Complexity in online collective assessments: Implications for the wisdom of the crowd

A B S T R A C T

This research investigates how the complex intertwining of multiple assessments influences the way in which scientific consensus and health policy are perceived. We identified an extreme case in France, with its divided political views on glyphosate, which enabled us to highlight unusual variations and develop a richer, more thorough understanding of cognitive biases and complex collective assessments related to health policy. Our sample comprised 51 articles from four major French online media outlets, 2944 user-generated comments (84,386 words), and 52,023 social audience metrics collected during the heated period following the glyphosate renewal decision made by the European Commission, from November 27, 2017, to December 04, 2017. Througha discourse analysis, we uncovered the media articles' discursive strategies. We also explored the embedded user-generated comments and analyzed collective assessments of glyphosate policy. Our primary contribution lies in developing an understanding of the mechanisms involved in collective assessments of health policy and research consensus. We explored the role played by emotional and moral assessments as antecedents to online polari- zation. We argue that the complex intertwining of rational, emotional and moral assessments influences how academic consensus is perceived. This research answers the call for more research on the health policy communication process and on the logic of controversy at the interface between politics and science.

1. Introduction

Cognitive biases can hinder individuals from making optimal de- cisions (Tversky and Kahneman, 1974). Indeed, individuals have many unconscious strategies that help to maintain and build upon previous beliefs, causing them to avoid deliberate reasoning processes, over/ underestimate risks, and even engage in counterintuitive reasoning processes. In groups, biases such as conformity and polarization can be more powerful and lead to irrational assessments (Twardawski and Kind, 2023). Currently, the voice of social groups is strongly expressed through online media. Social media are particularly prone to algorithmic-related polarization (Arora et al., 2022; Iandoli et al., 2021; Reix et al., 2023). However, a large strand of research has shown that explicit and deliberate reasoning within (online) groups can lead to more rational collective assessments and group decisions (Salas et al., 2005; Schippers et al., 2014). Online forums can also help with the collection, dissemination, and interpretation of information and the development of critical skills (Lerman, 2017). Online collective assessments have proven to be efficient in reducing group biases (Gar- rett, 2009; Gentzkow and Shapiro, 2011) and leading to the 'wisdom of the online crowd' (Chen et al., 2014; Greenlaw and DeLoach, 2003).

However, health policy research has highlighted an interesting reasoning paradox: in the context of online assessments of health policies, irrational beliefs are more powerful than scientific evidence (Hoffmann and Mar, 2015; Hung and Chang, 2023; Islam et al., 2020). This research seeks to make empirical contributions regarding this paradox. The present paper seeks to contribute to prior research by examining how the complex intertwining of multiple assessments in- fluences how scientific consensus and health policy are perceived online by the general public. In particular, we answer the following question (RQ): How does the intertwining of different analyses affect the perception of academic consensus? Our research attempts to explore how social consensus generated in online environments is conditioned by the interaction of analyses of different natures. This study, which is exploratory in nature, provides evidence on how interrelating social and technological factors can be used to assess cognitive biases involved in the construction of distorted online reasoning.

Exploratory studies, such as the present one, prioritize the provision of empirical evidence over the development or testing of theories. This type of study is an excellent basis for further research focused on improving the existing theoretical basis (Ribeiro-Navarrete et al., 2021). In particular, this research employs a case study, which is an approach that is useful for analyzing complex problems (Martín et al., 2022). In this sense, we identified a case that could illustrate how health policy is assessed and the complexity of this public assessment process online: the glyphosate renewal decision in France in 2017. Indeed, glyphosate has political, economic, social and biotechnological implications. The case of glyphosate was discussed in Technological Forecasting and Social Change through the prism of its (un)sustainability (Labarthe et al., 2021; Paoletti and Pimentel, 1995) and political influences and the corruption related to glyphosate and GM crop adoption (Hall et al., 2011; Reid and Ramani, 2012), biotechnological trends (Huttner et al., 1995; Ramani and Thutupalli, 2015) and agricultural innovation (Deng et al., 2019) but not from the perspective of health policy and its controversy (Lab- arthe et al., 2021). However, as of today, technology-based environ- mental health risks posed by pesticides are still a significant public health problem (Covello and Frey, 1990). Public opinion in France was particularly divided on glyphosate and its carcinogenic nature. While one role of media is traditionally to disseminate and advocate public policies (Liu et al., 2021), French media coverage has focused on activist and lobbyist perspectives. This led to an extreme case that can enable us to develop a rich and thorough understanding of cognitive biases and the way they hampered policy-makers' ability to engage in strategic planning and efficiently communicate health policy in France. Selecting four major French media outlets, we collected 51 articles, their user- generated comments (*n* 2944) and their social audience (*n* 52,023 Facebook likes and sharing). We adopted an interpretative approach (Walsham, 1995), qualitatively analyzed the discursive strategies of each article (Van Leeuwen and Wodak, 1999), and quantitatively assessed the argumentation of each comment and their explicit and deliberate reasoning (n 2944). Our primary contribution is that we develop an understanding of the mechanisms involved in judging and explaining collective assessments of health policy and research consensus. While our research context is free from algorithmic-related polarization specific to social media (see Arora et al., 2022; Iandoli et al., 2021), we suggest that emotional and moral assessments are antecedents to polarization. Based on the results of this research, we argue that the complex intertwining of rational, emotional and moral assessments influences how academic consensus is perceived. In particular, health-related consensus recorded in online environments is subject to multiple and varied evaluations. Stakeholders seek to balance conflicting logics: rationality versus emotions and trust in science versus distrust in large pharmaceutical companies. It is concluded that the intense interactions between these stakeholders and the different interconnected analyses shape the way in which individuals understand and reflect on the health policy communication process.

This research is structured as follows. The introduction is followed by a theoretical analysis of how individuals and social groups construct their reasoning in online environments. The next step involves the presentation of the selected analysis methodology and the way in which the data were obtained. In the methodology section, the case study is presented. This is followed by an analytical presentation of the results. In the last sections— discussion and conclusions—the results are dis-cussed in relation to previous literature, and the limitations and future lines of research complementary to this one are identified.

2. Literature review

Rationality can be defined as the capability to hold relevant and logical beliefs and to make good assessments and decisions related to a goal (Gramajo, 2008). However, cognitive biases, systematic deviations that can be predicted with a minimalist normative model of rationality, hinder our ability to make optimal assessments and decisions (Tversky and Kahneman, 1974). These biases may be reinforced by the interaction of different types of analysis around a complex problem, or they may be the result of the interweaving of these analyses, which is the subject of this paper. Individuals have many active strategies (mostly unconscious) aiming to keep and strengthen their previous beliefs, ranging from selective exposure to memory alteration, biased interpretation and biased assimilation (Tversky and Kahneman, 1974). Individuals often show tendencies to omit information, to avoid deliberate reasoning processes (Simon, 1955), or even to engage in counterintuitive reasoning processes (Dijksterhuis et al., 2006). Overconfidence (Baumann et al., 1991), over/underestimation of risks (Collins and Street, 2009) and confirmation bias (Klein, 2005) have been shown to influence assessments and decision-making. Debiasing remains a challenging and contingent task (Bornstein et al., 1999). Cognitive biases lead to overcompensating effects, which in turn lead to irrational assessments (Braverman and Blumenthal-Barby, 2012; Hensher et al., 2017).

Research on groups as complex information processing systems assumes that reasoning processes take place in group contexts (Arrow et al., 2000; Healey et al., 2015; McGrath and Tschan, 2004). Findings from research on individual and group decision-making emphasize the importance of access to information and information collection in successful reasoning (Waller et al., 2004). However, some biases, such as conformity bias or polarization, seem to be even more powerful in group decision-making than in individual decision-making (Twardawski and Kind, 2023). Algorithmic- related polarization on social media in particular is known to reinforce such biases (Arora et al., 2022; Iandoli et al., 2021; Reix et al., 2023). Researchers have stressed the significance of explicit and deliberate reasoning in groups (Salas et al., 2005). Indeed, explicit uses of causal conjunctions and explicit

communication can enable groups to overcome the false consensus effect (Tschan et al., 2009). Explicit and deliberate reasoning leads more frequently to rational assessments and decision-making in the context of (online) groups (Schippers et al., 2014).

Online group research has showcased similar results, highlighting collaborative reasoning and learning processes (Wasko and Faraj, 2005), as well as the wisdom of the online crowd leading to rational assessments and beneficial decision-making (Chen et al., 2014). Online forum boards "*may aid the collection, dissemination, and interpretation of information by allowing a large group of participants to jointly carry out these processes*" (Lerman, 2017, p. 9), while electronic discussions may improve participants' critical skills (Greenlaw and DeLoach, 2003). A growing stream of research highlights confirmation bias in selective exposure to political information online and political polarization online (Arora et al., 2022; Knobloch-Westerwick et al., 2014). However, Dylkoet al. (2018) have nuanced this stream of research, as the authors found that system-driven customizability on selective exposure is reduced by user-driven customizability. Individuals countered selective exposure, resulting in a less polarized political attitude (Dylko et al., 2018). This is consistent with research moderating the effects of online polarization(Garrett, 2009; Gentzkow and Shapiro, 2011) outside of social media. Research at the boundaries of cognitive psychology and information systems suggests that cognitive biases may have different outcomes in real life and on the internet. Work by Andersson et al. (2006) on social phobia produced conflicting results in an online context, while Reinecke and Trepte (2014) emphasized the crucial implications of positivity bias in online social networks compared to traditional 'offline' social networks. Other researchers have studied the specificities of confirmation biases in online search processes (White, 2013), the role of online social media in propagating misinformation or correcting misperception (Bode and Vraga, 2015) and biased assimilation in the interplay between on-line and offline business operations and brand image (Kwon and Lennon, 2009).

A recent strand of research has emphasized a reasoning paradox: although complementary and alternative medical treatments are not supported by scientific evidence, general opinion values such medical treatments and groups of patients hold irrational beliefs related to their efficiency (Hoffmann and Mar, 2015; Islam et al., 2020). Work by DeBarra (2017) on biases in online medical product reviews provides interesting insights into this stream of research. The author derived his explanation of biases from features of the health communication process: biases emerged because of overreporting of positive outcomes by groups of online users. These early findings were tested and confirmed inthe technological forecasting and social change literature, particularlyin the literature framing the dialectical and socially constructed battle at stake surrounding the COVID-19 crisis. Indeed, algorithmic-related polarization on social media platforms such as Facebook (Iandoli et al.,2021) increased overreporting of 'alternative cures' to COVID-19 (essential oils, silver, gems, etc.) and citizen distrust toward health policies (Hung and Chang, 2023; Islam et al., 2020; Rowe et al., 2020). However, more research is needed on online polarization in contextsother than social media (Arora et al., 2022) and their algorithmic curation.

Because individuals' decision-making related to health is becoming increasingly and pervasively influenced by online health information and online media, we lack research on the communication process of health-related messages and public health discourse (De Barra, 2017). More research is needed (1) on 'the logic of controversy' at the interface between politics and science (McKee and Diethelm, 2010; Ramani and Thutupalli, 2015) and (2) on the health policy communication process and the cognitive biases involved in the construction of distorted and biased online argumentation (Hung and Chang, 2023; Islam et al., 2020; Wang et al., 2019). The present paper seeks to contribute to prior research by studying how the complex intertwining of multiple assessments influences how scientific consensus and health policy are perceived online by the general public, particularly on how individuals reason in online groups and assess health policy.

3. Methodology

3.1. Case study

We identified an extreme case of 'technology-based environmental health risks' (Covello and Frey, 1990) that could illustrate how health policy is assessed and the complexity of this public assessment process online. On Monday November 27, 2017, the European Commission renewed the license for the herbicide glyphosate for five years. This decision was made by experts from EU member states following a heated debate over whether glyphosate causes cancer. While representativesfrom 18 countries voted in favor of the five-year renewal, one abstained and nine voted, including France, voted against it. President Emmanuel Macron was one of the first to comment on the EC decision and in a bold move committed to banning glyphosate in France as soon as an alter- native becomes available and at the latest within three years (AFP, 2018). While the French National Health Security Agency (ANSES). West (2016) demonstrated that comment threads of online newspapers revealed complex patterns of interactions and were meeting the criteria for online communities (understanding of common ingroups and out-groups, shared acknowledgment of mutual influence, common history of the online community, sense of belonging). Such communities differ from social media: they do not lead to content echo chambers and algorithmic-related polarization, the latter being specific to social media (Arora et al., 2022; Iandoli et al., 2021). Indeed, such news commenting communities are created and managed by online media platforms to foster opinions, encourage the development of a community of readers (Meyer and Carey, 2014), and maintain "*democratic deliberation*" (Hopp et al., 2018, p. 1237). This also responds to a call for more research onthe antecedents of polarization in a context other than social media and their algorithmic curation (Arora et al., 2022; Liu et al., 2021).

Why was this specific time frame chosen? According to a Google Trends request (see Fig. A1 in Appendix, statistics from June 2017 to January 2019), during this period, between November 27 and December 3, 2017, the number of communications, exchanges and requests related to glyphosate in France on Google reached an unprecedented climax. Why was France chosen? In France, the decision to renew glyphosate took a political turn, with conservatives supporting the nonbanning of glyphosate and liberals supporting its ban. This European country wasone of the first to pass a bill against glyphosate immediately after the approval of the European Commission's proposal. President Macron'sAmendment No. 1570, seeking to ban glyphosate, came before the French Parliament in May 2018 but was rejected. The bill was put for-ward by the government a second time in September 2018 but was again rejected. Given this regulatory failure, the French government created a website promoting alternative solutions to glyphosate for farmers. In 2018, President Macron was a vocal opponent of chemicals, announcing that he would take additional measures to phase out glyphosate in France. Furthermore, in a recent national survey on French people's perception of science and expertise, 76 % of those surveyed agreed that "*scientists should better take into account public opinion before submitting their views*" (IRSN, 2019), suggesting the general public's lack of trust in scientists and scientific consensus. Moreover, the country is facing decreasing public confidence in health policy, as illustrated, for example, by the decline in vaccination (IRSN, 2019). In past research on technological forecasting and social change, it was found that beliefs of experts' trustworthiness reduced citizen risk concerns (Featherman et al., 2021; Hung and Chang, 2023). Thus, France appears to be an extreme case of polarization, with its divided political views on glyphosate, that can enable us to highlight unusual variations and develop a richer, more thorough understanding of cognitive biases and how scientific consensus and health policy are perceived online by the general public.

3.2. Media selection

We selected four major French online media based on the following criteria: (1) they allow online user comments; (2) they are mainstream Table A1), the French Ecology Minister asked the ANSES to undertake a thorough counter analysis to its previous findings.

Our case focuses on French online media and general opinion in the week following the renewal. Media have a crucial role in disseminating and advocating public policies (Liu et al., 2021), but why are online media specifically important? A growing strand of research describesonline media commenting spaces as communities. Indeed, despite its asymmetric nature, even Twitter is considered a community, enabling its users to create connections, influences and social bonds (Gruzd et al., 2011). Online media are increasingly seeking to create a sense of com- munity, with a sense of common history between commenters, socialbonds, and mutual influence between commenters (Hopp et al., 2018).In the past, news commenting spaces were sometimes qualified as loosely bonded online communities (Meyer and Carey, 2014) or as akind of "*online coffee house*" (Givskov and Trenz, 2014, p. 56). Coles and newspapers and/or online media covering both international and national news. We used sampling to determine content coverage (national and international news) and searched each online media website to find their editorial policies. We also used 2017 statistics from the French Audit Bureau of Certification (APCM) as a proxy for media importance. The APCM provides open data on the scope and importance of French media in France. We were interested in the average number of copies purchased per issue in France, the ranking of newspaper editions, the ranking of online editions (websites), the age of the media, and monthly unique online visitors. We selected four media: one daily national media (DNM), one daily regional media (DRM), one weekly magazine (WM), and one online media, pure player (OM). DNM is more known for its liberal and left-wing perspective, and WM is known for its conservative and right-wing perspective, while the other two take no political stances (DRM, OM).

3.3. Data collection

This case focuses on French online media and general opinion in the week following the European Commission's renewal decision involving glyphosate. We manually searched each of these four media websites for articles containing the word 'glyphosate' and selected all articles from Monday November 27, 2017, to Monday December 4, 2017. The initial request generated 97 articles. We then discarded articles that only mentioned 'glyphosate' in user comments or that mentioned 'glyphosate' without discussing it as their main topic (for example, snippets of texts, twitter news). The final sample comprised 51 articles, their user- generated comments (n 2944) and their social audience (n 52,023 Facebook likes and sharing).

3.4. Data analysis

We adopted an interpretative approach (Walsham, 1995) and analyzed the discursive strategies of each article (Van Leeuwen and Wodak, 1999). We first analyzed the context to understand the scientific consensus and arguments. We then carefully read the content and analyzed the author's objectives, discourses and argumentation (Van Leeuwen and Wodak, 1999). We analyzed and coded each argument in each article into five categories: 1. pro-glyphosate, 2. moderately pro- glyphosate, 3. neutral, 4. moderately against glyphosate, and 5. against glyphosate. An article was classified as 1 or 5 if it showcased an unambiguous and strong argument in favor or against (title, core arguments, testimonies, etc.). An article was classified as 2 or 4 if it expressed at least one argument or more in favor or against and if the global opinion and tone of the article were pro or against (order and selectionof the argumentation, title, choice of words, topics selected). When in doubt or if the arguments discussed in the articles were of equal value, we classified the articles as neutral. Details of the coding can be found in Table A2 in the Appendix.

Then, we analyzed the comments belonging to each article. In examining comment datasets, we were interested in "causal conjunctions such as because, therefore, if-then" (Tschan et al., 2009, p. 276) that would offer evidence of explicit and deliberate reasoning. We used a Python library for data mining (Demšar et al., 2013) as part of our analysis of the 2944 user-generated comments. This allowed us to preprocess the text (stopwords, data filtering) and conduct an association and similarity analysis, triangulated with a qualitative analysis of each comment (review, classification). Texts were cleaned, parts-of-speech tagged, and lemmatized. Our dataset of comments comprised a focus corpus, and we used frTenTen, the 10-billion-word French corpus of texts from the web, as a reference corpus (Jakubíček et al., 2013). This enabled us to identify 'keywords': typical words used in a focus corpus compared to the reference corpus, according to the following formula:

$$\frac{\text{fpm}_{\text{focus}} + n}{\text{fpm}_{\text{reference}} + n}$$

where $fpm_{reference}$ is the normalized frequency of the word in the refer- ence corpus per million, fpm_{focus} is the normalized frequency of the word in the focus corpus and n is the method parameter.

We analyzed user-generated comments ($n = 2944$). In presenting quotations in this article, we simply provide usernames when these were pseudonyms or first names only (i.e., 'Michel', 'Eva', 'lesceptique', etc.), and we anonymized usernames that looked similar to names+surnames ('JohnSmith', 'John DOE', etc.). The comment corpus comprised 84,386 words (517,320 characters with spaces): the average size of a user- generated comment was between 28 and 29 words. We also analyzed the social audience (n 52,023 Facebook likes and sharing) of each article to determine its social impact. Most shared and liked articles were articles against glyphosates (42,609, 82 % of the total number of shares& likes), while neutral articles were shared and liked 6462 times (12 %), and pro articles were shared and liked only 2952 times (6 %). If we remove neutral articles shared, sharing pro articles accounted for only 6.48 % of the total, while sharing articles against accounted for 93.52 %. The most popular articles highlighted the carcinogenic nature of glyphosate and the democratic issues surrounding its renewal.

The number of comments and the number of social shares are un- correlated. Indeed, one of OM's most shared articles (21,303 shares and likes) had only 12 comments on its page. Overall, OM seems to be the 'most shared, least commented' of the four media. This factor may be related to the typology of the media (news- and video-based) compared to the traditional press, such as WM or DNM, which has greater written analysis. For instance, one of WM's articles was shared 3802 times and generated 216 comments. Most of the comments were written a few days (1–3) following the publication of each article. Assessing comments replying to other comments and to the article and their explicit and deliberate reasoning enabled us to assess online collective assessments (Van Leeuwen and Wodak, 1999).

4. Results

4.1. Analysis of the context: Scientific consensus and article classification

As part of our understanding of the context (Van Leeuwen and Wodak, 1999), we gathered data on the scientific consensus on glyphosate to contextualize the current debate and provide background in- formation. First, glyphosate was introduced as an herbicide in 1974 and became one of the most popular and used broad-spectrum herbicides worldwide. Early studies reported no unreasonable risks to humans, but concerns about the carcinogenic nature of glyphosate persisted: in the last eight years, several international agencies have re-evaluated the carcinogenic potential of glyphosate.

In particular, in March 2015, the International Agency for Researchon Cancer (IARC), a subdivision of the World Health Organization(WHO), reported significant evidence for the carcinogenicity of glyphosate in experimental animals. A large number of articles from our dataset (16 out of 51) cited the IARC, which assigned a hazard classification for glyphosate of "*probably carcinogenic to humans.*" However, the IARC also reported in the same report that "*there is limited evidence inhumans for the carcinogenicity of glyphosate. A positive association has been observed for non-Hodgkin lymphoma*" (IARC, 2016, p. 78). Hazard identification and classification, including carcinogenic potential, is criticalfor assessing the potential human health risk of a pesticide. However, risk assessment is not only driven by the hazard profile but also a function of the potential exposure to the pesticide (amount of exposureand frequency). Thus, hazard and exposure potential must be considered together when undertaking risk assessment, since an identified hazard may be offset by the fact that the potential for human exposure is considered to be sufficiently low to avoid posing a risk of concern to human health. Studies on the use of glyphosate by cohorts of licensed pesticide applicators reported evidence showing a link between acute myeloid leukemia (AML) and the highest exposed groups (Andreottiet al., 2018). Several authorities (EFSA; ECHA; EPA; BFR; the Joint Food and Agriculture Organization (FAO)/WHO Meeting on Pesticide Residues (JMPR), etc.) conducted additional evaluations on the risks associated with glyphosate following this 2015 IARC report (see Appendix,Table A1). However, as of February 2023, the international scientificconsensus remains that (1) glyphosate is unlikely to pose a carcinogenicrisk to humans from exposure through diet or residential exposure (seeAppendix, Table A1) but (2) glyphosate is likely to pose a carcinogenicrisk to the highest exposed groups, such as licensed pesticide applicators. In the second step of our analysis, we uncovered the discursive strategy of each article. Out of 51 articles, 4 were pro-glyphosates, 4were moderately pro, 15 were neutral, 20 were moderately againstglyphosates, and 8 were against. If we exclude neutral articles, 'pro'articles account for 22.22 %, while articles 'against' account for 77.78 %
(see Table 1).

Table 1
Article repartition by journal.

Journal category	Number of articles	Pro	Neutral	Against
DNM	17	6 %	18 %	71 %
OM	11	9 %	18 %	73 %
DRM	7	29 %	43 %	29 %
WM	16	25 %	38 %	38 %

In the 51 articles examined, we counted 53 arguments that were proglyphosate and 105 that were against glyphosate. Our analysis revealeda wealth of arguments both pro and against glyphosate (see Table A2 in Appendix). Most of the arguments against highlighted the dangers of glyphosate (public health, environmental, for farmers) and its carcinogenic nature. On the other hand, pro arguments focused on the economic downsides of a glyphosate ban. Articles highlighted the power of lobbies and science corruption to tone down the consensus and dismiss academic expertise:

- "*European regulatory agencies* [...] *based their review on studies sponsored by Monsanto* [...] *or on studies selected by companies sellingglyphosate in Europe*" (DNM, 27/11/17)
- "*Everything converged toward a ban: citizen pressure, numerous inter- national organizations* [...] *and the scandals of the Monsanto papers, the controversy related to scientific evaluation*" (WM, 28/11/17);
- "*Doubts increased* [...] *related to the Monsanto Papers* [...] *revealing decades of media and scientific manipulation* [...] *and the failure of European scientific evaluation*" (DNM editorial, 28/11/17)

Most of the articles appealed to industry lobbyists and activists as external experts; 11 articles used statements from pro-glyphosates lobbyists (FNSEA, Glyphosate Task Force, Monsanto, COPA-COGECA), while 18 articles used statements from activists against glyphosates (Greenpeace, Friends of the Earth Europe, Foodwatch, Future Generations, Ligue Against Cancer, and member of the political opposition (EELV, José Bové, Socialist Party)). Some even appealed to anonymous authorities: "*experts agree that* [...]" (DRM, 01/12/17). Only five articles out of fifty-one (9,09 % of the total) contained interviews with academic experts and feedback from the scientific community, such as INRIA scientists, academics or members of health agencies. Overall, there is a lack of citations of academic papers or health agencies. With this lack of citations, the articles suggested that the current state of knowledge wasin crisis and fueled the community's doubts.

4.2. Analysis of comments: social media and group reasoning

We studied the user-generated comments (*n* = 2944) and social audience (*n* = 52,023 Facebook likes and sharing) for each article. Table 2 lists the 'keywords', typical words used in a focus corpus (our dataset), compared to the reference corpus (see Methodology). These are not necessarily the most cited words, but this analysis enables us to identify abnormal word frequency compared to a general corpus (French web).

Table 2
Keyness scores and identified keywords in the dataset.

Item	Score	Frequency
glyphosate	3743.270	506
macron	1916.440	210
monsanto	1467.340	171
hulot	668.060	83

merkel	640.570	76
fnsea	604.610	66
germany	395.950	132
Eu	394.500	126
european union	350.810	38
europe	310.020	257
precautionary principle	277.170	30
circ	248.170	29
carcinogenic (cancérigène in French)	237.400	58
roundup	228.850	26
public health	221.940	24
gmo	210.330	30

Table 2 shows the focus on politicians (French President Emmanuel Macron; Nicolas Hulot, Minister for the Ecological and Inclusive Transition; Angela Merkel, Chancellor of Germany) as the public figures most criticized in the comments. It also highlights the contrast between European policy (Germany, EU, Europe, European Union) and principleswidely applied in France (the precautionary principle: when extensive scientific knowledge is lacking, policy-makers are socially responsiblefor public protection and can make discretionary decisions). Last, thislist emphasizes how the vocabulary moves toward mentioning products (Roundup) and GMOs related to discussions surrounding public health and the dangers of glyphosate. Fig. 1 below displays the most cited words (in French) in the corpus of comments (the size of a word denotes its frequency in the corpus).

First, Fig. 1 translates the weight of contrasting conjunctions ('mais' translates to 'but' and appears 391 times in our corpus of 2944 comments) and negations ("n," "non" and "ne" are French negative forms) expressed in comments such as:

- "*we can't prove that glyphosate is harmless*" (user pigeon3, 28/11/17),
- "*the majority of agricultural organizations (FNSEA, JA, CR) are against this potential ban; they do not want glyphosate to be banned*" (user Philippe 01/12/17),
- "*studies don't prove the harmlessness of this product*" (user openeye, 29/ 11/17)

These three expressions ("n," "non" and "ne") were used 3856 times ("n" and "ne" were the most cited words). In pro articles, negative expressions were used to challenge and express dissenting views. Indeed, in pro-glyphosate articles, 86 % of comments were critical of the articleor the situation and expressed an opinion against glyphosate. For instance, in a pro-glyphosate article from WM, users commented:

- "*FNSEA are irresponsible; they do not take responsibility for their mode ofproduction*" (user Pacham98, 27/11/17),
- "*lobbies haven't bought everybody yet? Lobbies are no longer what theyused to be…*" (user Bob Loop, 28/11/17),
- "*it's incredible: the EU is poisoning us while being paid by these assassins,and they are not happy?*" (user Charles, 28/11/17),
- "*Monsanto go home* [in English in the text]" (user dudule14, 28/11/17).

In articles against glyphosates, some comments (15 %) were pro-glyphosates and used negative forms to criticize the French govern- ment's announcement. For instance, someone commented the following on a DRM article:

- "*millions of idiots are against a product they do not use, so this ban will only impact others! Why aren't you so mobilized against tobacco, whichkills infinitely more people than glyphosate? Why aren't you planning toban the sun because of the thousands of cancers it causes every year?*" (user Yvan225, 28/11/17)

Here is another example from a DNM article:

- *ecology activists' stance on glyphosate is nonsense* […]; *the economy is not 'something for the lobbies', but something compulsory that you can'tavoid*" (user lesceptique 28/11/17)

Second, we also noticed the lack of mentions of 'carcinogenic' in the top-ranked list (Fig. 1). It appeared only 58 times in all the comments (*n* = 2944). This may be due to the poetic nature of the French language, with its numerous synonyms and images – "*Glyphosate is a killer*" (user Oskar, 28/11/17), "a poison" (user Tristan, 01/12/17), "a weapon" (user Paixdumonde, 27/11/17) – and to the numerous typos related to the use or variants of the words 'carcinogenic' and 'carcinogen' in French ("cancerigene" and "cancerogene," with frequent accent and spelling errors), which accounted for another 38 mentions, while 'cancer' accounted for an additional 29 results.

Some neutral articles generated far more debates among users: for instance, two articles from WM had more comments (n:184; n:316) than social shares (n:174; n:307), and the most commented article from DNM in our corpus (n:110) had a neutral tone. These greatly commented-on articles showcased long exchanges among users and a great deal of explicit reasoning and information interpretation:

Fig. 1. Most cited words in comments.

- "*there are multiple inconsistencies between political positions* [...] *in 2016, the ANSES* (*French national health security agency*) *concluded after a thorough analysis with experts* [...] *1) There is a limited level of carcinogenic risk* [...]; *2) Given limited evidence, the classification as a carcinogenic product could be discussed* [...]; *3) Given these results, the ANSES asked the ECHA* (*European Chemicals Agency*) *for further analysis* [...]; *Lastly, on March 15, 2017, the ECHA confirmed the non- carcinogenic nature of glyphosate and that there was a lack of scientificdata proving the contrary argument* [...]; *thus the German BFR concluded the same thing*" (user eol77, 28/11/17),

- "*Glyphosate pollutes water streams, groundwater, rains. How many cancers will develop because of this product in the next 5 years? How didthe farmers work before the invention of glyphosate? You know if we have done it in the past, we can do it easily now. Thus, we have to ban it now and prohibit its importation*" (user snitre12 01/12/17),

- "*OK, there are only two circumstances: France is in the EU, or France isn't in the EU. Therefore, if France is in the EU, the use and sale of glyphosate is allowed for 5 years in France*" (user Naceur, 04/12/17).

The other articles (pro and against) also showcased the numerous explicit uses of causal conjunctions:

- "*So, some scientists said these products aren't carcinogenic* [...] *but whyhas this 'innocuous' product been highlighted as a carcinogen? Why arethere ad-hominem attacks against scientists that highlight the carcinogenic nature of glyphosate?* [...] *What if this was a massive proof of corruption? We need to be protected against scientific manipulations* [...]; *a legal measure should be drafted to ensure scientific independence, integrity and transparency*" (user SixtyNine, 02/12/17),

- "*What is good science for you? If academic journals are not good enough, what should be trusted? A recent study was published in the Journal of the National Cancer Institute* (*thus not funded by industry and lobbies*): *there are no links between cancers and exposures to glyphosate. So I don't seeyour point about academic independence: everything is working fine*" [note: the user was referring to Andreotti et al., 2018] (user Saints, 02/12/17).

In terms of social engagement (Fig. 2), neutral articles attracted 590 comments, while articles against attracted 2219 comments, and pro articles had only 135 comments.

We categorized the tone of each comment (pro or against) depending on the focus of the article (pro, against, neutral). Insults, 'trolling' or personal attacks against other commenters were considered comments from the opposite side of the commenter being 'trolled'. TrollingIncluded irony, slightly off-topic comments, jokes, etc. Examples include the following comments:

- "*It's great to be a homeless person: we don't have to care about pollutionand glyphosate... We will die just like you, but at least we will keep our dignity!*" (user eva, 02/12/17),

- "*glyphosate is a tradition according to the FNSEA* [...]; *I had a cancer like my father, but at least my yield increased by 20%: I can die in peace*" (user Christian, 02/12/17),

- "*of course, the glyphosate is not dangerous* [...]; *my grandmother Madam Bouzin recommended a teaspoon of glyphosate each morning to stop badbreath, reinforce the immune system, ease the gastrointestinal tract andkill tapeworms*" (user Tropical, 27/11/17).

Comments on pro articles were mainly against glyphosate (83 %, 112comments out of 135), comments on neutral articles were more open to debate (76 % against, 448 out of 590), while comments on articlesagainst were mostly against glyphosate (88 %, 1953 out of 2219).However, most of the comments were not replying to other commentsbut rather replied to the article as forms of 'thinking aloud'. Interactions(addressing a user, employing a 'direct reply' to a user, naming a user, using quotes or replying to an argument or a point developed by a user)accounted for only 11 % of all comments (324 comments out of 2944).Out of 2944 user-generated comments, we found top contributors such as Alain (39 comments across the dataset), Claude (34 comments),Michel (29 comments), and Nicolas (28 comments); however, becausethese are very common names in France, we cannot suggest that theseusers were commenting on multiple platforms. We investigated userswith more complex or less common usernames (such as Achilletalion ormediacomtois or usernames comprising the real surname and real nameof the user) to determine whether they matched usernames in the foursubdatasets (i.e., comments from DRM; DNM; WM; OM) but found nosupport for cross-platform usage with only common name matching.However, through text mining for co-occurrences, we found redundancies and duplicated content in user-generated comments (see Fig. 3).

This behavior accounted for a small number of fully duplicated comments (*n* 17 out of 2944 comments), excerpts from copy-pasted sentences (*n*

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=
=

31 out of 2944) and similar shared hyperlinks (n 15 out of 54 hyperlinks shared) that were interrelated (user B wanted to argue his viewpoint, copied an excerpt from the national health security agency, and added a hyperlink to source his view).

Fully duplicated comments or comments containing hyperlinks to pro-glyphosate articles were extensively criticized by other commenters:

- "*This user always comments on debates about climate and environmental protection to contradict the truth. A subscriber (?)* [question mark in thetext] *probably paid by lobbies and industries. The worst is that he alwayscopies and pastes the same text* […] *and the discussion moderators let him freely do that again and again!*" (user Matteo, 28/11/17),
- "*here we go again, the communication department from the herbicide lobby*" (user bubard, 28/11/17 on the same comment),
- "*you are disinformed* […]; *we don't learn that in books*" […] "*this lookslike a lobbyist*" (user Acadiane, 28/11/17 on the same comment).

Conversely, fully duplicated content containing hyperlinks to articles against glyphosate was commented on or pinpointed. A user commented five times on DRM using the same sentence: "*Glyphosate, a controversial herbicide:* [*hyperlink*]," with a link to a website showcasing satirical cartoons against glyphosate. Hyperlinks were also used as part of reasoning processes, as a way to challenge other users' assumptions and as part of argumentations:

- "*Are we being deceived?* [*hyperlink*] *see this university professor's position. If we need to trust scientists, then we shouldn't doubt scientific research undertaken in Sri Lanka*" (User Valery, 03/12/17),
- "*Bayer also manage popular alternative products to glyphosate used in organic crop production* [*hyperlink*] *so your comment is pointless* […]; *if glyphosate is banned, then Bayer will profit much more because glyphosate-based herbicides have been in the public domain since the 2000s*" (User T, 04/12/17),
- "*This decision proves that the European commission is a puppet of international companies* […]; *Bayer AG, a German company, bought Monsanto in September 2016:* [*hyperlink*]. *Thus, Bayer now possesses theentire value chain by producing and healing degenerative diseases*" (user R, 03/12/17)

This section presented the outcomes of our interpretative approach. We began by analyzing the context of our case (scientific consensus on glyphosate), then the discursive strategies carried out in the articles within our scope (n 51), and last, the form of reasoning and discussions enacted in the comments of these articles (n 2944). In the next section, we discuss our findings and their theoretical implications.

5. Discussion

In this paper, we sought to specify how online communities make sense of the health policy communication process. We examined fourmajor French media's discursive strategies related to glyphosate ($n = 51$ articles collected during the climactic period of glyphosate renewaldebates), including social shares and user-generated comments (n 2944). Our primary contribution is that we develop an understanding ofthe mechanisms involved in judging and explaining biases in collectiveassessments of health policy and research consensus. We argue that thecomplex intertwining of rational, emotional and moral assessments influences the way in which academic consensus on glyphosate is perceived.
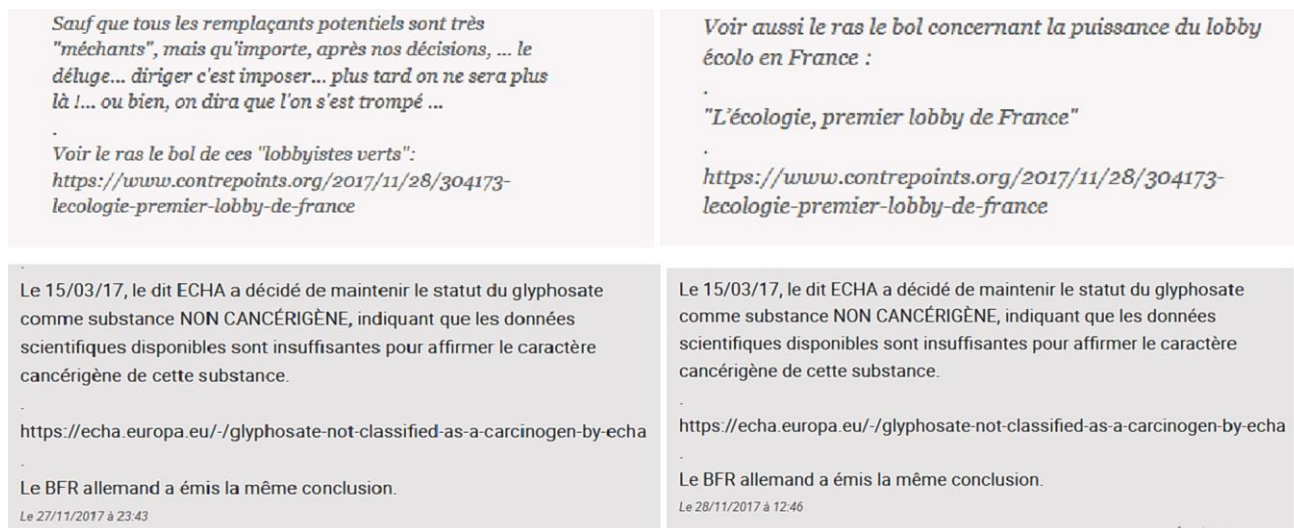

Fig. 3. Screenshots of two comments from the same user A on DNM (upper) and two comments from the same user B on WM (below).

Rational assessment of health policy: We observed rational assessment, analytical information processing and causal reasoning (Slovic et al., 2004). This was in line with the current literature stressing the use and significance of explicit and deliberate reasoning in groups (Salas et al., 2005). Indeed, the literature highlights that (*1*) explicit uses of causal conjunctions and explicit communication can enable groups to over- come the false consensus effect (Tschan et al., 2009), and (*2*) explicit and deliberate reasoning leads more frequently to rational decision-making in the context of groups (Schippers et al., 2014). Research into online groups demonstrated similar results, highlighting (*3*) collaborative reasoning and learning processes (Wasko and Faraj, 2005), (*4*) wisdom of the online crowd effect leading to rational assessments and beneficial decision-making (Chen et al., 2014), (*5*) joint processes of collection, dissemination, and interpretation of information (Lerman, 2017), and (*6*) improved critical skills of participants in online discussion forums (Greenlaw and DeLoach, 2003).

In our study, causal conjunctions such as "because, therefore, if-then" (Tschan et al., 2009, p. 276) comprised evidence of explicit and deliberate reasoning. In fact, the most-cited words in user-generated comments translate the weight of contrasting conjunctions and negations, while the most commented-on neutral articles showcased long exchanges among users and a large amount of explicit reasoning and information interpretation. The other articles (pro and against) also showcased numerous explicit uses of causal conjunctions. However, most of the exchanges were not direct interactions with other users but rather replies to the article as forms of 'thinking aloud'. Exchanges showcased spontaneity and intuitive reactions and engagement (social shares and comments). This led us to explore other forms of evaluations. *Emotional and moral assessments of health policy*: In the context of conflicting logics (simultaneous trust and distrust), the importance of emotional and moral assessment and its influence have been overlooked (Slovic et al., 2004; Toubiana and Zietsma, 2017). Emotions and moral values can precede cognitive judgments and be 'rationalized' and justified, deterring a purely rational response (Rindova and Martins, 2017). Online media have changed the nature of media discourse toward emotional and moral drivers rather than rational drivers (Etter et al., 2019; Liu et al., 2021). As noted by Pollock et al. (2019), these online media give "*voice to individuals and perspectives previously marginalized or ignored in public discourses*" (p. 38). This is reflected in our paper by the fact that most of the articles appealed to activists or industry lobbyists 'as experts', rather than to academics, to discuss the scientific consensus on glyphosate.

Emotional assessments differ from rational assessments: they are instantaneous, subtle and pervasive, experienced as feelings with or without consciousness, leading groups to selectively process information that confirms the initial emotion (Lerner et al., 2015; Slovic et al., 2004; Toubiana and Zietsma, 2017). In our case, user-generated comments were instantaneous and posted directly after the articles were published online. They involved intuitive reactions that overwhelmed fact-based information (Lerner et al., 2015), diffused and 'contaminated' other opinions and progressively formed a collective emotion (Menges and Kilduff, 2015; Pollock et al., 2019). Media platforms and user-generated comments enable easier and faster diffusion of collective emotions across social networks (Seidel et al., 2020; Veil et al., 2012). Technology-based environmental health risks posed by pesticides are a *threatening* public health problem (Covello and Frey, 1990) that generate fearful and emotional assessment. Second, our observations on the tone of the articles and comments also reflect the importance of moral evaluations, fueling emotional assessment. Indeed, the Monsanto company was involved in several scandals that violated social norms: it tried to hide lobbying activities and divert attention from its objectionable practices (Ramani and Thutupalli, 2015; Reid and Ramani, 2012; Vergne, 2012). Moral convictions and misalignment with Monsanto's values and actions (Rindova and Martins, 2017) may have fostered biased evaluations toward glyphosate. As highlighted by Verplanken and Holland (2002), individuals will avoid associating with groups that are against their values, will join groups that align with their values, and will consider their values when framing and making sense of a given situation. Emotional and moral assessments maintain group cohesion by shielding members from "*uncomfortable truths or disconfirming information*" (Delmestri and Goodrick, 2016, p. 241).

Understanding the complexity of embedded assessments:

While the literature highlights the benefits of deliberate, open ex-pressions of contradictory logics and the benefits of collective sense making (Friedman et al., 2018; Smith and Besharov, 2019), this has not given rise to a wisdom of the online crowd leading to rational assesments in our case (Chen et al., 2014). We argue that the complex intertwining of rational, emotional and moral assessments influences the way academic consensus is perceived. Health research consensus is subject to multiple and varying assessments from multiple and diverse sets of stakeholders balancing conflicting logics (rationality vs. emotions; trust in science vs. distrust of large pharmaceutical companies) with cumulative and interactive effects (Islam et al., 2020; Lew- andowsky et al., 2013; Rowe et al., 2020). Intense interactions among these interconnected stakeholders shape how they will make sense of the health policy communication process and reflect on it (Maitlis and Christianson, 2014). Network effects further propagate collective emo- tions and misinformation or sensationalized stories (Wang et al., 2019). While some researchers have suggested exposing stakeholders to mea- sures of collective opinion to reduce their tendency to share inaccurate health-related messages (Li and Sakamoto, 2015), this suggestion does not hold in our case, as social measures in the context we observed will favor distorted perspectives on the scientific community's consensus. Measures of collective opinion are contingent on the topic (vaccination, climate, GM food consensus), local political context and complex collective sense-making processes (Ramani and Thutupalli, 2015; Wang et al., 2019). Moreover, blurring boundaries contributes to the complexity of these intertwined assessments: blurred authorities as scientific institutions are challenged by the rise of expert-activists or expert-lobbyists (Islam et al., 2020), further increasing risk perception (Featherman et al., 2021; Hung and Chang, 2023); blurred narratives as individual opinions are formulated as fear appeals promoting distrust of health agencies (Bessi et al., 2015); and blurred boundaries of social inclusion and exclusion as deviant individuals bringing facts and scientific data are shamed (Douglas Creed et al., 2014).

Shared and intense collective opinions contribute to creating a sense of solidarity among individuals and to fostering the development of an "us against the world" group-think (Kreiner et al., 2006). Moral and emotional assessments can lead individuals to distance themselves from infamous organizations and alter their perceptions of their own beliefs and of outsiders' arguments (Elsbach and Bhattacharya, 2001; Pollock et al., 2019). We suggest that this distancing process shares similarities with identity threat assessment (Petriglieri, 2011): individuals engaged in "us against the world" group-think are less likely to reflect upon their own beliefs (Grandey et al., 2013) and may disregard threatening arguments that question their values and group identity (Kc et al., 2013; Scheepers et al., 2006). Strategies for addressing identity threats include reframing or refocusing the debate (Petriglieri, 2011), redefining or altering external comparisons (Kc et al., 2013), and blaming outsiders to maintain the group identity (Ashforth et al., 2007). While prior research has developed individual strategies for dealing with identity threats at length (Elsbach and Bhattacharya, 2001), it has overlooked the antecedents of threat assessment: the underlying rational, moral and emotional assessments and their influence on threat recognition, attribution and response (Petriglieri, 2011). More research is needed to further develop this preliminary finding. By deconstructing the media's discursive strategies and pinpointing the intricacy of complex assessments involved in online communities, our research further advances the knowledge of media's influence on collective opinions' attitudes toward health policy (Liu et al., 2021). Our paper reveals that although explicit and deliberate reasoning took place on media platforms, collective reasoning did not lead to rational assessment (Schippers et al., 2014) or to the wisdom of the online crowd (Chen et al., 2014; Greenlaw and DeLoach, 2003). In fact, collective inquiry reframed the debate (the Monsanto conspiracy and fears of chemicals rather than the carcinogenic nature of glyphosate) to avoid questioning the collective identity constructed

against glyphosate. This preliminary finding responded to a call for more research on the antecedents of polarization in a context other than social media and their algorithmic curation (Arora et al., 2022; Iandoli et al., 2021). This also calls for further research integrating individual- and collective-level assessments of health policy and its consequences for polarization.

This research has some limitations that also invite new avenues of research. First, given the purpose of this study (to explore discursive strategies and attitudes toward health policy), we adopted a qualitative methodology. More detailed quantitative or network analysis could be undertaken to provide a more comprehensive understanding of the diffusion of collective opinion. Second, this paper does not address the integration of the macro level and its micro foundations; thus, further research should address the coevolution of individual and collective assessments more specifically. In particular, in-depth analysis could be undertaken to investigate via interviews the microfoundation of negative attitudes toward authorities, health policies, and opponents' motivations.

6. Conclusion

We identified a case that illustrated cognitive biases and complex collective assessments related to health policy. Indeed, glyphosate generated heated debate in Europe, with the majority of French public opinion polarized against it. This was reinforced by Monsanto's shady practices (lobbying, multiple legal affairs, ghost writing, etc.). However, public opinion, government representatives and media in France were mainly hand-waving current state-of-the-art and scientific consensus regarding glyphosate.

This research highlights the complexity of public opinion's collective, multidimensional assessment of glyphosate (rational, emotional and moral). Elucidating the persistence and proliferation of online beliefs (Islam et al., 2020), we examined the complexity of these assessments to further our understanding of the unconscious and unexpected collective processes underlying attitudes toward health policy. Technology-based environmental health risks posed by pesticides have become a public health problem (Covello and Frey, 1990), with multiple implications for policy-makers regarding communication and trust(Featherman et al., 2021; Hung and Chang, 2023).

Should communication regarding scientific consensus adopt the codes of social media, focusing on emotional rather than rational responses? Should the health and medical research community provide substantial responses to unsubstantiated claims through similar media? Critically, our analysis suggests that disentangling complex assessments could have important policy consequences. Indeed, public opinion elevates the role that it should play in the health policy-making process while discounting the insights of the scientific community (IRSN, 2019). Policy-makers who are interested in increasing support for scientific state-of-the-art and scientific consensus must foster the dissemination of science popularization on social networks and online media's social platforms. Health education should move beyond global and general messages to combat misinformation and focus on disentangling the emotional, moral and rational responses to health-related messages.

Recent research has highlighted the need for more empirical accounts of individual and group biases in the spread of inaccurate health-related messages (Hung and Chang, 2023; Islam et al., 2020; Wang et al., 2019). While prior work has suggested that confirmation bias may promote the spread of inaccurate information against scientific evidence (Bessi et al., 2015; Lewandowsky et al., 2013), there has been little effort to explore the rhetorical techniques used in situ to maintain and confirm emotional and moral assessments. This paper joins a recent strand of research focused on the policy consequences of biases (Hung and Chang, 2023). It answers the call for more research on the logic of controversy at the boundaries of politics and science (McKee and Diethelm, 2010; Ramani and Thutupalli, 2015). This research investigated cognitive biases involved in the construction of distorted and biased (online) argumentation related to health policy (Hung and Chang, 2023; Wang et al., 2019) and finally explored the role played by emotional and moral assessments as antecedents to online polarization (Arora et al., 2022; Iandoli et al., 2021). Although the present paper contributes to prior research by examining the complexity of collective assessments of health policy, further research is needed to demonstrate the intricacy of the complex assessments found in online communities.

Data availability

Data will be made available on request.
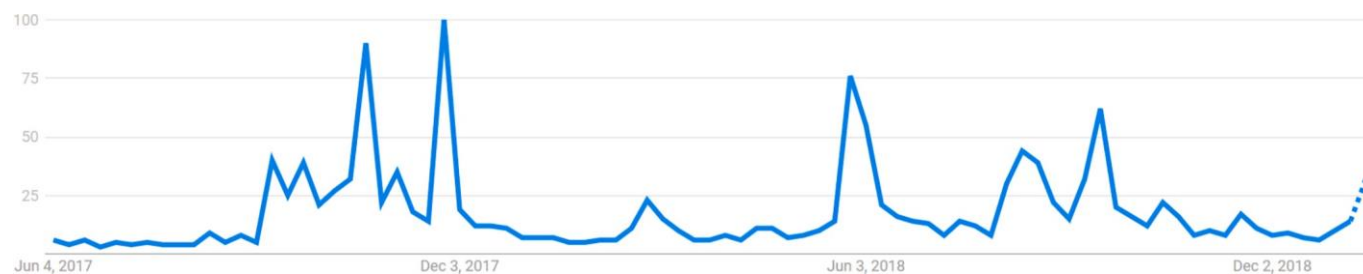
Appendix A

Fig. A1. Google Trends request from June 01, 2017 to January 01, 2019 on 'Glyphosate' showcases the peak of activity during the period of study (between November 27 and December 3, 2017).

Table A1

Scientific consensus regarding glyphosate.

Name of the health agency	Region	Assessment excerpt
(EFSA, 2015) (EFSA, 2022)	Europe	"The substance is unlikely to be genotoxic (i.e., damaging to DNA) or to pose a carcinogenic threat to humans. Glyphosate is not proposed to be classified as carcinogenic under the EU regulation for classification, labelling and packaging of chemical substances." (p. 1)
(ECHA, 2017) (ECHA, 2022)	Europe	"the available scientific evidence did not meet the criteria in the CLP Regulation to classify glyphosate for specific target organ toxicity, or as a carcinogen, as a mutagen or for reproductive toxicity"
(ANSES, 2016)	France	"relatively limited risk […] evidence does not allow us to classify the product in the 1B category [potentially carcinogen]" (p. 5)
(WHO/FAO, 2016) route in	World	"In view of the absence of carcinogenic potential in rodents at human-relevant doses and the absence of genotoxicity by the oral mammals, and considering the epidemiological evidence from occupational exposures, the Meeting concluded that glyphosate is unlikely to pose a carcinogenic risk to humans via exposure from the diet." (p. 36)
(ARLA, 2017)	Canada	"glyphosate is unlikely to pose a carcinogenic risk to humans" (p. 6)
(RDA, 2017)	South Korea	"the carcinogenicity was low or absent, and large-scale epidemiologic studies did not show carcinogenicity. […] No carcinogenicity or genotoxicity was observed […] the RDA indicated that the pesticide was confirmed to be safe as a result of the safety reassessment"
(FSC, 2016)	Japan	"Glyphosate had no neurotoxicity, carcinogenicity, reproductive toxicity, teratogenicity, and genotoxicity. "
(PMRA, 2015)	Canada	"In consideration of the strength and limitations of the large body of information on glyphosate, which included multiple short and long term (lifetime) animal toxicity studies, numerous in vivo and in vitro genotoxicity assays, as well as the large body of epidemiological information, the overall weight of evidence indicates that glyphosate is unlikely to pose a human cancer risk." (p. 22)
(APVMA, 2016)	Australia	"there are no scientific grounds for placing glyphosate and products containing glyphosate under formal reconsideration […] exposure to glyphosate does not pose a carcinogenic or genotoxic risk to humans" (p. 12)
(EPA, 2016) (EPA, 2021)	USA	"For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors 'carcinogenic to humans', 'likely to be carcinogenic to humans', or 'inadequate information to assess carcinogenic potential'. […] The strongest support is for 'not likely to be carcinogenic to humans' at doses relevant to human health risk assessment." (p. 141)
(NZ EPA, 2017)	New Zealand	"on the weight of evidence to date, glyphosate does not require classification under HSNO as a carcinogen or mutagen."
(BFR, 2015)	Germany	"the weight of evidence suggests that there is no carcinogenic risk related to the intended herbicidal uses and, in addition, no hazard classification for carcinogenicity is warranted for glyphosate according to the CLP criteria." (p. 4)
(FIOSH, 2016)	Germany	"Based on the epidemiological data as well as on data from long-term studies in rats and mice, taking a weight of evidence approach, no hazard classification for carcinogenicity is warranted for glyphosate according to the CLP criteria." (p. 98)

Table A2

Coding articles: weight of arguments.

Main arguments against	Number of articles	%	Main arguments for	Number of articles	%
Glyphosate is a carcinogen	17	30.91 %	A ban will create an unlawful competition among European farmers	9	16.36 %
Glyphosate is a public health danger	15	27.27 %	A ban will be costly	8	14.55 %
Glyphosate is a danger to the environment	10	18.18 %	For the moment, there are no alternatives to glyphosate	6	10.91 %
Glyphosate is potentially dangerous; we need to apply the precautionary principle	10	18.18 %	It is a political and ideological opposition	5	9,09 %
Glyphosate renewal is anti-democratic; political mobilization is needed	9	16.36 %	The AHS study does not classify glyphosate as a carcinogen	2	3.64 %
Monsanto Papers showcased manipulation and distorted scientific data (clear reference to the Monsanto Papers)	7	12.73 %	A ban will contribute to CO_2 increases	2	3.64 %
There is a hidden and powerful corporate lobbying power (without reference to the Monsanto Papers)	6	10.91 %	A ban will impact soil preservation	2	3.64 %
Glyphosate is a danger to farmers	6	10.91 %	A ban will contribute to other herbicides being created	2	3.64 %
Alternatives to glyphosate are already available	5	9,09 %	A ban will strongly impact the current yield of French agriculture	1	1.82 %
International and national agencies are inept and ineffective	3	5.45 %	A ban will contribute to increasing herbicides (in quantity)	1	1.82 %

| International and national agencies are corrupted | 2 | 3.64 % |

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