Strategic Science Communication

The "Flatten the Curve" Metaphor in COVID-19 Public Risk Messaging

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Abstract

This chapter discusses the emergence of the "flatten the curve" metaphor in the context of COVID-19 science communication strategies and its role in public messaging efforts that sought to inform world populations and mitigate the effects of the pandemic. Faced with the unexpected arrival and spread of the new coronavirus, governments worldwide have responded with mitigation policies to contain the dissemination of the disease. Prevention behaviours, such as washing hands frequently and maintaining social distancing, were thoroughly communicated to the public. However, despite the quality of the communication campaigns implemented, it is always hard to change people's perceptions, attitudes, and behaviours, even more so in the short term, as is required in a global health crisis. In pandemics, the literature on risk and crisis communication suggests that messages sent by authorities should enable the understanding of complex information, avoid misinformation, and promote the adoption of adequate behaviours. This assertion presumes that, ideally, communication campaigns follow a set of strategic decisions on target audiences, communication objectives, key messages, adequate channels and message format. Although the emergence of the "flatten of the curve" metaphor did not follow a classical strategic approach, it seems to have incorporated a set of valuable communicational principles that explain why it has become the defining message of about COVID-19. This well-known chart grew into a science strategic communication device, conveying complex scientific information in an engaging but also clear way to the general public. It is, therefore, a good example to advogate for a strategic science communication approach.

Keywords

science communication, strategic communication, risk communication, crisis communication, flatten the curve, COVID-19

Introduction

The COVID-19 pandemic provides communication scholars with an excellent case study to observe the process of delivering scientific messaging to the general public. Following this lead, a research was conducted to examine the emergence of the "flatten the curve" metaphor as a strategic communication anchor to share the risk of viral spread, in order to discuss how the use of narratives — with a simplified language and visual elements

— can fit in science communication strategies, to promote the public understanding of science and enhance the wellbeing of communities.

Literature on risk/crisis communication has already shown that the use of metaphorical and visual narratives can be convenient to enable the understanding of complex information, encourage the public's adherence to appropriate behaviours and, combat misinformation (Bielenia-Grajewska, 2015; Lipkus & Hollands, 1999; Shanahan et al., 2019). To analyze the relevance of such uses, the chart entitled "flatten the curve", adopted by science, health and political agents from the beginning of the COVID-19 pandemic, was defined as an object of study.

In January 2020, the World Health Organisation (WHO) declared a public health emergency of international concern in response to the global spread of the SARS-CoV-2 virus and the emergence of the COVID-19 disease. Following, scientists and medical professionals worldwide start working diligently to identify the pathogen behind this outbreak, set in motion adequate measures to reduce its impact, and share research results with the global community. This was a remarkable effort to protect global health and wellbeing that has been admired in many ways (Calisher et al., 2020).

However, as the pandemic has developed, it became clear that the risks of misinformation were huge, considering how hard it was for the public to understand the topic and the multiplication of messages from unverified sources. The need to provide clear, honest and valid information to the public worldwide has become evident. In an editorial in February, *The Lancet* stated: "there may be no way to prevent a COVID-19 pandemic in this globalised time, but verified information is the most effective prevention against the disease of panic" (Finset et al., 2020, p. 873).

Scientists, health professionals, and political leaders had a special responsibility to provide us with accurate information and implement measures to stimulate behaviour change to fight the pandemic. Though, the scale of the crisis and governments' responses gave rise to an immense flow of information about COVID-19 in "televised press conferences provided by both political leaders and health authorities, prime time speeches to the people by kings, presidents, prime ministers and religious leaders, as well as news analyses, debates and social media posts" (Finset et al., 2020, p. 873). As these communication efforts became massive (and often inconsistent) information flows, citizens struggled to read and understand the new and dramatic environment they were enduring.

Most of this information was based on scientific data — that pointed out the causes of the pandemic, the consequences for public health, and the paths to mitigate the problem — which increased the communication challenges. In the face of a pandemic that has spread so far and fast, scientists across the globe realised they needed to be able to share their data as quickly as possible to keep pace. As a result, the urgency to spread the information about the COVID-19 lead to more intensive forms of science communication and to test new strategic resources, as the "flatten the curve" metaphor (Koerber, 2021).

That worldwide used expression was retrieved from scientific texts and generalised by scientific, health and political spokespeople and media to legitimise the introduction of social distancing measures in fighting COVID-19. This expression represents a complex combination of three components: the shape of the epidemic curve, social distancing measures, and the reproduction number R0. Presenting the control of the epidemic as "flattening the curve" was a way of flattening the comprehension of the pandemic's natural-social complexity (Boumans, 2020).

In an era where information spreads more widely and quickly than ever imagined, no one would think that the communication of scientific knowledge is separate from the production of that knowledge. The communication sciences abandoned this notion decades ago, mainly due to significant progress in science communication. Today, it is widely admitted that understanding communication is pivotal to understanding the COVID-19 pandemic and that effective science communication has to be part of the solution (Koerber, 2021). But in this context, science communication was challenged to make a strategic turn and become a "strategic science communication".

Strategic Science Communication

Since the 1980s, there have been systematic discussions about what "appears to be a gulf between science and society" (Bennett et al., 2019, p. 10). Moreover, research shows that modern scientists need more than good intentions to engage the public and make a difference in their communities. They need proper communication skills and professional help to design communication strategies. Scientists have access to remarkable knowledge, but engaging in fruitful conversations with the public, namely in risk environments, requires more accessible messages and strategic decisions.

The fundamental decisions for strategic communication are finding a target audience, defining communication objectives, determining the critical message, and choosing the tactics to reach the goals. This model is standard in corporate communication but not that evident in science communication. Science communication is a term frequently used "as a synonym for public awareness of science (PAS), public understanding of science (PUS), scientific culture (S.C.), or scientific literacy (S.L.)" and often these terms are used interchangeably (Burns et al., 2003, p. 183). So definitions able to provide more operational guidelines are scarce, and conceptual discussions prevail. The proposal presented by Burns et al. (2003) is an exception. They advocate that science communication includes all activities that promote a set of responses to science, grouped under the label AEIOU (the vowel analogy): "awareness of science; enjoyment or other affective responses to science; interest in science; the forming, reforming or confirming of science-related opinions (or attitudes); and understanding of science" (p. 190). However, the technical skills needed to produce these responses are frequently unclear in the literature and professional practice (Bennett et al., 2019). A significant paradigm shift is then necessary within the scientific community involving an approach to strategic communication thinking.

As supported by Torp (2015), "the strategic turn" (p. 34) is a new understanding of communication that advocates the need to master it strategically and in a targeted way, including a design and linguistic shift. This strategic turn has roots in Plato and Aristotle writings but asserted itself in the corporate world after the Second World War and following the experiments carried out with propaganda techniques. Since then, the strategic approach has been applied to many other communication sectors, such as public or governmental, non-governmental, health, financial or cultural. This perspective sees communication as a permanent strategic effort, following communication theories advocating that all communication is strategic in nature.

As so, a vibrant theoretical and professional field has emerged in recent decades, which sees strategic communication as the "purposeful use of communication by an organisation to fulfil its mission" (Hallahan et al., 2007, p. 3). In this approach, communication is primarily perceived as intentional, persuasive, influential, and carried out with a specific objective. As a consequence, strategy became a relevant descriptor of communication practices. As stated by Kristensen (2010), the concept:

> is not merely equal to a set of supporting communication tactics, but to strategically intended, planned and purposeful mechanisms aimed

> at changing the attitudes or actions of specific target groups and with a potential value and mandate in relation to the communicating organization as such and in relation to its surroundings. (p. 137)

As so Holtzhausen and Zerfass (2013) pointed out that "strategic communication is the practice of deliberate and purposive communication that a communication agent enacts in the public sphere on behalf of a communicative entity to reach set goals" (p. 74).

The strategic communication field then highlights the importance of identifiying strategies to improve communication performance. Strategic communication thus integrates communication strategies, which are two deeply interconnected but distinct concepts. However, the literature on the concept of communication strategy is scarce. It can be conceptualised as a functional approach that focuses and directs the communication function (Steyn, 2003). It is the critical piece bridging the situation analysis and the implementation of communication programs. Furthermore, it emerges as "the outcome of a strategic thinking process by senior communication practitioners and top managers taking strategic decisions with regard to the identification and management of, and communication with, strategic stakeholders" (Steyn, 2003, p. 168). In fact, the effectiveness of communication campaigns depends on numerous factors, determinants, and conditions, but one of the most relevant requirements to enable effective campaigns is the strategic development process (Rossmann, 2015). As so, it is something that could be worth being prioritised by science communicators.

The Public Understanding of Science in Risk Scenarios

Over the past decades, the perspective of science communication as one type of interaction controlled by a group of "scientific communicators", such as researchers, universities, laboratories, research centres or other public institutions, has given way to a renewed vision that understands scientific communication as a broader phenomenon and in which several actors are involved (Schäfer & Fähnrich, 2020). Gradually, the field recognised that the scientific process is no longer accessible only to small restricted groups — composed of scientists and their host or funding entities — and started to advocate the relevance of public participation (Schäfer et al., 2015). To this end, the acknowledgement that the results of scientific activity are crucial for dealing with individual and social challenges (such as a pandemic) has had a significant contribution, and this enhanced the value of

the "public understanding of science" — a construct endorsed by the Council of the Royal Society of London in 1985[1]: "but our most direct and urgent message must be to the scientists themselves: Learn to communicate with the public, be willing to do so and consider it your duty to do so" (Council of the Royal Society, 1985, p. 36).

Miller, writing in 1983, already advocated for the importance of developing scientific literacy that seems to be dependent on three conditions, namely: the understanding of words and basic scientific facts, the general understanding of the scientific process, and the recognition of political issues related to science. In this regard, Simis et al. (2016) remind us that science communication, as a discipline, assumes that ignorance or scarcity of knowledge is the basis for the lack of support and interest that society demonstrates to science and technology issues.

It is therefore not surprising that, particularly in the last two decades, science communication efforts have turned to non-specialised audiences, aiming to promote the involvement of the general public, which is affected by the results of scientific activity (Bucchi, 2013). This public participation is especially relevant when it comes to risk and health communication, two disciplines dependent on the information produced by science and whose success rests on quick and effective responses from the public (Lewenstein, 2003).

> We also said, as had Bernal and others before us, that "Understanding the nature of risk and uncertainty is an important part of the scientific understanding needed both for many public policy issues and for everyday decisions in our personal lives." There is no such thing as "absolute safety" or "zero risk". (Bodmer, 2010, p. S155)

As a field of study, risk communication emerged in the health field (Ruão et al., 2012) to describe all activities of production and exchange of messages related to the nature, meaning and control of risk situations (Reynolds & Seeger, 2005). In the specific case of a pandemic, such as that due to the worldwide spread of SARS-CoV-2, risk communication fundamentally seeks to educate citizens on the prevention policies the authorities should

[1] In 1985, the British Royal Society published a historical report advocating "the need for scientists to learn how to communicate with the general public in all its shapes, and to consider it a duty to do so" (Bodmer, 2010, p. S151). The basic thesis of the report was that a better public understanding of science could be a crucial element in promoting national prosperity, raising the quality of public and private decision-making, and enriching the lives of the individual. This report initiated a movement for scientific organisations to take engagement between scientists and the public seriously (Council of the Royal Society, 1985).

implement and on individual behaviours (such as respiratory hygiene, frequent washing of hands and surfaces, voluntary quarantine, social distancing, and contact with health authorities in case of symptoms) and organisational actions (as temporary closure or hygiene measures of facilities) that must be adopted to prevent the spread of the disease (Reynolds & Quinn, 2008; Vos & Buckner, 2016).

However, the COVID-19 pandemic created a widespread demand for information that went far beyond prevention and containment practices. Audiences looked for quick and effective responses on dissemination, spread, and vaccination (Kearns & Kearns, 2020), and this urgency has incited misinformation originated in false news and conspiracy theories (like the one that guaranteed that the coronavirus SARS-CoV-2 was a biological weapon created by China) that have been published since the beginning of the pandemic (Bavel et al., 2020). In this context, the public has had difficulty distinguishing scientific evidence from unconfirmed facts or reliable sources of information from false news (Bavel et al., 2020; Saitz & Schwitzer, 2020).

The new coronavirus has therefore created a very challenging moment for science communication, unprecedented in recent history, as it became urgent to find answers to complex questions about the virus, to announce discoveries to fellow scientists and healthcare professionals, and to report these findings to a confused and concerned global audience, seeking to ensure their participation through prevention and containment behaviours (Saitz & Schwitzer, 2020). In this new and complex environment, science and risk communicators were expected to coordinate their efforts to clarify scientific facts and transmit the right messages to inform and motivate appropriate behaviours, to update risk information, to create feelings of security and trust, and to dispel rumours (Vaughan & Tinker, 2009).

Then, the communication of science and risk, in the COVID-19 scenario, to be effective demanded the promotion of public participation, which was decisive to contain the spread of the disease. Therefore, the communication strategies implemented should maximise the public's ability to act as an effective partner in prevention, containment, and recovery (Vaughan & Tinker, 2009). That implied, however, that the communication strategies adopted recognise that individuals do not receive information passively and that they process messages according to social and psychological schemes that their previous experiences, personal circumstances, and cultural background have shaped (Bavel et al., 2020; Lewenstein, 2003).

Encouraging public participation in the scientific process and avoiding risky behaviour means designing communication strategies that answer some questions: Whom will we talk to? What is the context (economic, social, and cultural) of our public? Through which channels do we reach these audiences? What is the most appropriate message? And so forth. The quality of society's response to science always depends on the quality of communication itself. Furthermore, given the urgent need to contain adverse effects during the pandemic, the complete and transparent conveyance of research findings is even more critical than in ordinary times to promote trust and behaviour compliance (Saitz & Schwitzer, 2020).

Risk Communication During COVID-19 Pandemic

During the COVID-19 pandemic, risk communication became prominent (Amidon et al., 2021). When the WHO declared the COVID-19 as a world pandemic (in March 2020), two of its guides stood out: *Risk Communication and Community Engagement Readiness and Response to Coronavirus Disease (COVID-19)* (World Health Organisation [WHO], 2020d) and *Managing Epidemics: Key Facts About Major Deadly Diseases* (WHO, 2018). The last one, developed using lessons learned during past major public health events, emphasises that "risk communication and community engagement is integral to the success of responses to health emergencies (…). Failure to communicate will lead to a loss of trust and reputation, economic impacts, and - in the worst-case - loss of lives" (WHO, 2020d, p. 1).

According to risk communication literature, messages should be clear, consistent, and concise because their purpose is to persuade the public to adopt preventive behaviours in the face of a health issue (Shen et al., 2015). These messages can be delivered in the form of advertisements, brochures, pamphlets and others. In this regard, much has been studied and published on how to structure communication strategies in times of a pandemic and many recipes combine science communication with risk communication to promote behaviours in society. Bavel et al. (2020) listed a set of principles to consider when contacting the public, namely: using reliable sources of information and spokespersons; cooperating with the media to disseminate the messages; using messages in line with the recipients' moral values; appealing to individual and public benefits brought by preventive measures; or preparing society for misinformation, providing credible sources of information.

As explained before, in today's risk context, public involvement with science is crucial. The misinformation and adoption of behaviours that do not comply with the containment measures represent a real threat to human life since there is still no treatment for the disease, and group immunity is not guaranteed. Kearns and Kearns (2020) stated that mass cooperation is vital in a pandemic because it is up to people to implement urgent isolation and social distance measures. However, promoting these cooperation depends on the ability to communicate information effectively, harnessing the power of scientific data and digital technology. According to Miller and Jarvis (2020), the events of the past few months have shown that the right information provided in the right way can encourage people to change their behaviours and save many lives.

Narrative Science Messages

One of the science and risk communication strategies tested in other health crises (as is the case of H1N1 and H5N1, for example) is storytelling in scientific messaging (Delp & Jones, 1996; Houts et al., 2006; Kearns & Kearns, 2020). Storytelling refers to the process of developing a plot that gives rise to a narrative (Moezzi et al., 2017). According to Shen et al. (2015), a narrative "is an umbrella term for personal stories, exemplars, testimonials, and entertainment - educational contents" (p. 105). When used in scientific contexts, these narratives seem to facilitate the visualisation of data in the form of stories that simplify complex information, such as the one that needed to be communicated about COVID-19 (Kearns & Kearns, 2020). However, this reworking is not always easy for scientists when in risk communication. As stated by Shanahan et al. (2019), "scientists depend on the language of probability to relay information about hazards", but "risk communication may be more effective when embedding scientific information in narratives" (p. 1).

The power of narratives has been theorised mainly in social sciences and humanities as a mechanism to induce persuasion. Narratology (Herman, 2009) conceptualises narratives as having the power to transport individuals to an alternative world by developing a story whose structure includes several key elements: characters, plot, and setting. According to this literature, the narrative structure in storytelling is universal, and this provides the ability to use narratives across time and space for different issues.

It is possible to identify narrative mechanisms in risk communication that serve as anchors to produce persuasive effects. Scholars already identified

some of these mechanisms, such as language, metaphors, frames or compelling visualisations. They act as rhetorical communication devices that express the imagery or story to evoke an affective and effective response (Shanahan et al., 2019).

Regarding language, some studies on risk communication show that using narrative language is more effective than using strictly scientific language when seeking to change perceptions of risk and promote behavioural changes (Houts et al., 2006; Shanahan et al., 2019). However, science communication is full of rules and jargon. Jargon has positive effects and serves essential functions as well. By definition, it conveys information in the most precise and efficient way possible. Nevertheless, much research has revealed that using jargon can be alienating, undermine comprehension, reduce engagement, and create barriers to enter specific fields (e.g., science, technology, engineering, and mathematics). Even under normal circumstances, communicating with technical, idiosyncratic words is viewed negatively by non-expert audiences (Rakedzon et al., 2017; Shulman & Bullock, 2020).

During the current pandemic this issue has often come up for debate. A critical aspect of science communication efforts to draw public opinion's attention around coronavirus has been the careful use of language to promote understanding of the phenomenon without losing accuracy when presenting data. As a matter of fact, the popular strategy in science communication to avoid scientific language, or jargon, when communicating with the general public has been highly quoted. Research in science communication and beyond concluded that using jargon damages persuasive efforts and can have a disengaging effect on audiences. Moreover, when precision and timing are paramount, such as during a crisis, communicating most accurately can mitigate costly miscommunications. For these reasons, science communicators are encouraged to keep it simple (Bullock et al., 2019; Shulman & Bullock, 2020).

To assist in this simplification process, a common linguistic resource in narratives is the use of metaphors. Metaphors are figurative comparisons with different concepts, often strategically used as discursive instruments to construct particular views, ideas, and ways of seeing the world, thereby creating social reality (Cammaerts, 2012). According to Cornelissen et al. (2011), "metaphors – that is, verbally referring to other cases and domains of experience – can guide thinking and can create understanding and social acceptance" (p. 1706). Thereby, the authors argue that metaphorical

language can be a powerful inductor of strategic change. Comparisons with other cases and familiar experiences seem to reduce uncertainty and support acceptance and apply to several domains such as business, warfare, sports or arts. Metaphors are considered valuable in the context of change because they facilitate the construction of meaning by the person or group experiencing them; provide structure, allowing audiences to comprehend changing or unfamiliar situations; produce links to action by evoking attitudes; and legitimise decisions and actions (Cornelissen et al., 2011; Gioia et al., 1994; Weick, 1995). In sum, the power of the metaphor lies foremost in its subliminal character, in its ability to express complex issues in an easily digestible language and through what can stimulate strategic change by activating stakeholders' judgments that a particular change is desirable, proper or appropriate (Cammaerts, 2012).

Metaphors also have a visual expression. Visual metaphors are, actually, common resources in strategic communication (e.g., advertising), namely in the health field (Lazard et al., 2016). Research shows that using narratives with visual elements is beneficial for communicating complex situations in health (Delp & Jones, 1996; Houts et al., 2006; Kearns & Kearns, 2020). Furthermore, risk literature confirms that visual communication offers creative solutions to bridge health literacy gaps, empowers communities through evidence-based information, and facilitates public health advocacy during a pandemic. Visual aids and graphics are, in fact, a powerful medium with a long history in the broader field of education research, which suggests that the combination of words and simple images into a unified model enhances learning and information retention (Hamaguchi et al., 2020).

> During the current COVID-19 pandemic, visuals have emerged as a particularly powerful vehicle of information dissemination. Perhaps, the best-known example is the "#flattenthecurve" graphic, a widely circulated image showing the anticipated effects of social distancing efforts. However, there remains a need for simple illustrated resources that consolidate key public health messages and validated clinical evidence into compact visual aids—especially those that can be seamlessly disseminated through social media outlets to reach diverse patient communities (Hamaguchi et al., 2020, p. 483).

Nonetheless, the study of narratives in risk and science communication is recent, and the deconstruction of narratives in such studies has not yet been deepened. Scholars found out that narratives influence risk perceptions and reported decisions, but the mechanisms involved in narrative persuasion

are neither clearly identified nor understood. "Greater precision in examining narrative mechanisms is then necessary if we wish to more accurately understand the narrative effects of communicating scientific information" (Shanahan et al., 2019, p. 4).

On the other hand, even if research has argued that visual representations are inherently strategic, strategic communication research lacks a visual perspective. Visual studies and strategic communication seem not to intersect, given their independent growth in humanities and social sciences. However, as communication through strategic campaigning is an essential part of todays' communicative universe, scholars argue that one should pay more attention to the intersection of those disciplines. Strategic communication is about creating expressiveness through communication practice, so it is vital to examine visuality roles. Besides, it is known that strategic visual communication can generate more participation and empowerment of stakeholders. Therefore, a multimodal approach to this field could enrich the strategic communication profession and conceptualisation (Goransson & Fagerholm, 2018).

That being the case, this chapter seeks to contribute to a deeper comprehension of how narratives, with their linguistic and visual devices, can strategically stimulate the imagination and help create a sense of community, exploring the mechanism of information simplification. Moreover, the "flatten the curve" metaphor was identified as a concept to be studied (Oerther & Watson, 2020), as it is a narrative responsible for encouraging people worldwide to collaborate in curbing the spread of COVID-19. As so, let us now look at this example more closely.

The "Flatten the Curve" Metaphor

Using narratives as resources for increasing comprehension or conveying negative realities through positive images has been common in COVID-19 public messaging (Elías & Catalan-Matamoros, 2020). Metaphors, such as "war", "front-line workers", "Chinese flu", or the already aforementioned "flatten the curve" are some examples of narrative devices used (Craig, 2020; James, 2020).

Looking to perceive how the "flatten the curve" metaphorical narrative emerged, and how it went from pure scientific information (based on the epidemic curve graphic) to the defining public message about the new coronavirus, this study gathered data on the origins of the chart, the transformation

process it underwent until it became a prominent visual story, the main actors on this path, and its strategic format. The following section presents data gathered for the first two months of this public health emergency and discusses the results found in the context of a strategic science communication approach. Considering that the WHO director-general declared that the outbreak constituted a "public health emergency of international concern" on January 30 (WHO, 2020a), February and March 2020 were assumed to be key moments in the emergence of the pandemic, which ended up confirmed on March 11 (WHO, 2020c).

The Beginning of Flatten the Curve Story

In February 2020, the novel coronavirus, known as COVID-19, had spread from the People's Republic of China to 20 other countries, and the international community was mobilising to find ways to accelerate the development of a global strategy and preparedness plan to fight this unsettling outbreak (WHO, 2020a). Soon national and international authorities realised that the risks surrounding the epidemic communication to the general public were high and the WHO (2020b) recommended: "rapidly assess the general population's understanding of COVID-19, adjust national health promotion materials and activities accordingly, and engage clinical champions to communicate with the media" (p. 22).

Within this context, the use of visual communication was strongly endorsed by the most important international health organisation through the concept "make it visual", already presented in the WHO strategic communication framework of 2017 (WHO, 2017). As stated in the WHO's website (WHO, n.d.): "communicators increasingly share health information through visual means, such as YouTube videos, photographs, infographics, charts and illustrations. Visual messages make WHO information easier to understand and can reach people of all literacy and education levels" (para. 1).

Many visualisations then came up as communication anchors for COVID-19 public messages (as those developed by the Johns Hopkins github[2] or the tableau COVID-10 data hub[3]), but the "flatten the curve" chart was the most successful one. As Miller and Jarvis (2020) describe:

> the iconic "Flatten the Curve" graph, which encouraged people everywhere to help contain the spread of COVID-19, is a case in point.

[2] https://github.com/CSSEGISandData/COVID-19

[3] https://www.tableau.com/covid-19-coronavirus-data-resources

> It shows how measures such as hand-washing and social distancing can squash the expected peak of the pandemic, and keep infection numbers low enough for healthcare systems to manage. This simple public health chart, which originated in specialist journals and reports, was widely shared by traditional newspapers and magazines, then refined to clarify the message even further, translated into many languages, and creatively reworked into animations, cartoons and even cat videos. (p. 2)

This first figure of an epidemic curve came from new developments in epidemiology at the beginning of the 20th century, namely from advances in mathematical compartmental models. As stated by Boumans (2020), "the curve of an epidemic was presented for the first time (…) in an article 'A contribution to the mathematical theory of epidemics,' published in 1927 and written by William Ogilvy Kermack and Anderson Gray McKendrick" (p. 2). According to the authors, Ronald Ross inspired this work. He applied mathematical reasoning to infectious disease dynamics, looking to understand malaria transmission and control. The authors refer that Ross was the first to develop a general theory of epidemic phenomena (the theory of happenings) of infectious disease dynamics. He did not tailor his theory to explain the expansion of a particular pathogen or public health problem, but he used prior assumptions on the spread of infections (Boumans, 2020).

Since then, the mathematics of epidemiology developed to search for ways to understand and represent the transmission of infectious diseases, anticipating future outbreaks. However, it took the SARS epidemic of 2002 – 2003 and the concern of a possible H5N1 influenza epidemic in 2005 to draw the attention of scientists to the urgency of deepening the understanding of how an infectious disease epidemic could be controllable, even when effective vaccines or treatments were not available, given the growing probability of its occurrence. Their equation also discussed social factors that make containment feasible, namely political decisions and citizens' behaviour (Fraser et al., 2004).

By the early years of the 21st century, scientists and policymakers' concerns were high with the fear that the world may soon face a pandemic in which neither vaccines nor sufficient antivirals would be available to protect the public. Epidemiologists' evaluations suggested that efforts should be concentrated in surveillance and case reporting, rapid viral diagnosis, hand hygiene, and respiratory etiquette in reducing virus transmission in the event

of a pandemic. Evidence also suggested contact tracing, voluntary sheltering, and quarantine (Boumans, 2020).

Following the SARS-CoV-2 pandemic in 2020, all evidence was summoned up and transmitted to the populations, but the difficulties were obvious. How could we convince the world population to restrict their movements, despite the severe economic and social consequences that would result? How could we change deeply rooted social and cultural habits? How could we easily transmit highly complex information? At this moment, the epidemic curve is recovered, redesigned and becomes a critical component of the communication of scientists, health professionals, journalists, and authorities. The new epidemic graph emerged accompanied by a narrative, summed up in the expression "flattening the curve", as a strategic element in simplifying information to build an effective global public health response to the crisis.

Actually, the "flatten the curve" chart of the COVID-19 pandemic had three different origins — institutional, journalistic, and academic — and soon became a hallmark of science communication about the new coronavirus. As Makulec described in March 2020, we all wanted to help, but we didn't know how:

> the stakes are high around how we communicate about this epidemic to the wider public. Visualisations are powerful for communicating information but can also mislead, misinform, and — in the worst cases — incite panic. We are in the middle of complete information overload, with hourly case updates and endless streams of information. We want to help flatten the curve to minimise strain on our health system. (Makulec, 2020, para. 2)

According to Amidon et al. (2021), Giannella and Velho (2020) or Boumans (2020), the Centers for Disease Control and Prevention (CDC) of the United States first depicted a "flatten the curve" visual as we know in 2007 (Figure 1), to compare two generalised outcomes for a pandemic: an unmitigated outbreak with a high peak number of cases and a managed event in which cases disperse over time. After being updated in 2017, the "flatten the curve" chart was retrieved from CDC literature, in 2020, by scientists, journalists, and bloggers as a new anchoring metaphor for the need to implement social measures to control the pandemic, with encouraging minimalist visual properties, communicating relationality and mapping real-world cases.

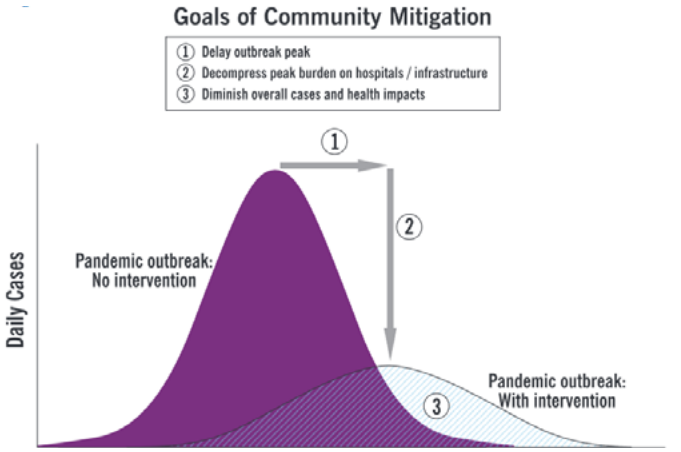


Figure 1 First illustration of the "flatten the curve" visual by Centers for Disease Control and Prevention. *Source*. From *Interim Pre-Pandemic Planning Guidance: Community Strategy for Pandemic Influenza Mitigation in the United States* (p. 18), by Centers for Disease Control and Prevention (U.S.), 2007.

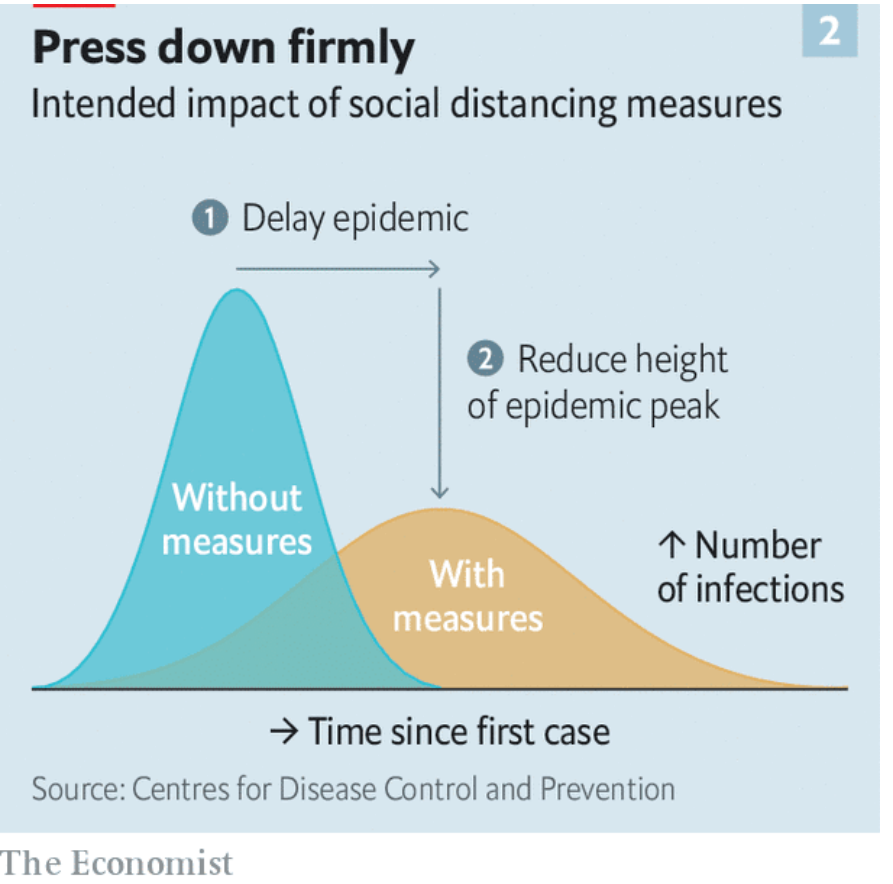
> On page 18, a graphic appears called Goals of Community Mitigation. No one I've talked to at the CDC can remember who made it, but the image is the root of Flatten the Curve as it appears today. Rendered in purple, it presents those two familiar curves with three numbered goals: 1. Delay outbreak peak 2. Decompress peak burden on hospitals/infrastructure 3. Diminish overall cases and health impacts. These curves don't appear to be rooted in hard, literal data. Rather, they are illustrative of the exponential spread of pandemics and how we might impact their speed of growth. (Wilson, 2020, para. 9)

However, as suggested by Boumans (2020), it was after the publication of the article "Flattening the Curve" in *The Economist* in February 2020 ("COVID-19 Is Now in 50 Countries, and Things Will Get Worse", 2020) that "flatten the curve" visibility has exploded. The article had a "viral effect", and political leaders worldwide started using this expression to legitimise the introduction of social distancing measures in fighting COVID-19. The article reported:

> the course of an epidemic is shaped by a variable called the reproductive rate, or *R*. It represents, in effect, the number of further cases each new case will give rise to. If *R* is high, the number of newly infected people climbs quickly to a peak before, for want of new

> people to infect, starting to fall back again (see chart 2). If *R* is low the curve rises and falls more slowly, never reaching the same heights. With sars-cov-2 now spread around the world, the aim of public-health policy, whether at the city, national or global scale, is to flatten the curve, spreading the infections out over time. ("COVID-19 Is Now in 50 Countries, and Things Will Get Worse", 2020, para. 9)

Rosamund Pearce, a data visualisation journalist at *The Economist*, was responsible for updating the CDC graphic "Goals of Community Mitigation" (presented above and assigned to Qualls et al., 2017) to illustrate the text (Figure 2).



"With sars-cov-2 now spread around the world, the aim of public-health (...) is to flatten the curve".

"Covid-19 Is Now in 50 Countries, and Things Will Get Worse", 2020

Figure 2 "Flatten the curve" illustration in *The Economist*, February 29 2020.
Source. From "Covid-19 Is Now in 50 Countries, and Things Will Get Worse", 2020, *The Economist*. Copyright 2020 by *The Economist*. Reprinted with permission.

She changed the labelling scheme to assist colourblind readers but kept the graphic as close as she could to the original in terms of shape, "because as a journalist, she didn't want to editorialise the work of scientists" (Wilson, 2020, para. 11).

> I thought it was a beautifully clear and simple illustration of an important concept, but I had no idea that it would end up causing such a stir on Twitter and elsewhere," says Rosamund Pearce, a data visualisation journalist at The Economist. Pearce first heard about the graphic from her colleague Slavea Chankova, and she decided to rebuild it for a piece the pair was working on about COVID-19 for *The Economist*. (Wilson, 2020, para. 10)

It was also in February that the author of the CDC representation was known. Drew Harris, an assistant professor at the Thomas Jefferson University College of Population Health and a CDC consultant, came across the graphic in *The Economist* and immediately felt it was a familiar image. He had designed a similar representation years ago for a pandemic preparedness training program. During the training course, Harris struggled to explain the concept of reducing the epidemic curve, so he added a dotted line

Harris' chart explained why slowing the spread of the infection was as important as stopping it.
Ruão & Silva

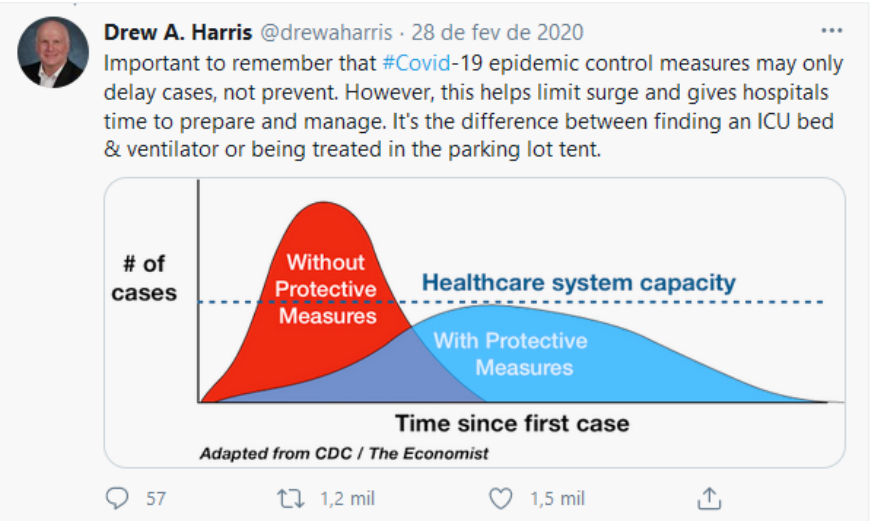


Figure 3 Harris first tweet about his "flatten the curve" chart.
Source. From *Important to remember that #Covid-19 epidemic control measures may only delay cases, not prevent,* by D. A. Harris [@drewaharris], 2020, Twitter.

indicating hospital capacity: "to make clear what was at stake", he stated later (Roberts, 2020, para. 4). After reading *The Economist*, he recreated his graphic and posted it on Twitter and LinkedIn, and the reactions were enthusiastic (Figure 3). Since then, he often referenced the original CDC pandemic graphic, which he had remade more simply (Barclay & Scott, 2020; Callaghan, 2020; Wilson, 2020).

In sum, *The Economist* article gave a new life into the CDC graphic, and Harris added an anchor, a single line that articulated its significance. However, Siouxsie Wiles, a New Zealander microbiologist, went further by proving that it was possible to reach the entire population through an even more simplified chart, demonstrating that individuals could make a meaningful difference in slowing the spread of COVID-19 (Barclay & Scott, 2020; Makulec, 2020; Wilson, 2020). In fact, in the academic field, Wiles is referred to as the first to use the chart outside scientific papers or books in a text published at the online magazine *The SpinOff* that described Wuhan's outbreak in March 2020 (Wiles, 2020a). Wiles (2020a) uses the "flatten the curve" graphic as a reference to a paper by Anderson et al. (2020), published in *The Lancet*, about the importance of keeping contamination as low as possible as the highest priority for individuals to avoid hospital crash (Figure 4). The graphic was then worked on visually by the illustrator Toby Morris that looked to simplify the representation of Anderson et al. (2020), giving the "flatten the curve" chart a new and more engaging shape ("COVID-19: Comunicação de Ciência", 2020).

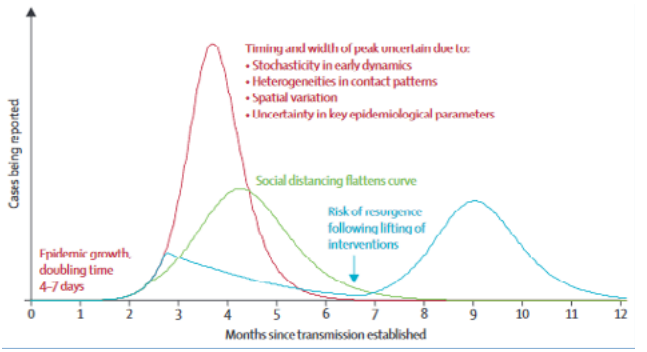
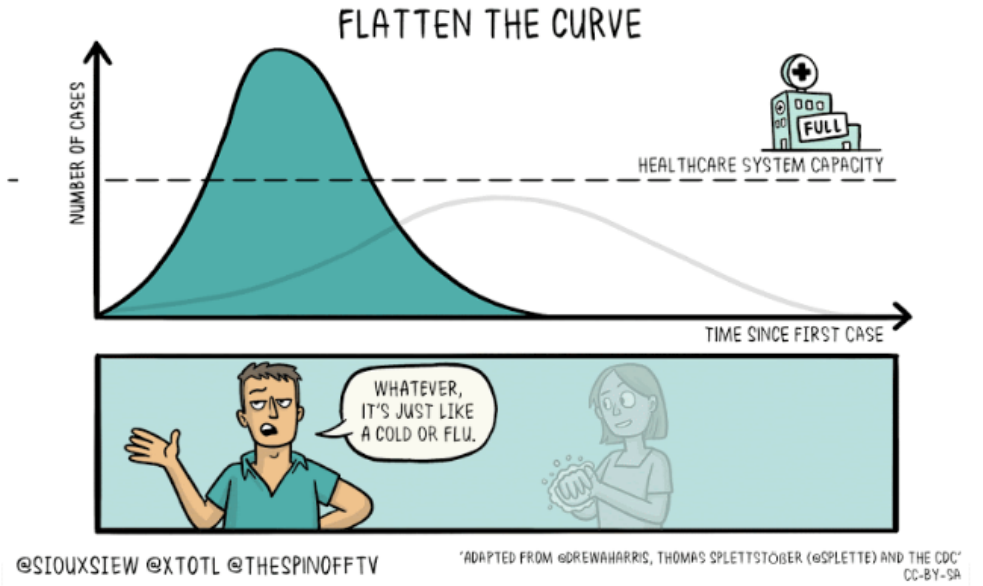


Figure 4 Illustrative simulations of a transmission model of COVID-19.
Source. From "How Will Country-Based Mitigation Measures Influence the Course of the Covid-19 Epidemic?", by R. Anderson et al., 2020, *The Lancet, 395*, p. 933 (https://doi.org/10.1016/S0140-6736(20)30567-5). Copyright 2020 by Elsevier Ltd.



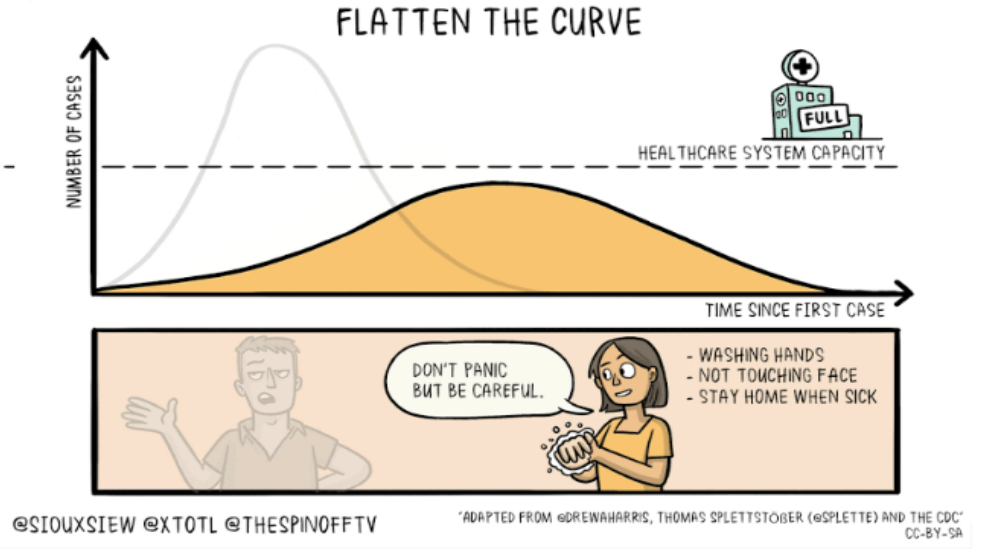
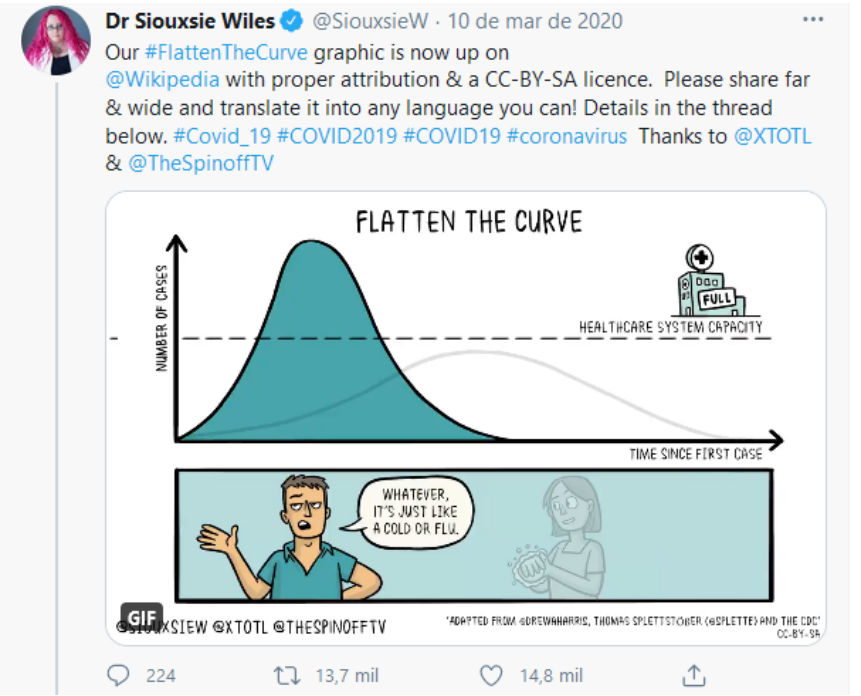


Figure 5 "Flatten the curve" by Wiles and Morris.
Source. From "The Three Phases of Covid-19 – and How We Can Make It Manageable", by S. Wiles, 2020a, *The Spinoff.* CC-BY-SA.

Figure 6 "Flatten the curve" by Wiles and Morris.
Source. From "The Three Phases of Covid-19 – and How We Can Make It Manageable", by S. Wiles, 2020a, *The Spinoff.* CC-BY-SA.

Morris applied his cartoon style to the illustration of hard math (Figure 5 and Figure 6), capturing the COVID-19 epidemic conceptualisation and giving it a shape that makes it more appealing and easier to understand. He represented two possible futures, subject to individual behaviour — to ignore the risks or take precautions — that polarised the nature of COVID-19 across social media.

After Wiles decided to share the chart on Twitter (Figure 7), the image went viral. "Flatten the curve" became a gif, a meme, and a hashtag, widely shared on websites and social media (Barclay & Scott, 2020; Wilson, 2020). It was an appealingly packaged message, easy to share, quick to understand, and giving people a sense of ownership of the situation: if we take basic precautions, like washing our hands, we can help slow the growth rate so that it doesn't overwhelm our health services. That was a very powerful and important message to send (Callaghan, 2020).



Siouxsie and Toby produced a set of graphics to help the general public understand science.
Rudo & Silva

Figure 7 Wiles first tweeter about the "flatten the curve" chart.
Source. From *Our #FlattenTheCurve graphic is now up on*, by S. Wiles [@SiouxsieW], 2020b, Twitter.

> Since first being shared on March 8, the gif has made 4.5 million impressions on Twitter and been shared across broadcast media. And after being translated into Czech, Italian, Spanish, and Welsh by volunteers, a coder developed an automated system to translate the comic into any language. (Wilson, 2020, para. 5)

Besides social networks, traditional media were also important replicators of the "flatten the curve" chart. After its first publication in the mass media, throught *The Economist* pages, it has been adapted countless times, within and outside the journalistic context worldwide. *Vox* (Barclay & Scott, 2020), *The New York Times* (Roberts, 2020), in the USA, and, in Portugal, *Público* (Freitas, 2020; Figure 8) and *Expresso* (Albuquerque & Santos, 2020) are some of the media that (in March) adjusted the graph to show non-expert audiences what was really at stake between one curve and another: the capacity of health systems (the availability of professionals, number of hospital beds, respirators, among others) to provide service to those in need.

"Very quickly the graphics began to be used by businesses, schools, universities and public organisations".

International News Media Association, 2021

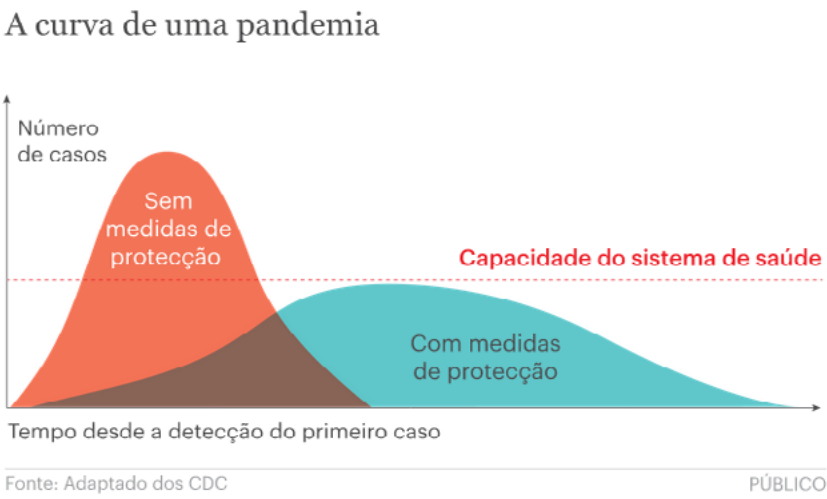


Figure 8 The "flatten the curve" chart translated to Portuguese by the newspaper *Público*
Source. "'Achatar a Curva' Pode Salvar Vidas", by A. Freitas, 2020, *Público*. Copyright 2020 by *Público*. Reprinted with permission.

At the same time as it was widely used on television and social networks, the metaphor was also incorporated in local, national, and global authorities's speeches. Here are some examples:

> "what we need to do is flatten that down," said Dr Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases, during the coronavirus task force briefing at the White House on a Tuesday evening in early March. "You do that with trying to interfere with the natural flow of the outbreak". (Roberts, 2020, para. 3)

> Chancellor Angela Merkel says Germany has made significant progress in fighting the coronavirus, but the situation remains fragile, and "caution should be the order of the day." She said, "the curve is flatter," meaning infection rates are down but added that models show those rates could easily go either way. The chancellor said if the right protections are in place, that will allow some restrictions to be eased. (*Merkel Says Germany's 'Curve Is Flatter' But Remains Cautious*, 2020, para. 1)

> Prime Minister Jacinda Ardern revealed in an interview (...), "I remember my chief science adviser bringing me a graph that showed me what flattening the curve would look like for New Zealand. And where our hospital and health capacity was. And the curve wasn't sitting under that line. So we knew that flattening the curve wasn't sufficient for us. ("Jacinda Ardern Says Flattening the Curve Was 'Not Sufficient' for New Zealand", 2020, para. 12)

> Instead, the WHO has repeatedly emphasised the importance of "flattening the curve" in order to tackle the pandemic. The idea of flattening the curve is to stagger the number of new cases over a longer period so that people have better access to medical care. (Meredith, 2020)

As stated by Panetta (2020), "up until a few months ago, the words flatten the curve didn't mean anything to people outside of the medical field. Now, it's an oft-repeated social media rallying cry to encourage people to practice social distancing and stay home" (para. 2). The "flatten the curve" chart, as a simplified visual representation of the COVID-19 transmission model, proposed a metaphor that showed to non-specialists how individual behaviour could influence dangerous "peaks" — representing high contamination and mortality rates —, or advisable "plateaus" — representing more manageable public health situations. Moreover, the rhetorical malleability

of this metaphor has enabled public and health authorities to communicate both empirical and conceptual representations of risk and scientific data, which has been immensely important in the different phases of the pandemic (Amidon et al., 2021).

This well-known visualisation allowed the development of a compelling narrative about the COVID-19 pandemic, built on storytelling that appealed to visual metaphors functions: generative heuristics, clarify complexity, and provide frameworks for future actions (Giles, 2008). The plot created by authorities all over the world was: it is not known, for sure, the number of cases of COVID-19 that can overload health systems, but science has proven that the position of the line tangent to the curve flattened visually determines the only scenario that can tackle the epidemic without significant risks to the population — the containment measures through social distance (Giannella & Velho, 2020).

Discussing the "Flatten the Curve" Metaphor

After the cases of COVID-19 exploded, showing that it was no longer possible to contain the spread of the disease, governments of many countries launched mitigation strategies, trying to slow the spread of the epidemic. Keeping contamination as low as possible and avoiding hospitalisations became the highest priorities for governments. However, authorities soon realise that they would not be able to minimise deaths if the health systems were not protected.

The need to contain the rapid spread of COVID-19 and proceed with community mitigation measures was then exhaustively communicated to the public. In order to enhance the public comprehension of infectious diseases' transmission models, the "flatten the curve" metaphor was widely used, communicating an important message: the greater the reduction in transmission, the longer and flatter the epidemic curve would be, and this would reduce hospitalisations and mortality. As shown in our data, the "flatten the curve" metaphor enabled scientists, health professionals, and politics to show the consequences of unmitigated spread and appeal to community action.

Epidemiologists and public health agencies create complex models to understand how diseases may progress, but when communicating this information to the general public, it is indispensable to think strategically, especially in the context of risk communication. To be effective, the strategic communication model supports that communication must consider a series

of strategic decisions that include identifying target publics and communication objectives, finding the right key messages to be sent through the appropriate channels/means, and developing the message format according to the selected publics, channels, and goals. After all these decisions have been made, the communication program will be ready to be implemented. Likewise, the "flatten the curve" example seems to have fulfilled all these requirements, as explained below.

The Strategic Communication Model in the "Flatten the Curve" Metaphor

Publics — With Whom Do We Intend to Communicate?

The "flatten the curve" chart dissemination followed scientific evidence on the usefulness of keeping populations informed during epidemic outbreaks. These populations were targeted in different countries and regions, according to their community groups, using geographic, cultural and administrative criteria. That explains why the chart was recreated and translated into different languages.

Objectives — What Are the Purposes of Communication?

The "flatten the curve" chart has been used for risk messaging purposes: to inform about the risks of a rapid viral spread and to show the need for community involvement in mitigation measures.

Key-Messages — What Should Be Communicated?

When used in popular texts, the "flatten the curve" chart communicates that COVID-19 is not a death sentence if the populations adopt appropriate behaviours. It communicates the seriousness of the situation, but also the possibility of control.

Channels — By What Means Should We Share the Message?

Scientists and authorities soon realised that it was necessary to use widespread media such as traditional mass media and social networks, which would have television and the internet as the most relevant platforms in the face of a pandemic. The "flatten the curve" chart was widely disseminated by these channels, as shown in this study.

Format and Concept in Use — How Should the Message Be Built to Be Effective?

The Visual Narrative

The first level of risk communication is to draw the public's attention without promoting panic. The complex language of science makes this challenging. The "flatten the curve" chart redesign followed scientific evidence on the usefulness of simplifying complex data through visual narratives when communicating to non-expert audiences. The use of illustrated data to transmit health information seems to increase message recall and favours adopting the communicated measures.

The Metaphor Attached

Building a narrative based on a metaphor of universal understanding is also an important mechanism to message recall and facilitates connecting ideas with similar previous experiences regarding large audiences. The "flatten the curve" sentence became a short and incisive message — the curve must be flattened to reduce mortality rates — with an associated strategic concept — we must all contribute to this effort.

The Emotional Link

The "flatten the curve" metaphor was also able to provoke an emotional stimulus. Research shows that images and storytelling tend to stimulate people's emotional sides. This visual narrative was able to identify, frame, and point to appropriate behaviours, creating a sense of action. By telling the story, data and analytics leaders sought to take audiences to action.

The Simplification Process

The story of the "flatten the curve" chart design is the story of a simplification process to facilitate understanding a phenomenon: the functioning of an epidemic curve combined with mitigation measures. Then, the graphic message was condensed into a visual narrative, synthesising the most relevant ideas, increasing understanding, and creating acceptance of pandemic conditions.

The Relevance of the Content

The "flatten the curve" chart is an engaging narrative but supported in very accurate information. Scientific visualisations must not lose accuracy in the

simplification process. Incorporating numbers into a mass visual narrative during an epidemic can be problematic, as they account for the diseases' conditions, human behaviour, and environmental factors, and these numbers can change rapidly. The use of well-known models (as those from the WHO, CDC, and other public health experts) is advisable (as they go through peer-review verification processes), such as replacing the numbers with colour nuances.

The Impact of the Narrative

Visualisations have the potential to incite panic just as much as they have the potential to inform, so it takes a lot of care and message testing to avoid adverse effects. The "flatten the curve" message was one of social responsibility regarding citizens' and organisational behaviours, more than a scientific data message. The expected impact was to produce attention, generate interest, create a desire to help and enhance action.

The Communication Risks

Visual narratives utility also comes at the cost of simplification. The "flatten the curve" narrative reduces various forms and degrees of intervention to a single best-case scenario, disregarding the increased risk of resurgence and collapsing local subpopulation dynamics into a single broad curve. The "flatten the curve" graphic can also cause global-local tensions by presenting a unique and standardised solution. It can also promote the stigmatising of people from countries and regions with many cases by endorsing that they were not socially responsible. Furthermore, visualisations can also incite fear and alarm if not anchored in a positive verbal or written narrative.

Therefore, using visual narratives requires considering all the risks associated with them and searching for the best solutions to reach target groups and achieve communication purposes. However, the "flatten the curve" case also shows that using the strategic communication model in risk scenarios can favour science communication activities, with countless benefits for the community.

Conclusions

The "flatten the curve" metaphor was created almost accidentally (as it did not come from a structured strategic communication thinking process), but it became the defining graphic of the first months of the COVID-19 pandemic. The idea is simple: taking steps, like washing hands or staying

home, can slow down new cases of illness so that the finite resources of our healthcare system can handle a more steady flow of sick patients rather than a sudden deluge. This metaphor has become a synthesis of a strategic message, rooted in the scientific understanding of epidemics and disseminated by politics and health agents.

The challenge of communicating scientific data about COVID-19 was enormous. No matter how well a communication campaign is developed and implemented, it will always be difficult to change perceptions, attitudes, and behaviours in the population, not only in the science or health domains but also in other areas of strategic communication (as corporate communication or advertising). People are surrounded by many influences and messages in their everyday life. Behaviours are not easy to change due to ingrained habits and fear of the new. Moreover, campaigns convey several messages simultaneously, often accompanied by a series of unintended effects. As such, scientific messages forwarded to to society need to be well prepared and adequately disseminated to target publics, to increase performance and avoid unintended effects. Science communication and the quest for the *public understanding of science* can be more effective by embracing a strategic dimension.

At the same time, science also needs to open up to a holistic view besides the science, technology, engineering, and mathematics model. Arts, humanities and social sciences can serve as a bridge to connect the individual and the society with science purposes, methods, and discoveries. They offer a creative medium to the unconventional integration of seemingly disparate factors of advanced research and daily life. They implement several tools to reimagine critical issues and engage in the responsible stewardship of graphic data within a modern social media landscape that is increasingly uncensored, rapid, and visual.

Therefore, the “flatten the curve” metaphor is an excellent example of a strategic communication device used by hard scientists, politics, journalists, bloggers, social media influencers, and cartoonists to increase public comprehension and confidence in science. It also represents an interdisciplinary work that literature evokes for science and strategic communication. The result was a valuable and creative message sent to a worldwide audience and an impeccable case to advocate for a strategic science communication approach.

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