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Article

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Social dynamics and ethical principles: keys to reading about retraction in publications

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ABSTRACT

Introduction Retraction in scientific publications is a phenomenon that challenges the integrity of science. Despite its importance, the retraction process is often misunderstood, both by researchers and the general public. Objective: This study explores how ethical concepts and sociological theories can broaden the understanding of retraction practices in scientific publications, analyzing the mobilization of these theoretical contributions as interpretative tools that strengthen scientific integrity. Methodology: A critical review of the literature was used, focusing on classic and contemporary texts selected for their theoretical and empirical relevance. The analysis was structured into two main axes: the first investigates ethical approaches through the contributions of philosophers such as Aristotle and Kant, and contemporary theorists of Information Science; the second examines sociological perspectives from authors such as Durkheim, Weber, Merton and Bourdieu, as well as more recent theories such as social constructivism, actor-network theory and social studies in science, technology and society. These approaches elucidate how social and cultural interactions shape current scientific practices, including retraction. Results: It was observed that retractions often occur due to failures in conducting and communicating research, in addition to systemic pressures to publish. These findings are essential to understanding how these causes affect scientific integrity and highlight the need for more rigorous review and editorial management practices. Conclusion: It was found that, when informed by an integrated view of ethical and sociological perspectives, retraction practices not only correct the scientific record, but also strengthen trust in science, underlining the importance of promoting a transparent and accountable scientific environment.

KEYWORDS

Scientific retraction. Ethics in science. Sociology of science. Scientific integrity. Scientific communication.

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Dinâmicas sociais e princípios éticos: chaves de leitura sobre retratação em publicações

RESUMO

Introdução A retratação em publicações científicas é um fenômeno que desafia a integridade da ciência. Apesar de sua importância, o processo de retratação é muitas vezes mal compreendido, tanto por pesquisadores quanto pelo público em geral. Objetivo: Este estudo explora como conceitos éticos e teorias sociológicas podem ampliar a compreensão sobre as práticas de retratação em publicações científicas,

analisando a mobilização desses aportes teóricos como ferramentas interpretativas que fortalecem a integridade científica. Metodologia: Utilizou-se a revisão crítica da literatura centrada em textos clássicos e contemporâneos selecionados por sua relevância teórica e empírica. A análise foi estruturada em dois eixos principais: o primeiro investiga abordagens éticas através das contribuições de filósofos como Aristóteles e Kant, e teóricos contemporâneos da Ciência da Informação; o segundo examina perspectivas sociológicas de autores como Durkheim, Weber, Merton e Bourdieu, além de teorias mais recentes como construtivismo social, teoria ator-rede e estudos sociais em ciência, tecnologia e sociedade. Essas abordagens elucidam como as interações sociais e culturais moldam as práticas científicas atuais, incluindo a retratação Resultados: Observou-se que as retratações frequentemente ocorrem devido a falhas na condução e comunicação da pesquisa, além de pressões sistêmicas para publicar. Estes achados são essenciais para entender como essas causas afetam a integridade científica e destacam a necessidade de práticas mais rigorosas de revisão e gestão editorial Conclusão: Verificou-se que, ao serem informadas por uma visão integrada das perspectivas éticas e sociológicas, as práticas de retratação não apenas corrigem o registro científico, mas também fortalecem a confiança na ciência, sublinhando a importância de promover um ambiente científico transparente e responsável.

PALAVRAS-CHAVE
Retratação científica. Ética na ciência. Sociologia da Ciência. Integridade científica. Comunicação científico.

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1 INTRODUCTION

> *Academic science has never been an entirely instrumental, anything-goes-if-it-happens activity. It is driven by and completely dependent on personal norms of integrity, honesty, sincerity, and trust that cannot plausibly be explained away as enlightened self-interest alone. (Ziman, 2001, p. 176.)*

More than two decades ago, theoretical physicist and scientific epistemologist John Ziman emphasized the essence of academic science as an endeavor rooted in values of integrity, honesty, sincerity, and trust, emphasizing that these principles transcend mere self-interest and reflect a commitment to truth. Today, this perspective resonates strongly, especially as we face challenges related to fraud, plagiarism, and other forms of scientific misconduct that undermine scientific integrity and culminate in retractions of publications. These not only signal the unreliability of published results, but also serve as a critical reminder of the need to maintain integrity at the core of scientific research.

The practice of retraction in scientific publications has evolved significantly throughout history. In recent decades, there has been an increase in the number of retractions (Banerjee; Partin; Resnik, 2022), driven not only by greater awareness of scientific integrity but also by improved techniques for detecting errors and fraud. In addition, the digital age has transformed the dynamics of scientific publications, with faster dissemination of information and the possibility of more effective oversight by the global academic community.

Despite its importance, the retraction process is often misunderstood, both by researchers and the general public. Some see retraction as a stain on a scientist's career, while others see it as proof of the functionality of the scientific system, which strives to correct its own errors. This duality reflects the complexity and critical nature of retractions in academia, making understanding this phenomenon essential for anyone involved in scientific research.

In view of these challenges, this article mobilizes theoretical perspectives from sociology and ethics in science to understand how retractions of publications affect the scientific communication process. The aim is to answer the following question: how can ethical and sociological perspectives broaden the understanding of retraction practices in scientific publications, contributing to strengthening integrity in scientific communication? The main objective of the research is to investigate the theories of ethics and sociology mobilized in the context of retractions to elucidate and enhance scientific integrity. Specifically, the study aims to: analyze the contribution of ethical theories in guiding scientific retraction practices, highlighting how ethical principles can guide the conduct and correction of errors in scientific publications; explore the sociological theoretical bases that shape scientific integrity, examining how social dynamics and cultural norms impact scientific practices; integrate ethical principles and classical and contemporary sociological perspectives to offer a more complete understanding of how retractions impact trust and conduct in science, aiming to sustain or restore scientific integrity. It is worth noting that the citations from foreign scientific literature used in this study were translated by the authors of the article.

The research is characterized as a theoretical investigation. To achieve the proposed objectives, the methodology of critical literature review (Grant; Booth, 2009) was adopted, focusing on the main theoretical axes of sociology and ethics in science. This method involved a thorough analysis of carefully selected classic and contemporary texts, based on their theoretical and empirical relevance, to provide a comprehensive view of the application of these theories to the phenomenon of retractions in scientific publications. The criteria for selecting the texts included the depth of the theoretical discussion, the relevance to the topic of retractions, and the academic impact of the works in the field of sociology and scientific ethics. The review was divided into two main parts, each focusing on different aspects that are described below.

Ethical approaches to science – this stage of the review focuses on ethical theories that inform scientific retraction decisions and practices. We will investigate the fundamental ethical perspectives of Aristotle and Kant, exploring how their ideas on ethical virtues and deontological ethics apply in the scientific context. We also include theoretical contributions from authors in the field of information science, such as Thomas J. Froehlich and others who discuss specific ethical issues related to scientific communication and integrity.

Sociological approaches to science – review of the contributions of the main theorists of sociology and sociology of science who have analyzed the social dimensions of science, exploring how these theoretical approaches elucidate the issue of scientific integrity. Specifically, the following were examined: Émile Durkheim's ideas on social norms and the role of ethics in social structures; Max Weber's analyses of scientific vocation, disenchantment of the world, ethics of conviction and ethics of responsibility, as instruments that promote integrity; Robert K. Merton's and John Ziman's theoretical perspectives on trust in science, with a particular focus on the institutional norms of academic and post-academic science that offer new perspectives on retraction practices; Harriet Zuckerman's views on deviations in scientific practice and the impact of retractions; and Pierre Bourdieu's approaches to the dynamics of the scientific field and their implications for scientific integrity. Next, we explore how theoretical strands of Social Constructivism, Actor-Network Theory (ANT), and Science, Technology and Society (STS) studies shape contemporary understandings of scientific practices.

Before we explore the ethical principles and complex sociological dynamics that influence retraction practices, it is important to establish a solid foundation of understanding of what constitutes retraction of scientific publications. This will help to outline the essential definitions, common causes, and processes associated with retractions of publications, providing the necessary context to assess the impact of these practices on scientific integrity.

2 FUNDAMENTAL CONCEPTS ABOUT RETRACTION IN SCIENTIFIC PUBLICATIONS

The phenomenon of retraction, the term of which presupposes the act of re-addressing something previously addressed, constitutes a form of declaring a mistake made and, in the context of scientific production, demonstrates a mechanism through which serious and compromising errors or flaws in a published article are declared. This practice justifiably results in the appropriate corrections or the removal of the published article.

In some cases, the authors themselves opt for voluntary retraction, demonstrating their commitment to transparency and scientific integrity. This gesture, although it may affect their reputations, is essential to preserve academic credibility. However, any interested party, including readers, reviewers, or even the editors of the scientific journal, can request the retraction of an article. The participation of these actors reflects the network of responsibility in scientific research and serves as a guarantee that the editorial process occurs with rigor in all its stages.

Thus, retractions are essential measures when a published work presents serious errors or, in more extreme cases, involves fraud and scientific falsification. They go beyond minor corrections or clarifications, highlighting that the original work is no longer reliable. Chen *et al.* (2013, p. 234) define retraction as a formal action to remove the article from the scientific literature due to its lack of reliability. As Santos-D'Amorim *et al.* (2023) pointed out, the retraction of a scientific article serves as a warning mechanism to the scientific community and society. It is important to emphasize that the reliability of a scientific work constitutes an essential element since, once published, it becomes part of an informational helicoid as it will be accessed, treated and appropriated to support the construction of new knowledge that, in turn, will materialize in a new publication, in a continuous movement (Guimarães, 2009).

The Committee on Publication Ethics (COPE, 2019) provides clear guidelines, pointing out that retractions serve to alert about problems such as redundant publication, plagiarism, manipulation of peer reviews, unauthorized use of data, copyright infringement, and other legal or ethical issues. According to the COPE and International Committee of Medical Journal Editors (ICMJE, 2024) guidelines, the retraction process includes clear steps such as request, procedures and deadlines, retraction notices, and transparency, highlighting the role of editors, reviewers, and authors.

The Retraction Watch website, created in 2010 by Adam Marcus and Ivan Oransky, monitors cases of scientific misconduct that result in retractions. By 2018, its database included more than 20,000 records, considered the largest archive on the subject. Recently, Crossref took over the management of this database, ensuring its maintenance and free access, as reported by Durrani (2023).

The need for retraction can arise for several reasons related to research misconduct, including falsification and fabrication of data, as well as plagiarism. Methodological errors or inappropriate interpretations, although often unintentional, also require retraction to maintain the integrity of the scientific literature.

A significant challenge is the persistence of citations of retracted articles, which can spread false information. To address this situation, indexing systems can clearly flag such articles and correct or remove their citations.

Based on a literature review, Santos-D'Amorim *et al.* (2021) pointed out some premises that permeate the phenomenon of retraction in scientific communication, namely: a) retraction constitutes a mechanism for cleaning up the literature, correcting its records; b) its approach raises issues related to misconduct and scientific integrity, important challenges for science today; c) its causes often reside in the pressure of "publish or perish" that characterizes the so-called academic productivism; d) retraction alone does not prevent subsequent harmful effects, as the literature records a high incidence of citations of retracted works, after this retraction; e) retracted articles may evidence the presence of "misinformation" in the scientific community, often equating to the phenomenon of fake news in the mass media. In the latter case, the example offered by Bar-Ilan and Halevi (2021, p.55) that "falsified medical data can mislead the public and cause real harm to people" suggests that retractions and fake news have similarities.

Finally, to minimize retractions, it is essential to adopt proactive strategies such as education on research ethics, rigorous data management, and transparent peer review. However, as Zhaksylyk *et al.* (2023) argue, combating scientific misconduct requires a continuous and collaborative effort, emphasizing honesty, transparency, and rigor in science.

Having explained the concepts of retraction in scientific publications, it is necessary to establish the ethical principles of science, examining the moral bases that guide this process.

3 ETHICAL PRINCIPLES IN SCIENTIFIC COMMUNICATION: FOUNDATIONS FOR INTEGRITY AND RETRACTION

Ethics, a fundamental theme in all fields of human activity, promotes a deep reflection on the values that guide our actions. Originating in philosophy, ethics focuses on the values that inform conduct and rules within society, exploring concepts such as individual and collective good, right action, duty, obligation, virtue, freedom, rationality and choice. The focus is on moral behavior, which is intrinsically linked to freedom of choice (Sánchez Vázquez, 1975; Martins, 1994; Severino, 1994; Blackburn, 1997; Srour, 1998; Ferrater Mora, 2001).

In ancient times, Aristotle conceived of ethics as the pursuit of happiness. During the Middle Ages, within the context of Christian ethics, the goal became the pursuit of God. During the Enlightenment, the issue of free will gained prominence in ethical studies. With Kant, the

concept of the categorical imperative emerged, which serves as a guide for ethical actions. This imperative is seen as the essence of the moral norm – the sense of morality and duty as a principle in itself – proposing that good should be pursued for its own sake, based on freedom and the idea that good will is a supreme good. In short, it would be the idea that actions should be guided by what their agents consider to be a universal law, applicable to all. The categorical imperative, in turn, overlaps with the so-called hypothetical imperative, in which the action is guided by a justification such as fear of punishment or the expectation of some benefit. It is worth highlighting that, in the categorical imperative – reiterating: essence of the moral norm – the will is considered autonomous, not as a means to achieve other ends (Sánchez Vázquez, 1975; Andrade, 1993; Weckert; Adeney, 2000).

This historical path reaches the Contemporary Age, especially after the Industrial Revolution, which had a strong impact on professional segments. This led to the need to investigate not only the technical and operational issues related to professions (how to do it), but also the objectives and social insertion of these professions (why and what to do it for). This context gave rise to professional ethics, which reflects an everyday dimension of ethics in the environment of the development of work relations.

It is important to highlight that, with professional ethics, also called Deontology, ethics gains a new dimension. In addition to the axiological elements, which refer to the moral values involved, deontological elements are incorporated, which concern the duties inherent to good professional practice. These, in turn, are embodied in codes of professional ethics.

Referring more specifically to professional duties, Deontology has its roots in the studies of the English philosopher Jeremy Bentham, in the mid-19th century. It consists of "a set of rules that are expressed in a formal and explicit manner", making those who transgress them subject to sanction (Silva, 2021, p. 28). According to Siroux (2007, p. 405), deontology transcends the axiological dimension of ethics and approaches a legal dimension, since "maintaining the integrity and coherence of a practice" entails the possibility of coercion against those who disrespect it.

Silva (2021, p.29) offers a conceptual synthesis of Deontology, describing it as the study of the moral system — focused on duties — that governs a given professional practice. This approach is embodied in codes that not only prescribe specific rules and procedures for the professional category in question, but also establish forms of punishment for cases of non-compliance (Souza, 2002; Siroux, 2007; Japiassú; Marcondes, 2008).

In the field of information — which includes the professional activities of production, organization, communication and dissemination —, Froehlich (1994) was a pioneer in systematizing the factors that influence ethical decisions. These factors include social utility, social responsibility, organizational and professional survival, respect for oneself and others, as well as collective and legal cultural standards. Guimarães (2000) complements this view, highlighting the ethical commitments to the information user, the context of production and the content of the information.

Exploring the processes, instruments and products involved in the organization and representation of information, Guimarães *et al.* (2008) identified and systematized a set of pertinent ethical values and issues. Among the highlighted values are transculturality, cultural guarantee and hospitality, respect for knowledge domains, reliability, impartiality, accuracy, consistency, literary guarantee, updating and cooperation. Regarding ethical problems, the authors point out issues such as biases, including prejudices and idiosyncrasies, literalness, excessive reductionism and generalization, omissions, proselytism, inaccuracies, inconsistencies, adulterations and distortions, partiality, alienation, lack of clarity, inaccessibility, negligence and censorship, among others.

If these values and ethical issues are identifiable in the organization of information intended for dissemination and use, it is important to recognize that many of them originate in

the process of production, materialization and communication of information. This, in turn, directly affects scientific communication.

Therefore, in the process of scientific communication — more specifically in relation to scientific publications — the relevance of the ethical commitments highlighted by Guimarães (2000) is reiterated. When publishing, it is mandatory to consider that the publication will be read and used by users who, in principle, trust the data presented. In addition, the publication must reflect a context and a trajectory of expertise and academic seriousness of the authors. As a consequence, the published content must be reliable, up-to-date and accurate, since it will serve as a source for new research.

When applying the reflections of Guimarães *et al.* (2008) to the context of scientific communication, it becomes clear that a publication must be committed to mediating the cultures of its authors and users, since the purpose of writing is to be read and understood. In addition, the publication must be consistent with the paradigms, theories and literature of the area of knowledge to which it belongs. It is also essential that it be reliable in relation to its origin, preparation and dissemination, requirements that encompass the accuracy, consistency, foundation and timeliness of its content. This also leads to consideration of the need to avoid ethical problems in scientific communication, such as the dissemination of prejudices, idiosyncrasies and proselytism, in addition to inaccuracies in content. These inaccuracies include literal interpretations, reductionisms, excessive generalizations, omissions, inaccuracies and inconsistencies, as well as adulterations and misrepresentations. Such problems must be prevented at all costs to preserve the integrity of the information.

It can be said that ethical commitment is inherent to the entire scientific process, from the development of research to its communication through scientific publications. This commitment is mainly manifested by the reliability and accuracy of the published content.

As in any human activity, scientific publications can also accidentally contain errors or inaccuracies. In such cases, an author or group of authors, motivated by an ethical duty, can spontaneously request the necessary correction. On the other hand, there are also cases of scientific misconduct, where, guided by bad faith and various interests, authors can falsify, hide, manipulate or copy data and information. When such frauds are detected by editorial boards of journals or scientific committees of funding agencies, it becomes mandatory for the authors to retract, publicly declaring their errors in order to correct them. This is essential to guarantee the reliability of the publication vehicle.

It is also worth noting that scientific production and subsequent communication are central elements of academic professional practice, which implies a code of ethics in this field. This is mainly embodied in codes of good scientific practice, which establish clear guidelines for the ethical conduct of research. These codes are essential in preventing retractions by requiring rigor in the verification of data and transparency in the dissemination of results, ensuring that scientific contributions are reliable and verifiable. Implementing these practices not only strengthens scientific integrity, but also minimizes the occurrence of errors and deviations that could lead to the need for retraction.

While the ethical principles discussed here provide the normative and axiological framework for research conduct and the retraction process, it is essential to understand how these principles are interpreted in the complex social dynamics of science. This understanding not only illuminates existing ethical norms but also reveals areas where adaptations or improvements may be needed. This requires exploring the diverse sociological perspectives that shape and are shaped by these ethical norms, addressing concepts such as scientific ethos, deviant behaviors, and scientific capital, among others, that are fundamental to understanding the implications of retractions in the scientific community.

4 SOCIOLOGICAL PERSPECTIVES OF RETRACTION IN SCIENCE

Understanding the dynamics involved in scientific retraction requires examining the perspectives of renowned theorists in sociology and philosophy of science. Although they have not directly addressed retraction in their work, their theories allow us to understand how this phenomenon affects integrity in science.

4.1 The vision of Émile Durkheim (1858-1917)

Beginning with Émile Durkheim, one of the founding fathers of sociology, his studies address the socially integrative role of values and relationships between society and the individual. This approach emphasizes the importance of social norms and cohesion in maintaining social order. Morality and the connection between science and society also influenced Durkheim's work on professional ethics. According to Sica (2005a), Durkheim's ability to blend science with ethics is part of his effort to create what he called the "science of morality," which gives it a unique status in the living tradition of classical social theory.

In a lecture given at the University of Bourdeaux, while tracing the history of sociology, Durkheim (1888) notes the emergence of several subfields, among them the "science of morality, which would treat moral beliefs and maxims as natural phenomena from which causes and laws could be sought." In addition to this subfield, there would also be another that concerns moral maxims considered so obligatory that society takes precise measures to apply them. From this perspective, as Bellah (1973) explains, specially authorized representatives are responsible for maintaining respect for these moral norms and are not left solely to the sanction of public opinion.

Durkheim's view of the "science of morality" may have implications for the context of scientific retractions. The moral maxims he describes are reflected in the ethical norms and standards of integrity that govern scientific practice. As Turner (1993) points out, Durkheim's theories are considered even more applicable today than they were at the time he formulated them. For example, when a scientific article is retracted, the action can be seen as an application of these mandatory moral norms within the scientific community, where integrity and truthfulness are fundamental values. Just as Durkheim mentions the existence of authorized representatives who ensure respect for moral maxims, in science these "representatives" can be understood as ethics committees, editors of scientific journals and other institutions that monitor and regulate good scientific practices. They are responsible for ensuring that ethical standards are maintained, taking precise measures, such as retraction of articles, to correct deviations and maintain trust in the scientific literature.

In another classic study of the social division of labor published in 1893, Durkheim (1999) asked how morally binding norms could be enacted in a secularized society. His answer was that such norms would have to be shaped by professional groups, each of which would be responsible for guiding and monitoring the behavior of its members. Hypothetically, consider the case of a biology study published in a renowned scientific journal, where, after publication, it was discovered that the experimental data had been partially falsified by one of the co-authors. According to the Durkheimian perspective, the scientific community, acting as a professional group, plays an essential role in maintaining ethical norms. In this case, the scientific community, through its structures such as ethics committees and review boards, can intervene to ensure that integrity is restored through the process of retraction. Retraction not only corrects the scientific record, but also serves as a morally binding act, reaffirming the community's commitment to truth and honesty. This example demonstrates how professional norms, in a secularized society, still guide and monitor the behavior of members within scientific

communities, thus aligning with Durkheim's thinking about the role of professional groups in promulgating and maintaining moral norms.

Durkheim saw society as a complex organism in which each part has an essential function, and science, as part of this society, would be subject to the same expectations of integrity and moral conformity. In the context of scientific publishing, his theories offer interesting insights into how social norms influence retraction practices. For Durkheim, social norms are fundamental in defining acceptable and unacceptable behavior within a group. In the academic environment, these norms establish expectations of honesty, transparency, and scientific rigor. Retraction of scientific publications, in this sense, can be seen as a response by the scientific community to preserve these norms and the integrity of research.

Durkheim's ideas on social cohesion also help us understand how the scientific community reacts collectively to maintain its credibility. Retractions are not only individual acts of correction, but also collective movements that reinforce the unity and shared values of the community. Such actions are essential to maintain public trust in science and ensure that the basis of scientific knowledge remains solid and reliable.

Durkheim's contributions to the understanding of scientific retractions highlight the role of social norms and cohesion in regulating scientific practices. By examining retractions through a Durkheimian lens, we can see how ethics and collective responsibility shape publishing practices and the maintenance of scientific integrity.

As Sica (2005, p. 552) noted, Durkheim always praised modern science, although he did not neglect the 'bigger questions' that "have troubled ethicists since Plato and Confucius, culminating in Leo Tolstoy's famous question: What constitutes a life worth living?' To this pressing question, science has no answer, as Durkheim well knew."

Reflecting on Durkheim's consideration of the limits of science in answering life's 'bigger questions', we will delve into the theoretical contributions of Max Weber, whose reflections on vocation, disillusionments and limitations of science, as well as on the ethics of consequence and responsibility, offer an enriching perspective for understanding the complexities involving the phenomenon of scientific retractions.

4.2. The contributions of Max Weber (1864-1920)

Weber was arguably the most important social and political theorist of the twentieth century, as well as 'the reluctant father of modern sociology', a role he unwittingly shared with Émile Durkheim, as described by Sica (2005b, p. 2057). His importance only grew over time, culminating in the early twenty-first century with the naming of a scientific journal in his honor, the journal Max Weber Studies (2024), published since 2000. This journal is committed to the application and dissemination of his ideas, addressing, among other issues, the dilemmas of life conduct and vocation in the contemporary world, the analysis of the stratification of power and its modalities, and the validity of an interpretative science of social reality.

In his classic study of 1904–1905, "The Protestant Ethic and the Spirit of Capitalism," Weber (2004) addressed the ethical foundations of social orders. Stoerger (2005, p. 1823) notes that while Weber examined social structure with a focus on value-free science, he also emphasized the autonomy of the individual, emphasizing the importance of acting on one's own behalf rather than emphasizing the role of society as a collective whole. In his work, Weber emphasizes the idea that people should not wait for science to tell them how to live their lives.

Weber brought a profound insight into science and its practice, especially in two of his most famous lectures, "Science as a Vocation" and "Politics as a Vocation," delivered between 1917 and 1919 at the University of Munich. These lectures, aimed at intellectuals and students, featured notable figures, including the poet Rainer Maria Rilke, as Sica (2005) points out.

In "Science as a Vocation", Weber (1999) argued that scientific practice requires objectivity and an approach free from personal values, where practitioners must be motivated

exclusively by a vocational calling (Beruf) dedicated to discovering the truth. He criticized worldly self-aggrandizement and the influence of political values, also warning against the cult of personality and the dangers of promoting a worldview that could compromise the integrity of scientific work. To support his view of scientific investigation as an obstinate search for truth, Weber relied on influential thinkers such as Kant, Nietzsche, Luckács, as well as references to literary works by Goethe, Baudelaire and Dostoevsky, and ethical discourses such as the Sermon on the Mount (Freund, 1986). As Sica (2023, p.3) highlights, "it was in the company of Goethe and other writers of similar stature that the young Max Weber began his climb towards polymathic brilliance".

In this conference, when addressing a group of potential academics, Weber asked about the meaning of science as a vocation, when all the old illusions that saw in it the path that leads to the true God and happiness had disappeared. For Weber (1999, p. 169), it was Tolstoy who gave the simplest and most indisputable answer: "Science is meaningless because it does not answer our question, the only question that matters to us: What should we do and how should we live?" As Weiss (2014, p. 132) explains, "science cannot tell us anything about what we should do, because it has no means of affirming what the true path is; it cannot tell us anything about the meaning of life, because it does not know such meaning."

Weber (1999) also emphasizes the importance of intellectual honesty and selfless dedication to the search for truth. For him, the scientific vocation requires a deep commitment to integrity, as the scientist must be impartial and resistant to external pressures that may compromise the objectivity of the research. Today, this refers to the ethical challenges faced by scientists, such as the pressure to publish positive results, which can lead to questionable practices such as data manipulation or the omission of negative results. Recent cases of retraction often reflect ethical failures that Weber would criticize as contrary to the scientific vocation. For example, the retraction of studies due to the discovery of falsified or plagiarized data highlights the rupture with the principles of honesty and dedication to the truth.

Another central concept in Weber's analysis of modernity is the "disenchantment of the world," also discussed in the conference "Science as a Vocation." Weber describes this process as the replacement of the magical and religious view of the world by a rational and scientific perspective. In science, rationalization can be seen in the incessant search for causal explanations and the systematization of knowledge. In Weber's words (1999, p. 165), this implies that "there are no mysterious incalculable forces, but that we can, in principle, master all things by calculation." This reflects the disenchantment of the world. Therefore, Weber (1999, p. 182) emphasizes that "the destiny of our times is characterized by rationalization and intellectualization and, above all, by the disenchantment of the world."

Weber's concept of "disenchantment of the world" offers several connections to the practice of retraction in scientific publications. First, this practice reflects a commitment to rationality and scientific accuracy, as the retraction of scientific articles seeks to correct errors, aligning with the search for objective truth and strengthening scientific integrity. Furthermore, disenchantment promotes a culture of transparency and openness, aspects that are indispensable to maintaining public trust in science as an honest and rigorous activity. Disenchantment also demystifies scientific authority, demonstrating that scientists are fallible and that scientific knowledge is, by nature, provisional. By reflecting this reality, retractions demonstrate that science is a human process, subject to errors and corrections. In a world where efficiency and expertise are valued, the ethical and practical dilemmas faced by scientists can lead to lapses that require corrections, underscoring the importance of retractions to maintain the credibility of scientific research.

In turn, in the conference "Politics as a Vocation", Weber (1999) introduced one of his most famous distinctions, that is, the difference between the ethics of conviction, or of ultimate ends, and the ethics of responsibility, or of consequences. The ethics of conviction focuses on absolute moral principles, while the ethics of responsibility considers the consequences of

actions. These concepts are central to understanding the tensions between absolute values and the practical consequences of actions, also applicable to the issue of retractions in scientific publications.

The ethics of ultimate ends is based on the uncompromising adherence to absolute moral principles or values. According to Weber, this type of ethics implies acting in accordance with a set of ethical convictions, regardless of the practical consequences of actions. The focus is on the purity of motives and loyalty to principles considered unquestionable. In the words of Weber (1999, p. 144), however, there is "a huge contrast between conduct that follows the maxim of an ethics of ultimate ends (...) and conduct that follows the maxim of ethical responsibility, when one must then account for the foreseeable results of the acts committed."

In the context of scientific publications, the ethics of ultimate ends can be associated with the pursuit of truth and scientific integrity. By adhering to these ethics, researchers may be less flexible with regard to compromises or adjustments that compromise the accuracy and honesty of scientific results. Therefore, the decision to retract an article could be seen as a manifestation of adherence to these absolute values of truth and transparency.

On the other hand, the ethics of responsibility emphasizes the consideration of the consequences of actions. Weber suggests that this type of ethics requires individuals to evaluate the potential outcomes of their actions and take responsibility for these outcomes. The ethics of responsibility is therefore more concerned with practical impacts and the management of consequences, often involving a cost-benefit analysis and the search for a balance between values and outcomes. However, Weber (1999, p. 144) warns that "no ethics in the world provides us with a basis for concluding when, and to what extent, the ethically good end 'justifies' the ethically dangerous means and their ramifications."

In science, the ethics of responsibility can be reflected in the assessment of the practical implications of a retraction. When considering a retraction, scientists can weigh the effects of such an action on the scientific community, on public trust in science, and on the researchers themselves. The decision to retract, in this case, is informed by a careful consideration of the consequences for all parties involved and for the integrity of science as a whole. This implies not only the pursuit of truth, but also transparency and accountability for the social and scientific impacts of one's research. Retractions in scientific publications, then, can be viewed in the light of the ethics of responsibility, where correcting errors, even if belatedly, is an act of responsibility towards the scientific community and society.

Retractions in scientific publications can occur for a variety of reasons, including fraud, honest mistakes, or pressure to obtain results. Each case of retraction not only affects the reputation of the researchers involved, but also undermines trust in science as a whole. The pressure to publish, often summarized as the phenomenon of 'publish or perish', can lead to unethical practices, contradicting the Weberian scientific vocation that values honesty and the selfless pursuit of truth.

Considering the intersections of Weber's thought and the retractions, one can assume that the ethics of responsibility offers a lens through which we can broaden our understanding of the importance of scientific integrity. Integrity is the cornerstone of the scientific vocation and must be protected against any kind of ethical compromise. The application of the ethics of responsibility suggests that scientists have a duty not only to scientific truth, but also to the impacts of their research on society.

To reduce the incidence of retractions, it is essential to foster a culture of transparency and accountability. Institutional policies that encourage the correction of errors and the full disclosure of data can be effective. In addition, fostering an ethic of responsibility can help create an environment where scientists feel compelled to act with integrity, even under pressure.

A review of Max Weber's thinking shows the continued relevance of his ideas to contemporary ethical challenges in science. The scientific vocation, with its focus on honesty and dedication to truth, and the ethic of responsibility, with its emphasis on the consequences

of actions, provide a solid foundation for promoting integrity and trust in scientific publications. By integrating these principles, the scientific community can more effectively address issues related to retractions, strengthening the credibility and positive impact of science on society.

As Sica (2023, p. 1-2) states, Weber's ideas continue to resonate among contemporary scholars, and like any intellectual, he was a product of his time, a particularly fruitful period of European and American academic life on whose shoulders we continue to stand. Stoerger (2005, p. 1824) also pointed out that the works of Durkheim and Weber paved the way for Robert K. Merton to follow. This is what we will see below.

4.3 The theoretical contributions of Robert King Merton (1910-2003)

Robert Merton, an American sociologist considered the founding father of the Sociology of Science, made the first systematic and influential attempt to identify the main norms operating among scientists and to demonstrate how they contribute to the advancement of scientific knowledge, as described by Mulkay (1980). Briggle and Mitcham (2012) add that Merton was one of the pioneers in the investigation of scientific practices, beginning the explicit articulation and examination of social or behavioral norms in science. These norms provide a consistent framework for understanding the retraction process in scientific publications.

By formulating the institutional norms of science, known by the acronym CUDOS (communalism, universalism, disinterest, and organized skepticism) and consolidated in the scientific ethos, Merton not only shaped the academic understanding of scientific dynamics, but also highlighted their practical applicability in maintaining integrity and transparency within the scientific community. These values, as Croissant (2005, p. 1817) explains, "continue to be defended and are presented to students of science and technology as the primary values that govern good science."

In this context, Merton's approach to the sociology of science, with its focus on universal norms of science (Merton, 1942; 1973), provides a solid basis for understanding how these ethical principles not only guide but also legitimize practices of retraction as vital components in the self-regulation of the scientific community. Distinguishing science from politics in terms of four norms of scientific behavior, Merton considered the motivations operative in science as a social institution (Mitcham, 2003).

In Merton's words (1973, p. 268), these norms are expressed in the form of "prescriptions, proscriptions, preferences, and permissions, and are legitimized in terms of institutional values." He describes these imperatives as transmitted by precept and example and reinforced by sanctions, which are internalized to varying degrees by scientists, shaping their scientific consciousness. Merton adds that although the ethos of science is not formally codified, it can be inferred "from the moral consensus of scientists, manifested in usage and custom, in numerous writings on the scientific spirit, and in the moral indignation at contraventions of that ethos" (Merton, 1973, p. 269). Based on this perspective, it can be argued that these norms establish a code of conduct that promotes integrity, objectivity, and collaboration in the scientific community. Calhoun (2010, p. 140) notes that "the scientific ethos, like many other Mertonian concepts, has been incorporated into the common sense of both sociologists and scientists."

The institutional norms or imperatives that express the Mertonian scientific ethos are often cited as antecedents of the codes to which scientists should adhere. By adopting these norms, the scientific community can view retractions not as failures or stigmas, but as opportunities to enhance public trust in science and strengthen dialogue among researchers. Chart 1 provides a summary of these norms and their interpretations in the context of retraction practices.

Chart 1. Mertonian norms and their applications in retraction practices

CUDOS	Scientific ethos	Applications in retraction practices
Communalism	Substantive scientific discoveries are a product of social collaboration and are attributed to the community. They constitute a common heritage in which the capital of the individual producer is severely limited. It requires that scientific knowledge be treated not as the private property of its creator, but rather as a common good, to be freely communicated and distributed.	Promotes honest sharing of knowledge by correcting the public scientific record to ensure that the scientific community and the public have access to accurate and reliable information. When a study is retracted, it is usually because it has been determined that it cannot be considered reliable knowledge that can be built upon by others. Retraction ensures that only verified and reliable information is used as the basis for future research.
Universalism	The scientific merit of knowledge claims is assessed based on pre-established and impersonal criteria, and is not influenced by the personal or social characteristics of scientists: their race, nationality, religion, and class, as such, are irrelevant.	It reinforces the principle that all scientific contributions should be evaluated using objective criteria, regardless of the researcher's reputation or position. This ensures that scientific merit prevails over personal or institutional interests. The retraction of a scientific article, when subsequent discoveries or analyses reveal errors or falsehoods in the original data or conclusions, is an example of how universalism manifests itself in practice. The correction is applied regardless of the author's prestige.
Disinterest	Disinterest requires the subordination of extrinsic interests to the intrinsic satisfaction of finding the truth. Scientists must act for the good of the community, avoiding fraud and personal interests that could compromise the integrity of science. The requirement of disinterestedness has a solid basis in the public and testable character of science. This circumstance, it can be assumed, contributed to the integrity of scientists.	By retracting papers based on identified errors or problems, the scientific community demonstrates a commitment to the selfless pursuit of truth, placing the integrity of knowledge above the personal or professional interests of researchers. Retracting a paper, especially when done voluntarily by the authors themselves after discovering errors, can be seen as an act of scientific integrity.
Organized Skepticism	It is a methodological and institutional mandate. It means that all knowledge must be tested and subjected to rigorous examination. This requires the temporary suspension of judgment and the impartial scrutiny of beliefs, even those considered by some groups to be beyond the bounds of rational analysis.	It allows for the questioning and reassessment of established knowledge, valuing verification and critical review. It promotes retraction as a natural correction mechanism, essential for self-criticism and continuous improvement of science. This enables the correction of errors and ensures that scientific conclusions are always subject to review and verification, reinforcing the commitment to healthy skepticism and self-criticism.

Source: Created by the authors based on Merton (1942; 1973)

As Kalleberg (2007, p. 154) points out, Merton's contributions are descriptive in nature, since he "did not develop a normative conception of research ethics that could be codified for use by scientists or in the regulation of research institutions and individual scientists." However, Kalleberg points out that Merton's analysis of scientific ethos is compatible with an explicable and normative research ethics, which makes it suitable for

application, for example, in prescriptive research ethics courses. In Sztompka's view (2007, p. 210), we have witnessed the emergence of a different model of science, which can be characterized by "dependence on significant financial resources, privatization and secrecy in research, commodification of results, bureaucratization of scientific institutions, and instrumentalization of science," which subjects it to extra-scientific interests. These changes will form the backdrop for exploring the counterpoint made by epistemologist John Ziman to the Mertonian vision of the scientific ethos.

4.4 John Michael Ziman's approach (1925-2005)

Drawing on a critical perspective at the end of the twentieth century, John Michael Ziman characterizes the evolution of science as a transition from "academic science" to "post-academic science" (ZIMAN, 2000). This English philosopher of science argued that this new form of science was increasingly oriented toward practical, commercial, and governmental interests, in contrast to the Mertonian ideal of science driven by curiosity, disinterestedness, and communalism.

In Ziman's words (2000, p. 78-79), although the social organization of academic science can be described in terms of Mertonian norms, this description is, of course, highly idealized, but not completely unrealistic. On the contrary, industrial science contradicts these norms at almost every point, because its various ways of life "are not those of a self-conscious community claiming allegiance to an unwritten ethos. Indeed, the social practices characteristic of industrial science are based on principles that effectively deny the existence of any ethos at all." As Reis (2010, p. 13) argues, Ziman did not intend to formulate a new ethos, "but to safeguard some characteristics of the Mertonian ethos by demonstrating that the strength of science is centered on its social and cooperative production of knowledge, which must be carried out in a public space and aiming for consensus among peers"

In response to this change, Ziman (2000) reformulated the CUDOS standards and introduced a new set of standards that he called PLACE, an acronym that reflects the other characteristics of this new "post-academic science" (Guimarães; Hayashi, 2016), to reflect what he saw as the realities of contemporary science, that is, Proprietary, Local, Authoritarian, Commissioned and Expert. In his view, this new mode of science produces proprietary knowledge that is not necessarily made public, is centered on local technical problems, such that industrial researchers are employed as problem-solving experts rather than for their personal creativity, and act under administrative authority rather than as individuals. Thus, their research is commissioned to achieve practical goals rather than in the pursuit of knowledge. Although Ziman, like Merton, did not address retraction directly in his writings, we can infer how it fits into the context of "post-academic science", as outlined in Chart 2.

Chart 2. The new ethos of "post-academic science" and its implications for retraction practices

PLACE	Novo *ethos*	Aplicações nas práticas de retratação
Proprietary	Research results often become private property, which does not necessarily need to be made public.	This can lead to conflicts of interest, where favorable results are prioritized, increasing the risk of publications that may require retraction if they are later unmasked as untrue or manipulated. Thus, in an environment where ownership of knowledge is tightly guarded, retraction is a mechanism to correct results not discovered to be flawed or fraudulent.
Local	Post-academic science is driven by local concerns, aligned with specific	This localism can limit the generalizability of results, leading to conclusions that may not

	commercial or political interests of the funder.	be replicable in other contexts, which is a common reason for retractions. Retraction here can be a means of ensuring that science maintains its credibility and trustworthiness, even when it is conducted under local influences that may otherwise compromise objectivity.
Authoritarian	Authoritarian science is where decisions about what is researched and published are heavily influenced by those who fund the research. It may derive less from academic merit and more from institutional power or access to resources.	Such control may suppress findings that are contrary to the sponsor's interests or promote uncritical acceptance of results that, if revealed to be flawed, would require retraction. The practice of retraction serves as a reminder that scientific authority must also be held accountable and that correcting errors is essential to maintaining trust in scientific authority.
Commissioned	Commissioned work means that research is carried out under contract to meet the specific needs of sponsors who may be external clients including companies and governments.	This can lead to bias in the selection of subjects, methods, and interpretation of results, increasing the chances of erroneous results that would eventually require retraction. Retraction in this context emphasizes the importance of scientific integrity, even when research is conducted with specific goals in mind. It ensures that the interests of the sponsors do not override truth and accuracy.
Expert	Intense specialization leads researchers to be seen as professional problem solvers rather than as original, critical thinkers.	Retractions in highly specialized fields can be complex. Extending the peer review process with reviewers from related disciplines or even different fields can help identify problems that may not be obvious to specialists, and increases the likelihood of identifying and correcting errors and avoiding retractions.

Source: Created by the authors based on Ziman (2000)

In summary, through the prism of Ziman's PLACE (2000), retraction in post-academic science can be seen as an essential tool for maintaining integrity, responsibility, and trust in a scientific environment that is increasingly influenced by external interests, expertise, and intellectual property. Therefore, the practice of retraction not only aligns with the traditional ideals of science, as described by Merton, but also adapts to the needs and challenges of contemporary science, as identified by Ziman.

As Sztompka (2007) has pointed out, the period of "post-academic science" marks a certain decline in trust, leading to the question of why Mertonian norms of scientific ethos are circumvented or diluted and why recognition of excellence by peers is no longer the main reward for academics.

In this author's view (Sztompka, 2007, 218-219), five advances in science as an institution and as a scientific community shake the foundations of trust and affect Mertonian norms: a) the monitoring of science derived from the need for more resources to finance increasingly expensive research, resulting in science's dependence on external agencies, which contradicts the norm of universalism, since external and non-meritocratic criteria invade the domain of science; b) the privatization of science, that is, more and more research is owned by sponsoring institutions, in contradiction with the norm of communalism; c) the commodification of science, that is, scientific results assume the form of marketable

merchandise, undermining the norms of disinterest and organized skepticism; d) the bureaucratization of science, which absorbs academics into an extensive bureaucracy of project writing, financial planning and results reporting, with assessments taken from academic peers and transferred to external bodies, annihilating the norm of organized skepticism; finally, e) the reduction of the exclusivity and autonomy of the scientific community, which has been permeated by politicians, marketing experts and lobbyists, who are driven by interests and values other than the disinterested pursuit of knowledge. This causes academics to use their academic credentials in political or marketing struggles, abusing and polluting the prestige of science, and eroding their reliability as academics. As a result, Mertonian norms of disinterest and universalism are suspended.

Based on this view, Sztompka (2007, p. 219) argues that in post-academic science "there is a visible decline in the Mertonian ethos, probably related to the weakening of the bonds of trust in relation to science". In the words of Ziman (2000, p. 330) "the moral integrity of science has become more debatable", with the additional result of the increasing potential for fraud and other forms of pathology that undermine good scientific practices.

Finally, since academic science changed dramatically in the first half of the twentieth century when Merton formulated the four institutional imperatives of the scientific ethos, post-academic science has assumed a new social role. In Sztompka's view (2007, p. 219) this does not mean that "the Mertonian image of science self-regulated by the scientific ethos and permeated by trust is obsolete and can only be the object of nostalgic memories". For this theorist, the reconstitution of Mertonian principles adapted to the new situation of science can still provide a standard against which "'post-academic' science – more globalized, more industrialized, more bureaucratized, more politicized, more transdisciplinary, more dependent on funding – should be measured and held accountable" (Sztompka, 2007, p. 219).

Ziman offers insight into post-academic science, characterized by greater pressure for results and greater public visibility, contributing to an understanding of the motivations and challenges involved in scientific retractions. In considering these aspects, it is also pertinent to examine how sociologist of science Harriet Zuckerman approaches deviant behavior in science, offering a complementary analysis that illuminates the ethical and practical implications of retractions.

4.5 Harriet Zuckerman's approaches (1937-)

Harriet Zuckerman is an American sociologist of science recognized for her research on the scientific elite and the phenomenon of consecration in the scientific field, widely explored in her work "Scientific Elite: Nobel Laureates in the United States" (Zuckerman, 1977a). She collaborated extensively with Merton, further enriching his analytical perspective on norms and anomalies in the academic environment. One of her focuses also includes deviation behavior in science.

In this study, also published almost half a century ago, Zuckerman (1977b) discusses the incidence of deviations in science, which range from intentional errors to explicit fraud, also analyzing their distribution and the mechanisms of social control that act to correct them. Understanding this range of deviations helps to identify which types of errors and misconduct are likely to result in retractions, increasing the importance of Zuckerman in the discussion on scientific integrity and retraction practices.

Zuckerman (1977b) examines the social control mechanisms implemented by the scientific community to deter deviant behavior, including the importance of peer review and ethical vigilance in preventing and identifying deviations. In this context, retractions function as a form of social control, acting as a tool for correcting the public record of science, as well

as discouraging future deviations by maintaining trust in the scientific literature. The effectiveness of these control mechanisms is critical to the integrity of retraction practices.

An emblematic example of the importance of social control mechanisms such as peer review and ethical oversight is the case of Wakefield's (1998) paper published in The Lancet. The study, which alleged a link between the MMR vaccine and autism, initially passed the peer review process, but significant flaws in methodology, undeclared conflicts of interest, and fraudulent data eventually led to its retraction in 2010. This case highlighted the critical need for rigorous editorial control and ongoing ethical oversight, resulting in greater awareness of integrity in the conduct and reporting of scientific research. The retraction not only corrected the scientific record, but also served as a strong deterrent to future deviations, reinforcing trust in the scientific literature.

Another aspect addressed by Zuckerman (1977b) is the long term consequences of deviant behavior for scientist's career and for science in general. This view suggests retractions may have a significant impact on both the reputation and career progression of those involved, in addition to affecting the public perception of science. These effects are not limited to academia, but may influence other spheres in society. For example, Shuai *et al*. (2017, p. 2235) argue, through the retracted study by Wakefield, how the consequences of retractions may extend to public perception and to policies in critical areas, like public health, affecting not only the individual career of the scientists, but also the public dialogue and the trust in health policies.

In his analysis, Zuckerman (1977b) also highlights the importance of effective governance and regulations to prevent and respond to deviant behavior. This perspective highlights the need for clear and transparent retraction processes that not only penalize deviance but also promote a culture of continuous correction and learning. Implementing such practices not only helps maintain scientific integrity but also encourages a constructive response to failure, which is essential for scientific progress.

Criticisms of the concept of deviant behavior in science, as explored by Zuckerman (1977b), highlight several limitations. These include the underestimation of systemic problems in science, such as the structural pressures and perverse incentives that foster them. While mechanisms of social control and sanctions are necessary, they may not be sufficient to address these underlying causes. In line with Merton, who presents the scientific community as fundamentally self-regulating, this idealization may obscure the many ways in which science, like any human field, is susceptible to conflicts of interest, corruption, and abuse of power.

The advent of digital technologies and the open access movement has brought new challenges to maintaining scientific integrity, suggesting that the control mechanisms proposed by Zuckerman may be inadequate under current conditions. Furthermore, more traditional analyses may fail to consider the experiences of underrepresented groups in science, where issues of inequality and exclusion may influence who is most likely to be accused of deviant behavior and how punishments are applied. These complexities require a more inclusive and adaptive approach to scientific governance.

In a more recent study, Zuckerman (2020) revisits the issue of retractions, highlighting the deficiencies of the available data on scientific misconduct. She expresses surprise that, despite her pioneering study of misconduct in science being over forty years old, an "epidemiology of misconduct in science" has yet to be developed – a field that, paradoxically, "values data accuracy, rigorous record-keeping, and statistical sophistication" (Zuckerman, 2020, p. 947). Although the volume of retractions published in specialized databases is substantial, Zuckerman questions the usefulness of these data for effective research on misconduct, pointing to a critical disconnect between data collection and their practical applicability in studies of scientific integrity.

Another concern highlighted by Zuckerman (2020, p. 954) is whether the increasing incidence of retractions serves as an indication of flaws in the peer review system, traditionally seen as a bulwark against research misconduct. Zuckerman questions the ability of this system

to filter fraudulent submissions from reliable ones, noting that despite its critical function, many fraudulent articles are still published. The complexity of this issue is amplified by the fact that reviewers often do not have access to the raw data on which research is based, which prevents them from independently verifying the conclusions derived from these data. This limitation may contribute significantly to the inability to detect and prevent scientific misconduct, suggesting an urgent need for review and possible reforms in the peer review process.

Thus, by considering Harriet Zuckerman's work on deviant behavior in science, we understand that retractions are not merely corrections of specific failures, but significant acts that reflect the prevailing norms and social controls within the scientific community. This understanding is essential to address the ethical and normative complexities of contemporary scientific practice, pointing to the need for constant and adaptive vigilance of research conduct.

Moving forward in our discussion, we next explore the contributions of post-Mertonian sociology. This approach expands our understanding of the social dynamics in science, introducing new perspectives on how multifaceted social and cultural factors influence retractions. Topics such as the social construction of scientific credibility and the impact of power networks will be analyzed to provide a broader view of the mechanisms that shape scientific practices and retraction in science.

4.6 The point of view of post-Mertonian theories

From the 1970s onwards, Merton's theory of science began to face intense debates, challenged by sociologists, philosophers, anthropologists, historians and other scholars from various subfields of scientific knowledge. These debates questioned Merton's ideals about the normative structure of science and marked a turning point, moving from the traditional internalist view to more externalist interpretations. This transformative context encouraged the emergence of interdisciplinary fields, including the social studies of science, technology and society, which were formalized in departments, programs, associations and journals, adopting the acronym STS (Science, Technology and Society) as a distinctive feature of a more activist strand.

The current sociology of science, influenced by approaches such as social constructivism, actor-network theory (ANT), and science, technology, and society (STS) studies, offers a more heterogeneous and contextual view of scientific practice.

Social constructivism in science is a sociological current that examines how scientific knowledge is, in part, social constructions, influenced by cultural, political, and social factors. Its main representatives include Bruno Latour, Steve Woolgar, and Karin Knorr-Cetina, who highlight the role of social interactions in the formation of scientific facts and challenge the view that science is purely objective and detached from its social context.

From a Social Constructivist perspective, retraction can be seen as a mechanism that reflects the constructed and negotiated nature of scientific knowledge. Errors, fraud, or misunderstandings that lead to the retraction of a scientific paper are part of the process by which the scientific community negotiates what is considered valid knowledge. In this context, retraction is not simply the correction of an error, but an act that reaffirms the community's standards and norms about what counts as legitimate knowledge. Essentially, retractions highlight the fluid and evolving nature of scientific norms, demonstrating how knowledge is not only constructed but also constantly revised and refined in light of new evidence and interpretations.

In turn, Actor-Network Theory (ANT), proposed by Bruno Latour, Michel Callon, John Law, and others, views science as a network of human and non-human actors—such as instruments, articles, etc.—that work together to produce scientific knowledge, challenging the traditional distinction between subject and object and highlighting the agency distributed

among multiple actors. From this perspective, retraction can be seen as a process that realigns knowledge networks by removing or correcting nodes, e.g. scientific articles, that do not hold up under scrutiny. This highlights the importance of relationships and connections between different components of the scientific network in maintaining the integrity of knowledge. For example, the retraction of an influential study on the efficacy of a drug can not only correct the scientific record, but also alter medical practices and public health policies. This demonstrates how a single publication, a node in the network, can influence a wide range of actors and entities, whose actions and decisions are adjusted in response to the new configuration of the knowledge network.

The social studies of Science, Technology, and Society (STS) is an interdisciplinary field of academic teaching and research that also incorporates elements of a social movement. The main focus of this field is the analysis and explanation of science and technology as complex social constructions that carry significant epistemological, political, and ethical implications. This field has been described in detail by Cutcliffe (2005) and includes prominent figures such as Sheila Jasanoff, Donna Haraway, Dorothy Nelkin, Suzan Cozzens, and Alan Irwin (Hayashi, 2014).

The central themes addressed by the STS field are varied and include: constructivism, which assumes that scientific and technological developments are socially constructed phenomena; contextualism, which as a corollary of constructivism, postulates that science and technology are embedded in historical, political and cultural contexts and, therefore, can only be understood within these contexts; problematization, based on the view that scientific knowledge and technological development are value-laden and, therefore, not neutral, promoting an in-depth critique of both; and democratization, which considers the problematic nature of science and technology and accepts their social construction, proposing greater democratic control over technoscience (Cutcliffe, 2005)

The Science, Technology and Society (STS) approach offers other perspectives for understanding retractions in scientific publications. From a constructivist perspective, retractions are seen as essential mechanisms for correcting and validating knowledge, reflecting the dynamics of power, values and expectations of the scientific community. They emerge not only as corrections of errors or mistakes, but as manifestations of how science negotiates truthfulness and credibility. Contextualism, in turn, suggests that retraction practices should be examined within the specific contexts in which they occur, taking into account the institutional policies, community norms and economic incentives that influence the likelihood and manner of retracting works. Furthermore, problematization challenges the neutrality of scientific practices, encouraging a critical analysis of who decides what needs to be retracted and based on what criteria, emphasizing the importance of equity and transparency. Finally, democratization emphasizes the need for broader democratic control and inclusion in scientific practices, applicable also to retractions, suggesting that a greater diversity of stakeholders, including minorities and underrepresented groups, should influence retraction policies and practices.

Retractions in this context not only correct the scientific record, but also interact with issues of public trust in science, the accountability of scientists and institutions, and the role of science in society. The way in which retractions are communicated and perceived by the public can significantly influence trust in science and highlight the need for ethical and transparent practices by scientists and institutions. For example, retractions of vaccine-related studies not only correct the scientific record, but also play a key role in restoring public trust after episodes of misinformation. This case illustrates how retractions can have significant repercussions beyond academia, affecting public health policy and the acceptance of medical treatments by the general public.

Finally, through the lens of contemporary sociology, retraction can be seen as a fundamental ethical issue, reflecting the responsibility of scientists and institutions to ensure

the accuracy and reliability of scientific knowledge. This involves not only the obligation to retract work when necessary, but also to cultivate an environment where errors are openly admitted and corrected, without fear of reprisal. Such an environment fosters a culture of openness and transparency, essential to maintaining public trust and the integrity of science. Consider, for example, a research institution that adopts a strict transparency policy and encourages its scientists to openly report any errors. This approach not only facilitates the prompt correction of errors and the retraction of inappropriate publications, but also builds a reputation for reliability and integrity. In contrast, environments that penalize the admission of errors can lead to the suppression of errors until they become unsustainable, seriously undermining the credibility of the institution and the public's trust.

In summary, when examining retractions from the perspective of post-Mertonian sociology of science, it becomes clear that these events are not mere setbacks, but critical elements in the dynamic process of validation and evolution of scientific knowledge. Retraction practices, shaped by interdisciplinary influences and ethical responsibilities, reflect the complexity and responsibility inherent in the construction of science in contemporary society.

While post-Mertonian perspectives provide a rich understanding of the social interactions and constructions within science, Pierre Bourdieu's scientific field theory offers additional theoretical tools to explore the power dynamics and social structures that shape these interactions. This theoretical framework is fundamental to understanding ethics and integrity in science, especially as it relates to retractions of scientific publications.

4.7 Pierre Bourdieu's theories (1930-2002)

Pierre Bourdieu (1930-2002), an influential French sociologist, developed extensive theories on power, culture and society that transformed modern sociology. His analyses of cultural and social capital and how they influence struggles for authority and recognition are fundamental within the field of the sociology of science. These theories are particularly relevant to understanding norms and behaviors in science and shed light on practices of retraction in the scientific community.

We begin with his theory of the scientific field. For Bourdieu (1976, 2001), this field is a space of competition for scientific capital, which in turn is defined by an individual's credibility and recognition within the scientific community.

The scientific field is described by Bourdieu as an arena of structured competition, where challenges and interests are centered on the accumulation of scientific credit and control over science. For him, the scientific field acts as a stage for a political struggle for scientific domination, by assigning "to each researcher, according to the position he occupies, his problems – inseparably political and scientific – and his methods, strategies that are scientific and, at the same time, political" (Bourdieu, 1976, p. 91). In this field, agents, or scientists, compete for what he calls "scientific capital", which includes forms of recognition, prestige and intellectual authority.

Bourdieu also highlights that the very functioning of the scientific field produces and presupposes a specific form of interest, which refers to judgments of merit regarding "the scientific capacity or competence of a student or researcher, which are always contaminated, throughout their career, by knowledge of the position they occupy in the established hierarchies" (Bourdieu, 1976, p. 89).

In Bourdieu's view, researchers' practices are oriented towards the acquisition of scientific authority, which is a particular type of capital that can be accumulated, transmitted and even, under certain conditions, reconverted into other types. In this process, capital accumulation occurs through access to administrative positions, government commissions and

also through their reputation among peers to obtain research funds, attract students, invitations, awards, among others (Bourdieu, 1976).

This dynamic of the Bourdieusian scientific field directly influences how ethical practices are perceived and applied. Based on this perspective, it can be assumed that retractions can be seen as a regulatory mechanism that realigns the scientific field with its normative principles. In other words, they act as a correction of practices that deviate from accepted norms, reaffirming the value of scientific capital based on honesty and integrity.

In turn, the concept of capital – social, economic, cultural and symbolic – in the scientific field affects researchers' decisions, including the way results are presented and the likelihood of questionable practices that may lead to retractions. In the context of retractions, scientific capital can be negatively affected by the need to retract a work. A retraction can be seen as a loss of credibility and a sign of weakness in the scientific field, resulting in a decrease in the author's scientific capital. This capital is negatively impacted whenever the need to retract a work arises.

Although Bourdieu does not specifically address scientific fraud, the implication of his theories in the context of retractions can be illustrated by the observation of Santos-D'Amorim *et al.* (2021). These authors highlight that when a researcher is better known for his/her frauds than for his/her achievements, scientific capital acquires a negative character, diverging radically from the form of capital that Bourdieu describes as beneficial and prestigious. This deviation not only tarnishes the researcher's reputation, but also harms his/her career in the long term, restricting his/her opportunities to accumulate the positive capital predicted by Bourdieu in the field.

Bourdieu (1976, p. 93) also argues that researcher recognition is socially marked by "specific signs that competing peers grant to each of their members, based on the distinctive value of their products and original contributions to accumulated scientific knowledge." This aspect refers to issues of priority in scientific discoveries, where fierce competition for scientific capital can lead to hasty publication of works. This impetus to publish quickly, exacerbated by the pressures of the scientific field described by Bourdieu, can encourage questionable practices, such as data manipulation or the omission of unfavorable results, culminating in retractions.

Given Bourdieu's concept of scientific authority and recognition, it is important to recognize how internal struggles for scientific power and authority can compromise the integrity of research. Such competitions can sometimes result in dishonest behavior or the suppression of vital information, culminating in retractions.

Using Bourdieu's theory to examine retractions in scientific publications provides a deeper understanding of the underlying dynamics that influence these events. The Bourdieuian theoretical framework contributes to understanding how tensions between personal interests and collective norms can lead to ethical compromises, and how the scientific community can respond to these challenges to maintain or restore its integrity, possibly through adjustments in publication policies and governance practices. This approach helps to contextualize retractions within a larger system of scientific practices, rules, and struggles for power and prestige.

5 CONCLUSION

The ethical principles discussed here underscore the centrality of ethics in the conduct and interpretation of scientific retractions. Ethics not only guide the conduct of researchers, but also shape editorial policies and institutional responses to issues of scientific integrity. By fostering a culture of accountability and transparency, ethical principles help ensure that retractions are treated as information and correction procedures, ensuring a fair and constructive approach, minimizing the associated stigma, and highlighting their role as part of the process

of self-criticism and continuous improvement of the scientific community. Therefore, it is imperative that training and awareness of scientific ethics be considered essential components of research education and practice. This approach not only strengthens the integrity of scientific publications, but also supports the development of an environment where errors can be openly admitted and corrected, contributing to the continued reliability and progress of science. Although the number of retractions may seem low compared to the total volume of publications, their growth reflects an ongoing effort to improve the quality and credibility of scientific research.

The practice of retraction, therefore, is not only a correction mechanism, but also a vital element for maintaining trust in the scientific process. Sociological analysis, as seen through the lenses of Durkheim, Weber, Merton, Ziman, Zuckerman, Bourdieu, among others, offers different perspectives and contributions on how retractions are perceived and managed within the scientific community. These theorists highlight the importance of norms, scientific capital, and social structures that influence academic practices, illustrating the complexity of the interactions that shape the scientific field.

Furthermore, consistent application of ethical principles and ongoing development of scientific integrity policies are essential for retractions to fulfill their corrective and educational role. Research institutions, together with journal editors, are challenged to create environments that not only discourage dishonest practices but also promote transparency and accountability. This entails ongoing education on research ethics and the development of more sophisticated tools to detect and prevent fraud and errors. Finally, recognizing retractions as an integral part of the scientific dynamic is essential to destigmatizing this process. Rather than viewing them as failures or negative events that may, in certain situations and depending on their severity, affect a researcher's career, it is essential to view them as a testament to self-correction and an ongoing commitment to truthfulness and integrity in science. In an increasingly informed and connected world, the ability to correct the scientific record openly and transparently protects scientific progress and reinforces public trust in science.

Therefore, although the increase in the number of retractions may initially seem worrying, it also indicates that the scientific monitoring and self-regulation system is working and continually adjusting to new realities and challenges, influenced by several factors, such as technological changes, economic contexts and issues related to peer review. Recognizing these factors is essential to understand the dynamics of retractions and the importance of maintaining a strong system of scientific integrity. By integrating an ethical and sociological approach, such as the implementation of diverse ethics committees and regular trainings with content on research ethics and sociology of science, the scientific community can better manage the complexities of retractions, thus ensuring the integrity and continuous evolution of knowledge.

Although this article has addressed several ethical and sociological perspectives to understand the social dynamics of scientific retractions, this reflects a limitation of the study, as there are other theories that could be explored to further enrich the understanding of retractions in the scientific community. However, this limitation does not compromise the contribution of the article, which offers an analysis of the selected theories, encouraging a more in-depth and reflective academic debate on integrity and trust in science. Therefore, it is suggested that future research investigate other approaches to examine how different theoretical frameworks can offer new insights into retraction practices. Furthermore, a more detailed examination of the ethical principles that guide retraction decisions in different scientific fields could provide a more heterogeneous understanding of ethical expectations and their cultural and disciplinary variations.

Ultimately, promoting effective and transparent retraction practices is critical to ensuring that science continues to be a trustworthy and progressive enterprise, capable of addressing the ethical and social challenges of our time.

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