Dr. Juan-Pedro MOLINA-CAÑABATE
Universidad Carlos III de Madrid. Spain. jpmolina@hum.uc3m.es

Dr. Raúl MAGALLÓN-ROSA
Universidad Carlos III de Madrid. Spain. rmagallo@hum.uc3m.es

Misinformation and scientific journalism. The case of Maldita Ciencia

Desinformación y periodismo científico. El caso de Maldita Ciencia

Abstract
The objective of this research is to analyse the work of the journalism community Maldita Ciencia during its first year of life, including its fact-checking and dissemination processes. Thus, employing a combination of methodologies both quantitative (social media use and analysis) and qualitative (personal interviews) allows for the study of the processes to create false contents that appear like scientific information, how audiences end up assuming they are true and how they go viral. In parallel, it is essential to know how these types of misinformation are verified and picked apart, and we propose analysis methods depending on the type of hoax or unfounded rumour in question.

Keywords
Fact-checking; scientific information; pseudoscience; health

Resumen
El objetivo de esta investigación es analizar el trabajo del colectivo periodístico Maldita Ciencia en su primer año de vida, incluidos sus procesos de verificación y difusión. De este modo, a través de una combinación de metodologías cuantitativas (uso y análisis de redes sociales) y cualitativas (entrevistas personales) se estudian los procesos de creación de contenidos falsos con apariencia de información científica, de qué forma los públicos los asumen como ciertos y cómo estos la viralizan. Paralelamente, resulta imprescindible saber cómo se verifican y se desmontan este tipo de desinformaciones y se propone una tipología de análisis por el tipo de bulo.

Palabras clave
Fact-checking; información científica; pseudociencias; salud

1. Introduction

Anti-vaccination and flat Earth movements, alleged diseases caused by electromagnetic waves, climate change denial and pseudo-therapies have all been seen in recent years in the digital world, seeking to amplify their discourse and convert new sympathisers and militants (Bigas, 2019).

False contents that seems scientific have commonalities with *misinformation* on politics or migratory movements (Fletcher, Cornia, Graves and Nielsen, 2018). From this perspective, as Alexandre López-Borrull and Candela Ollé point out, 'the scientific world has also the challenge of facing the truth, half-truths and misinformation' (López-Borrull and Ollé, 2019).

These falsehoods often arise from misinformation strategies whose aim is to create traffic towards specific pages for the financial benefit of their owners (Silverman, Singer-Vine and Thuy, 2017). There are often underlying moral or ideological reasons as well (Benkler, Faris, Roberts and Zuckerman, 2017). On occasion, they go viral extremely quickly because they speak (and advise us) about matters that affect our daily lives (Freelon, 2017). In any case and as Javier Salas (2018) reminds us, the main noteworthy causes of this new scenario include the fact that 'platforms like Facebook and YouTube do not stop spreading misinformation and unfounded rumours about health'.

Moreover, one of the problems posed in the fight against scientific misinformation is that regular consumers of scientific news are less committed to disseminating science and more likely to leave comments on conspiracy pages (Bessi, Coletto, Davidescu, Scala, Caldarelli and Quattrociocchi, 2015).

The present research has two main objectives:

- The first one is to find out how false contents that appear like scientific information are created, how audiences assume they are real and how they go viral.

- The second objective is to find out how these types of false messages are fact-checked and deconstructed.

To conduct this study, we chose a methodology that combines both quantitative and qualitative analyses. Thus, we analysed the Twitter account of the journalism organisation *Maldita Ciencia* during its first year of life (from 27 June 2018 to 27 June 2019)[1] and we interviewed its project coordinator, journalist Rocío Pérez, seeking patterns to recognise unfounded rumours (Magallón-Rosa, 2018)

During the design phase for this research, we started from these hypotheses:

H1 – Contents with a scientific appearance are easily propagated via social media because information consumers cannot easily compare them and do not know which reliable sources to turn to.

H2 – There is a need for an independent fact-checking body that, without employing academic or scientific language, is capable of debunking false information in a way that is approachable and easy for audiences who (without any previous knowledge of the topic and barely aware of this) have contributed to it going viral.

1.1. Status of the subject

In 2018, 'misinformation' was picked as the Word of the Year by Dictionary.com. In 2017, Collins chose the expression 'fake news' and in 2016 Oxford Dictionaries selected 'post-truth'.

Since then, and despite the fact that the media debate on the importance of not using the term *fake news* has not received the support needed, the use of the word 'misinformation' has garnered more success in academic settings. In 2017, Claire Wardle and Hossein Derakhshan published a report entitled *Information Disorder: Toward an interdisciplinary framework for research and policy-making*, in which they advocated:

> We refrain from using the term 'fake news' for two reasons. First, it is woefully inadequate to describe the complex phenomena of information pollution. The term has also begun to be appropriated by politicians around the world to describe news agencies whose coverage they find disagreeable. In this way, it's becoming the mechanism by which the powerful can clamp down upon, restrict, undermine and circumvent the free press (Wardle and Derakhsan, 2017: 16).

In this regard, approaching the misinformation phenomenon has become increasingly more glocal – compared to the initial research that was primarily centred on the US elections and the Anglo-Saxon context – and, in parallel, more specialised, incorporating new methodologies and players that try to fight against the updating of misinformation software that is being developed in different fields that have very little a priori in common, such as politics and science.

In this new ecosystem, fact-checkers 'not only report the facts, but publicly decide which ones they are' (Graves, 2013: 18). In any case, and if fact-checking is almost never capable of repairing the damages caused by misinformation, its mere existence can in fact help to reduce the misinformation that is disseminated (Nyhan and Reifler, 2012).

1.2. Research methodology and questions

Firstly, this research presents a theoretical corpus that defines the parameters within which misinformation moves, what its causes are and the interests behind them.

Secondly, we conducted a quantitative study and a qualitative analysis whose object of study is the fact-checking work done by the journalism team *Maldita Ciencia*, via its Twitter account.

We chose this platform because an easily delimited and measurable sample can be obtained there. To this end, we analysed the contents published during its first year of life (27 June 2018 to 27 June 2019). A total of 3242 tweets.

We used two complementary analytical tools. The first, open source: *T-Hoarder*, which works with a methodology called *t-hoarder_kit*. It has been active since 2012 and meets the requirements for objectivity, transparency and knowledge sharing (Congosto, Basanta-Val and Sánchez Fernández, 2017). These tools must be employed in a Linux and Python environment. *T-hoarder_kit* uses the Twitter APIs: *REST*, *Search* and *Streaming*.

The second tool we used is the premium version of a commercial application: *Twytonomy*, a Twitter analysis tool.

In total and as summarised in Table 1, we recorded 3242 tweets that had 283,902 retweets and 140,511 likes throughout the defined year, which translates into 87 retweets per tweet and 43 favourites per tweet.

Table 1. Posts, retweets and favourites reached

Post type	Total interactions	By tweet
Total retweets	283,902	87.57001851
Total favourites/likes	140,511	43.34083899
Total tweets	3,242	

Source: Prepared by authors.

Then we selected a sample of the most retweeted tweets (and therefore, the most visible) to discover their paradigmatic traits and establish a debunking type. Finally, we interviewed Rocío Pérez, the coordinator of *Maldita Ciencia*.[2]

These steps led to us validating our hypotheses, discovering traits for debunking and posing lines for discussion. Under this approach, our initial research questions were:

> Q1. Which tweets have the most *retweets* and *likes* posted on the account? What types of tweets are they?
>
> Q2. What are the posting patterns for disproving unfounded +rumours?
>
> Q3. Can we classify the types of unfounded rumours related to science communications from the use of its Twitter account?
>
> Q4. What relationship is established with scientific experts by *Maldita Ciencia*?

2. Information on scientific contents versus communication of pseudosciences

The problem with the dissemination of science (Peters, 2013) has been affected by the new global and cross-cutting scenario of misinformation. However, and despite the fact that there are common problems, each country has its own particular features (Humprecht, 2018).

As Salas 2018 points out, 'Internet is the second means to access information on pseudo-therapies in Spain and two-thirds of the citizens research and get information about health on the web'. A report by the *Barcelona Association of Physicians and Surgeons,* the *Catalan Department of Health* and the *Catalan Audiovisual Council* reported that when searching for 'cure' and 'cancer' on YouTube, 74% of the top 50 results were hoaxes and pseudoscientific messages (Vega, 2019).

In this regard, one of the challenges of scientific communication is that the defenders of conspiracies and pseudosciences may not only reject scientific proof, but also spend cognitive resources to discredit them (Sunstein and Vermeule, 2009). From this perspective, Scheufele and Krause (2019) list these difficulties for advancing with scientific dissemination and popularisation: lack of understanding of science, upholding of beliefs that are unsustainable with scientific progress, imprecise opinions about scientific knowledge and conspiracy-paranoid beliefs (Byford, 2011).

For his part, López-Borrull points out that 'under the umbrella of fake science, we can include two phenomena: on the one hand, there is specific knowledge that is still not firmly established among the scientific community and, on the other hand, part of fake science actually occurs within the scientific community itself' (Bigas, 2019).

This fragmentation of reality becomes stronger and more deeply-rooted because conspiracy theories tend to reduce the complexity of reality to then explain significant social or political issues as traumas designed by powerful individuals or organisations (Bessi et al., 2015). In this way and as with political misinformation, individuals tend to seek cognitive shortcuts to complex problems with the aim of taking a side, feeding their own biases or establishing social responses (Lewandowsky, Cook, Oberauer and Marriott, 2013).

3. Fact-checking scientific contents: the case of *Maldita Ciencia*

In recent years, fact-checking initiatives have evolved very quickly. In this regard, the establishment of the International Fact-Checking Network (IFCN) merits mention, whose central offices are at the Poynter Institute for Media Studies. In the United States, which is a leader and reference for fact-checking projects, the format has been developed since the 2008 presidential elections (Graves and Glaisyer, 2012), although *FactCheck.org* was launched earlier, in 2003, and the *Washington Post's Fact Checker* in 2007. At the beginning of 2020, the Duke University *Reporters' Lab* counted 225 active fact-checking organisations.[3]

However, the checking of scientific contents has not had almost any impact and has not been widespread to date, due to which the study of *Maldita Ciencia* was an innovative and significant undertaking. Just like *Maldito Bulo*, *Maldita Migración* (Molina-Cañabate and Magallón-Rosa, 2019) and *Maldita Hemeroteca*, *Maldita Ciencia* is another section of *Maldita.es*, a non-profit organisation whose purpose is to fact-check information circulating on the internet, especially on social media like Facebook and Twitter, messaging apps like WhatsApp and platforms like YouTube.

Maldita Ciencia started online on 27 June 2018 with the aim of broadening the range of fact-checking to also include scientific information. According to Rocío Pérez, project coordinator, the types of unfounded rumours and hoaxes are really not so different across subject matters. Thus, there wouldn't be much difference between the causes for example, of misinformation on migrants and the misinformation promoted by the pseudosciences:

> 'It is not really that different. There are several interests: one is financial, as there are people who earn money if you believe that organic food is healthier than non-organic food, and there are people who earn money if you buy specific pills for losing weight. That is easy to understand. But then there are also underlying ideological questions, although not the ideology that we commonly consider. For example, if we consider that whether or not believing in vaccinations is an ideological fight, then you've got a battlefield.'

For matters of scientific misinformation, Facebook and YouTube are the two platforms with the greatest power to go viral, each one for different reasons. According to Pérez, the false information in the guise of science that most often goes viral has a common pattern: the more of an everyday issue that it is, the more viral it goes and the more debate it generates.

They even go viral – explains Pérez – because people want to help others, giving them advice. To this she adds that 'not everyone has the knowledge required to form a sound judgement to start with'. Information related to health is the clearest example. Concretely, information on diets and eating habits and cancer.

These types of unfounded rumours are tough to debunk and, as Pérez explains, because the cause-effect of an eating habit takes decades to be seen. From this viewpoint, the misinformation categories that they work with at *Maldita Ciencia* are:[4]

1. Hoaxes and unfounded rumours: When information is simply a lie.

2. What we know: When at *Maldita Ciencia* they do not say something is a lie, but that it is not exactly the truth either. This tends to happen when there is a study that is done poorly ('Bad science leads to bad scientific information', explains Rocío Pérez) or is misinterpreted.[5]

3. Explanation: 'Maldita explains', Questions that people have been listening to for a long time.

In this regard, it is important to point out that false information reaches people via several channels:

1. The most basic channel is monitoring social media.

2. The audience can make any queries it wants, and privately via WhatsApp (+34 655 19 85 38).

3. Scientific consultancy.

4. They pay attention to the searches that users make on its websites.

5. Finding hoaxes on Facebook through an agreement with this platform. From there, *Maldita Ciencia* checks certain posts with dubious contents.

In this context, it seems advisable to ask ourselves: Does fact-checking need to be done by third parties, independent journalism organisations? Pérez is unsure whether all independent institutes doing fact-checking actually have authority and influence. What she does know is that the general public penalises for-profit organisations and *Maldita Ciencia* is a non-profit platform that has committed to transparency (economic and their working method process) and has progressively been creating its own community under the umbrella brand *Maldita*.

3.1. Internal organisation, methodology and fact-checking processes

The transparency of fact-checkers is one of the fundamental principles of the signatories of the IFCN (IFCN International Fact-Checking Network). In this regard, we should remember that *Maldita* is a non-profit organisation that relies on several agreements for its survival:[6]

1. An agreement with Facebook, for which it does fact-checking tasks.

2. A crowdfunding campaign to become a foundation.[7]

3. Collaboration agreements with different traditional journalism media.

4. By obtaining awards, such as the one granted by the Telefónica Foundation to make an app, and by the European Journalism Centre to conduct CRM.

5. The group also raises funds through talks and training courses.

With regard to newsmaking and fact-checking methods (Cassany, Cortiñas and Elduque, 2018), the procedure *Maldita Ciencia* works with is – as Rocío Pérez acknowledges – traditional journalism (Secko, Amend and Friday, 2013). When they receive information with signs or evidence of it being fake, they turn, on the one hand, to documentary sources (scientific articles, papers and studies) and, on the other, scientific societies and different experts with whom they can compare the information.

Maldita Ciencia does not sign its articles for two reasons: the first is to make it clear that the text is the outcome of teamwork and a methodology and, second, to protect authors' identities from possible haters, trolls and personal attacks. Pérez explains that they have had to vary their debunking method over the course of time. They are increasingly more cautious in their use of categorical phrases like: 'That is not true' and prefer to use expressions like 'There is no evidence that'. Being less conclusive when refuting information perhaps makes them less forceful or emphatic, but they are aware that scientific information must be handled with scientific prudence.

4. *Maldita Ciencia's* use of Twitter: dissemination and popularisation, literacy and creation of communities

4.1. Sources of hoaxes

According to the sample of the most retweeted tweets, the vast majority of misinformation that *Maldita Ciencia* deconstructs is related to health: homeopathy, drinking raw milk, whether or not vaccinations are advisable, detox diets, whether or not a sexual option is considered a disease.

The analysis of the most retweeted tweets and their accompanying news articles lets us design the types of sources of the false information being dismantled. Thus, we can differentiate between vague sources, celebrities who support movements without scientific grounds and institutions that delay revealing proof.

Table 2. Types of misinformation sources and main characteristics

Vague sources	This is the most common origin. General beliefs that are taken as true due to being heard or read. They are often supported by scientific or pseudoscientific studies that are misinterpreted, taken out of context or that lack validity due to not being corroborated over time or having any scientific research conducted.
Celebrities	Celebrities that get carried away by an idea and share it publicly.
Institutions that delay in showing proof	Official reports and contradictory studies that feed into general uncertainty.

Source: Prepared by authors.

When we speak of vague sources, we are referring to the false information that assures that vaccinations cause serious diseases, how good detox diets and foods are for you, that milk is bad for our health or that it is better to drink it unpasteurised.

Image 1. Tweet refuting detox.

Source: Maldita Ciencia.

Examples of celebrities that are carried away or influenced by an idea and share it publicly would be Iker Casillas questioning whether the Earth is flat and Teresa Jordá, former Catalan minister of Agriculture and Livestock, advocating drinking raw milk. An example of institutions that delay in revealing evidence: the WHO considered homosexuality a disease until 1990.

Image 2. Tweet debunking the good qualities of raw milk.

Source: Maldita Ciencia

From the viewpoint of impact, notable results include the fact that *Maldita Ciencia's* dissemination of tweets is indeed important if we bear in mind the 82,550 plus followers it had only 12 months after it was founded (close to 95,000 at the beginning of 2020). Our quantitative analysis show that its tweets obtain one *favourite* (like*)* for every two retweets, which means they are contents people save to read at a later time, but also that a lot of information is recycled and periodically posted again.

Percentage of retweets and likes reached per month
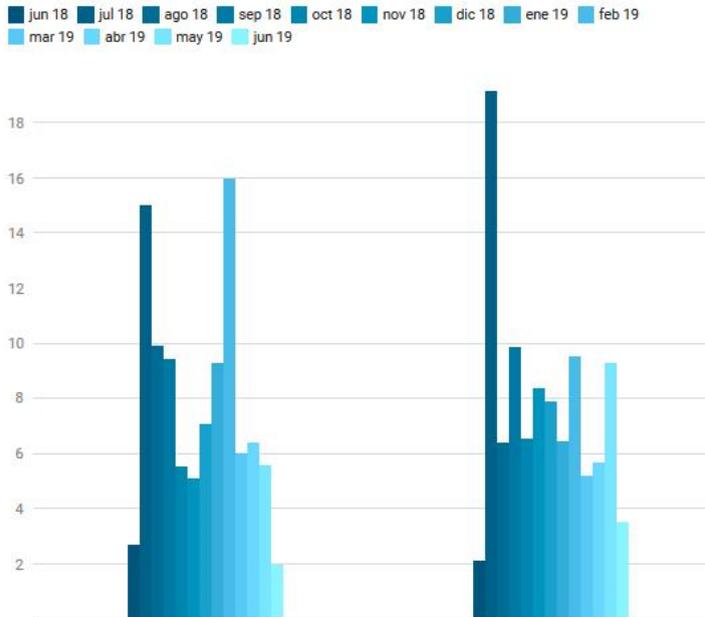
Percentage of retweets reached per month　　　　**Like´s percentage reached per month**

Source: Prepared by authors.

Moreover, it is clear that – if we bear in mind the growth curve of the impact of *Maldita Ciencia* – its first month (July 2018) was the most important, with over 42,513 retweets and 26,870 favourites, never reaching similar figures again in subsequent months (only in February 2019 did the number of retweets exceed those in July 2018.

4.2. Debunking standard related to pseudoscientific information

The content we are studying is transmedia (Scolari, 2013: 46). All its items form part of a large narrative, where users can consume them either separately or as a whole. Users also have the power to take part in the creative communication process: not only can they retweet a tweet, for example, but they can also add to it or participate in a thread.

Table 3. Formal content patterns of *Maldita Ciencia*

Simple and educational language, often with a bit of humour.[8]
With photographs or videos that capture readers' attention.
Which include a link to a news article.
Which use hashtags for visibility or to cause a certain emotional state.
Which use a word in capitals or, otherwise, an emoticon.
Which open threads to encourage participation and go into greater depth on the subject.

Source: Prepared by authors

Generally (and this nuance is important, even more so for the case we are studying), transmedia content houses different levels of depth with regard to knowledge of the message. Thus, we find that the most superficial level is simply reading the tweet. The deepest level would be consulting the papers that *Maldita Ciencia* refers to as a source for comparison.

In the sample of the most retweeted tweets we find references to papers and documents from renowned universities, such as Harvard University, and organisations with visibility, such as Northern Rivers Vaccination Supporters, the *Journal of Human Dietetics and Nutrition* and the WWF. Expert opinions often include scientists and/or university professors. They include references to David Robert Grimes, physicist at the University of Oxford; Miguel Ángel Lurueña, doctor in Food Science and Technology, as well as experts on the subject, such as Álex Riveiro.

Position	Tweet text	Number of retweets
1	5 KEYS to distinguish WHAT IS SCIENCE AND WHAT IS NOT SCIENCE. Are you unsure of how to differentiate science from pseudoscientific lies? In this video we will explain how in a very simple way #StopPseudociencias	3318
2	Here is a somewhat odd and very special periodic table: one by female scientists! Creation by @tvaldessolis #11F2019 #MujeresEnLaCiencia https://naukas.com/2018/11/23/la-tabla-periodica-de-las-cientificas/	2592
3	Homeopathy https://twitter.com/i/status/1057632314497232896	1622
4	If you're thinking about ordering a 'detox juice' when you get to the beach on your holidays, you should know that… Everything, absolutely everything, about detox is a scam	1383
5	MILK is not UNNATURAL or BAD for your health. The beauty of artists @yo_doctor	1342

Source: Prepared by authors.

One of the purposes of fact-checking organisations is the search for their own distinctive style that will lead to their recognition as a trustworthy and reliable brand. From this perspective, *Maldita Ciencia* has established a series of patterns, both in form and in content, that let it be identified in order to create a contract of trust and recognition.

5. Conclusions

As we have verified, the immense majority of the misinformation that *Maldita Ciencia* deconstructs and debunks is health related: homeopathy, drinking raw milk, whether or not vaccinations are advisable, detox diets, and so forth. To this end, it offers five keys to knowing how to distinguish between scientific information and pseudoscientific information (Maldita Ciencia, 2018):

1. While science uses extremely precise terms, pseudoscience uses vague words (holistic, purify, mind, spirit, etc. etc.).

2. Science provides proof; pseudoscience does not.

3. Science uses data; pseudoscience takes advantage, especially, of testimonies.

4. Sciences advance; pseudosciences do not.

5. Science explains.[9]

With these premises, we have to point out that the present research study validates the hypotheses set out at the beginning of the text:

1. False information that apparently has a scientific nature is easily propagated via social media because information consumers cannot easily compare it and do not know which reliable sources to turn to. The sources that *Maldita Ciencia* mentions for comparison are not within reach of just any user. While true that the documentary sources openly reveal their knowledge, their contextualisation is the field of experts.

2. An independent fact-checking body is needed that, without employing academic or scientific language, can debunk false information in a way that is approachable and easy for audiences who (without any previous knowledge of the topic and barely aware of this) have contributed to it going viral. The general public tends to penalise for-profit institutions. *Maldita Ciencia* is not and this makes them seem impartial.

In this regard, digital literacy has become one of the agreed-upon solutions by governments and institutions to the problem of misinformation. From this viewpoint, the need to implement scientific literacy campaigns seems obvious, by the Ministries of Health or Science and by the competent autonomous community departments.

The adaptation of new codes and languages for scientific communication is seen as one of the most important challenges in upcoming years. In this regard, it would be interesting to explore the possibility that the WhatsApp issue of *Maldita Ciencia* could be disseminated and integrated into the calendars of the Maldita community, with the aim of reducing the focal points of misinformation and disinformation, but above all to make the scientific contents that form part of our society's daily conversations go viral and share them.

From an internal operational viewpoint, it would be advisable for *Maldita Ciencia* – like what is done with Maldito Bulo – to have a series of internal categories to identify contents by subject matter (health, diets, vaccinations, sex, etc.).

The present study also reveals that the survival of fact-checking institutions involves juggling several funding sources that guarantee their independence. However, we must ask ourselves if the future of these organisations is ensured, as they must rely on one-off collaboration agreements that have little continuity over time.

And, lastly, this research has discovered that misinformation in the scientific field is produced as a consequence of the slowness of corporate communications of the institutions involved in scientific communication: from hospitals to ministries and from universities to laboratories.

With regard to the future prospects for research into scientific misinformation and fact-checking, there must be more in-depth studies about how they are affecting the relationship between technology companies and fact-checkers to penalise the circulation of pseudoscientific contents. The benefits of these new studies would include being able to analyse which narratives work best to debunk hoaxes and falsehoods, depending on the network or social platform (Magallón-Rosa, 2019), understanding that reliable sources and false content distribution can be different and that mechanisms so that they go viral are also different.

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7. Acknowledgement

8. Notes

1. The complete database can be viewed at the link: https://doi.org/10.6084/m9.figshare.11635719.v1

2. The interview took place at the Maldita Ciencia editorial office on 18 July 2019

3. Please see: https://reporterslab.org/fact-checking/

4. At this time there are no internal categories established by subject matters.

5. For example, a hoax on the study that shows that gazpacho stops colon cancer. 'The study is real; it exists', explains Pérez. 'But it does not say what the headlines are claiming.' There is information, in short, that seeks clickbait.

6. Personal interview.

7. Please see: https://www.goteo.org/project/maldita

8. For example: ".@IkerCasillas, if you are trolling us... SHOW YOURSELF […]Proof and data to convince Iker Casillas and company that YES we have travelled to the Moon' (tweet 7).

9. The platform offers another important piece of information related to information sources: 'Always pay attention to who is trying to scare you.'