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ORIGINAL ARTICLE

Cliquepolitik: Multimodal online discourse coalitions on CRISPR-Cas genome editing technology

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Abstract

The influence of visualizations on decision-making about controversial policy issues is increasingly recognized in the political and policy sciences. In this paper, we explore how combinations of visuals and text on Twitter (now X) lead to the formation of networks of actors sharing similar textual and visual framings about a policy issue in an online setting, which we conceptualize as Multimodal Online Discourse Coalitions (MODCs). MODCs struggle over the meaning of contested policy issues. We examine multiple MODCs in 2018 in the context of the regulatory decisions in that year about CRISPR-Cas gene editing technology in the USA, Mercosur, and the EU. Based on an SNA and a qualitative visual and discursive analysis in three languages on Twitter in 2018 (covering in total ~ 427 k Tweets), we show that MODCs in English and Spanish focused on technocratic aspects of CRISPR-Cas, resembling the regulatory decisions in the USA and Mercosur. In Europe, next to technocratic MODCs, an MODC in French formed around ethical/normative framings of the consequences of CRISPR-Cas applications, using visuals of embryos to represent "GMO babies." These visuals were emotional triggers in their framing of CRISPR technology. The ethical/normative framing

reflected the argument brought to the CJEU by a group of French actors involved in the court case which categorized CRISPR-Cas as a GMO technology in the EU. These results suggest that the French MODC and their visualization was of influence on the EU decision-making process; however, more research is needed to verify the role of this online debate in the decision-making process.

KEYWORDS

CRISPR-Cas, discourse coalition, genome editing, multimodal framing, online public debate, policy controversies, technological governance

INTRODUCTION

Research on the influence of visualizations in public debates and on decision-making is an incipient field in political and policy sciences (Bleiker, 2018; Metze, 2018b; Morseletto, 2017; Niederer, 2016, 2018; Rabello et al., 2022; Rogers, 2019; van Beek et al., 2020). A recent review distinguished five different roles visualizations play in political and policy research. Visualizations can be (1) sense-making devices for interpreting complex information; (2) emotional triggers to strategically manipulate audiences' sentiments for political gains; (3) discursive objects of political meaning-making; (4) icons that convey social and cultural norms; and (5) portrayals of the underlying values that matter when representing situations in society. Visualizations can simultaneously fulfill these five roles for different groups of actors, and the roles can change over time (Rojas-Padilla et al., 2022). Online visualizations, for example, played a significant role in framing GMOs as controversial, influencing the regulatory policy decisions in Europe and the US (see Clancy, 2017; Clancy & Clancy, 2016). Similarly, findings show this role in the shale gas controversy (Gommeh et al., 2021; Hendriks et al., 2017; Metze, 2018; Rabello et al., 2022). Existing studies on the relationship between public debates and decision-making focus primarily on text, although some authors point out that the combination of text with visualizations is key (Clancy & Clancy, 2016; Kress, 2010).

In order to further investigate the influence of visualizations on policy making, authors such as McBeth et al. (2012), Guenther and Shanahan (2020), and Boscarino (2022) measured the impact of visualizations on individual public opinion by adapting the narrative policy framework. In this framework, narratives are strategic communication practices that have common structural elements regardless of topics or contexts (such as a defined setting, characters as heroes, villains, and victims, a plot, and the narrative's moral) (Jones & McBeth, 2010; Sabatier & Jenkins-Smith, 1993; Schlaufer et al., 2022). The image is a distinct narrative element that may be an attention grabber (McBeth et al., 2012) and influences information processing (Boscarino, 2022, p.724) and risk perception (Guenther & Shanahan, 2020). These pioneering studies within the narrative policy framework show that visuals indeed can increase attention, perception, and affective responses to an issue. However, there are mixed results as to visual narratives changing (risk) perceptions (Guenther & Shanahan, 2020) or encouraging activism compared to textual

narratives (Boscarino, 2022). The narrative policy framework literature indicates a possible limited relevance of visualizations in processes of agenda setting.

In this paper, we aim to add to these empirical studies of the impact of visuals on (individual) public opinion by better understanding what roles visualizations play in framing and discourse as meaning-making processes at a more aggregated level in the shaping of policy processes. Rather than measuring the impact of visualizations, we seek to explore possible explanations for different forms of impact on public opinion and decision-making. This is a different theoretical point of view from policy narrative research to engage with visualizations. Especially for public policy debates in online environments where large numbers of actors participate, intentional and non-intentional messages interact with large publics, and visualizations circulate in multiple languages across cultures and political contexts. In these different contexts, visualizations adopt diverse meanings for different groups of actors and resonate with different beliefs, values, or political interests (Bleiker, 2015, 2018; Doerr, 2017; Ercan et al., 2019; Jewitt & Oyama, 2001; Kress, 2010; Milman & Doerr, 2022; Rojas-Padilla et al., 2022; Rose, 2016). Our attention, rather than the effect or impact of visuals compared to text on individual public opinion, is on understanding the way groups of actors construct and negotiate meanings of a technology such as CRISPR-Cas and its public policy through visual and textual storylines and the policy preferences shaped in and by those storylines. Next to studies into visualizations in policy and politics (see above), we build upon discourse coalitions literature (Bulkeley, 2000; Hajer, 1993, 2002; Leifeld & Haunss, 2012; Metze & Dodge, 2016), which shows how networks of actors form around constructed understandings of public issues and reproduce (online) their understanding of (policy) solutions to address such issues accordingly. In discourse coalition theory, the interpretation of policy issues and the construction of discourses are vital in determining policy outcomes. Discourse coalitions literature, then, emphasizes shared discourses linking actors rather than coordinated rational self-interested actions based on reflective learnings or shared core beliefs. Discourse coalitions differ from narrative policy (or advocacy coalitions) frameworks in that individual actors are not the focus of the theory. Moreover, actors are not assumed to hold stable core beliefs assessed by informed rational reflections. Instead, language and context help to constitute what Hajer calls "unstable value positions" in groups of people. Thus, new discourses may influence existing values and positions of actors, for instance, because a new storyline in a policy debate constructs new perceptions of an issue, and that may give people new ideas about their potential role and the possibilities for policy decision (Hajer, 1995, pp. 68–72). This focus on the meaning a particular issue may take for people allows us to show how networks between actors in public debates may emerge based on interpretations – that may contradict their previously expressed core beliefs or interests. In addition, the study of the emergence of different discourse coalitions rather than policy narratives gives insights into less static narratives and more dynamic struggles between meanings.

We combine discourse coalitions with literature studying the role of (online) visualizations in policy controversies (Doerr, 2017; Gommeh et al., 2021; Hendriks et al., 2017; Niederer, 2016; Rabello et al., 2022; Rogers, 2019; Rogers & Niederer, 2020). As such, visualizations – together with text – are objects of political meaning-making and multimodal resources in the struggle of groups of actors to establish their competing discourses in public debates (Rojas-Padilla et al., 2022). Particularly, the multi-interpretability of visuals makes them play a role in opening up or closing down discourse coalitions.

The aim of this paper is threefold. First, we aim to make a conceptual contribution to understanding the combined role of visuals and text in the evolution of online policy controversies. Second, we innovate a methodological framework that includes visuals and text in the empirical

research of policy controversies online. Lastly, we provide an empirical case identifying and analyzing coalitions on CRISPR-Cas across different geographical regions and languages from Twitter data in the context of different categorizations and regulatory decisions on CRISPR technology. In order to achieve our aims, we (1) develop the notion of Multimodal Online Discourse Coalitions (MODC), which are digital coalitions of actors that (un)knowingly share similar textual and visual framings in online debates, (2) we analyze the multimodality elements (the text and visual frames as part and parcel of the same communication package) of the CRISPR-Cas debate on Twitter during the year 2018. Our research question is then: *what are the MODCs and their associated visual and textual framings of CRISPR-Cas in Twitter debates in the context of the 2018 regulatory decision-making processes about the technology in the EU, USA, and Mercosur?*

CRISPR-Cas is a genomic editing technology that allows a programmable endonuclease to target site-specific genome changes in human cells and other eukaryotes – developed in 2012 by Profs. Jennifer Doudna and Emmanuelle Charpentier (Jinek et al., 2012). The technology became a game-changer for medical and agricultural applications due to its low cost, quick adaptation to different systems, and high precision in identifying and editing DNA molecules (Doudna & Charpentier, 2014). It also became a controversial topic in political and public debates as it became associated – or conflated – with GMO technology and its regulatory framework. In 2018, there were three widely diverging policy positions on CRISPR-Cas technology: to regulate it as a GMO (EU countries), not to regulate it (USA), and leave open the possibility of regulation– but not as a GMO (agreement between Mercosur countries). These diverging policy outcomes in different political contexts make the debate about CRISPR-Cas technology an interesting study case to research visualizations' influence on technological policy controversies in social media.

By combining Social Network Analysis with a framing analysis of visual and textual framings together, we studied (1) what MODCs were emerging in Twitter during 2018 in debates in different languages (EN, ES, FR, PT), (2) the network structures of the different MODCs, and (3) their multimodal (visual and textual) framings of CRISPR-Cas. We (4) also explored possible relations between our results and the context of the different decision-making processes on categorization and regulations of CRIPSR-Cas technology in the EU, the USA, and the Mercosur bloc of countries.

MODCS AND THE ROLE OF THE VISUAL IN ONLINE POLICY CONTROVERSIES

We define a Multimodal Online Discourse Coalition as a digital coalition of actors that share similar textual and visual framings about a policy issue in an online setting. MODCs are characterized by having (a) multimodal content (textual and visual frames as a single qualitative information package) and (b) network structures based on digital platforms' affordances (i.e. affordances are the platforms' resources offered to interact with other users, in Twitter they include tweeting, RT counts, use of hashtags, use of visual media, the structure of the newsfeed, among others), and (c) networked-framing dynamics (see Knüpfer & Entman, 2018; Meraz & Papacharissi, 2013).

Groups of actors forming around shared understandings of controversies are a form of what Hajer (1993) described in policy sciences literature as discourse coalitions. Hajer uses the term "storyline" as the binding element of these coalitions and describes it as "narratives on social reality combining elements from different domains to provide actors with a set of symbolic references that suggest a common understanding" (Hajer, 1995, pp. 58–68). Following Bulkeley's work on policy networks, storylines play a crucial role in constructing coherent,

credible, and legitimate ways to achieve institutionalization of discourse in the understanding of policy problems in policy processes (Bulkeley, 2000). We apply the notion of storyline and argue that multimodal frames play the same binding element role in MODCs. In other words, sharing multimodal frames suggests common understandings of an issue for communities of actors online. Multimodal framing also contains symbolic references encoding additional layers of information for sense-making, emotional manipulation, political meaning-making, cultural and normative allusions, or representation of underlying values which speak to different actors online with similar (enough) views on an issue (Jewitt et al., 2016; Rojas-Padilla et al., 2022; van Leeuwen & Jewitt, 2001), facilitating the emergence of a multimodal online discourse coalition.

Interpretive research on policy controversies is usually text-based, especially in framing and discourse literature (Dewulf et al., 2009; Entman, 1993; Hajer, 1993; Metze, 2017; Schön & Rein, 1994). However, text-based analyses can be complemented with visual analysis to capture the (multimodal) nuances of political interactions in policy controversies (Grabe & Bucy, 2009; Kress, 2010). In distinct ways, these multimodal framings of policy issues mobilize specific information relevant to understanding policy controversies and their dynamics (Björkvall, 2017; Gommeh et al., 2021, 2022). For example, visualizations' contributions in framing add more nuanced and flexible interpretations than their textual counterpart (Clancy, 2016; Gommeh et al., 2021; Metze, 2018b; Rabello et al., 2022; Rojas-Padilla et al., 2022). In our CRISPR-Cas case, for instance, visual framing can be deliberately used to influence the viewer's emotions and political behavior (Grabe & Bucy, 2009) or in less strategic ways, using visual cues to make sense of and explain complex textual information (Graber, 1990; Messaris & Abraham, 2001) like the molecular workings of genomic technologies. Visualizations are also relevant for discourse coalition research as some visuals become symbols charged with semiotic relevance that create meaning and identity (Ademilokun & Olateju, 2016; Billig, 1995; Born, 2019; Doerr, 2017). A single visualization can summarize an entire political position in policy controversies (see Rojas-Padilla et al., 2022). Most importantly, text and visualizations work together in conveying particular meanings (Kress, 2010). Thus, multimodality offers a more informative approach to better understanding the nuances of political meaning-making in policy controversies (Rojas-Padilla et al., 2022).

Although initially described as an offline concept, discourse coalitions also emerge in digital environments and use visualizations online (Gommeh et al., 2021). The digital structure of social media platforms (i.e., Twitter) works as a media and interaction environment. Using a platform's affordances (the programmable resources to interact with other users) models how users interact and evolve cultures of practice in social media. The interplay between users and a platform's affordances shapes the network characteristics of online interactions (Marres, 2015, 2017; Marres & Gerlitz, 2016; Marres & Weltevrede, 2013; Rogers, 2019; Rogers & Niederer, 2020; Weltevrede, 2016; Weltevrede & Borra, 2016). In a digital environment, the characteristics of an MODC allow for identifying the qualitative content of its multimodal framings and for describing its quantitative network characteristics (i.e., hashtags use, visuals use, posting activity, retweet counts, coalition size, identifying opinion leaders (Friemel, 2015), among others). The digital nature of MODCs also considers the online traveling of issues and textual and/or visual elements of multimodal frames – forming multinational and multicultural publics participating in interrelated online versions of a policy controversy linked to different offline contexts where policy-making processes happen (Marres & Rogers, 2005; Niederer, 2018; Rogers, 2012, 2021; Rogers & Niederer, 2020).

MODCs, as political meaning-making structures, influence policy controversies – and, thus, policy-making processes – through networked interactions connecting online to offline groups

of actors and vice versa. The MODC notion expands the understanding and empirical study of the online world as a field of public participation in policy issues (Castells, 2008; Rabello & Gouveia, 2019; Rogers, 2019; Stevens et al., 2016). Researching MODCs provides a discursive understanding of (political) participation in trends of common visual and textual framing elements found across multiple versions of a policy controversy online and the ways these multimodal framings influence network dynamics, emotions, political behavior, alignments of online and offline actors, and – eventually – policy positions in policy-making processes (see Bulkeley, 2000; Van Hulst & Yanow, 2016). Through the concept of MODC, we can map emerging political meanings connecting online and offline actors' political participation in policy controversies in different political contexts but woven through digital public debates into discourse coalitions.

METHODOLOGY

Twitter data to research policy controversies online reflecting offline issues

To explore MODCs related to the CRISPR-Cas technology controversy online, we focused on the Twitter CRISPR-Cas debate in 2018, when the US, the Mercosur's Council of Agriculture Ministers, and the Court of Justice of the EU publicly announced their positions about the regulation of genome editing technologies like CRISPR-Cas (CAS, 2018; Confédération Paysanne and Others *v*. Premier Ministre and Ministre de l'Agriculture, 2018; USDA, 2018).

Twitter served as a digital space where all types of actors (including people, bots, and public and private institutions) exchanged multimodal communications in a massive "digital public square" (Glaisyer, 2019; Stevens, 2020; Zhao & Rosson, 2009). However, working with Twitter data to understand a policy controversy poses the challenge of contextualizing (or "grounding") the debate offline (Rabello et al., 2022; Rogers, 2019). It is challenging because controversies differ geographically. After all, actors, frames, and issues vary between regions (Marres, 2015; Marres & Moats, 2015; Rogers, 2015, 2019).

Researchers need strategies to ground Twitter information geographically to provide an offline policy context. Although geotagging tweets is possible, the practice is unusual among users, making geotagged data unreliable and forcing researchers to explore different proxies for grounding Twitter debates offline. We adopted a qualitative approach to ground our data based on affordances like hashtags and query limitations by language (Spanish, English, French, and Portuguese – later removed from the study) as proxies for offline political contexts. Other examples of qualitative strategies using hashtags are Crampton et al. (2013); Rogers (2019); Stevens et al. (2019); and limiting data by language Jaidka et al. (2020) and Souza and Vieira (2012). Alternatively, quantitative strategies such as inferential statistics or machine learning models (Compton et al., 2014; Nguyen et al., 2020; Zhang & Gelernter, 2014) have also been used in literature to ground Twitter data in a particular offline context.

Multimodal framing analysis: A framework for MODCs research

Previous online (multi)modality research studies have analyzed the coding of visual and textual data at the level of single-use instances (Jewitt et al., 2016; Xu & Löffelholz, 2021). However, these studies have limitations as they do not examine the network framing dynamics in policy

controversies beyond a specific group of actors and are limited to analyzing micro-interactions (e.g., individual tweets).

To address these limitations, we developed a new approach considering network framing dynamics online and exploring discourse coalitions by qualitatively analyzing their constitutive multimodal frames of CRISPR-Cas and quantitatively defining the affordances structure of a multimodal online discourse coalition (Figure 1). To be able to explore the online CRISPR-Cas policy controversy at the level of discourse coalitions, we performed a qualitative multimodal frame (MMF) analysis on the content of online discourse communities using a code book. First, we used the NetworkX Python library (Hagberg et al., 2008) for network analysis to identify clusters of accounts linked together by retweet relations based on Clauset-Newman-Moore greedy modularity communities (Clauset et al., 2004). Then, we selected the largest communities based on the number of members and debate coverage. We chose the top four communities from each dataset, covering 60%, 70%, and 97% of French, Spanish, and English datasets, respectively. Next, we performed a multimodal framing analysis. We developed a coding book for text coding, including the definition of CRISPR, sentiment, issue, frame, and prominent storylines. The coding of visuals included sentiment, image category, and depiction (Annex 1). We then studied retweet counts and posting activity to identify opinion leaders of each community in tandem with the MMF analysis.

To address network framing dynamics, we looked quantitatively at three network affordances: most (re)tweeted visuals, most (re)tweeted hashtags for issue mapping (Stevens et al., 2019), and a combination of posting activity and most retweeted posts for identification and political positioning of opinion leaders (Dubois & Gaffney, 2014; Lamirán-Palomares et al., 2019; Van Eck et al., 2011). We identify opinion leaders as accounts that exhibit considerable influence within their communities' information flow based on retweeting and posting data (see Parau et al., 2017, for a review on opinion leaders' identification). The use of network affordances is instrumental in the detection of MODCs (Table 1). Our framework facilitates the study of MMF analysis and a political analysis per MODC, including the position of its opinion leaders.[1] Lastly, we implemented an interpretive analysis, placing the inputs of each MODC analysis in the context of the

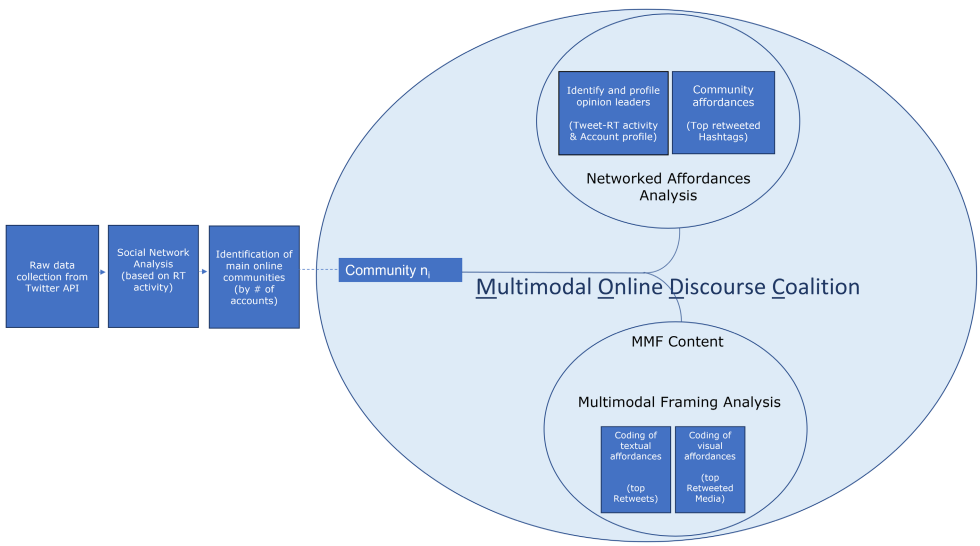

FIGURE 1 Methodology process leading to the identification of MODCs.

TABLE 1 Operationalization and empirics of an MODC.

Concept	Network affordances (quantitative metrics: Hashtags, tweets, & retweets)	Multimodal content (qualitative description: Multimodal analysis)
Multimodal Online Discourse Coalition	• Visuals • Hashtags • Tweets & RTs (Opinion leaders)	• Multimodal frames: visual and textual storylines (and role of visual)

regulatory policy decisions from the US, the Mercosur region, and the EU. Together, the MMF analysis of the community's content and network affordances are the core components of the **MODC** (Figure 1).

Data collection and identification of online communities

Our study covers economic, geographic, and political regions with different languages, so we filtered data by language in the query combined with the acronym "CRISPR." We selected Twitter data in English, Spanish, French, and Portuguese as the main languages for the US, EU, and Mercosur regions. We collected four different data sets from Twitter API in French (>12 K tweets), English (>374 K tweets), Spanish (>41 k tweets), and Portuguese (>2 k tweets) for 2018 using a search query with only the word 'CRISPR,' including retweets. We observed a considerable variation in absolute numbers of data, but considering population sizes and differentiated access to Twitter, we consider these numbers to be within expectations. However, we discarded the Portuguese dataset due to the lack of evidence for a Twitter debate about CRISPR-Cas in the dataset.

For each language separately, the dataset was processed as follows:

- Because of truncation in the Twitter dataset for retweets, the text of retweets beyond the 'RT @ username' was replaced by the original tweet text.
- All tweet images were downloaded and compared to identify identical images and to give each unique image a unique key in the dataset.
- All hashtags were extracted from the tweets.
- Based on a per-account sum of tweets posted and being retweeted, the top 1000 most prominent accounts were identified to serve as nodes in the network analysis, and every retweet relation between these nodes was used as an edge.
- Using the NetworkX library (Hagberg et al., 2008) network analysis, we identified communities in the Twitter data by applying Clauset-Newman-Moore greedy modularity clustering algorithm (Clauset et al., 2004).
- For each identified community, the entire tweets dataset for that language was scanned to retrieve the most frequently used hashtags and images by members of this community. Images of official documents or a recognizable logo imply a connection with the textual framings because images of documents elicit cognitive references and provide legitimacy to the (textual) information accompanying the visuals (see Coleman, 2010; Grabe & Bucy, 2009; Graber, 2012; Kress, 2010; Powell et al., 2015; Rojas-Padilla et al., 2022).
- Finally, the top 30% of retweeted tweets for each community were selected for further qualitative analysis.

To accurately represent our MODC in the figures, we normalized retweeted hashtags and visualizations by dividing them by the total number of hashtags or visualizations per community. This approach provides a representation of the relative weight of hashtags and visuals used in an MODC, and it reduces noise from isolates and size differences between MODCs and debates per language. As a result, the figures' sizes in the next section represent the relative weights of hashtags and visuals' use in their respective MODC.

RESULTS

Our results show that the public debate about CRISPR-Cas technology on Twitter differs considerably by language. Each debate has distinct network structures (network affordances (Marres & Weltevrede, 2013; Weltevrede, 2016; Weltevrede & Borra, 2016)) in their combination of visuals, hashtags, and opinion leaders, and in their visual and textual framings. In addition, the results show that there is at least one out of the four largest MODCs per language that generally resembles the regulatory decision in its visual and textual framing and in which distinct visualizations with different roles have been used.

We will first briefly describe the regulatory context of each region and sketch an overview of the online debate. In Annex 2, there is an extensive overview of the largest MODCs. In the second part of the results, we will look deeper into one selected MODC per language in order to analyze and better understand the role of the visual in combination with text in constructing interpretations and policy preferences. We selected the MODC in each language that, at first glance, seemed to resemble the most the interpretation and policy preference for CRISPR-Cas in each formal decision/region of study. This allows us to pay attention to storylines and symbols used by different actors, as these discursive elements shape interpretations and policy preferences (Hajer, 1995). We selected these three MODCS: *CRISPR-Cas innovation opportunities* from the English debate, *Agricultural policy for CRISPR-Cas* from the Spanish debate, and *CRISPR-Cas as GMO* from the French debate. We will look into detail the networked affordances, multimodal framing, and the role of visualizations in each MODC.

USDA and English online debate

In 2018, the USDA published their intention to categorize CRISPR-Cas as a novel genome editing technique, and its applications are not different to traditional methods of breeding. Therefore, edited crops would not become subject to further regulatory oversight. Moreover, the emphasis on the technology's promises to provide farmers with new ground-breaking crop varieties in shorter amounts of time justified such position. The public statement from the USDA specifically mentioned: "Plant breeding innovation holds enormous promise for helping protect crops against drought and diseases while increasing nutritional value and eliminating allergens" (USDA, 2018).

In the English online debate, we identified the four largest MODCs by number of nodes, covering 97.4% of the Twitter debate 2018. After an analysis (see Annex 2), we labeled these as (A) *CRISPR-Cas innovation opportunities* (size = 304, representing 33.3% of the total amount of nodes), described below in more detail; (B) *Evidence-based policy making for CRISPR-Cas* (size = 263, representing 28.8% of the total amount of nodes). The main textual and visual message in this MODC is that scientific knowledge should be the type of knowledge that informs CRISPR's policy decisions because CRISPR's meaning is (and can only be) technoscientific. In this MODC, there are primarily images of

notorious scientists, and the most relevant visual is the logo of the life sciences repository PubMed®. This prominent image is likely an artifact of the platform, as members of this MODC tweet links to scientific articles from this repository. (C) *CRISPR-Cas research* (size = 215, representing 28.8% of the total amount of nodes). The main message in this MODC is that scientific knowledge is the (only) way to generate knowledge and information about CRISPR-Cas, and the visuals used are figures in academic article-style article-figure style; (D) *Risk framing of CRISPR-Cas uncertainties* (size = 106, representing 28.8% of the total amount of nodes). The main message of this MODC is that CRISPR technology's uncertainties should be resolved with more scientific knowledge. Actors in it use a variety of visuals without an apparent trend, like corn labeled as GMO, figures in academic article-style depicting unintended edits, as well as images of animals and food.

Zooming in on the "CRISPR-Cas innovation opportunities": The role of visual and textual framing in the MODC

The MODC that resembled most of the position of USDA was the "*CRISPR-Cas innovation opportunities*" MODC. In this MODC, visualizations, in combination with text, convey a multimodal message of scientists and science as sources for entrepreneurship.

The MMFs in this MODC are mainly about categorizing CRISPR-Cas as an emerging genome editing technology framed in terms of its economic impact on the medical and food production markets. This MODC multimodally constructs CRISPR as a ground-breaking technology to generate innovations and drive competitiveness; therefore, its regulation should facilitate value creation and support entrepreneurship.

In this MODC, hashtags like #genediting, #biotech, #genetherapy, #crisprbabies, #cancer, #patent, #stemcells, or #bioethics flag main topics around which accounts in Twitter label their participation in a debate. Opinion leaders in this MODC are, most of all, academics, academic entrepreneurs, and developers.[2] Members of this coalition categorize CRISPR-Cas as genome editing technology and its regulatory policy should be defined in terms that facilitate genome editing innovations.

In terms of textual content, the construction of MMFs of CRISPR-Cas (Figure 2) categorizes CRISPR as an innovative technology with economic potential for investments in medical care and food innovations, constructing CRISPR-Cas genome editing around MMFs of economic opportunities and as instrumental for innovation and competitiveness. As exemplified in this tweet, illustrative of the 30% most retweeted texts of the English debate. This example highlights the perceived power of CRISPR as a critical technology for innovation in the 21st century. As such, its regulatory framework must allow CRISPR applications – within boundaries – as long as the trade-off for these applications fits the discourse of progress. Thus, the meaning of CRISPR-Cas adopted in this MODC is utilitarian, an opportunity for developing innovations through newly minted genome editing capabilities.

> Genome editing is one of the most powerful technologies of the 21st century. It's important that new tools such as CRISPR continue to be applied – subject to rigorous guidelines – so the world can continue to make remarkable progress.

The most retweeted visualizations in the MODC are photos, including scientists turned entrepreneurs, snapshots of patent documentation, timelines on genome editing research and John Hopkins's stem cell ethics and policy program, as well as infographics on the functioning of CRISPR as a technology and CGIs of DNA and manipulation of DNA strands.

FIGURE 2 Circle packing of multimodal affordances used in the "*CRISPR-Cas innovation opportunities*" MODC as part of the English online debate. The figure represents the use of multimodal affordances – represented as hashtags and visualizations – at the MODC level. Circle sizes represent the weight of each affordance in the multimodal framing of MODCs proportionately. We used RawGraphics for making the circle packing hierarchy.

Images of researchers/entrepreneurs, patents, timelines of genomic technology's evolution, infographics of CRISPR's workings, and images of DNA manipulation are part of the visual construction of CRISPR in a technocratic language, which complements the textual description of the technology emphasizing how to understand CRISPR. That understanding consists in making meaning of the technology in terms of its economic role for investments, entrepreneurship, and competitiveness forecasts in food and agriculture.

The use of these visualizations has two significant roles: (a) as discursive devices constructing a visual language that intertwines scientific information with market investments as part of a larger economic discourse that constructs the value of scientific knowledge through their value for the market(s), and (b) as sense-making devices to influence public opinion and gather public support to consider CRISPR-Cas as a new technology that becomes functional and impactful for society when incorporated – in the form of patentable industrial knowledge – to the economy. In

this MODC, visual framings complement textual framings with tangible examples that construct a multimodal framework of reference for members of the coalition on how to make sense of (this) new technology. But more specifically, on how to categorize CRISPR technology, placing it in an economic-thinking box, therefore framing also the type of goals in public policy that are suitable to govern CRISPR technology applications.

Mercosur countries and the online debate in Spanish

In 2018, the Council of Agriculture Ministers of the South (CAS) made public their commitment to adopt a common policy of public investment in genome-edited crops oriented to solve sustainability, production, and competitiveness issues in the agricultural sector of Mercosur countries. The agreement aims to "accelerate access to new (edited) varieties to producers and consumers while boosting transfers of technology, knowledge and know-how between National Research Institutes and regional biotechnological SMEs[3]" (CAS, 2018). To this end, the CAS Ministers expressed their position to categorize genome editing using CRISPR-Cas as a new breeding technique (NBT). They consider genome editing to provide results equivalent to conventional breeding processes. The Ministers also agreed to share scientific and regulatory information aimed at harmonizing regional and international regulations.[2] Additionally, Mercosur countries agreed to work in a block to prevent "scientifically unsupported trade barriers of edited crops with third countries[3]" (CAS, 2018). For the Mercosur countries, genome editing using CRISPR is a technology of public interest which should adopt science-based tailored regulations harmonized between Mercosur Member States. Moreover – by definition – their position states that edited crops are not to be arbitrarily designated as GMOs, nor should they follow the Cartagena Protocol of Biosafety when traded, which means that edited foods should be exempted from the additional trade documentation imposed on GMO foods (like additional labels or notifications, among others).

In the online debate in Spanish, all four biggest MODCs considered CRISPR-Cas as a novel technology with promising breakthroughs for medical and agricultural applications. In the Spanish debate, the four largest MODCs in number of nodes covered a total of 70% of the debate for 2018. We labeled them as (A) *the CRISPR-Cas promise for rare diseases* (size = 171, representing 20% of the total amount of nodes). The main framing in this MODC (mostly located in Spain) was that CRISPR technology holds promise for new medical treatments for rare diseases. This MODC is mostly a Spaniard MODC since the main researcher on this specific medical use of CRISPR is a prominent Spanish CRISPR scientist. The topic and its opinion leaders are located in Spain, which suggests that medical applications of CRISPR are not a major concern in Mercosur countries. CRISPR medical applications are not represented in Mercosur MODCs or by South American opinion leaders. Images used were of a Spanish CRISPR scientist (Prof. Francisco Mojica) who works on CRISPR to cure rare diseases, diagrams to explain CRISPR-Cas, scissors, and DNA picture, and a photo of a kid with albinism; (B) *an agricultural policy for CRISPR-Cas* (size = 148, representing 18% of the total amount of nodes) is described below; (C) the *Technoscientific solutions for CRISPR-Cas uncertainties* (size = 141, representing 17% of the total amount of nodes). The main framing in this MODC is that uncertainties about CRISPR technology are scientific (as opposed to societal), and those uncertainties require further scientific knowledge to address them. This MODC combines infographics on how CRISPR works with photographs of scientists and conferences, a photo of medical treatment, and CGIs of DNA, blood cells, and scissors cutting DNA precisely; (D) *Let's*

talk about CRISPR-Cas with everyone (size = 109, representing 13% of all nodes in the Spanish debate). The main framing in this MODC is that CRISPR is complex, and the scientists play a fundamental role in explaining the technology to society. This MODC uses infographics of the mechanics of CRISPR-Cas, a photo of a pair of scissors cutting a DNA molecule printed on paper, CGIs of a DNA strand cleaved at two points, photos of famous CRISPR researchers, and photos of researchers in radio shows and interviews.

Zooming in on the "Agricultural policy for CRISPR-Cas": the role of visual and visual framing in the MODC

The MODC "Agricultural policy for CRISPR-Cas" formed around the framing construction of an agricultural policy issue where science-based knowledge was considered to be needed to develop adequate public policies for agricultural applications of CRISPR-Cas technology.

The MMFs in this MODC are mainly about the need to categorize CRISPR technology as part of a new generation of breeding techniques that is different from GMO and inform its public policy adequately with science-based inputs. This MODC multimodally constructs CRISPR as a key innovation to take advantage of for the sake of progress of the agricultural sector; therefore, their shared position is that regulation should be science-based and tailored to such views.

In this MODC, we see hashtags such as #agricultura #transgénicos (GMOs) (which in South America is not necessarily a loaded word because it also means simply a genomic agricultural technology). The hashtags #ciencia, #biotecnología, #UE, #innovación (innovation), or #alimentación (food) show agriculture as a topic in common between the Spanish-speaking European and Latin-American views of CRISPR-Cas technology applications. Moreover, accounts from either side of the Atlantic share similar views of the role of science in informing public policy on CRISPR applications to the agrifood sector. To opinion leaders in this Discourse Coalition, editing crops is a new breeding technique which bears more resemblance to conventional breeding than transgenic technology. Opinion leaders in this MODC included the Spanish pro-biotech NGO @fundacionantama, the Chilean lobby group @chilebio_ag, a Spanish SME @gram_positivo, and the Ibero-American news outlets[4] @munagropecuario, @huerta_digital, @biotech_si, as well as academic researchers and science journalists.

In terms of the textual context, the analysis shows that within this MODC, CRISPR is considered the poster technique for a generation of new breeding techniques that are not – and should not be – subjected to the hassle of international trade regulations for transgenic foods (the term "transgenic" is not necessarily a negative label for members of this MODC). Furthermore, the technicalities of CRISPR-Cas are constructed to make genome editing an innovation from transgenic technology, a new technological development which can incorporate novel traits in crops more precisely and in less time than conventional breeding without having to engage with the regulatory hassle of GMO regulations. In the textual framing of this MODC, CRISPR-Cas is part of a new generation of breeding techniques that are closer to conventional breeding strategies than transgenic breeding strategies, and their regulation should make that difference clear. For example, the following Tweet selected from the top 30% most retweeted posts in the dataset:

> La mutagénesis inducida mediante agentes químicos o físicos que se usa desde los 70 y ha dado origen a más de 3000 variedades de alimentos sería igual, pero CRISPR es más dirigido, rápido y seguro

The induced mutagenesis using chemical or physical agents that's been in use since the 70s and has produced more than 3000 crop varieties would be the same, but CRISPR is faster, quicker and more precise[3]

These textual framings in this MODC categorize CRISPR-Cas technology as different from GMO and in need of agricultural policies informed by science.

The most retweeted visuals in this MODC include photos of rapeseed and wheat agricultural landscapes, greenhouses, tomatoes, potatoes, soybeans, and a pasta meal with edited cabbage (later eaten by the scientists who edited the cabbage). CGIs depict DNA strands clipped at specific points, and Infographics depict the process of editing a plant using CRISPR-Cas genome editing, showing the differentiation between transgenesis and genome editing where CRISPR-Cas is symbolized as scissors. These visuals work as sense-making devices because they reference schemata of technological progress in the agrifood sector, priming the framing of CRISPR technology as a novel technology and its applications as welcomed innovations. Simultaneously, these visuals seem to work as discursive elements, reinforcing discourses of linear growth by representing and understanding CRISPR as a symbol of progress.

The EU Court of Justice and the French online debate

In 2018, the Court of Justice of the European Union ruled that genome-edited crops fall under the regulatory framework established in the Directive 2001/18EC, also known as the GMO Directive. The ruling considers the mutagenesis process induced by technologies like CRISPR-Cas as a genetic modification, emphasizing the uncertainties of the technology's use in crops and its consequences for the environment. This case was brought to court by the High French Court that requested the CJEU's opinion on the interpretation of the Directive 2001/18EC after nine French environmental NGOS filed a case against the French government and their policy toward genome editing technologies. The plaintiffs presented the case before the CJEU – including a public petition entitled "*No thanks to the new GMOs*" with 107,000 signatures (Tumerelle, 2016). On July 25, 2018, the CJEU sided with the plaintiffs, reshaping the policy-making process for CRISPR-Cas technology in the whole European Union (Confédération Paysanne and Others *v.* Premier Ministre and Ministre de l'Agriculture, 2018). This ruling upended policy preferences in other Member States considering categorizing mutagenesis induced by CRISPR technology as different from GMO and conceiving regulating it accordingly (see Eriksson, 2018).

In the analysis of the online debate in French, we found competing framings of CRISPR-Cas where the technology is categorized as GMO and constructed negatively, or where it is considered genome editing and it is constructed in a more positive light. In the French debate, we identified the four largest MODCs in number of nodes, covering a total of 60% of the debate for 2018. We labeled them as (A) *the Battle to categorize CRISPR-Cas* (size = 135, representing 18% of the total amount of nodes). This MODC formed around the debate of the classification of CRISPR, where two groups engaged in competing frames of CRISPR as GMO or as a genome editing technology. This MODC uses mostly photographs of scientists, and a baby. Also, diagrams explaining CRISPR-Cas technology and CGI images depicting DNA strands being cut by scissors, tweezers, or an enzyme; (B) *CRISPR-Cas not as GMO* (size = 123, representing 16% of the total number of nodes). This MODC's main MMF framing was that CRISPR-Cas is not a GMO but a genome editing technique (with French origins) applied to agriculture as part of a package of genomic technologies called new breeding techniques.

It used mainly a photograph of the French scientist and co-inventor of CRISPR-Cas, Prof. Emmanuelle Charpentier. Additionally, other images such as CGIs representing CRISPR as scissors and infographics of agricultural yields and investments by major powers, together with texts from promoters of the technology like Bill Gates, complement the visual storyline of CRISPR-Cas as a genome editing technology with French origins, and with no resemblance to GMOs; (C) *CRISPR-Cas as GMO* (size = 99, representing 13% of the total amount of nodes) described below; (D) *Improving humans through CRISPR-Cas* (size = 95, representing 12% of the total amount of nodes). This MODC's main MMF was that CRISPR is a novel group of technologies called NBICs, which together will improve humankind beyond its human condition. Actors use mainly CGI images depicting DNA strands cleaved by enzymes and imaginaries of mass production of babies. Other visuals are infographics describing the mechanism of genome editing with CRISPR and a photo of a pregnant woman.

Zooming in on the "CRISPR-Cas as a GMO": The role of visual and textual framing in the MODC

The MODC selected was the one CRISPR as GMO. This MODC constructs CRISPR-Cas technology around the politicization and moral rejection of CRISPR-Cas applications, especially in reproductive health.

The MMFs in this MODC are mainly about categorizing CRISPR-Cas as GMO technology applied to human reproduction, and it is framed as an ethical red line that cannot be crossed. This MODC multimodally constructs the consequences of CRISPR applications in humans as uncertain and risky as GMO, and its application generates "GMO babies."

The emergence of hashtags like #bébéssurmesure (bespoke babies) or #bébésogm (GMObabies) highlights the normative dimension rather than the technicalities of the CRISPR debate in France while facilitating the aggregation of the coalition as part of a network. Other hashtags used in this MODC are #ccne (French Commission for Bioethics), #bioéthique, and #crisprbabies, contesting the construction of a technocratic language to categorize CRISPR and its public policy and constructing instead an ethical language where GMO and CRISPR-Cas technologies are interchangeable issues. The most salient opinion leaders are @AllianceVita – a conservative lobby group – and its spokeswoman. @VotePoisson, an account related to the far-right politician Jean-Frédéric Poisson. @lamanifpourtous, a religious conservative movement against parenting rights and marriage equality. The Catholic media outlet @LaCroix and journalists from this outlet. @FondLejeune, a catholic research foundation on cognitive disabilities, a bioethics website funded by the same foundation, and a high-ranking developmental biology researcher at a French public research institution.

In terms of textual content, in this MODC, the framing of CRISPR is as GMO. Based on ethical argumentations, this MODC categorizes CRISPR technology as GMO. Moreover, the possibility of allowing public policy to apply CRISPR-Cas is considered immoral, unethical, and unacceptable. As exemplified in this tweet, illustrative of the 30% most retweeted texts of the French debate highlighting the unacceptable bioethical issue of CRIPR as genetic modifications in humans and their position to regulate the technology by law.

> La révision de la loi de #bioéthique en France sera l'occasion de légiférer sur la question des modifications génétiques de l'embryon humain qui fait déjà l'objet d'expérimentations inacceptable

The revision of the #bioethics law in France will be an opportunity to legislate on the issue of genetic modifications of the human embryo, which is already the subject of unacceptable experiments

The most retweeted visuals in this MODC are a photo of the spokeswoman for AllianceVita – a key account opinion leader against the technology in this MODC. Other visuals include photos of bioethical documents, scientists, and bioethical hearings. A relevant visual is a CGI image of a human embryo superimposed on DNA molecules, discursively claiming babies as symbols in their discourse. Other CGIs represent CRISPR-Cas as tweezers or scissors altering DNA molecules manipulated by scientists and a photograph of a leafy crop. The visuals in this MODC play three overlapping roles: (a) as political framing devices oriented to trigger emotional responses through the use of images of babies and fetuses for political gains, more specifically to mobilize support against the use of CRISPR-Cas in human reproduction initiatives; (b) as discursive devices using visuals to construct a language to understand CRISPR-Cas in an ethical discourse, based on the consequences of its application rather than scientific technicalities of its mechanism; and (c) as cultural icons, since key visuals such as the use of an embryo or the photograph of AllianceVita's spokeswoman become visual references to the CRIPSR-Cas issue. The baby GMO visual condenses a multimodal framing of (acceptable) values and policy positions toward CRISPR-Cas technology applications, while the photograph of AllianceVita's spokeswoman becomes a public reference to the defenders of (acceptable) values.

Together, the visual and textual framing of this MODC constructs CRISPR-Cas technology as GMO technology applied to human reproduction and, therefore, unethical. Visualizations in these MMFs provide an essential emotional trigger with babies and the ethics of genomic technologies. Together, the MMFs of this MODC categorize CRISPR-Cas as a genetic modification technology and its use in humans as an absolute redline that is unacceptable for the members of this coalition. Although there are small visual and textual references to the environmental consequences of the use of CRISPR, no concrete links between any of the nine plaintiffs of the European case to this MODC could be found in the data. However, the ethical framing of the consequences of the use of CRISPR found in this MODC reflects the position of the CJEU about the categorization and regulation of CRISPR technology under the GMO directive.

DISCUSSION

In this section, we compare the results by language in order to better ground the Twitter analysis in the political context of the three regulatory policy positions. We pay specific attention to differences and similarities between the role of the visual in each of the languages.

Relevance of multimodal framing for policy debates and policy positions

The first main finding is that two broad discourses emerged in different MODCs across the online debate in the three languages: (a) technocratic MODCs in English and Spanish debates; and (b)

a normative/ethical MODC in the French debate. The regulatory policy positions expressed by the USDA, Mercosur's CAS, and the CJEU are in line or resonate with these emerging discourses.

The technocratic discourse in the English and Spanish debate consisted of multimodal framings confining the debate of CRISPR technology to the scientific realm with mostly technical visuals such as diagrams and simplified models on how CRISPR works, and references to scientific knowledge and scientists, and as such seem to have the role of sense-making devices of what CRISPR is. Although the technocratic discourse can be found in all three debates (see Annex 2), the use of technocratic visual framing in combination with technocratic textual framing effectively contributed to the closing-down of the online debate of CRISPR-Cas to scientific meanings and technocratic decision-making. This is a mechanism familiar to scholars studying public debates about emerging technologies (Littoz-Monnet, 2015; Wynne, 2001). This technocratic multimodal framing is particularly dominant in the English and Spanish debates, which also resonate largely with the technocratic profile of the regulatory decisions adopted by the USDA and the Mercosur's CAS.

The ethical/normative discourse in the French language consisted of textual framings that conflated CRISPR and GMO technologies as interchangeable terms while visual framings of embryos, babies, and references to spokespersons as experts conveyed an alarming message about genetic modification of babies (and humans), including in the public debate normative and ethical arguments to make sense and give meaning to (the consequences of) CRISPR-Cas technology. In the online debate in French and in the reasoning of the EU Court ruling, an ethical and normative discourse competed with the technocratic discourse. In this ethical discourse, policy positions show more emphasis on the consequences of applications of the technology in society rather than the technicalities of CRISPR functioning. In the debate in French, and in particular to the concerted campaign mobilized by key opinion leaders in the MODC "CRISPR as GMO," the visual framings of embryos and babies, together with textual framing of CRISPR as equal to GMO, were instrumental to frame CRISPR's consequences as a technology that produces "GMO babies." The MMF of this MODC simplified the technical complexity of CRISPR and reduced it to an ethical argument that GMO and CRISPR technologies are the same because the consequences of their use are the same (and they are bad). The data indicate that this multimodal framing contributed to opening up the technocratic debate in French to ethical arguments about CRISPR-Cas applications and their consideration for its public policy options (a discourse beneficial to the CRISPR agenda of diverse actors in the French political context). However, more research is needed to study how this normative ethical discourse entered the French online debate and how it was interpreted by tweeter users within and from different MODCs.

The dominance of technocratic discourses in policy has been criticized in academic literature as oriented toward catering to the interests of business and technology-developing sectors (Jasanoff, 2004, 2006; Jasanoff & Kim, 2015; McKenna & Graham, 2000; Rooney, 2005). The role of the visual in our study shows an empirical example of visualizations in combination with text used in the opening-up and the closing-down of online public debates on an emergent technology, which also reflect policy positions from their respective languages/regions. We can see when grounding (Rogers, 2019) the online debates in three different languages in the policy positions from the USA and Mercosur countries about regulatory policy preferences that the technocratic discourse became dominant, unlike the online debate in French, in which there was room for an ethical/normative framing.

The role(s) of visualizations in the multimodal framing of CRISPR-Cas technology

When we dive deeper into the visual aspects of each MODC, we see that computer-generated images, diagrams, drawings, and infographics are prevalent in all languages. These types of visuals depict either representations of enzymes around DNA strands, cleaved double-stranded DNA fragments, representations of scissors or tweezers cutting DNA, persons in lab coats rearranging DNA strands, diagrams showcasing timelines of CRISPR research, infographics differentiating genome editing from genetic modification, or metaphoric ballerinas dancing along a double strand of DNA. These visualizations are all representations in each MODC in each language and "show" what CRISPR **is**: a revolutionary gateway to innovations, a molecular mechanism that cuts DNA precisely, the outcome of decades of research, a way to manipulate life, or a powerful tool to edit DNA, a new technology.

Other visualizations of the same type have contents like medical procedures, agricultural fields and greenhouses with crops, depictions of food, graphs of yields over time, or models depicting the molecular mechanics of CRISPR-Cas9 in cleaving DNA inside a cell. In the case of the French MODC that we studied in detail, there is a computer-generated image of a human embryo surrounded by darkened blue DNA strands and depictions of molecules. These visuals depict what CRISPR **does**: CRISPR produce breakthroughs in medicine; CRISPR creates innovations and business opportunities (*CRISPR-Cas innovation opportunities* MODC, Figure 2); CRISPR improves food, increases yields, produces new crop varieties, CRISPR (Agricultural policy for CRISPR-Cas MODC, Figure 3); and in the French case (CRISPR as GMO, Figure 4), CRISPR modifies embryos and babies, CRISPR tinkers with life itself, CRISPR produces scientific hubris, CRISPR changes humanity. The use of both types and content of visualizations is key in the construction of differentiated multimodal frames about CRISPR-Cas.

Hence, in the selected three MODCs, computer-generated images, diagrams, drawings, and infographics are used to communicate – and visually frame – what CRISPR is – a denotative message (Barthes, 1977; Rodriguez & Dimitrova, 2011). Additionally, the content of these visuals also conveys a connotative layer of meaning (Barthes, 1977; Rodriguez & Dimitrova, 2011): what does CRISPR do – which, in essence, implies ideas and concepts about what is acceptable and what is not acceptable from CRISPR technology. In the "*CRISPR-Cas innovation opportunities*" MODC, CRISPR is visually framed as a source of innovation and, therefore, is acceptable because it generates economic and technological benefits. In the "*Agricultural policy for CRISPR-Cas*" MODC, CRISPR is a genome editing technology with promising agricultural applications; therefore, CRISPR is desirable. Finally, in the French CRISPR-Cas as GMO MODC, which resembled the regulatory decision the most, CRISPR is a technology to modify humans, and its consequences endanger the human condition. Therefore, it is unacceptable to have CRISPR applications allowed in society. These visual frames in all three languages underlie political meaning-makings – the ideological meaning (Rodriguez & Dimitrova, 2011; Rojas-Padilla et al., 2022) about CRISPR, whether it is desirable, acceptable, or neither. Hence, the combinations of types of visuals and their content are similar across all MODCs in the three languages; however, their meaning differs between coalitions. The different construction of meanings using visuals of similar content speaks more to the social semiotics of visual meanings (Kress, 2010) and to the use of similar types and content of visualizations in the construction of different political meanings by and for different groups of actors (Rojas-Padilla et al., 2022). We have explored this briefly, and this should be further investigated to better understand the role of different layers of visual framing and how they influence the public debate.

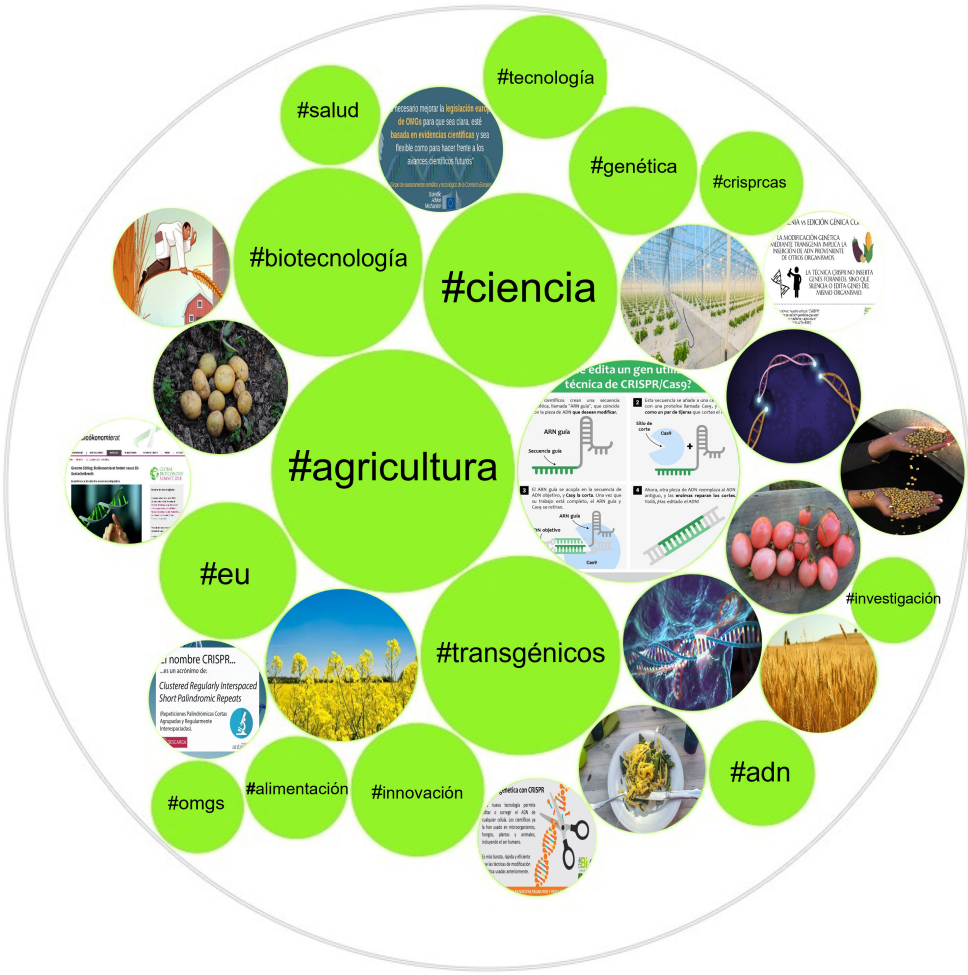

FIGURE 3 Circle packing of multimodal affordances used in the *"Agricultural Policy for CRISPR-Cas"* MODC as part of the Spanish online debate. The figure represents the use of multimodal affordances – represented as hashtags and visualizations – at the MODC level. Circle sizes represent the weight of each affordance in the multimodal framing of MODCs proportionately. We used RawGraphics for making the circle packing hierarchy.

A second observation about the type of visualization is that pictures of documents refer to knowledge and normative claims, for example, scientific publications, reports from official committees, photos of scientists-turned-entrepreneurs or the spokeswoman of AllianceVita (a key actor in the debate in French). In the English case, these documents refer to patents on CRISPR uses, books on genome editing, or logos of prestigious Academic institutions. In the Spanish debate, these documents are fact sheets and references from institutions promoting agrobiotechnology on both sides of the Atlantic. In French, these photos of documents refer to the National Ethics Advisory Committee and other bioethicists. Together, these photos of the people, documents, and institutions – along with the ideas and concepts associated with the images – obtain recognition by members of the coalition who reproduce them and give them visibility in the online public debate about CRISPR-Cas technology, which can help advance frames (Thompson, 2005) from MODCs. Moreover, photographs of experts and references to actors regarded as legitimate

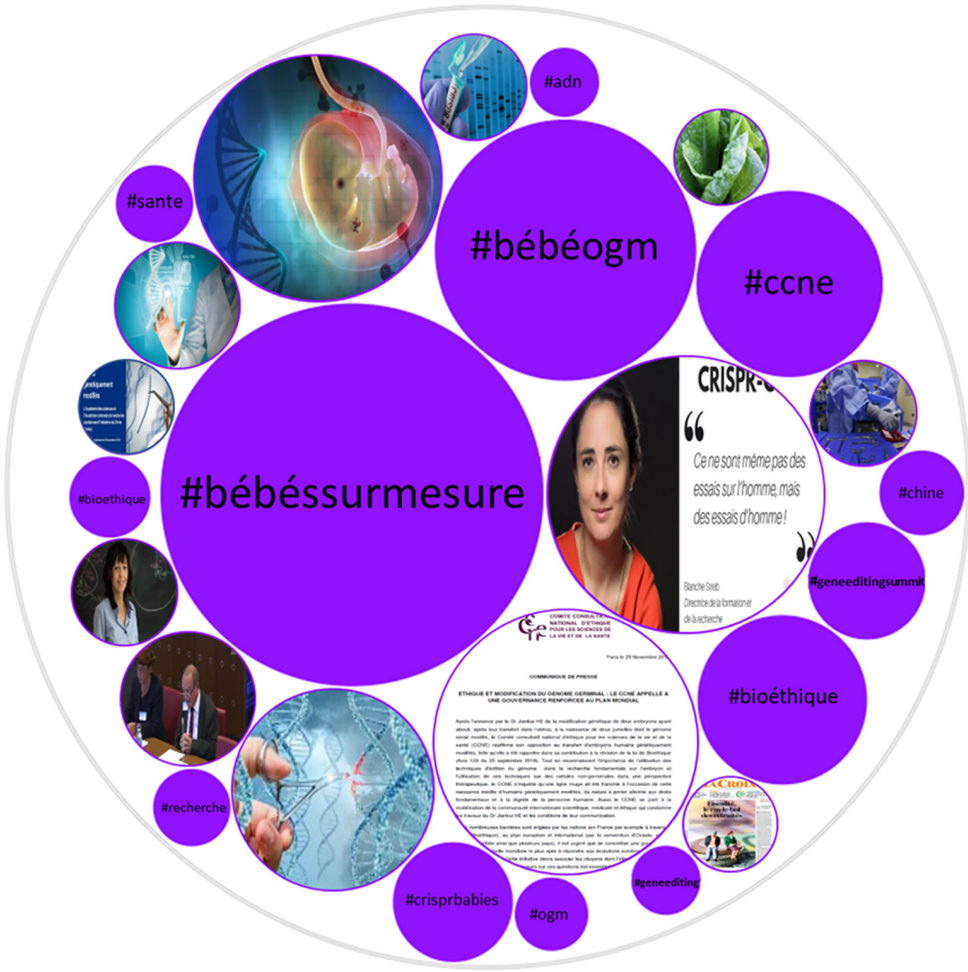

FIGURE 4 Circle packing of multimodal affordances used in the "*CRISPR-Cas as GMO*" MODC as part of the French online debate. The figure represents the use of multimodal affordances – represented as hashtags and visualizations – at the MODC level. Circle sizes represent the weight of each affordance in the multimodal framing of MODCs proportionately. We used RawGraphics for making the circle packing hierarchy.

sources of information then serve as primers for the type of persons and the type of knowledge that are in a position to discuss and inform decision-makers about CRISPR technology (Domke et al., 2002; Powell et al., 2015). The analysis of the use of these visualizations speaks more to the construction of discourses in which the visual and textual language used to multimodally frame CRISPR also helps to give political meaning to the way we should discuss and agree on who and how is in the position to inform public policy on CRISPR.

Our findings have implications for the different roles visualizations have in policy controversies.

First of all, visualizations code the values of groups of online actors (Stevens et al., 2016), and this coding within MODCs is intersubjective, contributing to struggles about the meanings of CRISPR-Cas in the controversy. For example, in the construction of the meaning of CRISPR in a technocratic discourse, the use of scissors in models to represent how CRISPR cleaves DNA reinforces the message of CRISPR as a precise technology, but in another MODC, it can adopt a meaning of unnatural manipulation of life, or scientific hubris. In the scissors example, the

visual is a sense-making device to understand what CRISPR-Cas is and how its molecular characteristics make the technology more precise. In the second example, it is a discursive object in the political meaning-making of CRISPR-Cas, where the scissors depict/negotiate what is acceptable or not about CRISPR-Cas applications. The scissors example is a finding that opens the door to explore more in-depth what mediates individual users to become part of an MODC by perceiving one political meaning over others. Visuals in themselves certainly frame information, but their interaction with text should not be understated. Our results point to the relevance of adopting and developing multimodal approaches to framing and discourse research in online public debates. However, a caveat of the multimodal approach is the difficulty to establish the influence of the visuals when combined with different texts during individual and collective meaning-making process in debates online (not to mention the wider context of a public debate or the particularities of individual's schemata). Although results like the scissors finding in the CRISPR debate, together with other empirical research (Boscarino, 2022; Clancy & Clancy, 2016; Doerr, 2017; Gommeh et al., 2021), suggest that the combination of both text and visuals are relevant for meaning-making processes, there is still an open question about what factors mediate the differences in perception of multimodal messages among – for example – Twitter users participating in the construction of meaning in an online debate.

A second point is that visuals may trigger emotional and affective responses (Boscarino, 2022; Rojas-Padilla et al., 2022). As we saw, in trying to convey a normative/ethical discourse, the use of embryos and babies works as a political visual framing (Rojas-Padilla et al., 2022). The emotive responses triggered by visuals of embryos and babies linked with textual frames defining what is politically acceptable from science in society are aimed at mobilizing people against CRISPR-Cas applications in humans (for social movements mobilization see Snow & Benford, 1988).

A third related point is that in combination with particular texts, visual framings may have the possibility to open-up debates in ethical discourses about CRISPR or close-down debates in technocratic discourses about CRISPR (Rojas-Padilla et al., 2022; Stirling, 2008). By making them more political – by opening up technocratic thinking, the necessity and desirability of the technology may be better scrutinized – which may contribute to responsible research and innovation efforts or to sustainable transformation agendas.

While our empirical study contributes to understanding the functioning of MODCs in the online policy controversy about CRISPR technology and their potential links to shaping public debates and decision-making processes, our study is a snapshot at the apex of the debate's evolution. A longitudinal MODC study of the French case in the CRISPR controversy can shed more light on questions of the evolution of the MODCs through time and what role visuals have in the emergence of an MODC during a policy controversy - If and how they opened up or closed down the ways of thinking and making meaning about CRISPR-Cas – and its regulation. Our results suggest that the French MODC and their use of visualizations was of influence on the EU decision-making process. However, more research is needed to verify the role of this online debate in the decision-making process.

Something to develop even further is the methodological ways to study online public debates and to "ground" these digital data in geographical contexts (Rogers, 2019). We have now limited ourselves to comparing the general regulatory decisions in three geographical regions to three online languages. Our methodology also allowed for identifying opinion leaders (Twitter accounts) in each MODC and geographically locating them. In this way, opinion leaders served as a reference to establish some offline links to provide a better interpretation of our data in a particular policy context, regardless of any potential black-boxed regional influences of the Twitter algorithm in the controversy's dynamics.

This should be further developed through other approaches like surveys, experimental settings, or interviews in order to contribute to a better understanding of the influence of online public debates through the formation of MODCs (and their visual and textual framings) on actual policy decisions.

CONCLUSIONS

We conducted an analysis of visual and textual framing by Multimodal Online Discourse Coalitions in English, Spanish and French on Twitter about CRISPR-Cas technology in the context of the 2018 positions by the USDA, CAS, and EU Court of Justice. Our study shows that two broader discourses emerged in the three languages. First, technocratic framings of CRISPR-Cas using visuals of molecular models of the system or referential simplifications of the textual framings, like a pair of scissors cutting a strand of DNA. Second, an ethical/normative discourse emerged in the French debate with visuals of embryos representing the textual framings of the ethics of CRISPR uses as GMO applications in humans, additionally, images of the spokeswoman of AllianceVita also presented this person in the role of expert in the ethical/normative discourse.

The role of visualization in MODCs varied by groups of actors, although visual framings in a technocratic discourse play mostly a sense-making role in constructing meanings about the technology, such meanings tended to close down the debate around scientific knowledge. On the other hand, the use of visualizations in the construction of the ethical discourse to make sense of CRISPR-Cas in France plays mostly a political framing role, appealing to the emotions of viewers by using emotionally triggering images of embryos and babies, as well as sense-making images referencing members of the coalition as experts. These visualizations, in combination with text, seemed to have opened up the online public debate toward including normative and ethical aspects of applications of the technology.

These conclusions reinforce the idea that policy scientists ought to pay a greater emphasis on studying public debates on specific policies and on what people do to influence such policy processes (Burstein, 2003, 2020). Our research suggests a relationship between online controversies, MODCs, and decision-making processes. However, more research is needed to clarify this relationship.

CONFLICT OF INTEREST STATEMENT

None of the authors have a conflict of interest to disclose.

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ENDNOTES

[1] The authors disclose accounts upon ethical considerations of the consequences for the persons involved. Institutional or non-personal accounts are openly disclosed.

[2] For example: MIT's magazine @techreview, journalists, science magazines, @Naturenews, @Nature, @Siceam @Newscientists, and biopharma & life sciences-related accounts. Other opinion leaders are @Wired, @StadNews, the market investment tracker @_b_i_o_t_e_c_h_ and other academics/entrepreneurs.

[3] Translated from Spanish by the authors.

[4] Media outlets are considered active members of discourse coalitions because of their diffusing role in debates about complex issues (Garnier et al., 2019) instead of neutral open spaces for structured democratic debates (Garnier et al., 2022).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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