addition, a growing number of scientists from both government and academia are establishing financial relationships with private companies. Some of these scientists are managing the dual roles of academic researchers and entrepreneurs by starting their own enterprises. These changes have led to a growing influence of commercial interests on science practices in government laboratories as well as academic settings.

Lazonick (2007: 11) creates a similar image using information regarding internal R&D (i.e. R&D made in-house by pharma companies). The high drug prices in United States, exacerbated by

a generous intellectual property regime and lax price regulation, have led to a rise in pharmaceutical companies like Pfizer. These companies argued that profits from these high prices allow more R&D to be done in the US. However, from 2003 to 2012, Pfizer channeled 71% of its profits into buybacks and 75% into dividends, using its capital reserves to finance these activities. As Lazonick says, this demonstrates that US citizens pay high prescription costs to boost stock prices and CEO compensation. Neoliberal politics in the U.S. has influenced scientific research in biomedical science, focusing on financially successful fields. This strategy, supported by market values, aims at producing ongoing scientific advancement and social gain by reducing government restrictions on information exchange and knowledge sharing. This approach supports deregulation and the conversion of scientific research into a carrier of commercially viable goods.

Unfortunately, allowing market forces to determine numerous fundamental disciplines of study —like the biopharmaceutical one— has resulted in a deterioration in epistemic quality: “a sacrifice of epistemic standards at the altar of profit” (Biddle, 2011: 246). Knowledge is not appreciably “in motion” anymore. Universities and private companies were able to patent research results funded by the government under the U.S. Congressional Patent and Trademark Amendments Act, while government laboratories could patent research results under the Stevenson-Wydler Technology Innovation Act of 1980 (which was later amended in 1986) (Biddle, 2011). Prior to these laws, findings from privately promoted research could be privately appropriated, while publicly supported research definitely resulted in innovations that stayed in the public domain. We are seeing a “[...] proprietary treatment of research results, with the

commercial interest in secrecy overriding the public's interest in free, shared knowledge" (Brown, 2000: 1701). In conclusion, it is evident that political and economic decisions, rather than the scientific community, are what gave rise to the current "obsession" with commercialization in general and patenting in particular (Biddle, 2012).

As neoliberals increasingly pressure (public) universities to actively pursue the so-called "technology transfer", which calls for universities to produce knowledge that is easily transferable to businesses so they can use it commercially, I believe the situation is getting worse. So, academics are impacted by the fact that they are also under continual pressure from this concern with "technology transfer", which frequently seems nonsensical in those nations that invest too small amounts of money in research.

The significant impact of epistemic irresponsibility on the eco-cognitive environment of key areas of science leads to threats to scientific discovery productivity and discoverability. This irresponsibility, particularly in biomedical and pharmaceutical research, poses a significant threat to the survival of fields not directly marketable, such as humanities, mathematics, and science, which are essential to preserve and feed western civilization. This irresponsibility could spread throughout various scientific and technological fields. Neoliberals have weakened state institutions, limiting the freedom of scientific study. Positive freedom, which allows for specific actions or results, promotes knowledge, and optimizes eco-cognitive situatedness. However, neoliberals view freedom as the absence of constraints, which is insufficient for real freedom. This has weakened state institutions, unable to regulate conduct and distinguish between public and private interests, affecting commercialized scientists.

Strangely and contrary to all expectations, a new and significant obstacle also emerged: scientists are no longer free to share research findings after their work has been “commercialized” and dependent on the private sectors, thereby paradoxically violating negative freedom that would otherwise be defended. The sponsored biopharmaceutical industry and agricultural biotechnology, for example, are both impacted by this finding because for-profit companies tend to only investigate research that is profitable for them and to avoid research that is not so that otherwise-defended negative freedom is instead violated (Elliott, 2012).³ Another example regards the statement that “for-profit corporations have a history of biasing studies to increase the likelihood of obtaining desired results” (Biddle, 2014: 17). Big Pharma is known for concealing information that might raise questions about the safety or effectiveness of their products.

Financial factors influence research problem selection, method selection, data interpretation, and dissemination and public dissemination strategies. They also indirectly influence these decisions by fostering an atmosphere that discourages researchers from pursuing particular research topics. The end effect is a type of repression of some study areas and, at the same time, the creative potential of those areas (Biddle and Leuschner, 2015: 274). As Brown observed “A recent study (Shulman, 1999) found that more than one-third of recently published articles produced by University of Massachusetts scientists had one or more authors who stood to make money from the results they were

³ The author also shows how information-dissemination strategies are often employed, for example, only to quell public fears (as in the case of genetically modified –GM– crops).

reporting. That is, they were patent holders or had some relationship, for example, as board members, to a company that would exploit the results. The financial interests of these authors were not mentioned in the publications” (Brown, 2000: 1701).

It is also necessary to discuss the phenomenon known as “publication bias”, which happens when some research results — usually scientific papers that highlight “problems” with certain significant patented or soon-to-be-patented products— are not published. It is an open secret that studies showing no statistically significant relationships —that is, neither positive nor negative statistical relationships— are not even accepted for publication in management and economics journals. This is surprising because non-statistically significant study findings can be highly fascinating as they can refute and question certain presumptions and preconceptions (van Hilten, 2015).

Moreover, another way for endangering human creative abduction by inadequate epistemic niches is related to the problems of current expensive pharmaceuticals and the further mindless commercialization of abduction in science. The problems of expensive drugs addresses the issue of additional risks to the development of human creative abductive processes in high-tech, business-oriented environments. Again, these environments have resulted in a further commercialization of science because universities are increasingly depending on business and charity (Brown, 2000; Biddle, 2007). The “epistemological” effects of these processes on human creativity and its survival in scientific practice are, as I have previously noted above, equally significant as the basic social and political fact that pressures are making colleges become the silent employees of business. I deepened these last aspects in my recent book (Magnani, 2022: chapter four).

As a researcher in cognitive science, logic, and epistemology, I find it absurd that so many scientific methods and findings are being made into products for sale. A prime illustration of this is the fact that the “product” of a scientific discovery or innovation is controlled by a limited number of owners. It seems ridiculous because, as we all know, science is a collaborative enterprise that has evolved over many generations, implying that any new discovery is also reliant on prior achievements. Without prior “theoretical” discoveries, which were of course difficult to sell and therefore appear to be unimportant in the context of the current commercialization process, several modern technologies would not exist today. Naturally, geniuses and personalities are significant, but their contributions have always been linked to something called the cultural “commons”, or the human social contexts in which they operated as well as the rich cultural legacy left by the past. In this context, it appears extremely problematic to provide a basic example of how to defend exclusive property rights when the subject matter is a GMO rather than a painting or a romance. Achieving a balance between safeguarding intellectual property rights and guaranteeing the public’s access to vital resources is crucial. The ethical, legal, and societal ramifications of this need to be carefully considered.

In sum, it is crucial to acknowledge the impact that intellectual property rights can have on innovation and progress. While these rights may incentivize research and development, they can also hinder collaboration and limit access to important advancements. Therefore, finding a balance between protection and accessibility is essential for promoting both innovation and social welfare.

4. Conclusion

Epistemic irresponsibility is a significant issue in the scientific enterprise, particularly in biopharmaceutical companies. This irresponsibility is characterized by the depletion of epistemic niches, which are crucial for the development of scientific human abductive cognition. The current organization of R&D in biopharmaceutical companies is a prime example of epistemic irresponsibility, as it threatens the core characteristics of contemporary science. The paper highlights the importance of knowledge in motion in multidisciplinary, interdisciplinary, and transdisciplinary scientific inquiry. The marketing of technoscientific products and the depletion of epistemic niches are negatively impacting the potential for abductive creative cognition in some areas of science, putting human creativity at risk.

Acknowledgements

Parts of this article are excerpted from chapters one and four of the book *Discoverability. The Urgent Need of an Ecology of Human Creativity*, Springer, Cham, 2022. For the instructive criticisms and precedent discussions and correspondence that helped me to develop my analysis of abductive cognition I am indebted and grateful to John Woods, Atocha Aliseda, Woosuk Park, Luís Moniz Pereira, Paul Thagard, Ping Li, Athanassios Raftopoulos, Michael Hoffmann, Ahti-Veikko Pietarinen, Gerhard Schurz, Walter Carnielli, Akinori Abe, Yukio Ohsawa, Cameron Shelley, Shahid Rahman, Cristina Barés Gómez, Matthieu Fontaine, Gerhard Minnameier, Pat Langley, John Josephson, Ferdinand D. Rivera

and to my collaborators Selene Arfini, Alger Sans Pinillos, and Riccardo Dossena.

References

- Adams, J., and Light, R. (2014). "Mapping interdisciplinary fields: Efficiencies, gaps and redundancies in HIV/AIDS research". *PLOS One* 19(12): e115092. doi:10.1371/journal.pone.0115092
- Biddle, J.B. (2007). "Lessons from the Vioxx debacle: What the privatization of science can teach us about social epistemology". *Social Epistemology* 12(1): 21-39.
- Biddle, J.B. (2009). "Advocates or unencumbered selves? On the role of Mill's political liberalism in Longino's contextual empiricism". *Philosophy of Science* 76(5): 612-623.
- Biddle, J.B. (2011). "Bringing the marketplace into science: On the neoliberal defense of the commercialization of scientific research". In Carrier, M., and Nordmann, A. (eds.), *Science in the Context of Application* (pp. 245-269). Dordrecht: Springer.
- Biddle, J.B. (2012). "Tragedy of the anticommons? Intellectual property and the sharing of scientific information". *Philosophy of Science* 79(5): 821-832.
- Biddle, J.B. (2014). "Can patents prohibit research? On the social epistemology of patenting and licensing in science". *Studies in History and Philosophy of Science Part A* 45(1): 14-23.
- Biddle, J.B., and Leuschner, A. (2015). "Climate skepticism and the manufacture of doubt: Can dissent in science be epistemically detrimental?". *European Journal for Philosophy of Science* 5(3): 261-278.
- Brown, J.R. (2000). "Privatizing the university—the New Tragedy of the Commons". *Science* 290(5497): 1701-1702.

- Elliott, K. (2012). "Selective ignorance and agricultural research". *Science, Technology, and Human Values* 38(3): 328-350.
- Fernández Pinto, M. (2020). "Commercial interests and the erosion of trust in science". *Philosophy of Science* 87(5):1003-1013.
- Feyerabend, P. (1975). *Against Method*. London-New York: Verso.
- Kitcher, P. (1993). *The Advancement of Science: Science Without Legend, Objectivity Without Illusions*. Oxford: Oxford University Press.
- Kuhn, T.S. (1962). *The Structure of Scientific Revolutions*. Chicago: The University of Chicago Press. Second expanded edition, 1970.
- Lakatos, I. (1970). "Falsification and the methodology of scientific research programs". In Lakatos, I., and Musgrave, A. (eds.), *Criticism and the Growth of Knowledge* (pp. 365-395). Cambridge: The MIT Press.
- Laland, K.N., and Brown, G.R. (2006). "Niche construction, human behavior, and the adaptive-lag hypothesis". *Evolutionary Anthropology* 15: 95-104.
- Laland, K.N., and Sterelny, K. (2006). "Perspective: Seven reasons (not) to neglect niche construction". *Evolution. International Journal of Organic Evolution* 60(9): 4757-4779.
- Lazonick, W. (2007). "The big idea. Profits without prosperity. Stock buybacks manipulate the market and leave most Americans worse off". *Harvard Business Review* 3: 1-11.
- Light, R., and Adams, J. (2016). "Knowledge in motion: The evolution of HIV/AIDS research". *Scientometrics* 17: 1227-1248.
- Longino, H.E. (1990). *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton: Princeton University Press.

- Longino, H.E. (2002). *The Fate of Knowledge*. Princeton: Princeton University Press.
- Magnani, L. (2016). "The eco-cognitive model of abduction. Irrelevance and implausibility exculpated". *Journal of Applied Logic* 15: 94-129.
- Magnani, L. (2017). *The Abductive Structure of Scientific Creativity. An Essay on the Ecology of Cognition*. Cham: Springer.
- Magnani, L. (2019). "AlphaGo, locked strategies, and eco-cognitive openness". *Philosophies* 4(1): 8.
- Magnani, L. (2022). *Discoverability. The Urgent Need of an Ecology of Human Creativity*. Cham: Springer.
- Odling-Smee, F.J., Laland, K.N., and Feldman, M.W. (2003). *Niche Construction. The Neglected Process in Evolution*. Princeton: Princeton University Press.
- Reiss, J. (2010). "In favour of a Millian proposal to reform biomedical research". *Synthese* 177(3): 427-447.
- Shulman, S. (ed.) (1999). *Owning the Future. Staking Claims on the Knowledge Frontier*. New York: Houghton Mifflin.
- van Hilten, L. (2015). "Why it's time to publish research "failures"". *Science Communication*.
<<https://www.elsevier.com/connect/scientists-we-want-your-negative-results-too>>