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Visual communication in the management of a global health emergency

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Abstract

As the Covid-19 pandemic took hold, governments and the media suddenly found themselves facing the difficult task of communicating details of the evolving health emergency to the public and of making technical concepts and massive volumes of data intelligible to the world's citizens. The challenge was to find a way of making this new, unfamiliar content accessible to all, by exploiting known, easily grasped formulas. Against this backdrop, it was quite clear what the strategy had to be for optimising the efficiency of this communication process: the transmission of this vital information by means of data visualisation. In this study, I analyse the problems associated with the data employed in these visualisations and critically review both good and bad practices that emerged to underpin these communication strategies.

Keywords

Information visualisation, coronavirus, pandemic, Covid-19, SARS-CoV-2, data visualisation, interactive visualisation, infographics, multimedia visualisation.

Título

Comunicación visual en la gestión de una emergencia sanitaria global

Resumen

Frente a la pandemia generada por el coronavirus, los gobiernos y los medios se encontraron de repente con el difícil reto de comunicar sobre este tema con la población y trasladar al gran público conceptos técnicos y grandes volúmenes de datos. Había que buscar una manera de hacer accesibles esos contenidos no familiares para todos, a través de fórmulas conocidas y asimilables. En ese contexto, la estrategia elegida para hacer más eficiente esa comunicación estaba clara: transmitir toda esa información vital a través de la representación visual de datos. En este trabajo analizamos los problemas asociados con los datos involucrados en esas visualizaciones y revisamos una selección de buenas y malas prácticas utilizadas en esas estrategias comunicativas.

Palabras clave

Visualización de la información, coronavirus, pandemia, COVID-19, SARS-CoV-2, visualización de datos, visualización interactiva, infografía, visualizaciones multimedia.

Note

This work is the result of reviewing, updating and editing a previous work (Pérez-Montoro, 2021).

1. Introduction

We woke at the start of 2020 to learn of the unsettling news that the Chinese were to build a hospital in just a week to care for those suffering a strange respiratory disease. Following the inevitable flood of memes in which this meteoric feat of construction was contrasted with that of the slowest ever (140 years and counting) of the Sagrada Familia temple in Barcelona, we were soon able to verify how an entire city (Wuhan) of more than 11 million inhabitants had been locked down in their homes, in almost military fashion, to stem the spread of this disease. The situation was obviously no longer a laughing matter.

We all know how the story was to pan out and, as I write, we continue to suffer its consequences: fear, uncertainty and, in the worst cases, grief at the loss of loved ones. Our social habits were revolutionised as the clouds of a major economic crisis formed over our heads and threaten to remain there for some time to come.

In the midst of this bleak, heart-breaking panorama – as if we had suddenly found ourselves characters in a dystopian science fiction novel – we began to employ a *neo-language* made up of foreign-sounding words hitherto unheard: *coronavirus, PCR, antigen test, IgG-IgM, lock-down, infection rate, de-escalation, cumulative incidence, hydroxychloroquine, FFP2, Covid-19, mortality rate*, and *SARS-CoV-2*, to mention just a few. A profusion of new concepts, guidelines, and directives, all extremely difficult for the lay population to digest.

2. Flattening the curve: information visualisation as a communication strategy

Against the backdrop of this global health emergency, the world's governments suddenly found themselves facing the exacting task of informing the public about this rapidly evolving situation. To stem the pandemic, they would have to find a way of making these technical concepts and massive volumes of associated data intelligible to their citizens. The challenge was to find a way of making this new, unfamiliar content accessible to all, by exploiting known, easily grasped formulas. It was quite clear what the strategy had to be for optimising the efficiency of this communication process: the transmission of this *vital* information by means of data visualisation.[1]

Such was the commitment to data visualisation that the principal motto underpinning the actions to be taken was "Let's flatten the curve!". Never before had a line plot been placed at

1 A number of authors have reviewed the attempts made in response to this challenge centred on the exploitation of data visualisation. In one such initiative, led by Paul Kahn (2021), some of these proposals have been classified according to their source type, country of origin, language used, the publisher, subject, technique, and date of production.

the epicentre of a communications campaign. The strategy underlying the motto was clear: the urgent need to reduce the number of Covid-19 infections so that the sick did not swamp the world's health systems. Without a vaccine, the goal was to ensure the system did not collapse, leaving the sick untreated and, so, avoid a heavy death toll.

One of the first news media outlets to disseminate this slogan was *The New York Times*. In an article entitled "Flattening the Coronavirus Curve", published at the end of March 2020, the editor headed the day's top story with a graph made up of two epi curves (Figure 1). One of the curves predicted the high number of Covid-19 cases that would be seen if no protective measures were taken, the other the number of cases with the protective measures in place. Cutting across the chart was a line of dashes indicating the capacity of the healthcare system, the maximum number of cases that hospitals could treat. The first curve rose up and clearly peaked at a point well above this dashed line, highlighting the massive number of citizens that would be denied care in a scenario without any protective measures. The message was clear: we would have to flatten the curve of Covid-19 cases by implementing the necessary measures if we wanted to avoid these terrible consequences.

Many other news media companies were to adopt this same strategy and a countless number of information visualisations were published that included some version or other of this graph. Arguably, however, one of the most effective did not appear in the news media but rather on a social networking service. The Japanese digital artist, Kenta, in a tweet posted on 3 April 2020, uploaded a video with a three-dimensional animated recreation of this same

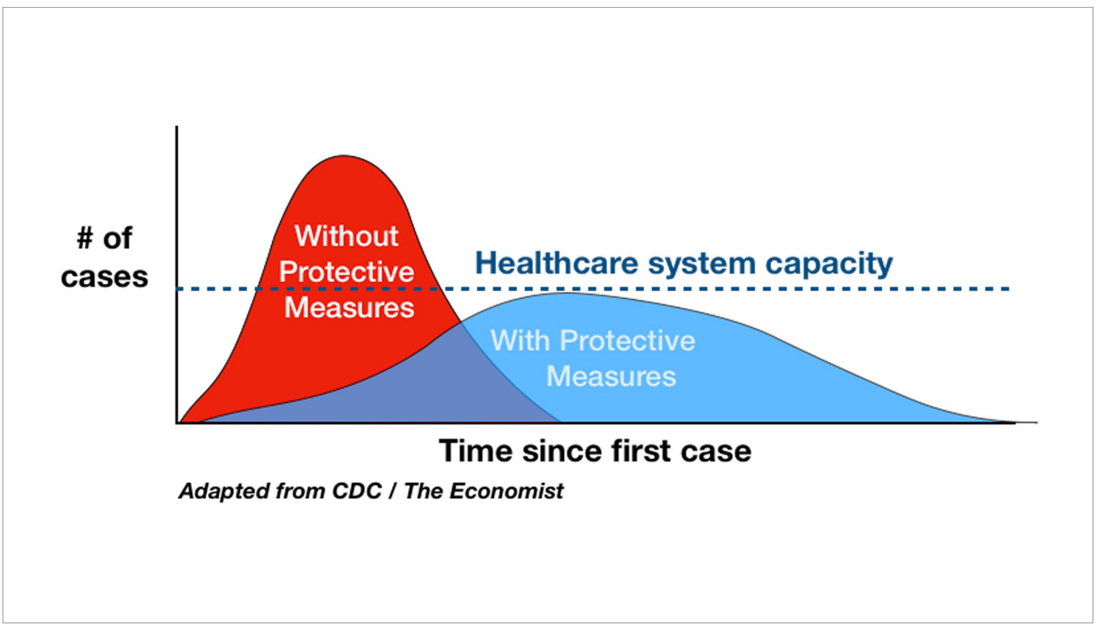


Figure 1. Line plot included in the header to the article "Flattening the Coronavirus Curve", *The New York Times*, March 2020. https://www.nytimes.com/article/flatten-curve-coronavirus.html

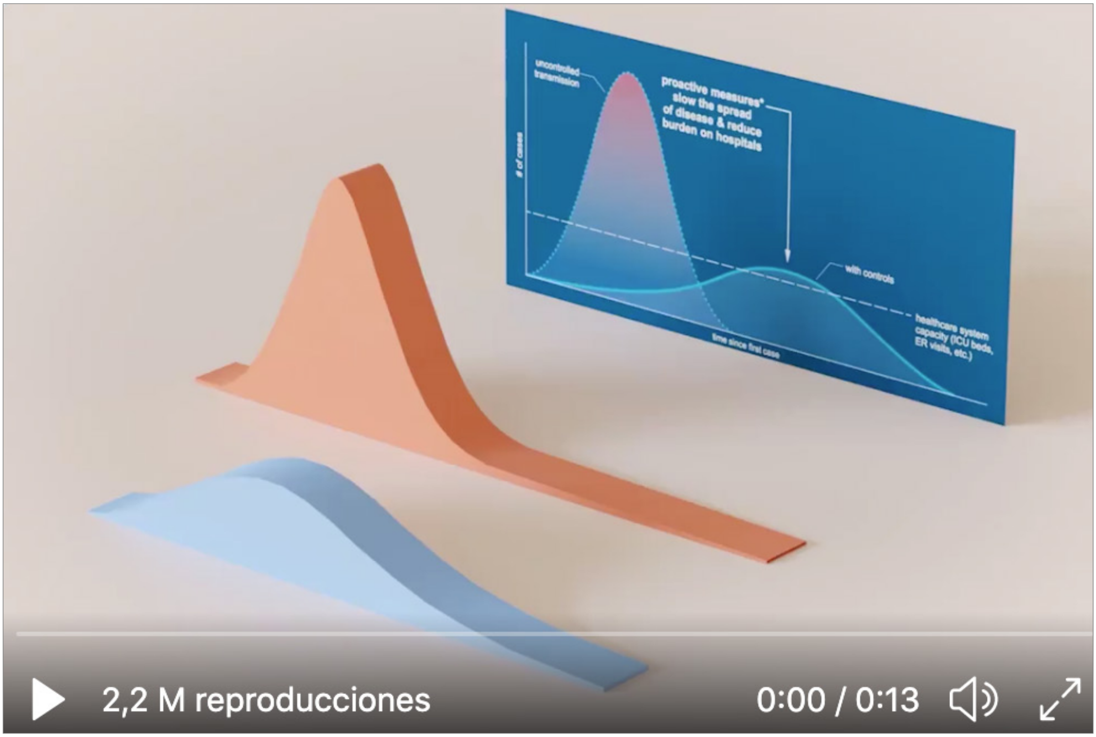


Figure 2. 3D animated representation of the line plot explaining the slogan "Flattening the Coronavirus Curve". https://twitter.com/kntktnk/status/1246011725293318151

graph conveying the same message, but emphasising much more persuasively, if that were possible, the need to stay home.

Turning 3D animation to good effect, the artist cleverly recreates the volume represented by the two epi curves. The two curves are seen moving along in parallel like two trains headed towards two tunnels that represent the capacity of the healthcare system. The curve of infections without any preventive measures in place is too high to pass through the tunnel of medical services and loses a sizeable chunk of its volume, whereas the other curve passes through without any problems (Figure 2).

3. Pandemic data: a source of problems

Despite the efforts made to ensure the danger of overstretching hospital services reached the public, the visual communication of the health crisis faced major problems from the outset. A large part of these problems centred on the data used in the visualisation, that is, on the actual content of these visual strategies. If the quality of the data was not good or the data were incomplete, the efficiency of the visual representations behind the communication strategies ran the risk of being drastically undermined.

From a conceptual perspective, a number of authors argue that there is no such thing as "raw data", that is, data that has yet to be processed. The expression "raw data", it is claimed, is a veritable oxymoron (Bowker, 2008). The simple fact of their being considered *data* means they are no longer neutral, that they have been endowed with a certain theoretical and conceptual meaning. And, to a greater or lesser extent, this controversy was never far from the surface when working with the pandemic data.

Without losing sight of this particular problem, the first difficulty I wish to highlight was that of data collection. During many long months, governments faced the challenging task of gathering data about the pandemic in order that they might implement measures on the basis of those data. In the first few months, in the absence of PCR and antigen tests, it was difficult to establish the real number of infected and asymptomatic cases and to be able, therefore, to calculate Covid-19 incidence and propagation rates. Unfortunately, the only data that could be considered reliable were that of the number of deaths. And even here some of those who died could not be tested and were not included on these lists. These problems of data collection made it impossible to predict, among other things, the real evolution of the pandemic or the effect of the measures that were being taken to alleviate it.

Leaving data collection to one side for a moment, the second notable problem concerned the management of the collected data. A joint national or international database or repository where these data could be managed, recorded and shared by the relevant experts has yet to be created. Each government managed their data on an individual basis and used their own criteria for recording them, thus often preventing any meaningful comparative analyses. To make matters worse, no steps were taken to enhance the interoperability of these data repositories, which could have improved the sharing and generation of aggregate data with respect to any political or geographical unit (region, country, continent, etc.) that experts might have wanted to analyse.

The third problem was that of updating the data. Clear criteria as to when and how to update data were never established. Some countries or governments opted to do so on a daily basis. Others weekly. Some, because of the time lag in obtaining the results of the antigen tests, collected the number of daily infections and then corrected these figures weeks later as the test results became known. This problem did little to help provide a clearer picture of reality, one, that is, on which decisions could be taken about what measures to maintain or implement.

The last of the data-related problems – and one that might at first glance appear unrelated to the specific topic we are addressing here – was a political one. Unfortunately, some governments (local, regional and national) saw an opportunity in their role of collecting, managing and updating pandemic data to reap political benefit and to present themselves to the electorate as exemplary managers of the health emergency. It lies outside the scope of the present study to analyse the degree of intentionality of these institutions, but among these distorting actions (wilful or otherwise), it is worth highlighting, for example, a possible reduction in the number of tests reported so as to lower the infection rate, the *a posteriori* updating (even months later) of the pandemic data assigned to a specific day to correct a particular trend, and the delay (or blocking, on some occasions) in assigning a code to those infected so as not to trigger a tracking mobile application as proposed by a higher government body.

However, in the midst of these problems, a number of proposals stand out for being especially creative initiatives that helped ensure the responsible collection and management of data. A good example is provided by the solution devised by *Public Health England* and the UK Government unit, *NHSX* (Figure 3). On its open website, the UK Government offers us a data dashboard of clean, simple graphics describing pandemic metrics for the country that can be visualised in a user-friendly way and which, moreover, are subject to constant updates (the date and time of the last updating being clearly indicated). Its home page provides graphs and charts of the number of people testing positive each day, the number of patients admitted to hospital, the number of deaths and the number of virus tests processed. The page also includes a search box so that users can access these data for a specific area of the country as well as an interactive map for conducting more detailed searches. The site's navigation system allows the user to access different visualisations and tables based on data sets built around the same home-page topics (i.e. cases, deaths, healthcare and testing). At this second level, each of the visualisations can be further explored, the metrics being disaggregated for each of the nations that make up the UK as well as by daily and cumulative data. Users, moreover, can access the (downloadable) data and obtain further information about that data and the visualisation that they are viewing.

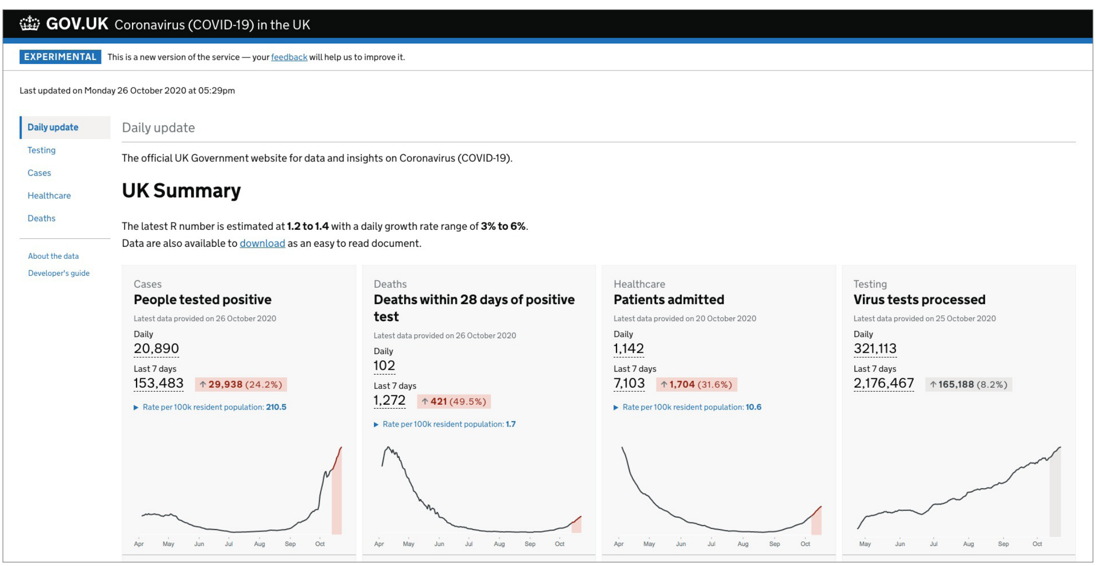


Figure 3. UK Government web resource offering a dashboard for visualising the country's pandemic data. https://coronavirus-staging.data.gov.uk

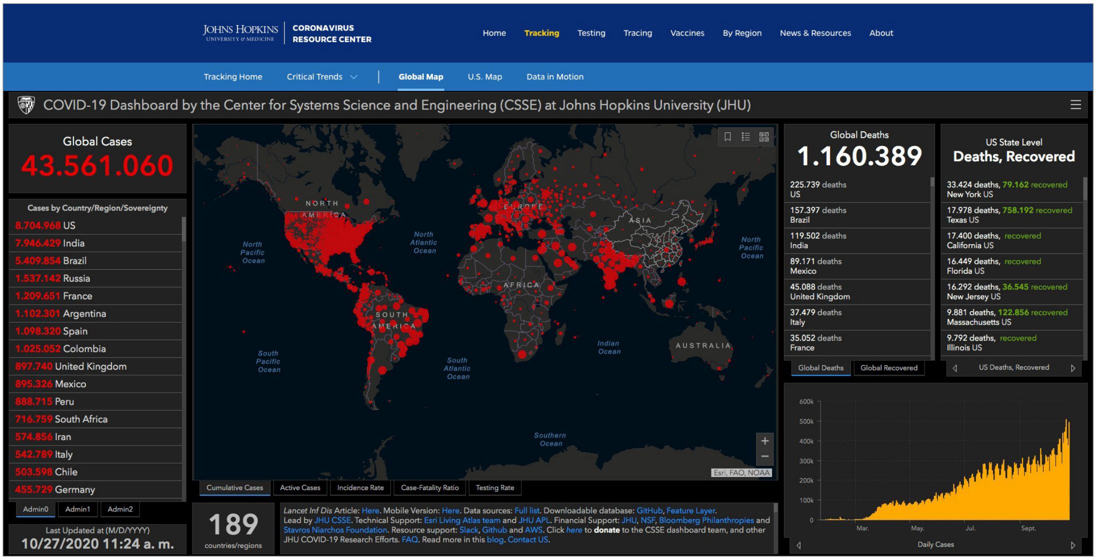


Figure 4. *Johns Hopkins University* web resource which collects and visualises global pandemic data. https://coronavirus.jhu.edu/map.html

A second solution that stands out for its value added is the resource generated by the *Center for Systems Science and Engineering* at the *Johns Hopkins University*. At a time when the epidemic was starting to acquire the characteristics of a pandemic and it was unclear where we should turn to obtain data on the health crisis, this research centre began to collect and visualise global epidemiological data, establishing itself as an obvious point of reference. The result is a data dashboard that allows the user to navigate a global map of symbols (red circles) representing the number of Covid-19 cases in each of the countries (the larger the circle, the higher the number of cases). It should perhaps be mentioned that some researchers have complained about the map's visual saturation, the result of the fact that the data for the United States are disaggregated by county and not included as a single metric for the whole country. This can create the mistaken impression that the U.S. presents many more cases of Covid-19 – given that each circle represents a separate county – while in Europe, for example, each circle represents a separate country.

To the left of the map, a table ranks the number of positive cases by country, state, province and city; while, to the right, there are two tables, one reporting the number of global deaths and recoveries from infection, and another with this same information, plus the number of tests administered for each of the U.S. states.

4. Good (and bad) communicative proposals

Leaving to one side the problematic nature of the pandemic data, their visualisation emerged as one of the most efficient communication strategies for maintaining the public informed and for controlling the health emergency. The list of communicative proposals here is endless: some offering innovative solutions, others characterised by quite severe limitations. In this section, I review a series of good practices that focus on the nature of the virus and its process of transmission, the spread of the disease and associated issues of mobility, as well as a number of examples of what might be considered bad practices, or inefficient visualisations, in this particular context. I conclude by presenting some of the most efficient communicative proposals related to the pandemic, which stand out for their effectiveness and communicative impact.

From the beginning of the pandemic, one of the first things the population needed to understand was the nature of the virus they were facing and how it was transmitted. Meeting this need was not an easy task as the information had to reach and be understood by the majority of the public, independent of their scientific background and knowledge.

One of the most interesting proposals was published on 11 May 2020 in the Spanish newspaper, *El País*, in an article entitled "*ccu cgg cgg gca. Las doce letras que cambiaron el mundo*" ["ccu cgg cgg gca. The twelve letters that changed the world"]. This article, using a series of attractive infographics and the narrative technique of parallax scrollytelling (interactive viewing of the piece by means of the scroll and overlapping layers on the screen), describes in an engaging, intelligible fashion the virus' genetic material, its physical structure, and the way it invades

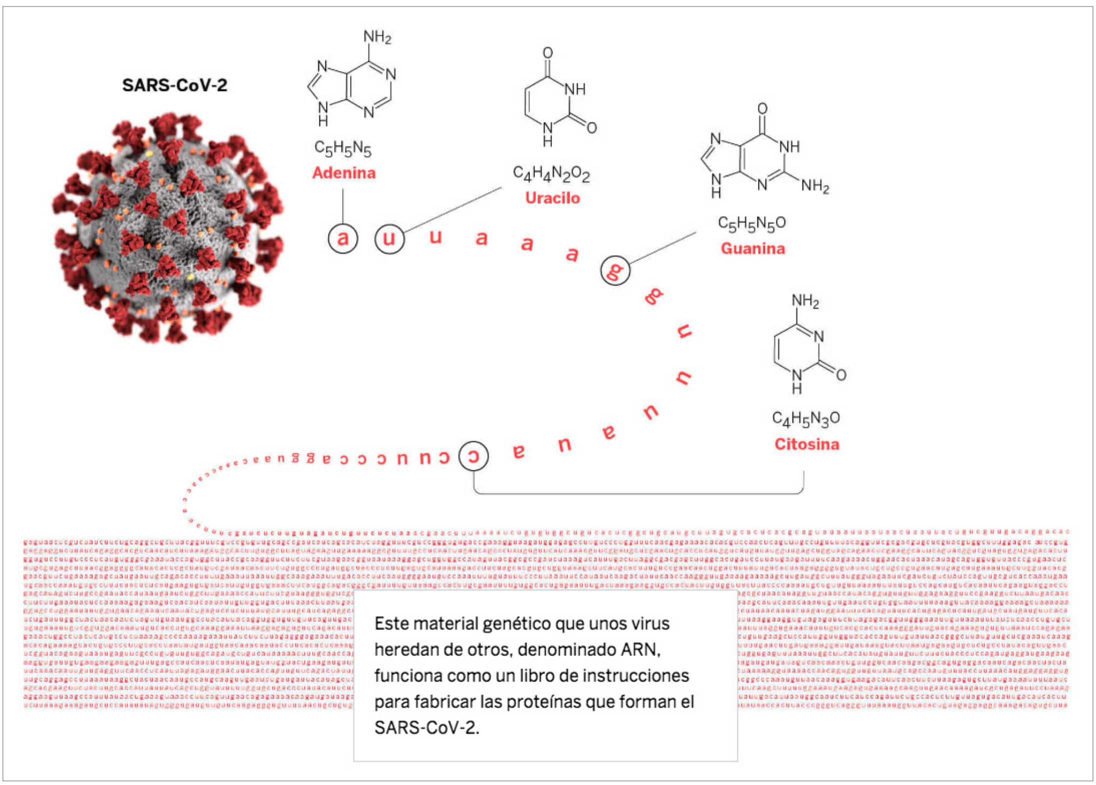


Figure 5. *El País* article offering an in-depth look at the nature of the coronavirus. https://elpais.com/elpais/2020/05/09/ciencia/1589059080_203445.html

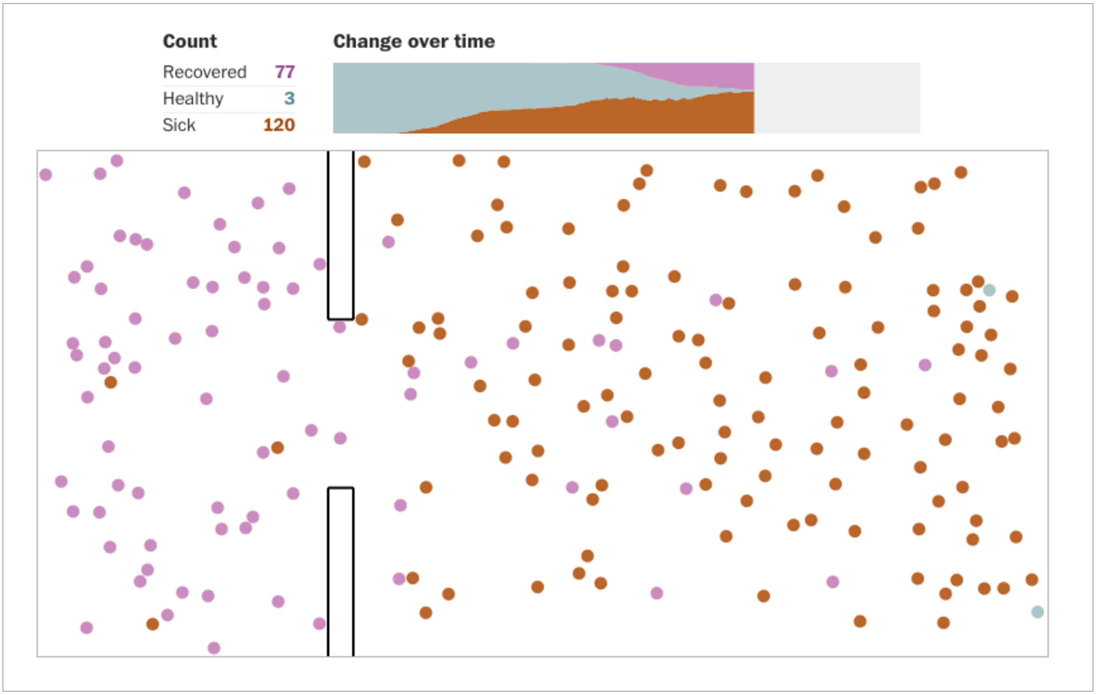


Figure 6. *The Washington Post* article in which the speed of contagion by the coronavirus is explained visually. https://www.washingtonpost.com/graphics/2020/world/corona-simulator/

and reproduces in the human body and also compares it with other viruses such as the flu (Figure 5).

Communicating how the virus was transmitted and how people could be infected was another challenge. On 14 March 2020, *The Washington Post* published an article entitled "Why outbreaks like coronavirus spread exponentially, and how to 'flatten the curve'", explaining visually and by means of simulations the speed of contagion and the importance of reducing social interaction (Figure 6).

Along similar lines, we find the excellent work carried out by the *Reuters* agency and the Spanish newspaper, *El País*. The graphics section of Reuters, in an article entitled *The Korean clusters*, dated 20 March 2020, offers us a journalistic product which explains visually how an outbreak of coronavirus spread in a church and a hospital in South Korea (Figure 7). Thanks to the information obtained from the intense tracking of those involved in the outbreak (through the use of mobile technologies), the article exhaustively describes the sequence of infections (including the family relationships and social interactions) from the first confirmed case of a patient who had flown in from Wuhan in China. The article concludes by analysing other outbreaks of contagion in the same geographical area.

Likewise, *El País*, in a piece entitled "*Un salón, un bar y una clase: así contagia el coronavirus en el aire*" ["A sitting room, a bar and a classroom: this is how the coronavirus spreads through the air"], offers an exhaustive visual explanation of the role played by aerosols in the spread

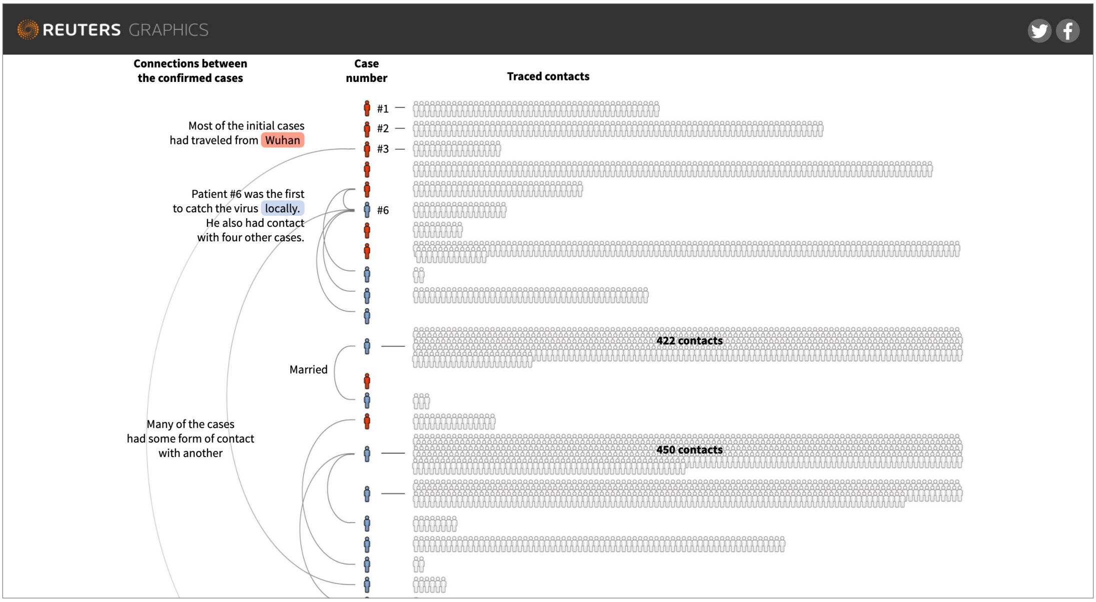


Figure 7. Analysis of the sequence of contagions in South Korea as described by *Reuters*. https://graphics.reuters.com/CHINA-HEALTH-SOUTHKOREA-CLUSTERS/0100B5G33SB/index.html

Figure 8. Explanation of the role of aerosols in the propagation of coronavirus in enclosed spaces published in the newspaper, *El País*. https://elpais.com/ciencia/2020-10-24/un-salon-un-bar-y-una-clase-asi-contagia-el-corona-virus-en-el-aire.html

of the coronavirus. Once again, using a series of attractive infographics and the narrative technique of parallax scrollytelling, the piece illustrates the variation in the rate of transmission of the virus by aerosols in enclosed places (a sitting room, a bar and a classroom) taking into account three variables: exposure time, the quality of ventilation and the use of a mask (Figure 8). Such has been the impact of the item that it has become the most visited digital content in the history of the newspaper's website.

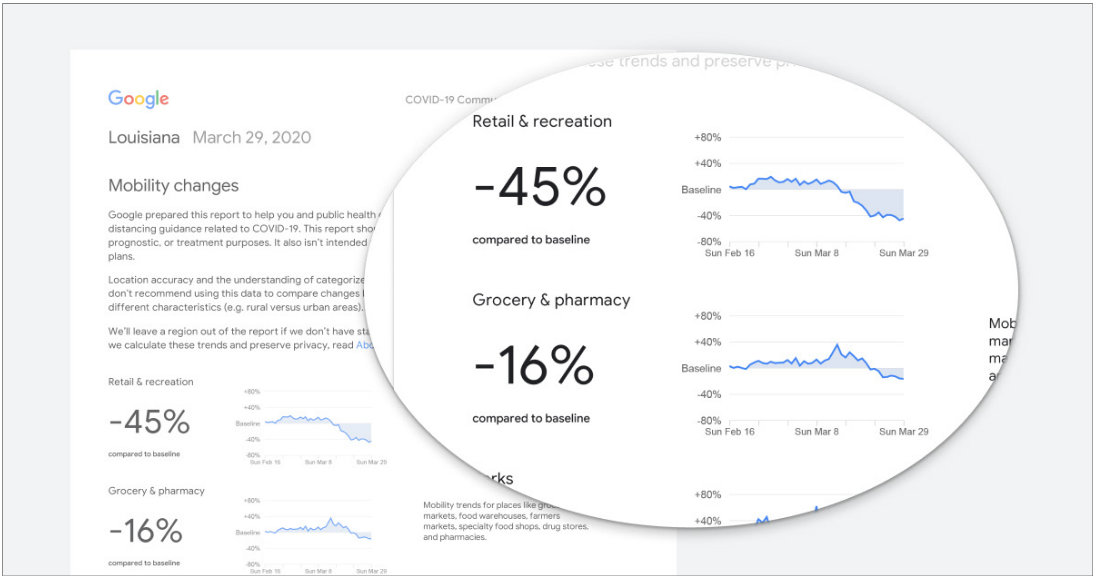


Figure 9. Google mobility report during the pandemic for the State of Louisiana. https://www.google.com/covid19/mobility/

Another area of interest explored by the media is the specific subject of mobility. In response to this information need, two visual proposals – one from Google and one from Apple – are worth highlighting. Both companies collect aggregate and anonymised (or so they claim) mobility data associated with mobile phones that use their respective operating systems. Google, using its *Google Maps* application, provides us with data and a mobility report describing trends for the geographic region of our choice. In this report, by using graphs, it shows us how visits to retail stores and places of recreation, groceries and pharmacies, parks, transit stations, workplaces and residential areas have varied during the pandemic compared to a benchmark for the previous year (Figure 9).

Likewise, Apple, using its *Maps* application, also provides us with data and a mobility report for any given region. In this report, a graph shows how mobility – that is, journeys on public transport, by car and on foot – has varied during the pandemic (Figure 10).

Continuing with good practices, I wish to highlight some pieces that are characterised by the use of unusual visual resources. In this group, the application of a very little used graphic stands out: the stream graph, a type of stacked area chart that can be employed to represent

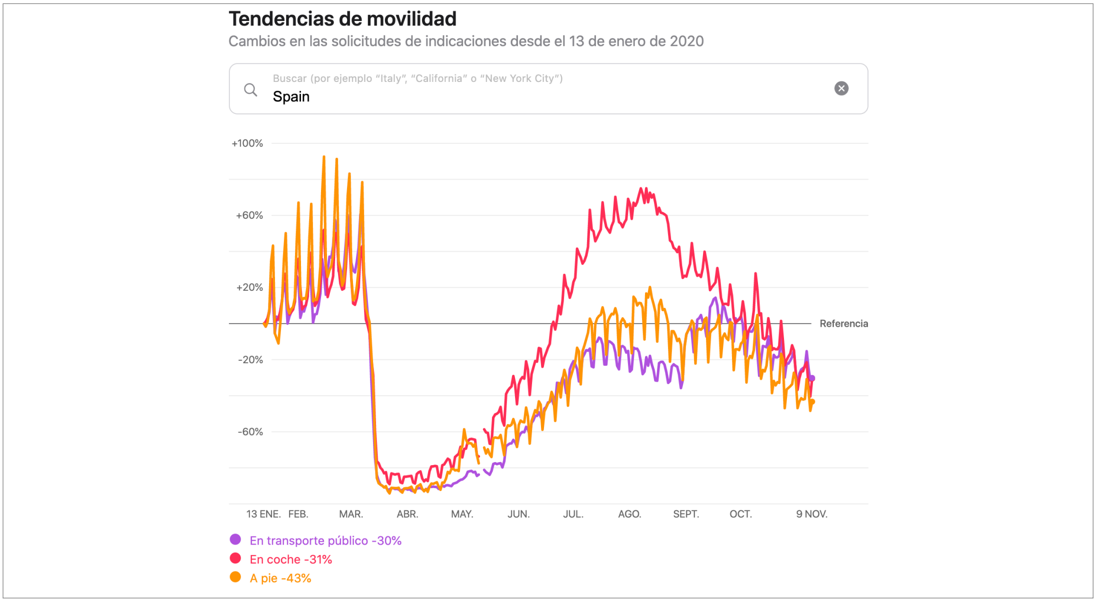


Figure 10. Apple mobility report during the pandemic for Spain. https://www.apple.com/covid19/mobility

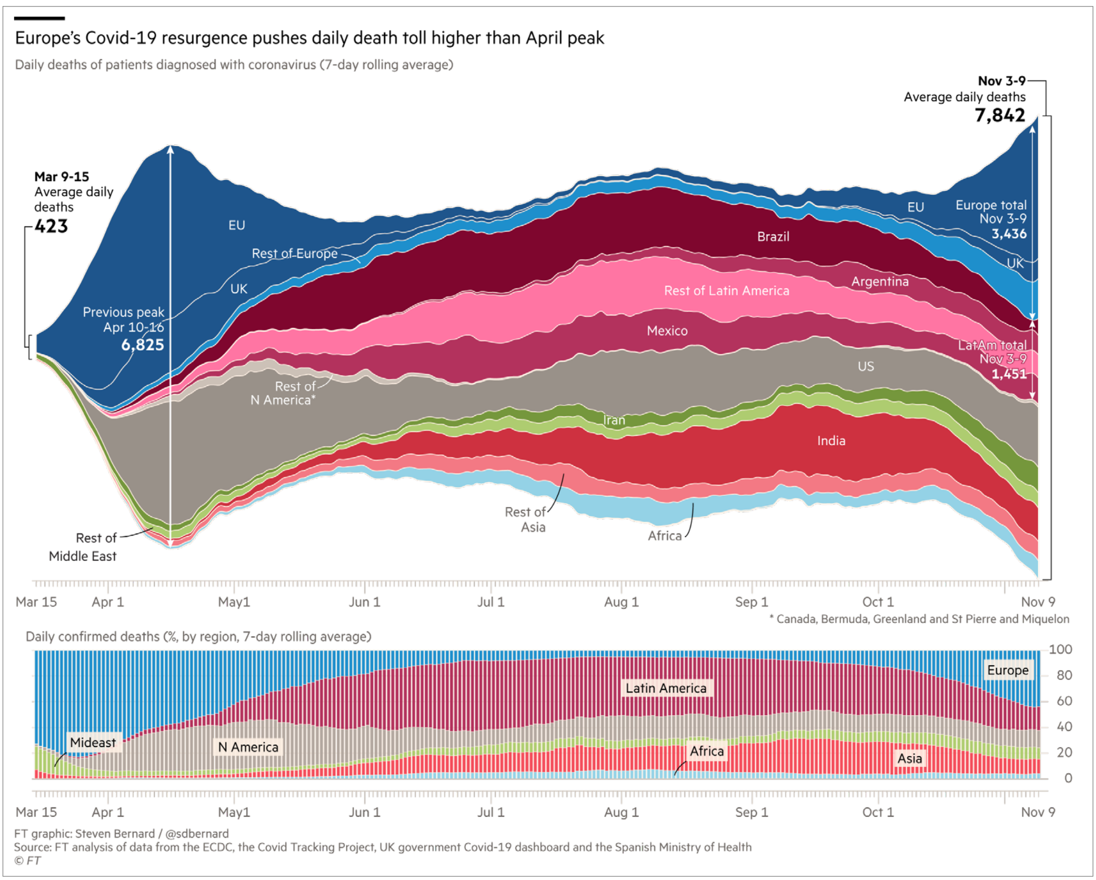


Figure 11. Evolution of daily deaths attributed to Covid-19 by country during the pandemic according to the *Financial Times*. https://www.ft.com/content/a2901ce8-5eb7-4633-b89c-cbdf5b386938

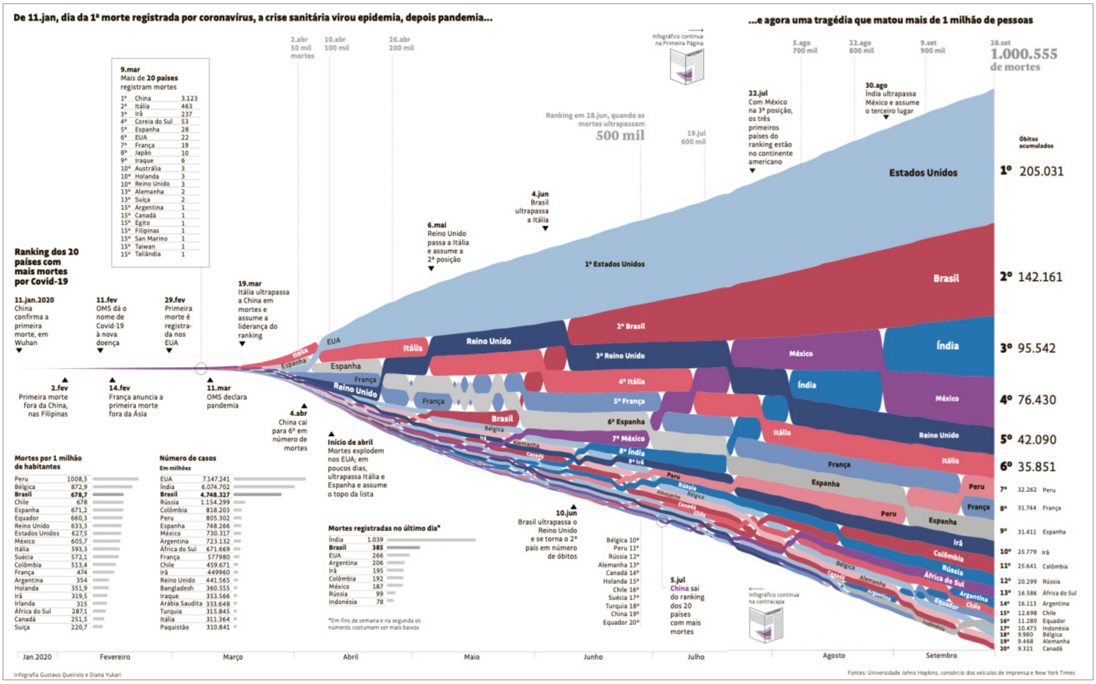


Figure 12. Evolution of daily deaths attributed to Covid-19 by country during the pandemic according to the *Folha de Sao Paulo*. https://64.media.tumblr.com/d25c0dfd70fc1b37d18dd21b6bad8c37/57290016272081f1-c3/s1280x1920/7e0a171159a02785ca7f0d3226874f3b65d199aa.png

several time series in the form of lines making up aggregate surfaces. Their defining feature is that the total stack (not just one category, but the sum of all categories at that time point) is displaced around a central point on the X-axis (located at a central point on the Y-axis). In this way they generate a visual effect for each category similar to that of the flow of a river. Two good examples of stream graphs can be found on the *Financial Times* website (Figure 11) and on the cover of the 29 September 2020 issue of the Brazilian newspaper *Folha de Sao Paulo*, where both media outlets show us the evolution of daily COVID-19 deaths by country during the pandemic (Figure 12).

But not all proposals visualising the pandemic are illustrative of good practices; indeed, there are some that lose their communicative efficiency due to visual design issues. The list is extensive, but here I have selected just a few.

The first, we have already seen. As pointed out in the previous section, the resource generated by the *Center for Systems Science and Engineering at Johns Hopkins University* has become a point of reference for obtaining and understanding data about the ongoing health crisis. Without ignoring its obvious value in this respect, the visualisation suffers from a certain visual saturation caused by the fact that U.S. data are disaggregated by county and not presented as a single value or, at least, on a state by state basis. As discussed, this can lead to the erroneous belief that in the U.S. there are many more cases of contagion (recall, each circle here represents a county) compared to Europe, for example, where each circle corresponds to a single country.

Figure 13. Evolution of daily deaths attributed to Covid-19 by country during the pandemic according to the Folha de Sao Paulo. https://64.media.tumblr.com/d25c0dfd70fc1b37d18dd21b6bad8c37/57290016272081f1-c3/s1280x1920/7e0a171159a02785ca7f0d3226874f3b65d199aa.png

The second item is offered by the Spanish Government's National Security Department. In a report on the prevailing situation (published on 7 March 2020), this body includes a map of graduated symbols representing the number of cases and deaths from coronavirus in the various Spanish regions (Figure 13). The problem with this representation is the symbol used for the quantitative coding: the circle. Leaving aside the inherent difficulty of comparing areas, if we look at the map it is immediately apparent that something is amiss. Circles of the same size and colour (such as those corresponding to Madrid and the Valencian Community) are used to represent very different quantitative values (174 cases and 4 deaths in Madrid vs 30 cases and one death in the Valencian Community).

The third visualisation I wish to describe was published on the *RTVE* website (Spain's television broadcasting corporation) on 13 April 2020 (Figure 14). Made using Flourish visualisation software, this graph provides a visual comparison of the evolution of pandemic data in Catalonia, on the one hand, and the Community of Madrid, on the other. The graph in itself presents no problems. The problem emerges when it is viewed on a mobile device. The fact of not having a *responsive* design version that adapts to the dimensions of the screen means that when the content is viewed on such a device the numeric data overlap preventing the user from reading the visualisation clearly.

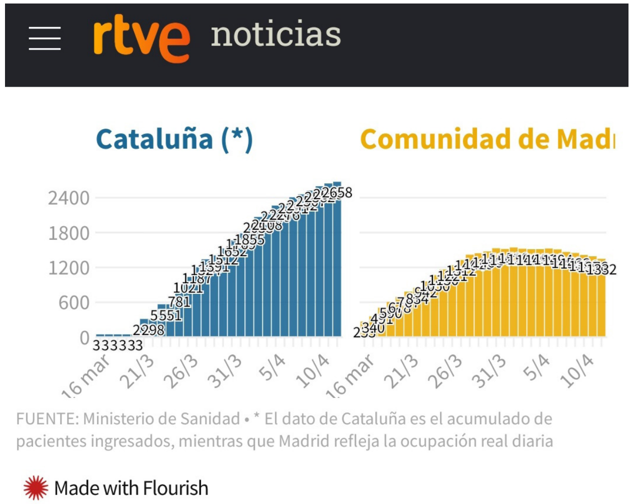


Figure 14. A comparison of the evolution of the pandemic in Catalonia and the Community of Madrid. https://www.rtve.es/noticias

The last of the visualisations that does not adequately fulfil its communicative function is the work of Danny Dorling, Professor of Geography at the University of Oxford. With the help of the illustrator Kirsten McClure, he offers us an unusual visualisation on his personal website (Figure 15). The graph shows the average number of deaths per day and also the rate of change in that number for seven countries: France, the USA, Spain, Italy, China, Germany and the United Kingdom as a whole. When a line curves to the right, deaths per day are increasing. When it curves to the left, they are decreasing. Loops indicate a change in trend.

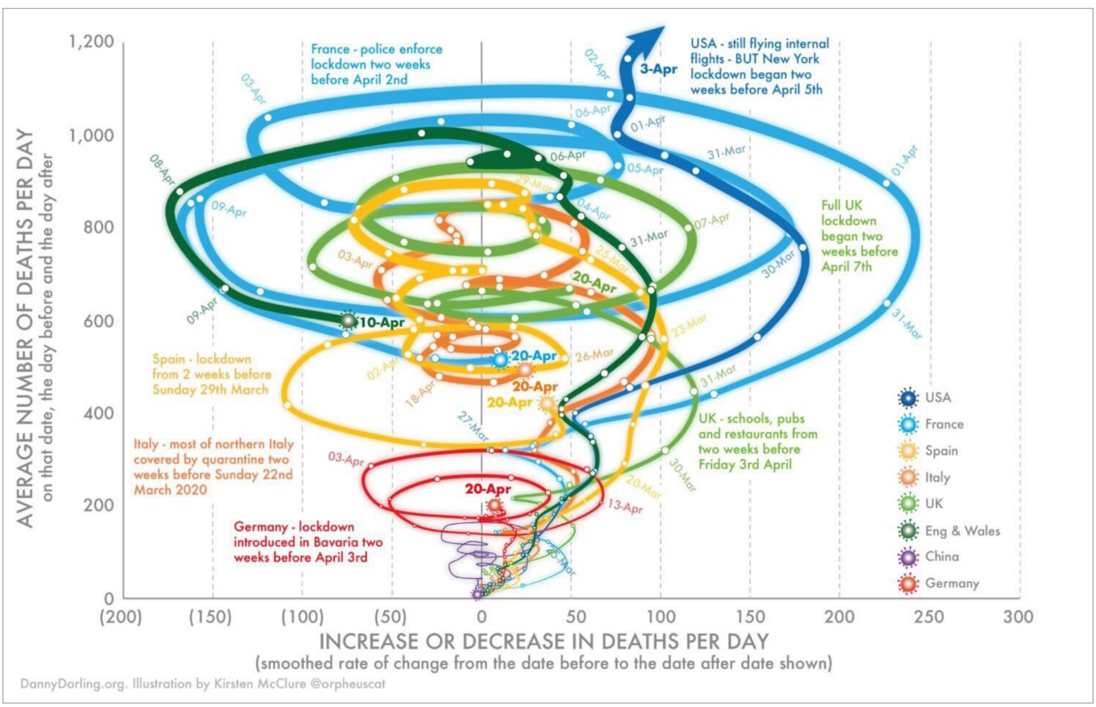


Figure 15. Graph showing the evolution in the number of deaths per day attributed to Covid-19 and the change in this rate. http://www.dannydorling.org/?p=7758

"All the News That's Fit to Print"

The New York Times

Late Edition

VOL. CLXIX ... No. 58,703 — NEW YORK, SUNDAY, MAY 24, 2020 — $6.00

U.S. DEATHS NEAR 100,000, AN INCALCULABLE LOSS

They Were Not Simply Names on a List. They Were Us.

Figure 16. Frontpage of *The New York Times* on 24 May 2020.

The original idea is not bad. However, the overlapping of lines, the overpopulation of the chart with additional text, and the poor choice of colour palette that does not facilitate visual discrimination means that the end result fails to communicate effectively the data analysed.

I would not want to finish this review of information visualisations without mentioning one that arguably does more than most to capture the reader's attention thanks to its effectiveness and communicative impact. It is not a visualisation that exploits an innovative idea or one that combines advances in visualisation; rather, the piece employs a classic strategy of visual representation.

Often, when wanting to commemorate or pay tribute to those that have died for some common cause, the decision is taken to read out their names in a roll call or to inscribe them on a monument. Putting names and surnames to the anonymous dead is a way of making these people visible, of escaping the coldness that comes from simply citing the number of victims, a way of moving from aseptic statistics to "convey the individual arcs of life".

And that's exactly what the American newspaper *The New York Times* did on its frontpage of 24 May 2020 (Figure 16). From the obituaries published in newspapers across the country, they selected the names of a thousand people to represent all those killed by coronavirus in the United States. The result is quite compelling. And it is even more so if we look at the interactive version launched on its website, where the deaths are shown in a more gradual fashion, as they occurred over time, and small biographical reviews are presented of some of the dead (Figure 17).

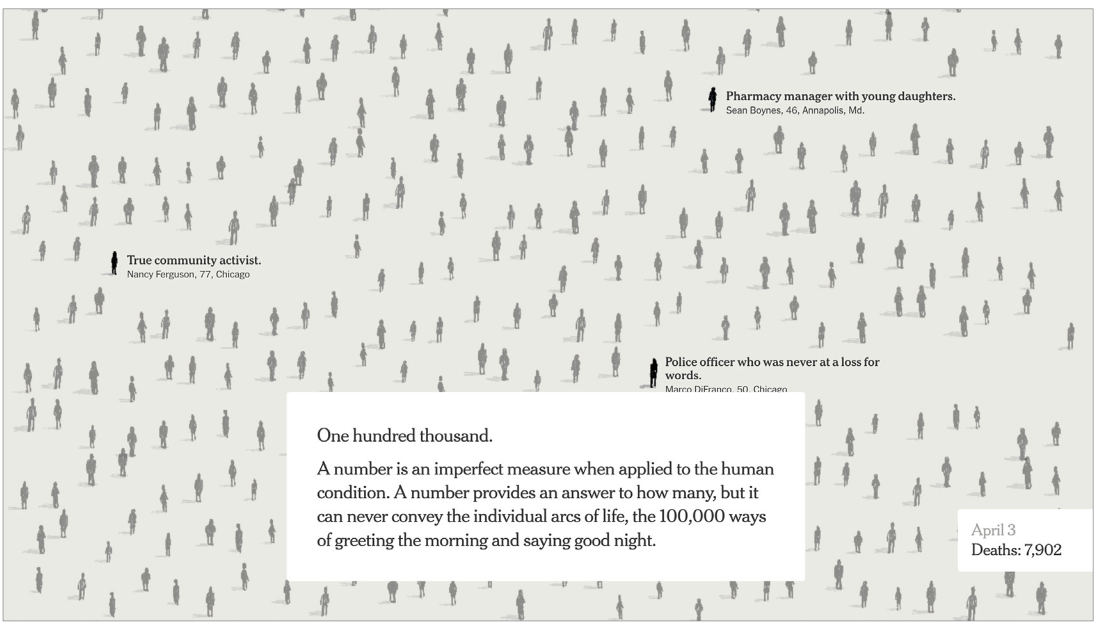
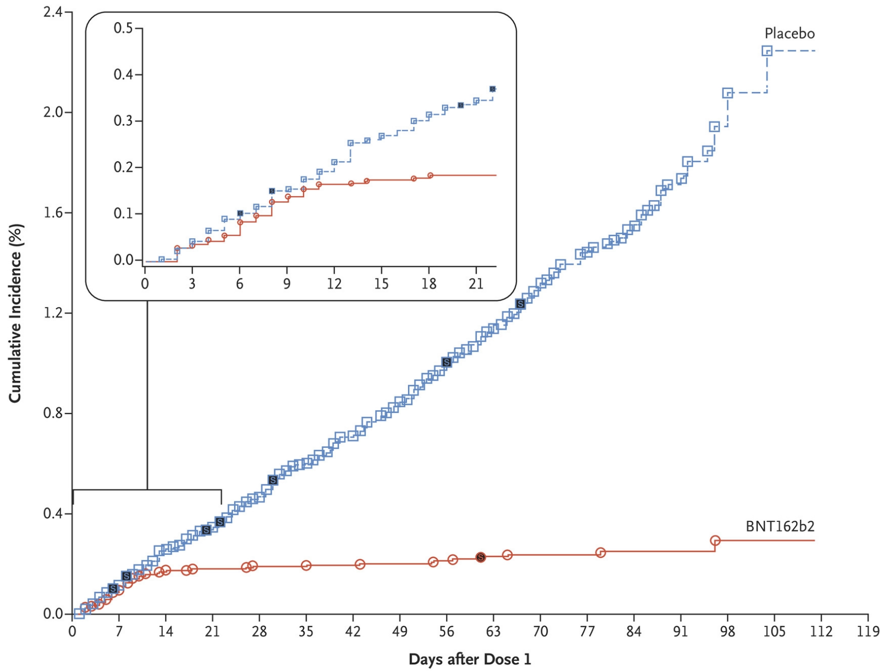


Figure 17. Piece entitled "*An Incalculable Loss*" published by *The New York Times* on 24 May 2020. https://www.nytimes.com/interactive/2020/05/24/us/us-coronavirus-deaths-100000.html



Efficacy End-Point Subgroup	BNT162b2, 30 μg (N=21,669)		Placebo (N=21,686)		VE (95% CI)
	No. of participants	Surveillance time *person-yr (no. at risk)*	No. of participants	Surveillance time *person-yr (no. at risk)*	*percent*
Covid-19 occurrence					
After dose 1	50	4.015 (21,314)	275	3.982 (21,258)	82.0 (75.6–86.9)
After dose 1 to before dose 2	39		82		52.4 (29.5–68.4)
Dose 2 to 7 days after dose 2	2		21		90.5 (61.0–98.9)
≥7 Days after dose 2	9		172		94.8 (89.8–97.6)

Figure 18. Graph appearing in an article published by *The New England Journal of Medicine* showing the effectiveness of the Pfizer/BioNTech vaccine. https://www.nejm.org/doi/full/10.1056/NEJMoa2034577

I would like to finish this review with one more graphic: what I would call "the graph of hope". A very simple, rudimentary graph that is included in an article in the prestigious journal *The New England Journal of Medicine* and which uses data to show that the Pfizer/BioNTech vaccine is 95% effective (Figure 18). In this work, and together with other scientists collaborating in the research, Polack (2020) shows us by means of just two lines how the two groups of subjects studied are being infected by COVID-19 during their trial: on the one hand, those who received a placebo – where cases grow linearly, and, on the other, the group of vaccinated – where incidences of the virus are barely recorded.

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