Experts and science communication in time of Covid vaccination campaign: the Italian case

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Since the first COVID-19 infections were recorded in January 2020, the connection between science and communication has grown significantly, playing a crucial role in providing citizens with information and guidance on how to address the pandemic and the various scientific advancements related to the evolving vaccination campaign. Particularly noteworthy has been the substantial involvement of scientific experts in media coverage and their exposure to the public's advice. With the symbolic launch of Vaccine Day, the role of science communication experts has proven to be instrumental in effectively promoting interventions supporting vaccine choices through mass media and addressing instances of misinformation that can cause social alarm. From the perspective of studies concerning the interaction between science and society, we aim to investigate the construction of the expert's image and scientific communication. This will be accomplished by comparing the self-representation of experts visible in Italy through their content published on social networks with their media representation in daily newspapers. Specifically, we intend to analyze all cultural products extracted using keywords such as «vaccine», «expert/scientist», «COVID/coronavirus» and a list of 33 experts selected from a preliminary survey, individually associated with the keywords during the COVID-19 vaccination campaign. We hypothesize the existence of new models of scientific communication and different communication strategies among experts.

Keywords: communication of science, COVID vaccination campaign, visible expert, expert role, media representation

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1 The communication of science during the pandemic

Throughout the pandemic, the speed with which science has operated within the uncertainties of COVID-19 has aligned and adapted with the increased need for public information, consequently identifying itself as a challenge also for information systems invited to respond quickly to the new demands imposed by the crisis (Thomas and Senkpeni, 2020). Debates, rumors and conjectures have been mixed with messages from governments and health agencies raising «an emergency within an emergency» since the beginning of the crisis. This results in concerns that the World Health Organisation (WHO) labels as an «infodemic» of fake news and information (WHO, 2021) and has given back to less adherence to basic health recommendations contributing even more to transmission and deaths. Despite the various errors, misunderstandings, and ambiguous knowledge for citizens, «follow the science» was an ever-present mantra throughout the world and, the var-

ious governments repeatedly asked the population to comply with scientific recommendations to fight the virus.

In this situation of uncertainty – where the demand of the population (and others) was to receive information and give effective answers quickly – experts were often involved by the media not only as scientific popularizers who were specialists in their field but rather as all-round experts ready to go beyond their expertise. The involvement of scientific experts in media coverage and public exposure during the COVID-19 pandemic recalls Goodell's (1977) concept of «Visible Scientists» and, their presence in public communication underlines changes in the dynamics between science and society (Maasen and Weingart, 2005; Cheng *et al.*, 2008; Bucchi and Trench, 2014). Scientists and experts coming out of their laboratory activities speak directly to the public, especially in the context of controversies, expressing their work through languages, codes, and representations that appear different and distant from their usual ways of interacting (Lorenzet, 2013). Rae Goodell in The Visible Scientists (1977) conceptualized visible scientists primarily neither for discoveries, for dissemination, nor for leadership of the scientific community, but for activities in the tumultuous world of politics and controversies (Goodell, 1977), to which the pandemic situation we have just experienced leads us to add the world of science communication.

The dynamics of technoscientific controversies refers to how science and technology become publicly relevant and how experts find that their work is discussed and debated outside the scientific community through languages, codes, and representations that appear different and distant from their usual ways of interacting (Lorenzet, 2013). The notoriety of some scientists was achieved because they were aggressively taking advantage of new media (*ibid.*) and at the same time had developed a remarkable cooperation and sophistication in dealing with the press. In short, they were attuned to the needs of the mass media (Fahy, 2015) and Goodell noted those changes that we can now label mediatization traits. The sociologist Massimiano Bucchi (2010) – in studying the different relations between science and society – pointed out how in certain situations, usually related to scientific controversies, scientists begin to address the public directly, skipping the usual stages of scientific communication. This is also due to that shift from a science separated from society to an integrated science-society system, in which there is continuous questioning by actors outside the scientific community and «social distribution of expertise» (*ibid.*). As explained by Fahy (2015), Goodell's visible scientists were controversial and articulate, had a colorful image and had a hot topic or theme that made their work relevant to social concerns. In these cases, controversies do not follow the traditional process of scientific debate but are pronounced in real-time and publicly (Bucchi and Trench, 2014). By following this, scientists partly

create a public image conforming to characteristics that make them more likely to be selected in the media. Tactical characteristics can also help ensure that science communicators can change beliefs, feelings, structures, and behaviours (Neresini and Bucchi, 2011). The role of expert is challenging for scientists because most are primarily concerned with the creation of knowledge and, scientific knowledge is usually insufficient as the only basis for giving advice or communicating. The COVID-19 pandemic proposed a media portrayal that contributed to exacerbating the scientific debate by creating an «intrascientific» conflict among different forms of knowledge (many scientists belonging to different disciplinary fields debated the legitimacy of their positions). In fact, we highlight how in pandemics the boundary shifted from advocacy science – understood as the communication of scientific results – to the media politicization of science – understood as the appropriation by expertise of media spaces whose management in the past was the exclusive exercise of the media-political relationship (Tipaldo, 2011).

1.1 Influence and Public Engagement: The Role of the Expert

The promptness with which the pandemic has permeated the global landscape, coupled with the enormous flow of communications, content, and data generated daily, poses various challenges for communication utilizing social media as an information source. In the early stages of the pandemic, before the dissemination of formal publications or webinars, the only available sources of information were the internet and social media. The sharing and re-tweeting mechanism serve as a vehicle through which original content is disseminated among social media platform users; elements that gain popularity can be amplified hundreds or thousands of times within a few days. While advantageous for reaching a wide audience with valid content, this phenomenon can also significantly amplify any inaccuracies within the disseminated material. Clinical cases, case series, and even preliminary reports were disseminated (and consequently widely distributed to a large audience) with limited emphasis on their respective limitations and biases, instead favoring attention-grabbing headlines to attract readers, stimulate interactions and impressions, thus gaining visibility on social media. In this context, the centrality of the role of the expert scientist emerges in discerning, evaluating, and accurately communicating information in a pandemic context characterized by an abundance of data and information. Communication between specialists – scientists and experts – and the public constitutes an effort to bridge the cognitive gap between the expert paradigm and public perception regarding public health issues, through the implementation of targeted communication strategies. This process represents an expression

of external communication. In the realm of risk communication, a significant challenge lies not only in transmitting knowledge but also in developing methodologies to convey comprehensive information reflecting intrinsic uncertainty (Gesser-Edelsburg *et al.*, 2015).

During the pandemic context, the expert scientist becomes a central figure in the communication process, holding the responsibility of articulating the scientific intricacies of public health issues accurately and comprehensibly. This aligns with Bauer and Jensen's (2011) definition, where public engagement in recent years has come to signify «communicative action», establishing a dialogue between science and various publics. Communicative action encompasses a wide range of activities: public lectures, interviews for newspapers, radio and television, writing popular science books, participation in public debates or science cafés, collaborations with non-governmental organizations, activism, and more, up to the presence in new media. Stephen Hilgartner (1990) argues that public engagement is based on a continuum of communicative genres hidden both by technical laboratory discussions through conference presentations and published scientific literature and by conferences and writings that address and reach a broader, non-specialized audience for public understanding of science. This sets public understanding of science on one side and the mobilization of scientists and resources to engage the public with science on the other (Bauer and Jensen, 2011). The two aspects are connected, with the former context providing understanding, observation, and social movement (*ibid.*). The latter, involving the mobilization of resources and public goodwill, known as public engagement, has taken on various forms and occurs in very different contexts worldwide (Zald, 1987). In this scenario, the expert plays a crucial role in ensuring that the conveyed information is complete, reflects inherent uncertainty, and enables the public to make informed health decisions based on available scientific facts. Therefore, it seems logical to infer that the centrality of experts in crisis management, especially in the era of social media, plays a crucial role in disseminating information and shaping public perception of risk (Ophir, 2018). The use of digital platforms by experts provides a rapid channel to communicate dangers and suggest mitigation actions to the public and patients. However, the speed of information on these platforms is a double-edged sword, as it can contribute to the rapid spread of misinformation (Rossmann *et al.*, 2018). Misinformation spread through social media can provoke public outrage, a critical element that experts must consider when implementing effective communication strategies (Eisenman, 2007). Understanding public outrage is essential for shaping risk perception and mitigation measures. Experts must address this aspect consciously, seeking to control risks over time. In a context where social media increasingly shape public opinion and risk per-

ception, it is essential for experts to be active on such platforms (Lwin *et al.*, 2018). Physicians can serve as reliable sources, providing timely updates and addressing individual patient concerns. Risk perception varies significantly from person to person, and the presence of physicians on social media can contribute to providing personalized information and reassurances. Political preferences based on reliable news sources influence the public's choice of media channels (Sandman, 2006; Colline, 2019). Social media, acting as an «echo chamber» of media attention (Cinelli *et al.*, 2021; Jiang *et al.*, 2021), facilitates the sharing of messages and news among individuals with similar opinions. Experts must take this dynamic into account when designing their communication strategies, aiming to reach a diversified audience and mitigate polarization in risk perception. In summary, the role of experts on social media is fundamental for communication during crises but requires a conscious approach to managing the speed of information, combating misinformation (Brindha *et al.*, 2020; Ferrara *et al.*, 2020) and adapting to the complex dynamics of public risk perception (Sjöberg, 1998; Motta *et al.*, 2020; Dyer and Kolic, 2020).

2 Research Methodology

Unlike other countries (Metcalfe *et al.*, 2020), in Italy a plurality of perspectives with different competences emerged to the point of opening and shaping that crisis in the emergency on the public and institutional communication side. Overall, the media exposure to the pandemic crisis has led different scholars to emphasise the task of scientists in the communication process and the challenges included, thus underlining how in times of pandemic the role of expertise and the scientist becomes increasingly crucial not only in the academic debate (Algan *et al.*, 2021). All this has reinforced the authority and key social role of scientists and science communication in society and in leading public debate (Scamuzzi and Tipaldo, 2015). Since the symbolic launch of Vaccine Day set for 27th December 2020 across Europe, the role of science communication experts has become increasingly central to effectively promote, through the mass media, interventions both in support of vaccine decisions and in response to instances of misinformation ready to raise social alarm (Diekema, 2012). It is in this context that our research work focuses on the figure of the expert. Considering the perspective of studies between science and society, the research objective aims at understanding the world of narratives and self-constructed or inferred representations regarding the figure of the expert during the vaccination campaign. Thirty-three experts were selected and it was necessary to divide the research into three areas, mainly following three research questions:

RQ1: Is the figure of the expert influenced by the institutional role they play as much as their position?

RQ2: Is their media relevance influenced by academic collaboration and networking as a proxy for their reputation?

RQ3: What is the social representation and which figure emerges instead from mainstream media such as the press and socials such as Facebook and Twitter?

RQ1 refers to the «positional» area, which is analyzed by considering the personal and biographical information of the experts. RQ2 refers to the «reputation» area, which is operationalized by analyzing their public positions, academic esteem, and the influence these experts exert through social media. RQ3, the last research question, focuses on the area of «communication» elaborated as self-presentation and representation in social media and representation in traditional media.

3 Data Description–Selected Experts and Keywords

The choice of experts, extraction tools, organization and analysis construction are delicate moments in digital methods (Rogers, 2013). To avoid the risk of missing relevant information, it was used a data collection strategy that best suited to the exploratory nature of the objective. The thirty-three selected experts[1] were entered into case-by-case variable matrices to collect all useful characteristics for the purpose of the research. The following platforms were used for data collection:

FanpageKarma for social media, Publish or Perish for publications, Google Search for resumes, Volocom for newspapers and social networks. The following software was used for processing, analysis and representations: Ucinet, Excel, Gephi, SPSS and T-LAB.

To answer RQ1 and RQ2 and thus to analyze the positional and reputation area for each expert, the following information was collected and analyzed: age, sharing on all articles (scientific and non-scientific), disciplinary field, specialization, possible institutional leadership role and political appointment in a scientific-technical committee (STC); and all functional data to apply network analysis paths. In detail, for that we

1. They were selected according to the inclusion principle of the Tips project (2021). The thirty-three experts2 who emerged from the Tips Project were selected according to the principle of inclusion, *i.e.*, every expert who is in at least one of the groups selected by TIPS (both on articles with scientific content and on articles without scientific content) was included in the list, except for Luca Parmitano, who was considered an expert of the medical field of interest. The reference list retains the scores measured by TIPS of the share of scientists, obtained accurately through the ratio of the number of articles where a particular expert appears over the total number of articles in which he was mentioned at least once. The list of experts is composed by: Walter Ricciardi, Silvio Brusaferro, Anthony Fauci, Andrea Crisanti, Massimo Galli, Roberto Burioni, Giovanni Rezza, Fabrizio Pregliasco, Franco Locatelli, Ilaria Capua, Alberto Zangrillo, Matteo Bassetti, Pierluigi Lopalco, Giuseppe Ippolito, Francesco Vaia, Mike Ryan, Massimo Andreoni, Nicola Magrini, Roberto Cauda, Giorgio Palù, Guido Silvestri, Antonella Viola, Maria, Rosaria Capobianchi, Alberto Mantovani, Giovanni Di Perri, Silvio Garattini, Giuseppe Remuzzi, Massimo Clementi, Paolo Ascierto, Maria Van Kerkhove, Eugenio Gaudio, Luca Richeldi, Alberto Villani.

call «positional area» we had: Year of Birth and subsequent calculated age as at 21st June 2021; Training and specialization area; Disciplinary academic area of reference for teaching and research activities; Medical specialization. Instead, for the «reputational area», we had: Number of publications on covid/Total publications; Number of citations on covid/Total number of citations; H covid index/General H index.
To study and analyze the «communication area» (RQ3), texts of articles from leading national newspapers were considered[2] and content from social networks such as Facebook and Twitter extracts using a set of keywords[3]. A content analysis was conducted on this collection and the results obtained were enriched with information like presence on social media, followers of the selected expert on Facebook/Twitter/Instagram, reaction to their contents, period of activities.
The choice of keywords focused our attention on the debate around the vaccination campaign, from the moment the first news was released on the introduction of the vaccine in Italy, following all the discussions on the decisions on the allocation of vaccinations, the administration of the first, second and third dose, closing before the debate on the possibility of introducing a fourth dose (from the 1st of January 2020 to the 31th of December 2021). From the materials collected and organized in this way, we will now discuss the main findings emerging from the analysis for the three areas identified to answer the three research questions.

3.1 RQ1: Positional area

Socio-demographic characteristics show that our sample of experts consists of 4 women, of whom only Maria Van Kerkhove is under 50, and 29 men. Italy also shows clear gender disparities in terms of scientific representation. This is particularly true during the pandemic and emphasizes those changes in people's lives, including that of female scientists. From this point of view, the pandemic offers itself as a magnifying glass of the inequalities that exist at different levels, including scientific and academic fields.
Moreover, among our experts, the average age is 64 and 30% have senior roles in public agencies. So how is the expert position constructed and accredited? To answer this question, our proposal was to reconstruct the pathways understood as relevant institutional stages in education and the professional sphere, studying the centrality and roles in these specific networks, but also changes and characteristics that make the profile of the expert identifiable.

2. Il *Corriere della Sera*, *la Repubblica*, *La Stampa* (considering their diffusion rates and centrality in the information panorama).
3. The extraction used keywords such as vaccin* and espert* and covid*, vaccin* and espert* and coronavirus, covid and scientiat* and vaccin*, coronavirus and scientiat* and vaccin*, vaccin* and espert*, vaccin* and scientiat*.

Thanks to the curriculum and the generation of an affiliation matrix, we reconstructed the university training network, considering both the university and doctoral pathways. Thanks to this expedient, we reconstructed an institutional affiliation network of our experts' training (Figure 1). In this network, where the largest nodes are the institutions that are the most followed by our experts, it is possible to trace three large clusters: the first one with a predominance of training abroad, the second one with the University of Rome «La Sapienza» as the central node closely linked to the Federico II in Naples, and the last one, with the centrality of the University of Milan. The network analysis allows us to view the most influential universities for our research and, we can deduce how the geographical proximity between them tends to strengthen collaborative relationships (as in the case of Milan-Pavia-Pisa or Rome with the universities of «La Sapienza» and «Tor Vergata»). Moreover, it is important to note that 10 of the 33 experts had an educational pathway that involved obtaining academic degrees outside Italian borders; in this regard, it is interesting to note that, following the ranking of TIPS experts, those with the highest total share (Ricciardi, Brusaferro, Fauci, Crisanti, Burioni), all had educational experiences in foreign universities.

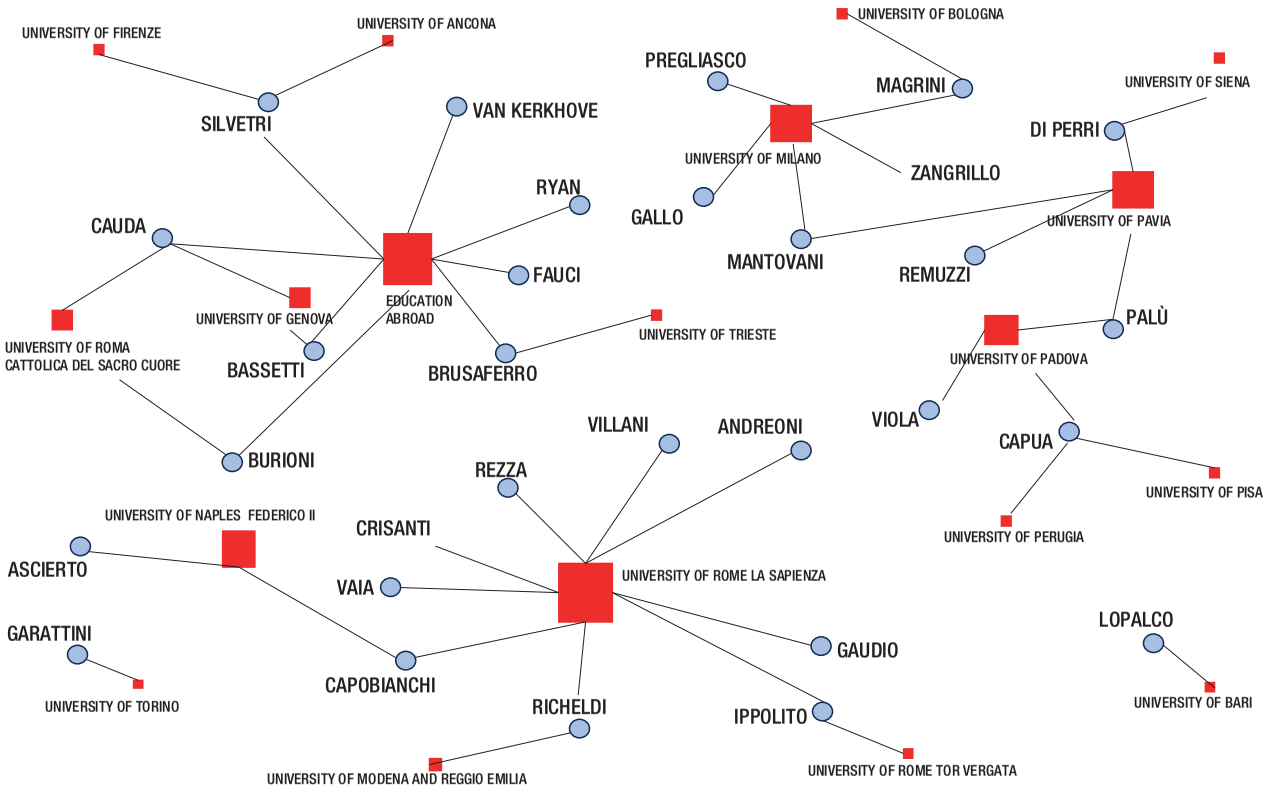
The main disciplinary areas are infectious diseases with Di Perri, Ippolito, Andreoni, Galli, Bassetti, Cauda and microbiology with Crisanti, Palù, Rezza, Capobianchi, Clementi and Burioni. Several disciplinary areas follow, but also a group of experts trained abroad. Table 1 shows how the multidisciplinary approach covered and covered the whole period of the pandemic and the vaccination campaign.

Table 1 **Disciplinary area**

Disciplinary area	Expert
BIO/14	2=Magrini, Garattini
BIO/16	1=Gaudio
Estero	5= Fauci, Silvestri*, Capua, Van Kerkhove, Ryan
MED/04 ·	2=Mantovani, Viola
MED/06 ·	1=Ascierto
MED/07 ·	6=Crisanti, Palù*, Rezza*, Capobianchi, Clementi, Burioni
MED/10 ·	1=Richeldi
MED/14 ·	1=Remuzzi
MED/17 ·	6=Di Perri, Ippolito*, Andreoni, Falli, Bassetti, Cauda
MED/38 ·	2=Villani, Locatelli*
MED/41 ·	1=Zangrillo
MED/42 ·	4=Pregliasco, Lopalco, Brusaferro, Ricciardi
SECS-P/07	1 = Vaia*

* Present in the scientific technical committee.

Figure 1 Educational network and doctoral study



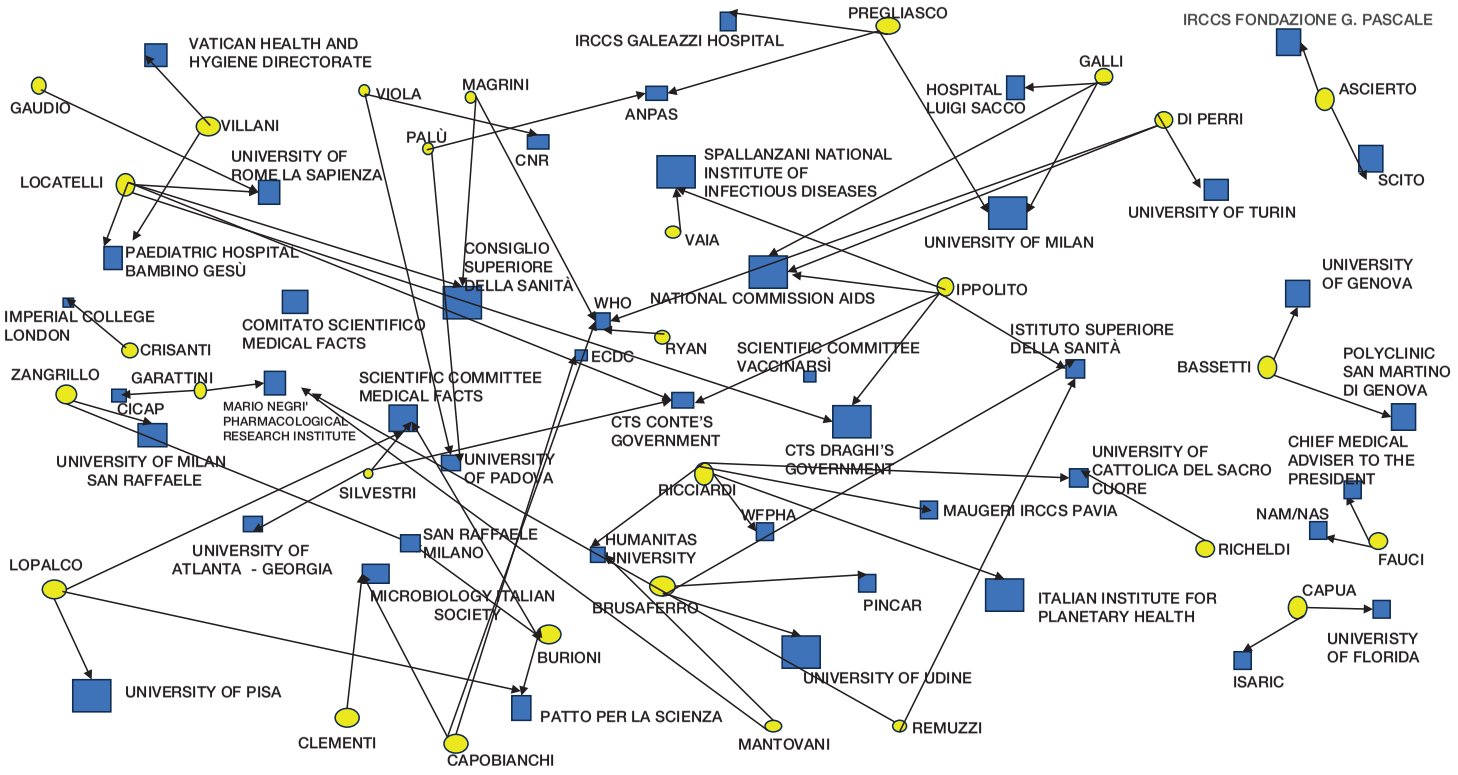
Processing with Ucinet, online CV source. Minimum connection: 1

Looking at the side of the professional network conceived as roles in relevant institutions, all our experts have held senior positions in institutes and agencies, except for Roberto Burioni. The visibility of a scientist becomes, especially in the period of the health crisis more than before, a credential that can be spent on the decision-making tables of political research (Beltrame, 2007; Rubin, 2020) and in the same way one can assume the dual role of policy advisor and public communicator (Roqueplo, 1997). One of the Italian government's political responses to the COVID-19 epidemic was the creation of the Comitato Tecnico Scientifico (CTS) both during the Conte II government (until 26th January 2021) and during the Draghi government – with new appointments and various confirmations – which were instrumental in the process of implementing the general rules established by law and not with various criticisms received. The CTS, composed of experts such as virologists and epidemiologists, in recommending containment measures between the present and the future by translating them into measures and ordinances, has addressed the choice of priorities between economy and health with different and contrasting opinions. The importance of maintaining roles has often diminished, creating a further problem as well as confusion for people. The actual mixing of roles of different scientists, for example, led to various doubts about the actual usefulness of the mask at the beginning of the pandemic. The data collection for the reference matrix – updated to September 2021 – considers the offices and institutional roles of the CTS to report the presence of 4 experts in the CTS during the Conte government: Silvio Brusaferro, Franco Locatelli, Giuseppe Ippolito and Guido Silvestri – with the confirmation of the first 3 plus the appointment of Giovanni Rezza and Giorgio Palù in the CTS during the Draghi government.

In this network analysis process, several associations and organizations, in which scientists worked, were identified. In detail, as shown in Figure 2, the association with the highest centrality value is the National AIDS Commission (NAC). Besides this, some public state agencies also have a high level of centrality, such as the Higher Health Council (HSC), the Istituto Superiore di Sanità (ISS) and WHO.

Furthermore, it is important to note that in addition to public and governmental issues, the Scientific Blog of Medicalfacts.it, an online magazine of scientific information and debunking of fake news directed by virologist Burioni, has also played a significant role. In this sense, the importance of this association, created to correctly inform web users on science and health issues, may mean that even within the most traditional media, such as newspapers, there has been a selection of personalities who have a propensity for a type of communication and dissemination of information that is characteristic of digital platforms.

Figure 2 Network of Expert Institutions



Processing with Ucinet, an online CV source. Minimum connection: 1

3.2 RQ2: Reputation area

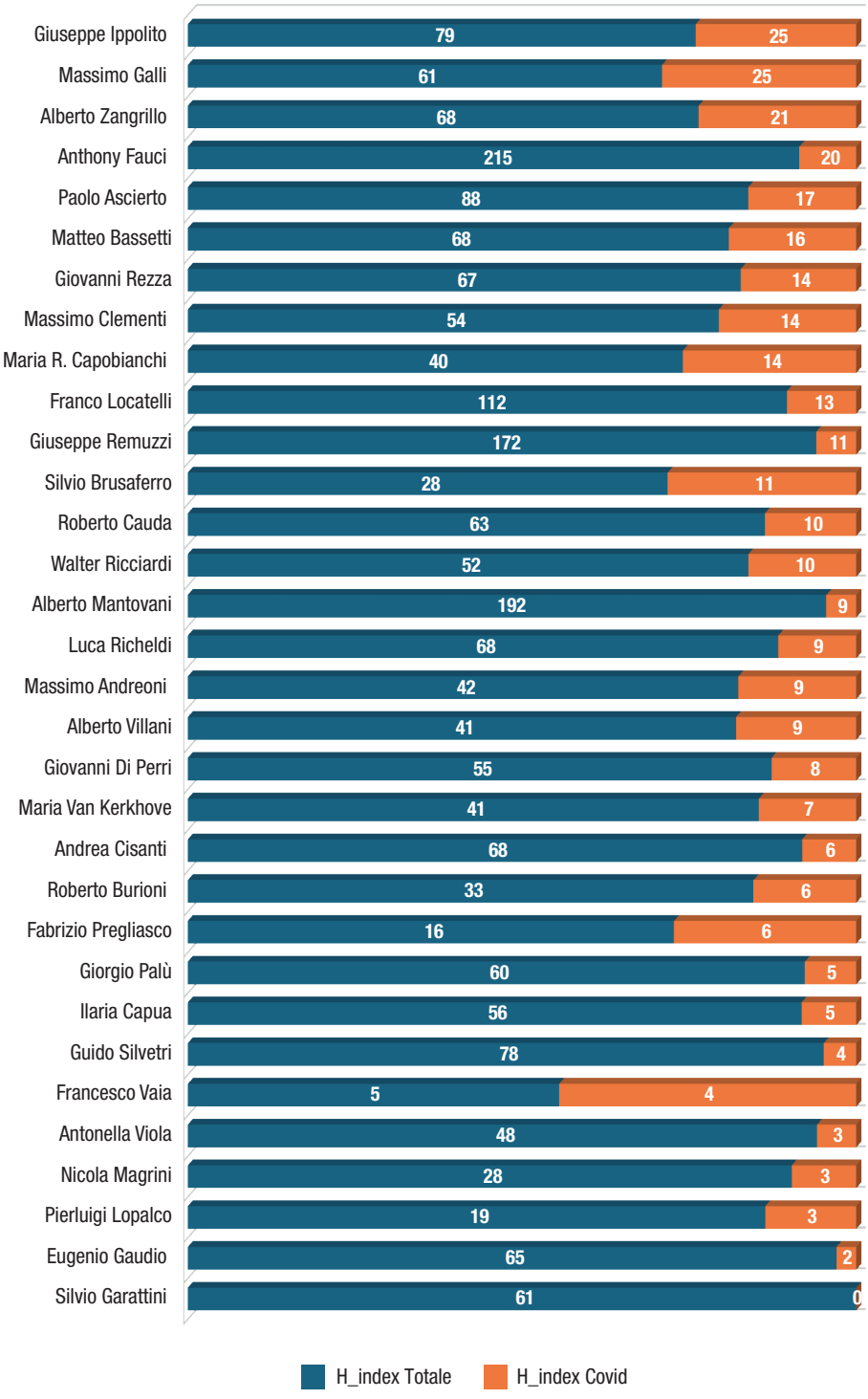
To analyze the reputational area, and thus to answer RQ2, we proceeded with the exploration of the coverage at the academic level, and, therefore, with the different scientific production of the experts and the network of collaboration that has been established between them over time, analyzing their presence and centrality on social networks. On this side, in contrast to the previous one focusing on the educational and professional network, the focus goes to the direction of academic relevance and distinctiveness on social platforms.

Considering the academic element, media coverage dominated by scientific actors and characterized by a diversity of experts was carried out focusing on those with high scientific expertise and often already recognized before the COVID-19 pandemic. This means reconstructing the academic relevance of the experts to be considered and comparing it with the media relevance in 2021. Two case-by-case matrices were therefore created containing for each of our thirty-three experts the ratio between the number of publications on covid/Total publications; Number of citations on covid/Total number of citations; H covid/General H index.

The study was conducted through the automatic calculation of h-indexes based on the Publish or Perish database, a software that allows one to browse the archives of other well-known search engines and scientific databases such as Scopus and Google Scholar. In the reference matrix, thanks to Hirsch's (2005) index, we quantify the prolificacy and scientific impact of reference experts through the number of (academic scientific) publications and citations on articles. In this way, academic relevance was reconstructed by considering both the entire span of their scientific career and during the pandemic period with the COVID-19 theme. Among the authors with the highest total h-index we find Fauci, Mantovani, Remuzzi, Silvestri and Locatelli, while on the COVID-19 centered topics of the various experts who are also in the CTS we note the reconfirmation of Fauci among the best unlike, for example, Silvestri who was busy following and working more on pandemic governance, thanks to Figure 3 we can see how the figure of the visible expert in the pandemic era was constructed not only by the previous path of publications but also by the possibility of research using the central theme (Vaia).

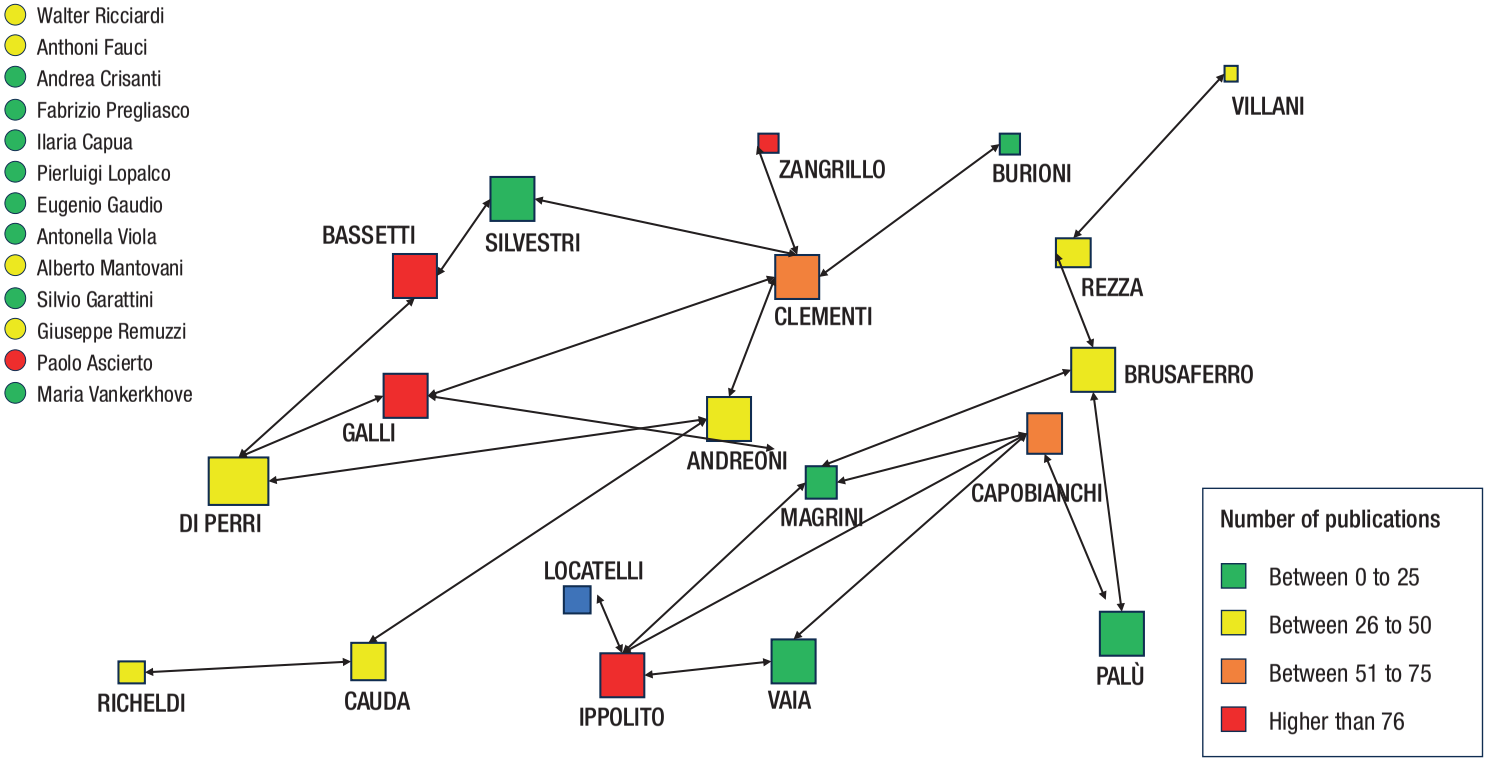
Collins and Evans (2002) argue that the highest form of scientific competence is when the scientist can contribute to science in his or her field of research. In this direction, therefore, collaborative networks are of great importance, since the influence of a group or institution's relationships is evident in an individual's opinions and actions (Piselli, 2001). For this reason, the work and training networks explained above (Figure 1 and Figure 2) and the collaborative network that follows (Figure 4) are interesting to observe. As can be seen in Figure 4, there are relevant connections among scientists: the most obvious is the group of scientists working at the

Figure 3 **Experts by total publications and publications only on COVID**



Spallanzani Hospital, consisting of Ippolito, Capobianchi and Vaia. Furthermore, we can also observe a strong connection between Clementi and Burioni, both protagonists of the 'Medical Facts' blog; and equally notable is a connection between Rezza and Brusaferro as collaborators at both the ISS and the Draghi government's CTS.
In our case, the list of reference experts allows us to place Zangrillo, Bassetti, Galli and Ippolito as nodes in the network with more collaborative publications, while Clementi and Andreoni as more prolific in a network of contacts. In fact, in Figure 4 we can see that the latter is a real link between the experts both in a multidisciplinary sense and for the centrality assumed.
A second element must be considered the centrality of the social platform of our experts. The pandemic has also shown the central role of communication within today's hyper-connected society, showing on the one hand a scientific debate shifted online, and on the other hand increasingly evident problems of misinformation and infodemics. Much of this misinformation spread mainly through social media leads to the question of whether it is a real duty for institutions and policymakers to be online. The question of whether social media fuels institutional distrust was at the heart of scholastic concerns about fake news and misinformation years before the COVID-19 pandemic (Bradshaw and Howard, 2018; Lazer *et al.*, 2018). Exploring the presence on various social platforms (Figure 5), we found that most of the reference experts are not online. The platform with the most members is Twitter, followed by Instagram and Facebook with only Burioni maintaining and updating his blog MedicalFacts, while the only CTS member active on at least two social networks is Brusaferro. The idea of true public communication of science is based on the need for mediation between scientists and the public. The complexity of the scientific content moved onto the platforms has allowed them to communicate with short messages or photos, again taking up the importance of exposing the numbers of the pandemic. A linguistic translation is made necessary by the need to communicate risks by accurately identifying that «process of information exchange between stakeholders about the nature, power, importance or control of a risk» (Covello, 1992, 359). Risk communication, in addition to monitoring an «ongoing risk» (Coombs, 2012), on the one hand has the task of performing preventive functions without leaving anything to chance, and on the other hand it allows scientists to proclaim themselves at the center of the communication process. As we know from the literature (Colombo, 2015; Riva, 2016) each platform has its target audience, and the fact of being followed on one of these platforms clarifies the place of importance within which the individual expert fits. The data collected allows us to observe a different distribution of followers among the three reference platforms. Burioni, in fact, on Twitter and Facebook is the first to be followed with more than 100,000 followers, Bassetti

Figure 4 Expert Collaboration Network – COVID-19 publications only



Processed with Ucinet, an online CV source. Minimum link: 1 Cuts by: Degree Centrality.
Color by: Number of publications

(not present on Twitter) is the most followed on Instagram and, with virologist Ilaria Capua alone, reaches 100,000 followers.

This highlights how, in the positional sphere, the presence in the mainstream media is reserved for only a few of the experts considered and only for those who know how to create their language, especially in a format characterized by a distinguishing feature. At this juncture, it becomes legitimate to project these considerations also by their presence in television broadcasts (where each television channel with its broadcast decided whom to address as experts).

The most «followed» experts on social networks are precisely those characters we have seen several times on TV.

If, from the point of view of content, a specific contribution is needed to enter into the analysis and understand «who publishes what?» and with what style of communication they do so, we stress the lack of use of individual blogs by experts despite an increase in the number of Italians who every day obtain information on scientific content on blogs or websites (reported by Science Technology and Society Yearbook, 2021). The individual blog, which, from the point of view of content and communicative functions, is configured for scientists as an alternative channel for publishing their research, has been replaced by the imposition and use of the best-known and most widely used platforms. Bucchi (1996) pointed out that in certain situations, often related to scientific controversies, experts prefer to address the public directly, skipping the different stages of scientific communication. Looking at Figure 5, moreover, one can deduce how the online mediation of science recalls the presence of some of the familiar faces. Marcinkowski and Kohring (2014) argue that while the need for science to present itself to the public is obvious, any kind of communication expressed must be understood as a real component of academic activity.

If we look, however, at how social platforms are used, we can see different types of use for different experts. Some use all platforms with the same intensity and tend to have a multi-platform profile of the content they produce, such as Zangrillo and Viola. Some experts use more visual and emotionally intense content, like Bassetti who dominates on Instagram. Some experts focus on the rational component and public and political debate, like Galli, who makes Twitter his platform of choice. Other experts choose Facebook as their digital forum, partly because it reaches a more generalist and diverse audience, and among them Burioni stands out, followed by Lopalco and Ascierto.

Burioni is the most followed on Twitter along with Capua, who, however, does not post much on it; Bassetti is consistently the most followed on Instagram as Burioni is on Facebook. This means that the relational component, the public and political debate that passes through Twitter is linked to other dimensions of reputation and importance, probably dictated by the content conveyed and not dominated by the amount of activity of the participants on the platform.

Figure 5 Use of social networks by experts

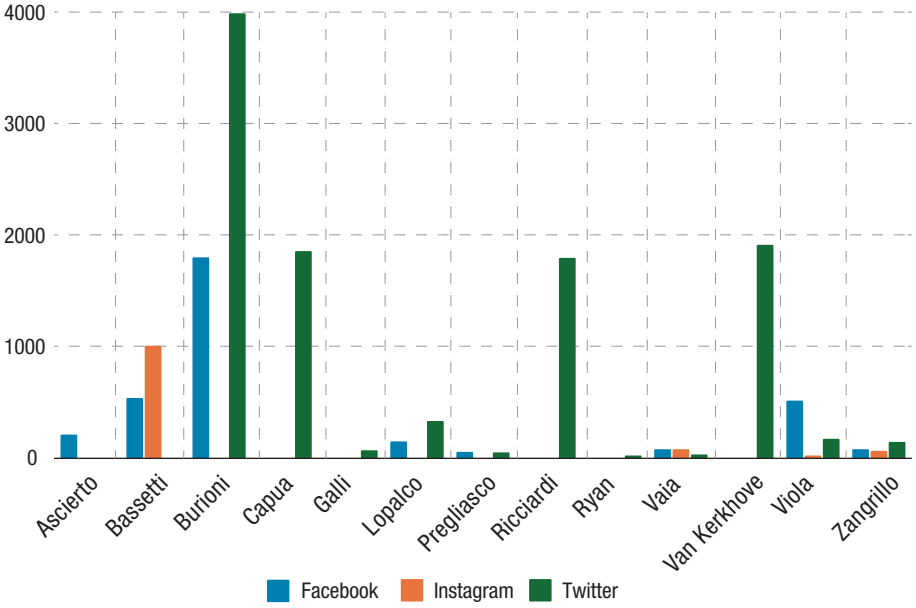
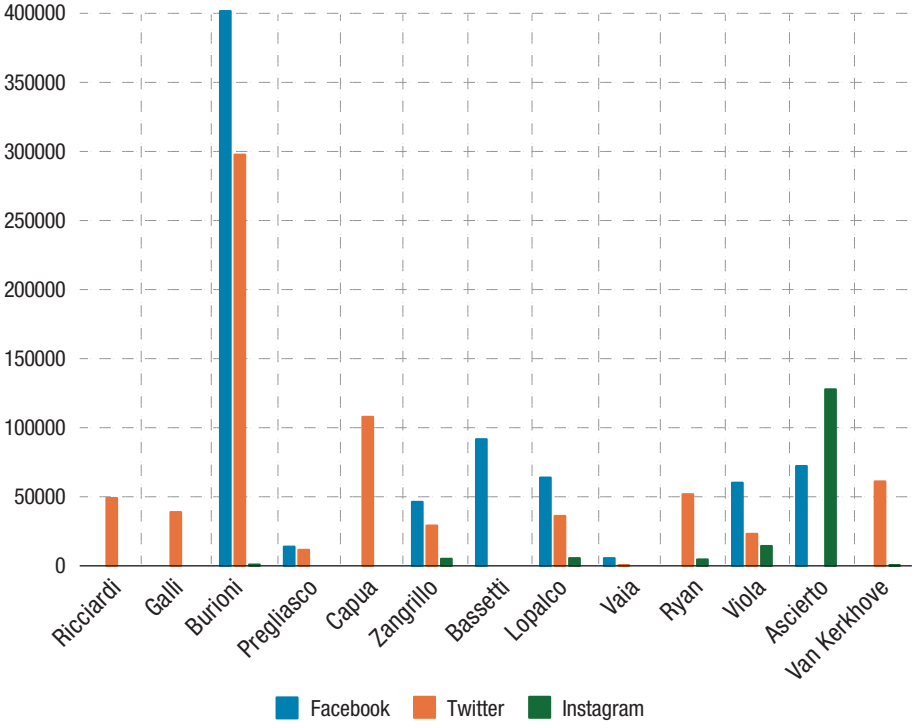


Figure 6 Follower of social networks for experts



3.3 RQ3: Communication area

To analyze the characteristics of the communication area and thus answer the last research question, we divided the analysis into two parts:

1. The first one to analyze scientist self-representation by exploring all content extracted with keywords (expert, Scientist, Vaccines, COVID, coronavirus) from daily newspaper articles such as *la Repubblica*, *La Stampa*, *Il Giornale* and from social networks Facebook and Twitter[4].
2. The second one is to analyze self-representation by considering all the content posted by the 10 experts on Facebook and Twitter.

A time period was considered to cover the debate from the time when the first news on the introduction of the vaccine in Italy was released, following all the discussions on the decisions on the allocation of the vaccination, the administration of the first, second and third dose, closing before the debate on the possibility of introducing a fourth dose (Table 2). The Ante-Phase mode is only present for the self-report matrix. This is because, rather than taking the vaccination object alone into account in the formulation of the experts' debate, which corresponds to the experts' inferred narrative and representation, it was decided to work on the experts' self-generated narratives and presentations alone from the emergence of a particular issue, COVID-19, around which each of the experts began to construct his specificity.
In the first part, thanks to content analysis techniques and the analysis of co-occurrences, it was possible to study the different associations among words by identifying those that appear closer to each other. Using T-Lab it was possible to study and explore the semantic relationships among words within the entire corpus and the network of experts.
Figure 7 and Figure 8 compare the position of the expert and the scientist based on the most used words. From the outputs we can see a different centrality of the figures of the expert and the scientist, differentiating the representation by type of media and elaborating through sequences of keywords, whose elements are lexical units in the corpus or a subset of it.
Observing Figure 6 which compares the expert and the scientist in the newspapers, we can see the expert, associations of words related to the period and, therefore, to the temporal distance of the administration of the doses (words such as week, month, years), and words related to the health and usefulness of the vaccine in the different variants of COVID-19 (arrival, variant, explain, people). The

4. All texts were collected between the months of November 2020 and October 2021 for a total of 7.72 8 cases organized in a case matrix by variables such as: media type, date, full corpus (title plus article) and, presence or absence of the experts' reference in the corpus with 32 dichotomous variables (YES/NO).

Table 2 Stages of the vaccination campaign in Italy

Ante-Phase	1/01/2020 30/10/2020	The first cases of infection, pandemic status declared by WHO, and several attempts in the search for effective drugs against the virus. At this time, it is premature to talk about vaccines and, we are witnessing widespread infection throughout Italy.
Pre-Phase	1/11/2020 2/01/2021	A pre-phase of storytelling upon vaccine arrival and preparation for government to vaccine strategy schemes.
1 Phase	3/01/2021 11/03/2021	It begins with the launch of the vaccination campaign with the Conte government and ends with the appointment of Figliuolo as extraordinary commissioner.
2 Phase	12/03/2021 2/06/2021	It begins with the approval of the National Strategic Plan for Vaccine Delivery.
3 Phase	3/06/2021 5/08/2021	Campaign to vaccinate the entire Italian population begins
4 Phase	6/08/2021 31/12/2021	It starts with mandatory green passes for access and a goal to vaccinate 90 percent of the population.

construction of the «Scientist» is interconnected with both science (scientific, pandemic, vaccinated) and people. Precisely the high frequency of the possessive plural of the form «our» is no coincidence, in fact, together with the world and people, it puts a figure of an inclusive scientist at the center of the debate during the vaccination campaign.

Figure 8 compares the expert and the scientist on social networks. In this context, the representation of the expert changes the communicative register with broad topics and a lexicon often oriented towards «giving answers» during the various phases of the vaccination campaign (words such as «discuss», «verify» and «explain» are verbs declined in infinitives that include an expert figure aimed at explaining the complexity of science).

The figure of the scientist on social networks, on the other hand, is associated with words such as «bad» and «scary». Worth mentioning are the experts of Silvio Garattini, one of the most illustrious pharmacologists in the world, and the figure of Enrico Bucci, Ph.D. in Biochemistry and Molecular Biology. Garattini, despite being present in the initial list of selected experts, is not present in the 13 selected experts with social profiles (also by his age). Bucci, despite running a Facebook page of nearly 50,000 regularly updated followers, was not included in the self-representation matrix.

Analyzing the lexical models relating to the self-representation of the figure of the expert and of the scientist, in Figure 9 we notice that the lemmas that characterize the self-representation of the expert offer a detailed reconstruction that allows us to mainly frame a figure aimed at scientific communication.

Figure 7 The expert and the scientist compared in the newspapers

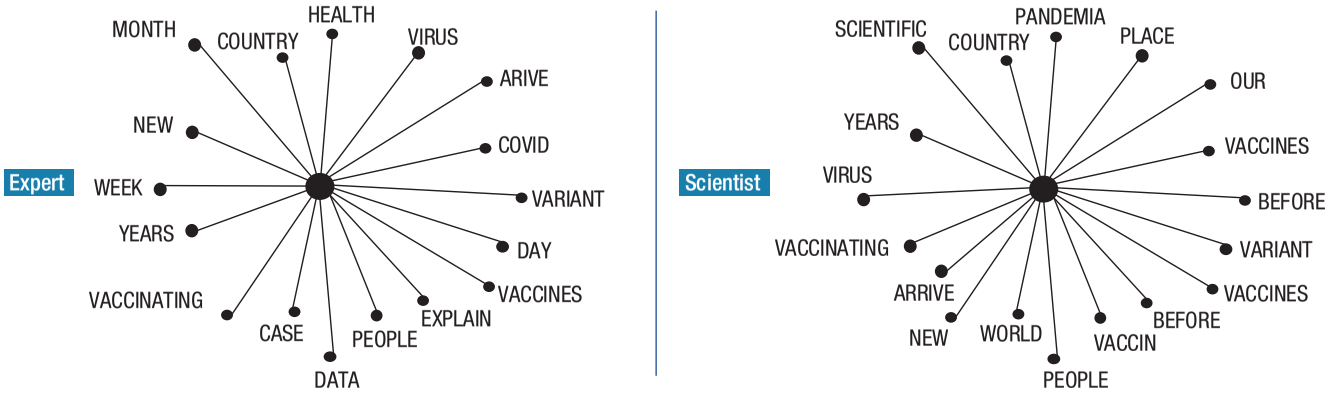


Figure 8 The expert and the scientist compared on social networks

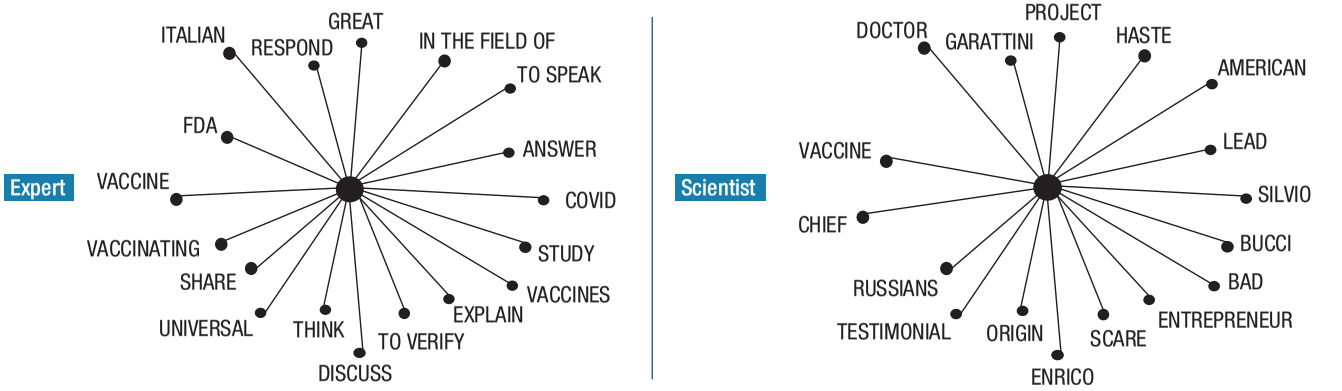
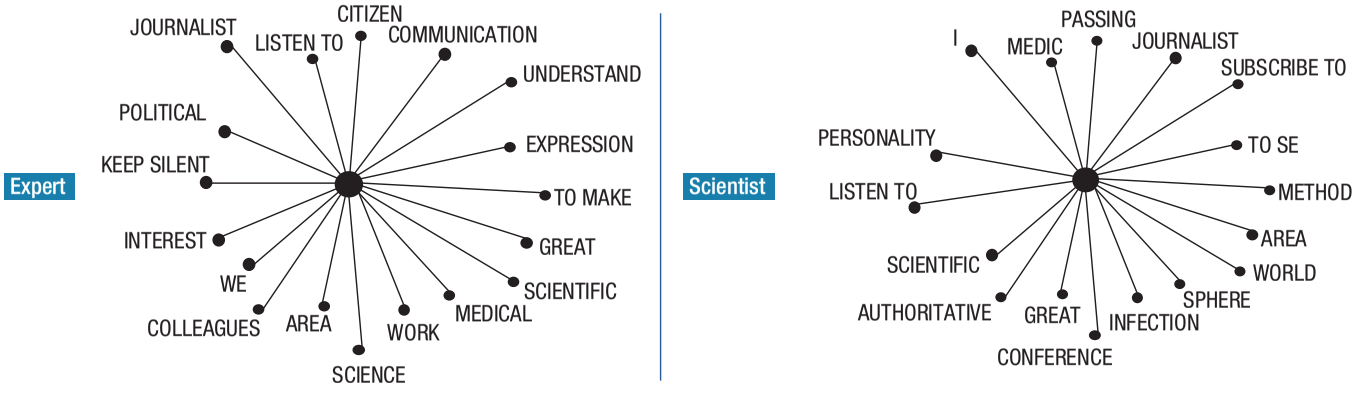


Figure 9 The expert and the scientist compared on self-representation



The participation of terms such as «scientific», «method», «conference», and «field» performs a function of «identification» for the public. A linguistic translation is made necessary by the need to communicate science accurately and to proclaim oneself an experts in a certain field. On the contrary, for the scientist, we notice a direct interconnection with science – with the participation of terms such as «scientific», «field», «create», «medical» and «work» – that offer dimensions close to the own colleagues, citizens, politics and journalism. The high frequency of the possessive plural forms «we» next to «colleagues» recall that multidimensional concept of scientific collaboration also on Facebook and Twitter. The terms «politician» and «journalist» next to «keep silent» tend to remember how science is used for political decisions without underestimating the role of transparency in communicating information on the vaccination campaign to citizens.

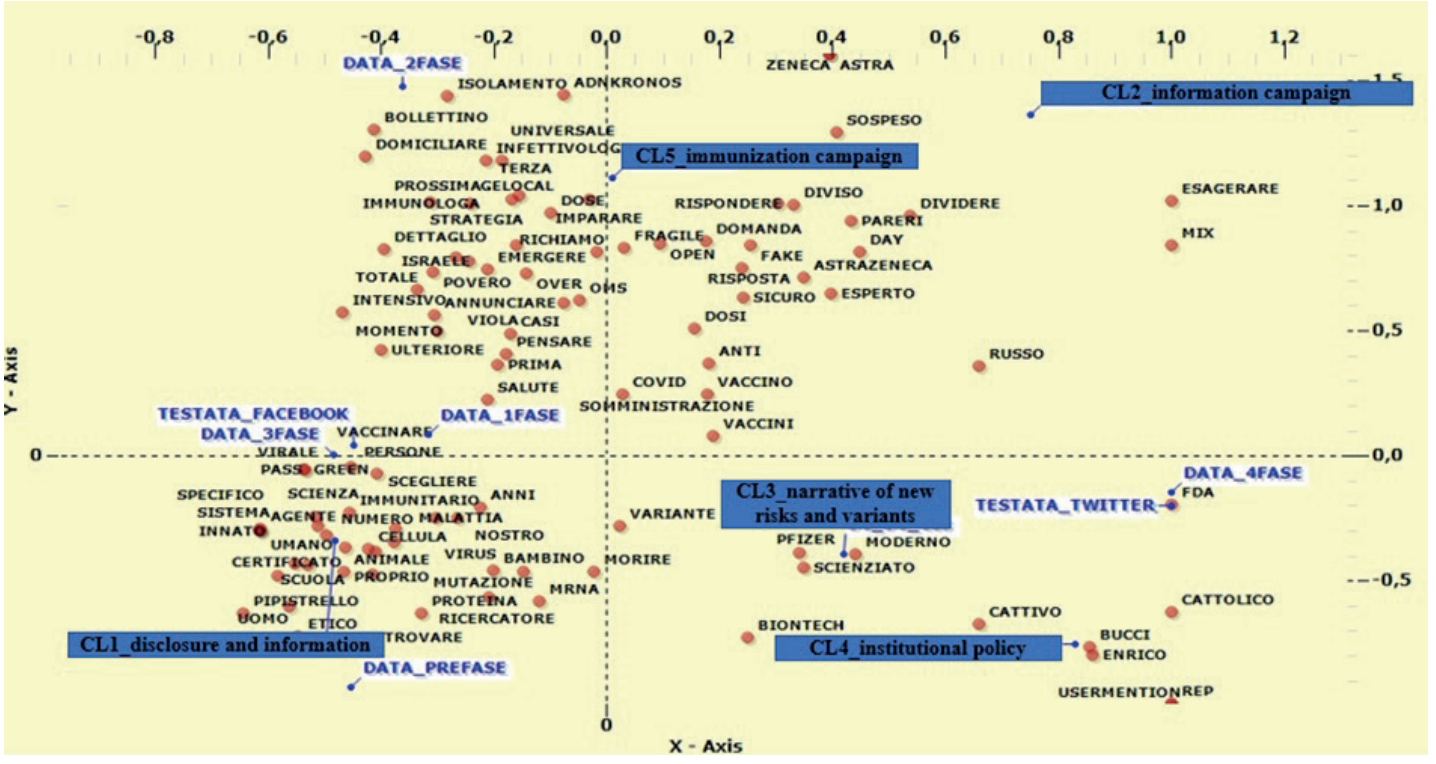
The next phase of the research allows, thanks to content analysis and lexical correspondence analysis[5] techniques, the reconstruction of «a thread» of the discourse in the overall plot of the representation and of the self-representation of the figure of expert/scientist constituted by the corpus or, in this case, by its subsets.

This analysis was carried out using the T-Lab software, which allows an analysis of the content with thematic classification of the documents and, the specificity of this technique is to build and explore a representation of the contents of the corpus through a few thematic clusters made up of elementary contexts described from lexical units. The analysis procedure chosen is with an unsupervised clustering method and involves grouping the lexical units present in the list of keywords under the same root and selecting the keywords according to some exclusion criteria by eliminating words that belong to the high-frequency rank (drop point), since they are obvious within the treated theme (Bolasco, 1999) and the words that belong to the low-frequency range because they make noise and do not allow to see the regularities[6].

Starting from the representation matrix of scientists – constructed by extracting tweets and posts thanks to the sequence of keywords mentioned earlier – Figure 10 shows the factorial plan resulting from the analysis of lexical correspondences (Total inertia explained by the two factors equal to 58.72; factor X with 33.15% and factor Y with 25.57%). We considered the type of social, stage, and the 5 clus-

5. Lexical Correspondence Analysis (ACL) is a method of factor analysis (Amaturo and Punziano, 2013) which allows you to analyze a lexical contingency table in which the rows contain the graphic forms and the columns contain the texts, reporting in each cell how many occurrences of each graphic form fall within a given modality of the variables. The ACL allows three important results: the synthesis of the information contained in the data, the visualization of multiple associations between words and the connection between textual data and context data.
6. This procedure involves the use of cosine measurement and clustering of context units using the bisecting K-means method, the construction of a contingency table of lexical units per cluster, the chi-squared test applied to all cross clusters x units lexical units and the correspondence analysis of the contingency table lexical units per cluster (Benzecrì, 1969).

Figure 10 ACL – Total inertia explained by the two factors: 58,72% (X=33,15%; Y=25,57%)



Elaboration with T-Lab

ters that emerged from the thematic classification of documents (Cluster 1=27.8%, Cluster 2=22.3%, Cluster 3=14.1%, Cluster 4=18.4%, Cluster 5=17.5%) as variables in assets.

The first factor extracted (X) reports a contrast between the two social networks Facebook and Twitter and defines a *different type of expert narrative* depending on the type of social network used. This factor on the positive side (+) is characterized by words that construct a specific and close narrative to the different pharmaceutical companies, while, on the negative side (-) a narrative much closer to the bureaucratic and «policy response» aspects. The second factor extracted (Y) represents the *argumentative time dilation of the vaccination campaign* and shows in the upper part of the graph the strategy of the vaccination campaign with characterizing lemmas such as first, over, strategy while in the lower part – or negative semi-axis – the actual phase of vaccine research.

In the I quadrant, we find Cluster 2 renamed as «information campaign». That cluster is close to words such as «relief», «safe», «herd immunity» and the infinitive verb «respond» and the social network mode Twitter. Between quadrants I and II we find Cluster 5 – renamed as «immunization campaign» and consists of lemmas such as «third dose», «booster», and «immunization».

In these first two quadrants, we reveal the description and development of vaccines along with the time dimension given by the speed of conception and approval unprecedented in the history of medicine. This shows how scientists and researchers have become a beacon dominating the debate and directing it in favor of prevention by offering answers and explanations. At the same time, however, we find diatribes on heterologous vaccination (*i.e.*, the mixing of different vaccines) with the different positions and the distinction of green pass certificates (basic, strengthened and booster) that has created both diatribes among scientists and no small amount of confusion for citizens.

In Quadrant III, the central element is Cluster 1 renamed as «disclosure and information» which is close to the Pre-Phase mode and offers a representation of scientists related to the population. Specifically, among the characteristic lemmas that make up the cluster we find «human», «people», «subject», «population» and «citizens» associated with both verbs conjugated in the infinitive such as «allow», «impose», «compel», «require» and the certification «green pass». In fact, in this cluster we find a representation of the scientist whose primary goal is to contain infection, and which touches on several areas, including compulsory vaccination for certain categories, the introduction of the third dose or booster dose, and the strengthening of controls and promotional campaigns on vaccination. All this also represents a policy response in the management of the pandemic and covering all the initial phases with «more weight».

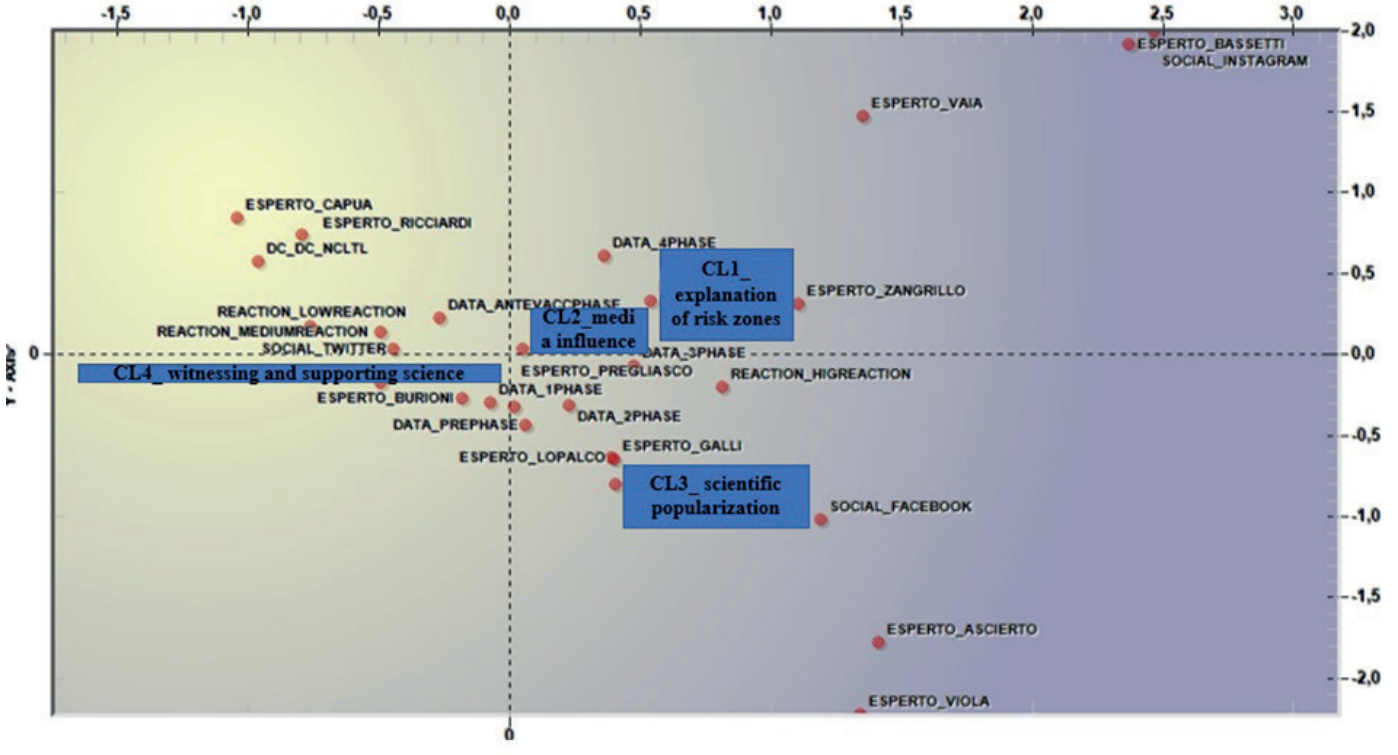
Finally, in quadrant IV we find Cluster 3 – renamed as «narrative of new risks and

variants» precisely offers a close representation of scientists' concern about newer, more infectious variants that may evade vaccines (with lemmas that lead back to variants even in projection on the Cartesian plane). Within the same quadrant, Cluster 4 renamed as «institutional policy» features the words of «authorization» and «patent». The ACL as in the last quadrant the characterizing lemmas are Pfizer Biontech and Moderna along with the social mode Twitter (which has become the platform of choice for scientific communication). This expresses a narrative with a dimension very close to a technical and scientific narrative reserved simultaneously for the public and the scientific community.

To analyze the figure of the expert/scientist from the perspective of self-representation, we constructed a matrix consisting of tweets and posts published by 11 experts (excluding from the social matrix of the 13 experts the posts and tweets of Van Kerkhove and Ryan as they are not in Italian). From an initial content analysis with the thematic classification of documents, it is possible to define four clusters (Cluster 1 with 28.1%, Cluster 2 with 33.9%, Cluster 3 with 27.7%, and Cluster 4 with 10.2%).

In particular, Cluster 1 – renamed as «explanation of risk zones» – consists of lemmas close to the health care world (intensive, hospitalization, treatment, ward) and different geographical representations (regions, red/yellow zone, close) also by the different measures taken for epidemic monitoring. Cluster 2 – renamed as «media influence» – offers a self-representation close to the media dimension and consists of terms such as book, social, presentation, interview, radio, and journalist. Cluster 3 «scientific popularization» is close to a technical dimension of vaccine efficacy (characterized by words such as an antibody, protection, MRna, protection, efficacy as well as pharmaceutical companies such as Pfizer and Biontech). The 4 cluster was renamed as «witnessing and supporting science» with a dimension close to outreach to citizens with words such as answer, ask, and understand. Thanks to the ACL (Figure 11) an attempt was made to capture the more general cultural aspects that emerged from this study to identify the characterizing dimensions within which the self-representation on social networks of the expert/scientist is placed. For this reason, we consider as variables in active the 4 clusters, the eleven experts, the period, the type of social, and the total reactions (likes, shares, and shares) under each type of post appropriately categorized into high, low, and medium reactions. Along the first factor (X, with inertia of 10.26%) of the factorial space the characteristic lemmas show a progression of the *different stages of administration* while the second factor (with inertia of 7.11%) is characterized by lemmas related to *vaccine reliability*. In the I quadrant, the Risk Zone Explanation and Media Influence Cluster is positioned and is characterized by Instagram social modalities, the fourth phase, and three experts-Basset-

Figure 11 ACL – Total inertia explained by the two factors: 17,37% (X=10,26%; Y=7,11%)



Elaboration with T-Lab.

ti, Vaia, and Zangrillo. A quadrant where scientists are not just science popularizers but real «science influencers» who use their knowledge to communicate science on social networks with a greater understanding of concepts, principles and arguments.

In the II quadrant we find experts Capua and Ricciardi close to the Ante-Vaccine Phase mode and social Twitter and in the third quadrant with predominance of the testimonial cluster and support of science we note the figure of Burioni creator of the very first social information on Facebook and Twitter of the dissemination of COVID-19.

Burioni, Capua, and Ricciardi are three figures who told the evolution of the pandemic and the vaccination campaign in different ways first on television and then in social media posts and tweets. Indeed: Ricciardi is present in many media because of his institutional role, Roberto Burioni was the expert questioned by the public television service in Rai 3's «Che Tempo che Fa» program while Ilaria Capua in La7's «Di martedì» format. Self-representation in this dimension covering 3 main actors and two quadrants offers a dimension of «science close to people».

In the IV quadrant with the science popularization cluster, the high reaction modes, 2 Phase, and social Facebook propose Galli Ascierto, Lopalco, and Viola as the main experts and this is also reflected in a remarkable h-index analyzed in the previous sphere.

4 Conclusion

During the period of the COVID-19 pandemic, the scientist has assumed a central role in the communication process, becoming increasingly crucial not only in the academic debate. It is precisely on the figure of the expert/scientist that this work focuses. In particular, the aim was to understand and analyze the self-constructed or deduced representations concerning the figure of the expert during the vaccination campaign. We have tried to describe the figure of the expert through three dimensions, the positional, reputational and communicative ones.

This study has demonstrated how the construction of the expert figure depends on various factors, often interconnected and interacting. It can be stated that the relevance and emergence of the expert about the theme of the vaccination campaign is accelerated both by his scientific activity (consisting of both a dense network of interdisciplinary relationships and various research institutions) and by the intersection between mainstream and social media. Even within the most traditional media, such as newspapers, there has been a selection of personalities and construction of the figure of the scientist who has a propensity for a type of com-

munication and dissemination of information characteristic of digital platforms. The media become vehicle tools in times of emergency and, according to their intrinsic characteristics, each one offers a representation and a self-representation of the expert/scientist in a different way. In this sense, the emergency has pushed towards the need for a new type of scientific practice, designed to address the pandemic itself. Desperately urgent decisions about the means to fight the pandemic, the threat of an overburdened medical system, the possibility of an economic collapse, and dwindling civil liberties have resulted in a dispute over values, putting against scientists, politicians and citizens (even several generations against each other). Disagreements among experts, even from different scientific disciplines, are expressed publicly and, throughout this time, we have seen members of the scientific establishment heatedly discuss their various knowledge and unknowns. Specific representation and self-representation frameworks emerge from the elaboration of the figure of the visible expert as opposed to that which is not visible or at least not visible to the media. It becomes necessary to distinguish the role of scientists as «public experts» (Peters, 2008) from other possible roles that scientists can assume in the public. This point of view reflects both how scientists' entry into media programming is not always linked to their academic activity, and how the priorities of experts in an institutionally relevant position are not only aimed at public engagement. At the same time, the «celebrity» status assumed by several scientists may allow them to comment on topics outside their field of expertise, unbalancing scientists' work towards self-image care. From this point of view, the representation given to the expert becomes sensationalist as an indispensable tool to obtain a greater number of recipients on the one hand, while from the point of view of self-representation, it is a promotion of oneself. The COVID-19 pandemic has marked a turning point in the perception and engagement of scientific experts in the public sphere. In a context of uncertainty and growing demand for information, experts have assumed a central role in communicating and managing the health crisis. The complexity of the situation has led to a dense network of multidisciplinary collaborations, involving experts in infectious diseases, microbiology, and other disciplines. The multidisciplinary approach is also reflected in the formation of the Technical Scientific Committee (CTS) in Italy, where experts such as Di Perri, Ippolito, Andreoni, and others contributed to defining management strategies. The construction of the expert's image is an intricate process, influenced by a series of interconnected factors. Their relevance in the vaccination campaign has been accelerated both by their scientific activity, grounded in a complex network of interdisciplinary relationships and collaborations with research entities, and by their interaction with the media, including mainstream channels and social media. However, the blending of roles has raised

questions and debates, especially regarding public health recommendations and the priorities between economy and health. The visibility of experts has been amplified by the media, often involving them not only as specialists in their fields but as spokespersons for science in general. This echoes Rae Goodell's concept of «Visible Scientists», highlighting how experts have acted as direct communicators with the public, transcending the traditional boundaries of scientific communication. Simultaneously, the analysis of the professional network of experts has highlighted the centrality of organizations such as the National AIDS Commission and state agencies like the Higher Health Council (HSC), the Higher Institute of Health (ISS), and the WHO. The role of the Scientific blog of Medicalfacts.it, led by virologist Burioni, has also resonated, emphasizing the importance of digital platforms in scientific communication. The pandemic has accelerated the mediatization of science, making experts more active figures in shaping public opinion. This became particularly evident during the «antiscientific» debate, where experts from various disciplines publicly discussed the legitimacy of their positions. The media politicization of science became apparent, transforming the traditional process of scientific communication and making controversies public and real-time. The pandemic has highlighted the need for a new scientific practice adapted to address the ongoing crisis. Urgent decisions regarding virus-fighting strategies, the threat of an overwhelmed healthcare system, and the prospect of economic collapse sparked disputes on values, pitting scientists, politicians, and citizens against each other. These disagreements surfaced publicly, with experts from different disciplines openly engaging in discussions. The expert's figure, as emerged from this analysis, appears as a sensationalistic media construction aimed at reaching a broad audience and, at the same time, as a self-referential tool. It is crucial to distinguish the role of scientists as «public experts» from other possible roles they may assume in interacting with the public. Media representation contributes to defining a visible version of the expert, while less evident or non-mediated aspects remain in the background. Scientists' participation in media programming is not always strictly correlated with their academic activity, and their visibility can also stem from a «celebrity» status. However, this raises questions about the possibility of scientists commenting on topics outside their expertise, shifting the focus from science to self-promotion. In summary, the representation of the expert during the vaccination campaign is a complex phenomenon intertwined with the dynamics of scientific communication, the ethical challenges of media visibility, and interactions within the scientific community. Exploring these dimensions provides an in-depth insight into the figure of the expert in a global health emergency context, paving the way for further reflections and research on the role of science in contemporary society. A multidimensional reflection that configures

how the figure and construction of the expert are influenced by various perspectives and angles, outlining a process in which self-construction intertwines with external constructions of the expert. In the period under consideration, the scientist emerges as the protagonist of a media drama during the vaccination campaign, transforming scientific communication into a spectacle of tensions and disagreements. The «sensationalistic» figure of the expert-scientist is reiterated, shaped by the fusion of roles and media visibility, while the «anti-scientific» debate reveals a politicization that challenges the traditional process of scientific communication. In this scenario, intriguing perspectives open for further reflections on the complex intersection between science and society. In this perspective and following this insight, we intend to pursue future reflections to be tested on the progression of events related to the Covid emergency, as well as on the increasingly accelerated changes in the relationship between science and society.

In this context, it is essential to recognize the limitations of the present work. Firstly, our analysis primarily focused on the media representation of the expert during the vaccination campaign, potentially overlooking some more nuanced and less visible aspects of their presence in the public sphere. The complexity of dynamics within the scientific community might necessitate further investigations to delve more deeply into how experts interact with each other and how these interactions influence public perception. Looking ahead, future research developments could enhance the understanding of experts' communication strategies, exploring how these impact the public's trust in science. The exploratory nature of this research suggests the possibility of longitudinal studies, which could track the evolution of the expert's image over time, not only during emergencies but also during periods of normalcy. Another area of inquiry could focus on the public perception of scientific controversies, examining how disagreements among experts are communicated and received by the public. This could lead to a more profound understanding of how the publicity of scientific debates influences public trust in the scientific community. In conclusion, while this research has shed light on crucial aspects of expert representation during the vaccination campaign, the exploratory nature of our study emphasizes the need for further exploration of these issues in future studies. Only through an ongoing commitment to research will it be possible to address the complexity of dynamics characterizing the role of experts in contemporary society.

References

Algan, Y., Cohen, D., Davoine, E., Foucault, M. and Stantcheva, S. (2021). Trust in scientists in times of pandemic: Panel evidence from 12 countries. *Proceedings of the National Academy of Sciences*, 118(40), e2108576118.

Amaturo, E. and Punziano, G. (2013). *Content analysis. Tra comunicazione e politica*. Milano: Ledizioni.

Bauer, M.W. and Jensen, P. (2011). The mobilization of scientists for public engagement. *Public understanding of science*, 20(1), 3-11.

Beltrame, L. (2007). Ipse dixit. I premi Nobel come argomento di autorità nella comunicazione pubblica della scienza. *Studi di Sociologia*, 1, 77-98.

Benzécri, J.P. (1969). Statistical analysis is a tool to make patterns emerge from data. In Watanabe, S. (ed.). *Methodologies of pattern recognition* (35-74). New York: Academic Press.

Bolasco, S. (1999). *Analisi multidimensionale dei dati*. Roma: Carocci.

Bradshaw, S. and Howard, P.N. (2018). Sourcing and Automation of Political News and Information over Social Media in the United States. *Comunicazione politica*, 37:2, 173-193, DOI: 10.1080/10584609.2019.1663322

Brindha, D., Jayaseelan, R. and Kadeswaran, S. (2020). Social media reigned by information or misinformation about COVID-19: a phenomenological study. *SSRN Electronic Journal.* http://dx.doi.org/10.2139/ssrn.3596058.

Bucchi, M. (1996). La scienza e i mass media: la fusione fredda nei quotidiani italiani. *Nuncius*, 2, 581-611.

Bucchi, M. (2010). *Scienza e società: introduzione alla sociologia della scienza*. Milano: Raffaello Cortina Editore.

Bucchi, M. and Trench, B. (eds.) (2014). *Manuale di comunicazione pubblica della scienza e della tecnologia* (2nd ed.). London: Routledge.

Cheng, D., Claessens, M., Gascoigne, N.R.J., Metcalfe, J., Schiele, B. and Shi, S. (eds.) (2008). *Communicating Science in Social Contexts: New Models, New Practices.* Switzerland: Springer.

Cinelli, M., De Francisci Morales, G., Galeazzi, A., Quattrociocchi, W. and Starnini, M. (2021). The echo chamber effect on social media. *Proceedings of the National Academy of Sciences*, 118(9), e2023301118.

Collins, H.M. and Evans, R. (2002). The third wave of science studies: Studies of expertise and experience. *Social studies of science*, 32(2), 235-296.

Colombo, F. (2015). *Social TV: Produzione, esperienza e valore nell'era digitale*. Milano: Egea.

Coombs, W.T. (2012). *Ongoing Crisis Communication: Planning Managing and Responding* (3rd ed.). Thousand Oaks, Cal.: SAGE.

Covello, V.T. (1992). Risk communication: An emerging area of health communication research. *Annals of the International Communication Association*, 15(1), 359-373.

Diekema, S.D. (2012). Improving childhood vaccination rates. *The New England Journal of Medicine*, 366(5), 391-393. doi: 10.1056/NEJMp1113008. PMID: 22296072.

Dyer, J. and Kolic, B. (2020). Public risk perception and emotion on Twitter during the Covid-19 pandemic. *Applied Network Science*, 5(1), 99.

Eisenman, D.P., Cordasco, K.M., Asch, S., Golden, J.F. and Glik, D. (2007). Disaster planning and risk communication with vulnerable communities: lessons from Hurricane Katrina. *American journal of public health*, (Suppl 1), S109-15. doi: 10.2105/AJPH.2005.084335. Epub 2007 Apr 5. PMID: 17413069; PMCID: PMC1855003.

Fahy, D. (2015). *The new celebrity scientists: out of the lab and into the limelight*. Lanham, MD: Rowman & Littlefield Publishers.

Ferrara, E., Cresci, S. and Luceri, L. (2020). Misinformation, manipulation, and abuse on social media in the era of COVID-19. *Journal of Computational Social Science*, 3, 271-277.

Gesser-Edelsburg, A., Shir-Raz, Y., Hayek, S. and Lev, O.S.B. (2015). What does the public know about Ebola? The public's risk perceptions regarding the current Ebola outbreak in an as-yet unaffected country. *American journal of infection control*, 43(7), 669-675.

Goodell, R. (1977). *The visible scientists*. London: Little, Brown.

Hilgartner, S. (1990). The dominant view of popularization: Conceptual problems, political uses. *Social studies of science*, 20(3), 519-539.

Hills, T.T. (2019). The dark side of information proliferation. *Perspectives on Psychological Science*, 14(3), 323-330.

Hirsch, J.E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National academy of Sciences*, 102(46), 16569-16572.

Jiang, J., Ren, X. and Ferrara, E. (2021). Social media polarization and echo chambers in the context of COVID-19: Case study. *JMIRx med*, 2(3), e29570.

Lazer, D.M.J., Baum, M.A., Benkler, Y., Berinsky, A.J., Greenhill, K.M., Menczer, F., Metzger, M.J., Nyhan, B., Pennycook, G., Rothschild, D., Schudson, M., Sloman, S.A., Sunstein, C.R., Thorson, E.A., Watts, D.J. and Zittrain, J.L. (2018). The science of fake news. *Science* (New York, N.Y.), 359(6380), 1094-1096.

Lorenzet, A. (2013). *Il lato controverso della tecnoscienza: nanotecnologie, biotecnologie e grandi opere nella sfera pubblica*. Bologna: Il Mulino.

Lwin, M.O., Lu, J., Sheldenkar, A. and Schulz, P.J. (2018). Strategic uses of Facebook in Zika outbreak communication: implications for the crisis and emergency risk communication model. *International journal of environmental research and public health*, 15(9), 1974. Published 2018 Sep 10. doi:10.3390/ijerph15091974

Maasen, S. and Weingart, P. (eds.) (2005). *Democratization of Expertise? Exploring Novel Forms of Scientific Advice in Political Decision-Making*. Switzerland: Springer.

Marcinkowski, F. and Kohring, M. (2014). The changing rationale of science communication: a challenge to scientific autonomy. *Journal of science communication*, 13(03), C04.

Metcalfe, J., Riedlinger, M., Bauer, M.W., Chakraborty, A., Gascoigne, T., Guenther, L., Joubert, M., Kaseje, M., Herrera-Lima, S., Revuelta, G., Riise, J. and Schiele, B. (2020). The COVID-19 mirror: reflecting science-society relationships across 11 countries. *Journal of Science Communication*, 19(7), Article-number. https://doi.org/10.22323/2.19070205.

Motta Zanin, G., Gentile, E., Parisi, A. and Spasiano, D. (2020). A preliminary evaluation of the public risk perception related to the COVID-19 health emergency in Italy. *International journal of environmental research and public health*, 17(9), 3024.

Neresini, F. and Bucchi, M. (2011). Which indicators for the new public engagement activities? An exploratory study of European research institutions. *Public understanding of science*, 20(1), 64-79.

Ophir, Y. (2018). Coverage of epidemics in American newspapers through the lens of the crisis and emergency risk communication framework. *Health security*, 16(3), 147-157.

Peters, H.P. (2008). Scientists as public experts. In Bucchi, M. and Trench, B. (eds.). *Handbook of public communication of science and technology* (145-160). London: Routledge.

Piselli, F. (2001). *L'analisi delle reti nelle scienze sociali*. Roma: Donzelli.

Riva, G. (2016). *I social network*. Bologna: Il Mulino.

Rogers, R. (2013). *Digital Methods*. London: The MIT Press.

Roqueplo, P. (1997). Entre savoir et décision, l'expertise scientifique. Éditions Quæ, Sciences en questions, ISBN: 9782738007131. DOI: 10.3917/quae.roque.1997.01.

Rossmann, C., Meyer, L. and Schulz, P.J. (2018). The mediated amplification of a crisis: Communicating the A/H1N1 pandemic in press releases and press coverage in Europe. *Risk analysis*, 38(2), 357-375.

Rubin, A. (2020). Fiducia, reputazione sociale e visibilità degli esperti. Il caso studio della Notte dei Ricercatori. *Quaderni di Sociologia*, 82(82-LXIV), 25-42.

Sandman, P.M. (2006). Crisis communication best practices: Some quibbles and additions. *Journal of Applied Communication Research*, 34(3), 257-262.

Scamuzzi, S. e Tipaldo, G. (a cura di) (2015). *Apriti scienza. Il presente e il futuro della comunicazione della scienza in Italia tra vincoli e nuove sfide*. Bologna: Il Mulino.

Sjöberg, L. (1998). Risk perception: Experts and the public. *European Psychologist*, 3(1), 1-12.

Thomas, K. and Senkpeni, A.D. (2020). What should health science journalists do in epidemic responses?. *AMA Journal of Ethics*, 22 (1), 55-60.

Tipaldo, G. (2011). «Né qui né altrove!». Critica alle grandi opere: un problema di «cultura civica?». *Rassegna Italiana di Sociologia*, 52(4), 607-638.

World Health Organization (2021). Background document on the inactivated vaccine Sinovac-CoronaVac against COVID-19: background document to the WHO interim recommendations for use of the inactivated COVID-19 vaccine, CoronaVac, developed by Sinovac, 24 May 2021 (No. WHO/2019-nCoV/vaccines/SAGE_recommendation/Sinovac-CoronaVac/background/2021.1). World Health Organization. Available to: https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccines-SAGE_recommendation-Sinovac-CoronaVac-background-2021.1

Zald, M.N. (1987). *Social Movements in an Organizational Society: Collected Essays* (1st ed.). London: Routledge. https://doi.org/10.4324/9781315129648.