

spike

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Abstract

In the first weeks after the coronavirus arrived on the European continent, few would have had anticipated that by the end of the year, the first two vaccines would receive their regulatory approval. Still, the quick availability of vaccines did not mean an immediate return to normality as it was often promised by politicians. One of the reasons is that many Europeans were hesitant to take one of these newly launched vaccines. Online information was often contradictory with both supporters and opponents of the vaccination campaigns taking part in the discussion.

spike aims to answer the following questions: How do the COVID-19 vaccines work and what are their risks and benefits? How has this information been communicated in Italy, the first European country being hit by the virus, Germany, a country with a strong opposition to vaccines, and the United Kingdom, suffering from the highest coronavirus-related death rate in Europe?

I will first present the functionality of the vaccines, outlining the different vaccine types and comparing them according to their benefits and downsides. Then, the communication of this information will be examined, looking both at government officials and non-government experts. Additionally, a quantitative research about the public opinion about vaccines and official communication will be conducted.

The insights have led to the creation of *spike*, a website acting as an objective information source for those who are still hesitant to get vaccinated. *spike* provides its users general information about the different types of vaccines and how they train the immune system against the coronavirus, as well as a comprehensive list of side effects for the available vaccines. A section explaining each vaccine type in a more detailed way is available for users who want to further deepen their knowledge.

Abstract

Nelle prime settimane dopo l'arrivo del coronavirus sul continente europeo, pochi avrebbero previsto che entro la fine dell'anno, i primi due vaccini avrebbero ricevuto l'approvazione normativa. Eppure, la rapida disponibilità dei vaccini non ha significato un ritorno immediato alla normalità come è stato spesso promesso dai politici. Una delle ragioni è che molti europei sono stati esitanti a vaccinarsi con uno dei vaccini appena rilasciati. Le informazioni online erano spesso contraddittorie, con sostenitori e detrattori delle campagne di vaccinazione che partecipavano alla discussione.

spike cerca di rispondere alle seguenti domande: Come funzionano i vaccini COVID-19 e quali sono i loro rischi e benefici? Come sono state comunicate queste informazioni in Italia, il primo paese europeo colpito dal virus, in Germania, un paese con una forte opposizione ai vaccini, e nel Regno Unito, che soffre del più alto tasso di morte legato al coronavirus in Europa?

Per prima cosa presenterò la funzionalità dei vaccini, delineando i diversi tipi di vaccino e confrontandoli secondo i loro benefici e svantaggi. Poi, verrà esaminato come queste informazioni sono state comunicate, guardando sia alla comunicazione dei funzionari governativi che di esperti non governativi. Inoltre, sarà condotta una ricerca quantitativa sull'opinione pubblica sui vaccini e sulla comunicazione ufficiale.

L'analisi di questi dati ha portato alla creazione di *spike*, un sito web che agisce come una fonte di informazione oggettiva per coloro che sono ancora titubanti a farsi vaccinare. *spike* fornisce ai suoi utenti informazioni generali sui diversi tipi di vaccini e su come questi allenano il sistema immunitario contro il coronavirus. Spike fornisce anche una lista completa degli effetti collaterali dei vaccini disponibili. Infine, è disponibile una sezione che spiega ogni tipo di vaccino in modo più dettagliato per quegli utenti che vogliono approfondire ulteriormente l'argomento.

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Introduction

The thesis *spike* has the scope of examining the communication on vaccines against COVID-19, leading to the realization of a website providing information about the different available vaccines.

From the beginning of the pandemic in early 2020, the hopes rested on vaccines to immunize the population, lowering infection rates and reducing the number of severe cases. In fact, vaccine trials were initiated only a few months later and by the end of the year, Astra-Zeneca and BioNTech together with Pfizer released the first vaccines to the European market. Even though the virus and its newly emerging variants continued to hold the world in its grasp for months to come, the swift development of vaccines helped save millions of lives.

There are several reasons for why the availability of vaccines did not put an earlier end to the pandemic, one being vaccine hesitancy, a term describing the “reluctance of people to receive safe and recommended available vaccines”.¹

A considerable amount of people in European countries was skeptical of the newly released vaccines—particularly of nucleic acid vaccines, a technology that had been used for the first time for publicly available vaccines. The low vaccination rates facilitated pandemic waves, significantly affecting the economy, restricting public life and bringing hospitals to their capacity limits.

Information about the vaccines was available in abundance, both in traditional and online media, but not everyone was an advocate for the vaccines. Anti-vaccination groups spreading fake news and politicians sharing one-sided views were contributors to vaccine hesitancy, revealing a need for unbiased communication of scientific information regarding the vaccines.

spike aims to investigate this informational aspect. How do the COVID-19 vaccines work and what are their risks and benefits? How

has this information been communicated in Italy, the first European country being hit by the virus, Germany, a country with a strong opposition to vaccines, and the United Kingdom, suffering from the highest coronavirus-related death rate in Europe?

In the first chapter, I am taking a look at the different types of COVID-19 vaccines and outline how they work, in which ways they differ and where similarities lie. I will also point out risks, downsides and benefits of the individual vaccine types.

After exploring the functionality of the vaccines, the second chapter examines how governments communicated this information to the public. The politician's posts on Twitter are categorized and then the content of individual tweets will be examined in chapter three to discover the different ways politicians talked about the vaccines. The fourth chapter analyzes the reach of non-government related communication on social media and how it compares to that of the communication by decision makers.

In chapter five, I examine the way the COVID-19 vaccines were received by the public and how different polls measuring vaccine hesitancy fit into the timeline of the pandemic. In order to gain more in-depth insights into the public opinion about vaccines, I conducted a poll about vaccine readiness which will be discussed in chapter six. The poll insights are then used to create personas which will represent the starting point of the design project.

With the gathered insights, a website will then be created which serves as an information platform for those who are still hesitant to get vaccinated. After an ideation phase, the concept will be presented and subsequently validated with User Journey maps. A sitemap and a low fidelity prototype will be created, leading to the final design of the website.

spike is a website with a mobile-first approach, allowing users who are still hesitant to get vaccinated to access information about the functionalities, side effects and benefits of the different vaccines.

¹ Machingaidze S., Wiysonge C. S., *Understanding COVID-19 vaccine hesitancy*, in Aa. Vv., *Nature Medicine* vol. 27, no. 8, London, Nature Publishing Group, 2021, p. 24.

Part I Research

1 The types of COVID-19 vaccines

In the fight against COVID-19, a multitude of vaccines were developed that are based on different platforms—some of them proven, some recently developed concepts that were used for the first time. In the following chapter, I will take a look at these technologies and outline how they work, in which ways they differ and where similarities lie. I will also point out risks, downsides and benefits of the individual vaccine types, since different types should be considered for different scenarios.

The COVID-19 vaccines that are on the market today or currently undergo testing can be split into four types.¹ The newest of these technologies are nucleic acid vaccines.² These include mRNA vaccines, the most prominent example being Comirnaty by BioNTech and Pfizer, and DNA vaccines, with ZyCoV-D, approved by India in August 2021, being the first product that is commercially used.³ The second type are viral vector vaccines, examples are the vaccines by AstraZeneca and Johnson & Johnson. Another type are protein subunit vaccines, here Novavax is among the companies that have successfully developed a vaccine. Lastly, the most traditional approach are whole virus vaccines.⁴ These consist of two categories, inactivated vaccines, one made by Sinopharm, and live-attenuated vaccines, with Codagenix having developed a candidate that is currently in its trial phase.

Apart from the whole virus vaccines, every other approach shares the same concept of fighting the coronavirus, which is to target its

¹ <https://www.gavi.org/vaccineswork/there-are-four-types-covid-19-vaccines-heres-how-they-work> (accessed on 01/01/2022).

² Thorp H. H., *A breakthrough for us all*, in Aa. Vv., *Science vol. 370, no. 6523*, New York, AAAS, 2021.

³ Mallapaty S., *India's DNA COVID vaccine is a world first—more are coming*, in Aa. Vv., *Nature vol. 597, no. 7875*, London, Nature Publishing Group, 2021.

⁴ Kremer E. J., *Pros and cons of Adenovirus-based SARS-CoV-2 vaccines*, in Aa. Vv., *Molecular Therapy, vol. 28, no. 11*, Cambridge, Cell Press, 2020.

spike protein.⁵ Spike is the main surface protein of the virus, which attaches to receptors on human cells, thus enabling delivery of the viral genome into the cell.⁶ By invoking an immune response which results in the creation of antibodies, vaccines train the body to neutralize the virus.⁷

1.1 Nucleic acid vaccines

mRNA and DNA vaccines are such a new technology that prior to the COVID-19 pandemic, it had never been commercially used, while the concept itself, however, is over 30 years old.⁸

mRNA vaccines against the coronavirus are manufactured by extracting the DNA of the spike protein and then translating it into mRNA.⁹ After the translation process, each of the manufactured mRNA snippets gets wrapped in a lipid nanoparticle consisting of fats, that allow the information to enter the patient's cells. Here, the body will produce the spike proteins, triggering an immune response.

While this method has proven to be highly effective in the fight against COVID-19, it also has some downsides. Firstly, mRNA vaccines must be stored and transported at freezing temperatures, making distributing the vaccines more difficult for warm countries with lacking infrastructure like India.¹⁰ Being a relatively new technology, it has also

⁵ Cohen J., *Shots of hope*, in Aa. Vv., *Science vol. 370, no. 6523*, New York, AAAS, 2021.

⁶ Aa. Vv., *SARS-CoV-2 mRNA vaccine design enabled by prototype pathogen preparedness*, in Aa. Vv., *Nature vol. 586, no. 7830*, London, Nature Publishing Group, 2020.

⁷ Cohen J., *Shots of hope*, art. cit.

⁸ Dolgin E., *The tangled history of mRNA vaccines*, in Aa. Vv., *Nature vol. 597, no. 7876*, London, Nature Publishing Group, 2021.

⁹ mRNA (messenger RNA) carries genetic information just like the DNA, its purpose however is to deliver the information outside the cell's nucleus to ribosomes, which will use it to make proteins.

¹⁰ Aa. Vv., *Dangers of mRNA vaccines*, in Aa. Vv., *Industrial Psychiatry Journal vol. 30, no. 3*, Association of Industrial Psychiatry of India, 2021.

been the cause of concerns for many people: Since it has been linked to rare but severe side effects, it has been a major contributor to vaccine hesitancy.

One of the top reasons for the success of the mRNA vaccines is their quick production time. They can be manufactured in a matter of weeks, since producing mRNA is a relatively uncomplicated process and the production of the antigens, the spike protein, is outsourced into the patient's cells. This leads to a quick adaptability, shortening the reaction time needed for newly emerged virus variants significantly. Another benefit is the method's versatility. The high control over the information encoded in the mRNA snippets permits training the immune system against a wide variety of diseases, numerous tests in treating cancer or malaria have shown to be promising.

The second type of nucleic acid vaccines is DNA vaccines. They work similarly to mRNA vaccines, but skip one step in the manufacturing process. Instead of translating the DNA of the spike protein, it is directly inserted into the patient's cell inside a plasmid, which is a ring-shaped molecule allowing the DNA to enter the cell. Here, the body needs to translate the DNA into mRNA before the immune response can occur.

Here lies the first downside of DNA vaccines, which is that they are one step behind mRNA vaccines in invoking an immune response. Another difficulty is that the DNA needs to reach the cell nucleus, while mRNA is delivered into the cytoplasm.¹¹ A solution is to deposit the vaccine under the skin, as opposed to deep in muscle tissue, because more immune cells can be found here that help capture the DNA more efficiently.¹² Combined, these challenges lead to three doses of the ZyCoV-D vaccine being required for obtaining full protection.

Benefits of DNA vaccines are, like with mRNA vaccines, their short

¹¹ Cytoplasm is the liquid that fills the inside of a cell, surrounding the cell nucleus.

¹² Mallapaty S., *India's DNA COVID vaccine is a world first—more are coming*, art. cit.

manufacturing time and thus their quick adaptability to coronavirus variants. A unique characteristic is their stability at higher temperatures, making them easier to distribute in less accessible regions. Also, in the case of ZyCoV-D, the vaccine is deposited under the skin by a needle free device that punctures the skin with a fine, high pressure stream of fluid, which is less painful than an injection.¹³

1.2 Viral vector vaccines

Like DNA vaccines, viral vector vaccines also work by inserting the spike protein's DNA information into the cell. It uses a different method of delivery though: The DNA is placed in a vector, a modified adenovirus. In case of AstraZeneca, a chimpanzee virus is used that was altered to make it impossible to grow in humans.¹⁴ The viral vector docks to the host cell, delivering its custom information into the cell.

One risk of this type of vaccine are its side effects: Many adults have had previous infections by multiple adenovirus types and thus have pre-existing immunity against adenoviruses, which can lead to side effects caused by an increased immune response.¹⁵

Since vector vaccines have been used prior to the pandemic against Ebola outbreaks, they are a proven technology. They are also easily distributable, since no extensive cooling is required, and, like mRNA vaccines, can be quickly manufactured and thus adapted to coronavirus variants.

¹³ *Ibidem*.

¹⁴ <https://www.health.gov.au/initiatives-and-programs/covid-19-vaccines/is-it-true/is-it-true-does-the-vaxzevria-astrazeneca-vaccine-contain-animal-dna> (accessed on 05/01/2022).

¹⁵ Kremer E. J., *Pros and cons of Adenovirus-based SARS-CoV-2 vaccines*, art. cit.

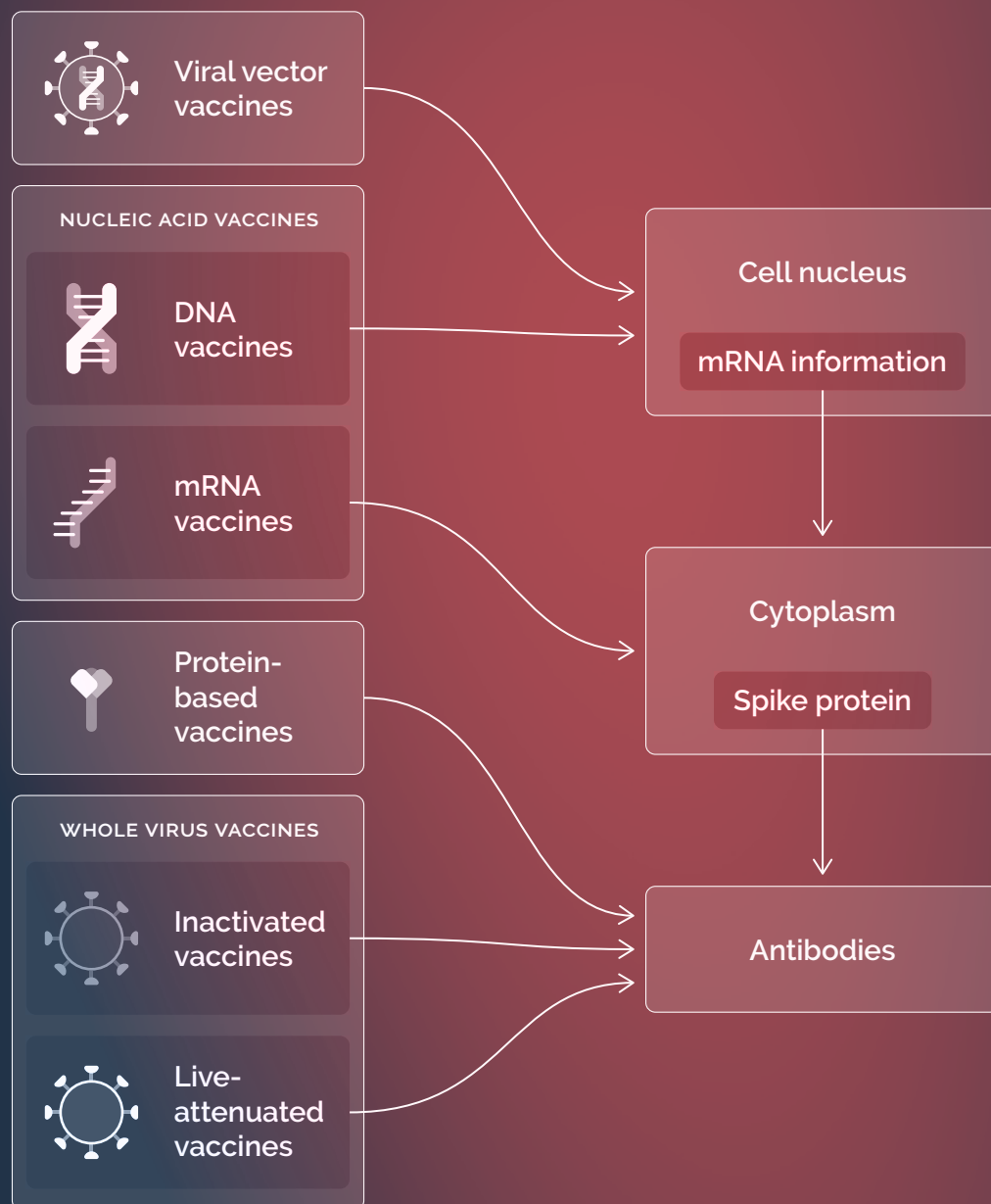


Figure 1.1. The types of COVID-19 vaccines and how they trigger an immune response

1.3 Protein-based vaccines

Protein-based vaccines belong to the family of subunit vaccines, meaning that only a harmless part of the virus is used to train the immune system. Like with the previously mentioned types of COVID-19 vaccines, the protein-based vaccines use the coronavirus spike protein. It is produced in the lab and then directly inserted into the body, triggering an immune response.

The European Medicines Agency (EMA) approved the protein-based Novavax vaccine in December 2021, roughly a year after Comirnaty. This longer development time is due to the fact that cultivating the vaccines is more complicated than producing mRNA strands, where the cells produce the protein themselves.

What gives protein-based vaccines an advantage over other types is their few side effects. This makes them attractive to patients prone to acute immune reactions who have been hesitant to take COVID-19 vaccines that were released earlier.¹⁶

1.4 Whole virus vaccines

Lastly, whole virus vaccines consist of coronaviruses which were modified to be harmless to the body. Among these are inactivated vaccines, the oldest approach to vaccination, working by growing the virus in a laboratory and then killing or inactivating it with chemicals. Live-attenuated vaccines, on the other hand, use not a killed but a weakened version of the virus.

Downsides of both vaccine types consist of a long manufacturing process and thus a slow reaction time to emerging virus variants. An additional concern with live-attenuated vaccines is that they may not be suitable for people with compromised immune systems.

Since inactivated vaccines are a well-known concept, many sciep-

¹⁶ Dolgin, E., *How protein-based COVID vaccines could change the pandemic*, in Aa. Vv., *Nature* vol. 597, no. 7885, London, Nature Publishing Group, 2021.

tics hesitant to get vaccinated have been waiting for their country to approve this type of vaccine. Another benefit is that they can easily be manufactured at scale, which is why countries like China have focused on this technology to rapidly vaccinate their population. Live-attenuated vaccines could prove to be even more effective because the weakened virus comes closer to a real infection and could invoke a better immune response.¹⁷

Looking at the multitude of COVID-19 vaccines, each with their downsides and benefits, it becomes clear that this variety is an important factor for a successful global distribution of vaccines: One type of vaccine might be preferred by one part of the population or region of the world, while another type might be more suitable for others.

¹⁷ Okamura, S., Ebina, H., *Could live attenuated vaccines better control COVID-19?*, in Aa. Vv., *Vaccine* vol 39, no. 39, Amsterdam, Elsevier, 2021.

2 Government communication

In the following chapter, I will analyze how governments communicated information about the vaccines to the public. They were the ones steering their countries through the pandemic, thus their voices were among the most influential in regards to the success of the vaccination campaigns.

The pandemic affected all countries to some extent and decisions and communication regarding the vaccination campaign varied across the countries. For a national comparison, I selected Italy, Germany and the UK—all European countries that were hit hard by the virus—to see how communication differed.

I looked at information from the countries' heads of government with them having the most responsibility for a successful vaccination campaign, as well as their health minister, who also played an important role in informing the public about the vaccines.

As a source, I chose Twitter since it was used by many of the politicians to share updates on the pandemic, thus providing a direct access to their communication. Since 2009, when Twitter users moved from posting about their personal lives to what's happening in the world, the platform is a useful source of information:¹ "It is here that Twitter asserts itself as a tool to know what is happening and therefore, for sharing-information, marking the transition from an area of ambient intimacy to a tool that works well in the event of disasters, such as natural events, man-made events, conferences, and here the pandemic."²

I extracted information by using a scraping tool. This allowed me to download a complete collection of tweets that meet the criteria. The scraping occurred on November 27th, 2021, with the first tweets collected from January 1st, 2020, the beginning of the pandemic. Keywords

¹ Aa. Vv., *Lockdown and Breakdown in Italians' Reactions on Twitter during the First Phase of Covid-19*, in Aa. Vv., *Partecipazione e Conflitto* vol. 14, no. 1, Lecce, Università del Salento, 2021.

² *Ivi*, p. 263.

included the terms for vaccines and the anti-vaccination movements in their respective language, in order to understand what information was spread about the vaccines and how opposers of the vaccination campaign were addressed. For Italy, these keywords were *vaccino*, *vaccini*, *novax* and *no-vax*. The German keywords were *Impfung*, *Impfstoff* and *Impfgegner*. Lastly, for the United Kingdom I chose *vaccine*, *vaccines* and *anti-vax*.

In total, I obtained 340 tweets which I then organized in a database and grouped by content. These categories provided insight into the way the government officials communicated and made it comparable across the countries. I defined the following categories:

- Acknowledging helpers of the vaccination campaign
- Report on a recent national success regarding the vaccine development and/or distribution
- Report on a recent international success regarding the vaccine development and/or distribution
- Update on the national state of vaccine development and/or distribution
- Update on the global state of vaccine development and/or distribution
- Report on a meeting of leading politicians and/or scientists discussing the vaccine development and/or distribution
- Underlining the importance of the vaccine development and/or distribution
- Plea to the citizens to get vaccinated
- Report on a recent setback regarding the vaccine development and/or distribution
- Reacting to doubt or criticism
- Other news regarding the vaccines
- Other

Date	Username	Tweet	Category
10.11.2020	sajidjavid	Thank you Kate Bingham for getting us to the front of the queue in the race for a vaccine.	Acknowledging helpers of the vaccination campaign
02.12.2020	sajidjavid	Proud that the UK is the first country in the world to have a clinically-approved vaccine ready for supply. NHS will start providing it to the most vulnerable as early as next week. 2021 looking much brighter. https://t.co/dBVgFhtWjZ	Report on a recent national success regarding the vaccine development and/or distribution
10.12.2020	sajidjavid	Fantastic news that our local hospital, The Alex, will be the first to deliver the COVID-19 vaccine in Worcestershire. Vaccinations are expected to begin next week, with @NHSuk contacting those who will receive the vaccine first in #Bromsgrove https://t.co/WC43bplZ4g	Report on a recent national success regarding the vaccine development and/or distribution
07.01.2021	sajidjavid	Fantastic news that more vaccines will be available for residents in #Bromsgrove District. Another big step in our local fight against Covid-19. The vaccines will be targeted towards priority groups and delivered by GP practices, who will contact residents directly.	Report on a recent national success regarding the vaccine development and/or distribution
15.01.2021	sajidjavid	Great to speak with #Bromsgrove GP network this afternoon about vaccine rollout. Fantastic progress made with all eligible elderly care home residents vaccinated. Also approx half of over 80s already done. Huge thank you to everyone involved! https://t.co/xNnRTwdLtM	Report on a recent national success regarding the vaccine development and/or distribution
26.01.2021	sajidjavid	Vaccine rollouts are at a critical early stage for all countries, and the Handelsblatt report shows why cool heads must prevail. We will all lose if threats and misinformation are allowed to impede their progress.	Reacting to doubt or criticism
30.01.2021	sajidjavid	My mum just had her first shot of the vaccine. Huge, huge thank you to everyone that made it happen. The docs, nurses, scientists, volunteers, officials, ministers. Thank you. (Pre-Covid pic—can't wait to hug her again!) https://t.co/3OTQ2puOXU	Acknowledging helpers of the vaccination campaign
02.02.2021	sajidjavid	Great progress from #Bromsgrove GP's on first vaccine jabs: -All eligible care home residents done -98% of over 80s done -98% of health and social care workers done -And fantastic progress on over 70s Thank you for your amazing work!	Report on a recent national success regarding the vaccine development and/or distribution

Figure 2.1. An excerpt of the database with tweets by Sajid Javid [1/2]

Date	Username	Tweet	Category
02.02.2021	sajidjavid	Great work from the team at the Artrix vaccination centre in #Bromsgrove. Over 7,000 thousand vaccines delivered since it opened last week. Please remember, only turn up if you already have an appointment booked. https://t.co/5UjcjpbnCj	Report on a recent national success regarding the vaccine development and/or distribution
17.02.2021	sajidjavid	Thank you to Dr Matthew Dakin and all of the team at #Alvechurch Medical Centre for your work in delivering the Covid-19 vaccine to local residents. Fantastic that 29% of over 65-70s have already received their first jab. https://t.co/MR3LNaEWz2	Acknowledging helpers of the vaccination campaign
19.03.2021	sajidjavid	Very encouraging update on the vaccine rollout from the #Bromsgrove GP network. All over 50s who have accepted the invitation to book their jab will be vaccinated by tomorrow! Over 50s in #Bromsgrove can contact their GP or book an appointment online https://t.co/fOc8GWs5Aw	Report on a recent national success regarding the vaccine development and/or distribution
28.06.2021	sajidjavid	This tribute is hugely deserved. Thank you to the scientists who have developed life saving vaccines as well as all those who have worked day and night to provide care for people.	Acknowledging helpers of the vaccination campaign
30.06.2021	sajidjavid	Our vaccine rollout is saving lives and protecting our country. I welcome today's interim advice from the JCVI. We are planning for a vaccine booster campaign to start in September which will help keep the virus at bay. https://t.co/Pep52JG7CV	Update on the national state of vaccine development and/or distribution
02.07.2021	sajidjavid	More than 45 million adults across the UK have now had at least one vaccine dose. This is a phenomenal achievement—thank you to the team and everyone who has come forward for their jab.	Update on the national state of vaccine development and/or distribution
06.07.2021	sajidjavid	Jab by jab we are building a wall of protection against this virus. If you haven't done so already—please come forward for your vaccine and make sure you book your second.	Plea to the citizens to get vaccinated
08.07.2021	sajidjavid	Thanks to the progress of our vaccine programme, we can safely take steps to ease restrictions on travel, as we are doing at home. Allowing quarantine-free travel for fully vaccinated people means they can be reunited with loved ones overseas	Update on the national state of vaccine development and/or distribution
08.07.2021	sajidjavid	Our vaccine rollout is building a wall of protection—it has already saved tens of thousands of lives and prevented millions of infections. If you haven't already, please get your jab!	Plea to the citizens to get vaccinated

Figure 2.1. An excerpt of the database with tweets by Sajid Javid [2/2]

The last category included a tweet by the British prime minister Boris Johnson expressing his commitment to overcoming the pandemic, and one by his health minister, Sajid Javid, apologizing for a poor choice of word after he had been cured from the virus.

2.1 Heads of government

The first leader' tweets I looked at is Giuseppe Conte, who was Italy's prime minister until February 2021. With one million followers by the time of scraping, he had the second highest following of the politicians analyzed. Within the selected timeframe though, he posted only 10 tweets, which is substantially less than the tweet rate of his colleagues. His first vaccine-related tweet was posted on April 4th, 2020.

The main content of his tweets are updates on the state of Italy's vaccination campaign, as well as underlining the importance of quickly developing and distributing the vaccines. Other topics include international successes regarding vaccines, updates on a global level and reports of meetings with other leaders to discuss the topic.

Giuseppe Conte was replaced by Mario Draghi in February 2021. Data regarding his communication was not retrievable, since he didn't have an official Twitter account by the time of the scraping. While Twitter is certainly not necessary for politicians to address the public, this hints to a more conservative way of communication.

Angela Merkel, the German chancellor until December 2021, didn't maintain a Twitter account either.

The British prime minister Boris Johnson, on the other hand, maintained a strong presence on Twitter throughout the pandemic. With 3.7 million followers, he had by far the biggest reach and his 117 tweets were the highest activity of the leaders I analyzed. The first tweet was posted on March 3rd, 2020, which makes him the first to post about the vaccines.

Updates on the national vaccine development and the vaccination campaign formed the biggest part of his tweets. This was followed by

thanking helpers of the campaign and health care workers, and tweets about recent national successes. He also partially talked about the importance of vaccination, pleaded to the citizens to get vaccinated and even made a few tweets about setbacks regarding the vaccines.

2.2 Health ministers

Roberto Speranza is Italy's health minister that led the country through the pandemic. With about 167,800 followers he had the lowest number among those analyzed, and he tweeted 38 times in the selected time frame, which also is the least among the health ministers. His first tweet regarding the vaccines was posted on May 5th, 2020.

Speranza's tweets revolve around reporting on national, but also international successes regarding the vaccines, showing that he is not only focused on his country but also shares more global updates. Apart from this, he mostly reports about meetings with other leaders and underlines the importance of a successful vaccination campaign.

The German health minister, Jens Spahn, was more active than Speranza with 75 tweets. He had about 278,000 followers, which is the most of the health ministers. His first tweet was posted on October 14th, 2020, which is relatively late compared to the other leaders.

Spahn mostly posts updates about the vaccination campaign. In his tweets, he reports on the most recent numbers of vaccinations in Germany, leaving aside technical information about the vaccines and more detailed information on the vaccination campaign. In some cases, he also asks the citizens to get vaccinated, and in one tweet, reacts to critics of the vaccine.

Lastly, Sajid Javid, the British health minister, has a following of about 266,900 and tweeted 100 times in the selected timeframe, which is the highest amount among the health ministers. He first tweeted about COVID-19 vaccines on November 21st, 2020, making him the last to join the discussion on Twitter.

Javid mainly tweets about updates on the national state of the vac-

ination campaign as well as pleas to the citizens to get vaccinated. This way, he addresses the citizens most, while others talk more about the situation and less to the public directly. Javid also, like Johnson, acknowledges helpers of the vaccination campaign and reports on national successes.

Comparing the different approaches to communicating about the vaccines on Twitter, one finding is that politicians of the same country seem to follow a similar pattern. The content of Giuseppe Conte's tweets shows similarities to the ones of Roberto Speranza, with both not only focusing on giving updates on national but also on international news regarding the development of the vaccines, and reporting on meetings they attended. They also underline the importance of the vaccination campaign, but do not address the public directly by asking them to get vaccinated. Boris Johnson and his health minister Sajid Javid also tweet in a similar way, they both focus more on giving updates on the national situation, acknowledge helpers of the vaccination campaign and even report setbacks in a few tweets.

A second insight is that even though the search included keywords for anti-vaccination movements, this topic remained unaddressed. Apart from a few tweets reacting to doubts or criticism, no attacks on these groups were launched, and the politicians chose to keep their focus on the vaccination campaigns.

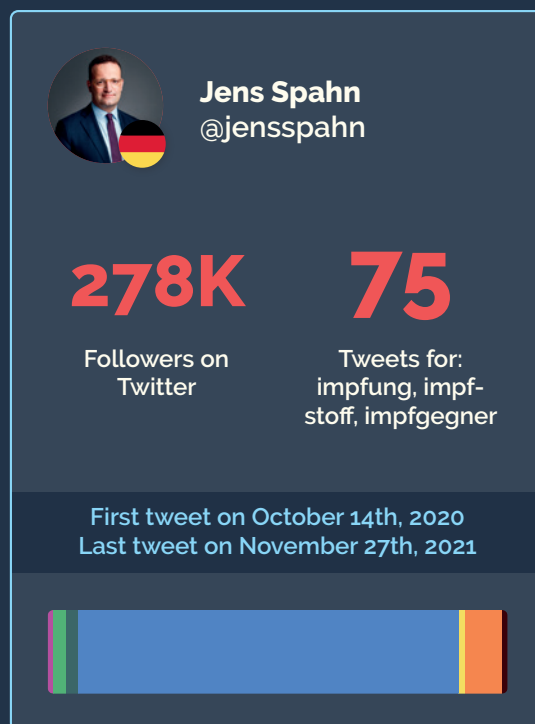
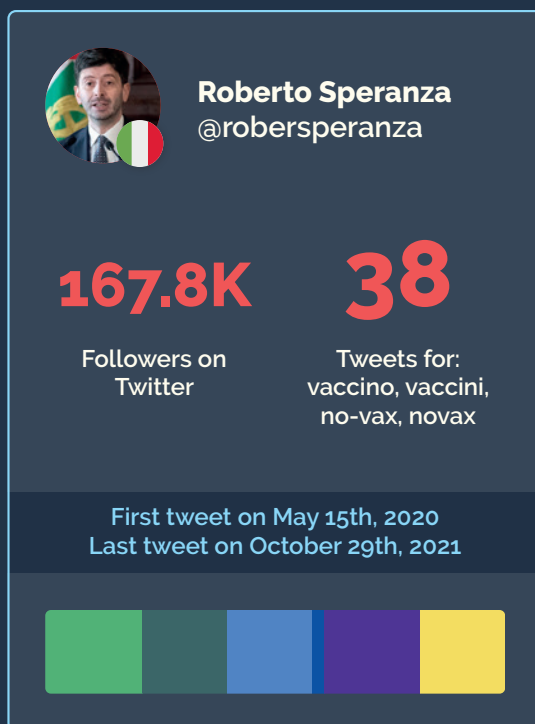
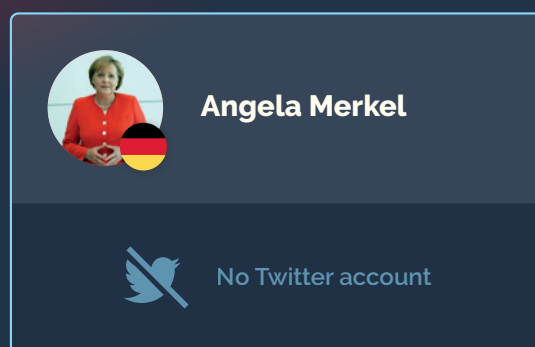
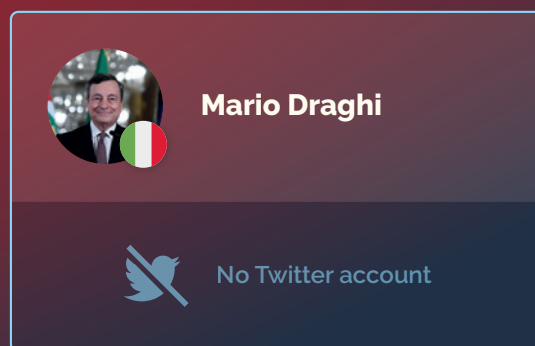


Figure 2.2. Heads of government and health ministers on Twitter [November 27th, 2021]

3 Framing of vaccine development and distribution

After categorizing the tweets by politicians, I will now look at the content of the individual tweets to see the different ways politicians talked about the vaccines.

Reporting on the development of vaccines is complex in itself, but in the case of the COVID-19 pandemic, scientific research was performed while the pandemic unfolded, which led to a changing status quo with every new finding. Politicians faced the difficulty to inform the public about the vaccines in such an uncertain situation.

By communicating from their individual perspectives and choosing certain aspects of the distribution and development of vaccines, each politician frames the subject in his own way. Looking at the series of tweets, characteristics of the politician's communication can be discovered.

Using the database discussed in chapter two, I looked at the tweets in chronological order. I chose the tweets by the countries' health ministers Roberto Speranza, Jens Spahn and Sajid Javid since they were all active on Twitter before downloading the tweets on November 27th, 2021.

3.1 Roberto Speranza

The Italian health minister Speranza talks a lot about the global state of vaccine development, as mentioned in chapter 2.2. In July 2020, he states that the positive first test results of the AstraZeneca vaccine developed in Oxford are encouraging. He adds that this will not bring an immediate end to the pandemic, saying: "We still need time and caution."¹

Apart from focussing on foreign vaccines, many tweets can be found discussing Italian vaccine development. Here, the viral vector vaccine developed by ReiThera is mentioned most. He emphasizes

¹ <https://twitter.com/robersperanza/status/1285232753965969410> (translated, accessed on 01/02/2022).



Fig. 3.1. Tweets by Roberto Speranza, translated to English

Italy's role: "Italy and its excellences are at the center of this global challenge."² Only good news can be read about the nationally developed vaccines here. For the nationally developed vaccines, Speranza also leaves out the remarks that even if the vaccine was a success, it would still take some time before normality could return.

On January 27th, 2021, he tweets about the Italian state investing public capital in ReiThera. A few months later, this investment is rejected by Italy's court of audit, being dissatisfied with the fact that not only vaccine development should be funded, but also the firms headquarters were to be purchased. The project now lacked sufficient funding, rendering its future unclear.³ After this event, Speranza stops mentioning the development of the ReiThera vaccine.

In February 2021, Speranza makes a remark about the distribution of monoclonal antibodies, calling it "one more chance to fight covid 19".⁴ After it became clear that this type of treatment was not viable due to its difficult distribution, he does not inform his Twitter audience about this setback.

Overall, Speranza focuses on informing about the development of vaccines, emphasizing Italy's role in the process. He gives realistic assessments on the future of the pandemic, stating that even with vaccines available it will take time to overcome the virus, which proved to be true. At the same time, Speranza ignores setbacks concerning topics that he previously talked about, and instead chooses to focus on future opportunities.

² <https://twitter.com/robersperanza/status/1280183867459227648> (translated, accessed on 01/02/2022).

³ Guglielmi, G., *Future Unclear for Italy's COVID-19 Vaccine*, in Aa. Vv., *Nature Italy*, London, Nature Portfolio, 2021.

⁴ <https://twitter.com/robersperanza/status/1358007347751374848> (translated, accessed on 01/02/2022).

3.2 Jens Spahn

The German health minister Jens Spahn tweeted on December 27th, 2020, when the first vaccine rolled out in Germany, that this event made him hopeful and that vaccination was "the key to get out of the pandemic."⁵ While this probably mirrored his own feelings about the future, his tone turned out to be too optimistic, where his colleague Roberto Speranza's cautious rhetoric proved to be more reasonable in regards to the future course of the pandemic.

In a tweet from March 2021, he reports on the fact that the AstraZeneca vaccine is now recommended for people older than 65 years. In fact, he does not put the focus on nationally produced vaccines like the mRNA-based BioNTech/Pfizer vaccine, but talks regularly about other vaccines.

In a following tweet, Spahn shares a scientific insight coming from a new study, showing the best interval between the first and second dose of the vaccine. This tweet seems to be purely informational.

On May 14th, 2021, Spahn writes that he made the decision to take the AstraZeneca vaccine, stating that "this is the way out of the pandemic".⁶

He continues to recommend the vaccines to more groups of people, in August he addresses parents with the message that a vaccination is safe at a young age, and in October he urges people over 60 to get their vaccination, since it "protects and is safe."⁷

Jens Spahn does not limit his tweets to talk about national efforts to develop and distribute vaccines, but also mentions foreign vaccine development.

⁵ <https://twitter.com/jensspahn/status/1343110379430359040> (translated, accessed on 01/02/2022).

⁶ <https://twitter.com/jensspahn/status/1393222867760947200> (translated, accessed on 01/02/2022).

⁷ <https://twitter.com/jensspahn/status/1444210287960371202> (translated, accessed on 01/02/2022).



Fig. 3.2. Tweets by Jens Spahn, translated to English

Additionally, he talks about some scientific findings in a detailed way and states which groups of people are recommended to take a vaccine. What he leaves out though are the potential risks of the vaccines and who a vaccine is potentially harmful for, like people with compromised immune systems, an aspect that many among those unvaccinated are concerned about.

3.3 Sajid Javid

When in December 2020 the *AstraZeneca* vaccine received its approval in the UK, the British health minister tweeted: "2021 looking much brighter."⁸ Another tweet from July 2021 states: "Jab by jab we are building a wall of protection against the virus".⁹ This choice of words shows an even more optimistic view on vaccines than Jens Spahn does, which clearly was a wrong assessment of the situation.

He also talks about specific milestones that will be reached, like quarantine-free travel that he promises in July 2021. In October, he calls the vaccines "the game changer which has allowed us to restart society and get back to the things we've missed—like football."¹⁰ This statement is, again, overly optimistic, leaving out the fact that in the same month, coronavirus infections were among the highest in the world, as shown in figure 6.1.

One tweet by Javid addresses pregnant women, assuring them that the vaccines are safe and recommended for pregnant women.

Two tweets from October and November 2021 seem contradictory: The first one discusses "excellent results from @pfizer showing their booster vaccine is safe and 95.6% effective against COVID-19."¹¹ The other tweet states that "boosters slash the chances of catching

8 <https://twitter.com/sajidjavid/status/1334068102032658434> (accessed on 01/02/2022).

9 <https://twitter.com/sajidjavid/status/1412428257853595651> (accessed on 01/02/2022).

10 <https://twitter.com/sajidjavid/status/1450543080545951746> (accessed on 01/02/2022).

11 <https://twitter.com/sajidjavid/status/1451269155538317315> (accessed on 01/02/2022).

COVID-19 by 60%.”¹² While both numbers are probably correct, they can be confusing to someone trying to obtain insights into the effectiveness of booster vaccines.

Among the health ministers analyzed, Javid shows the most optimistic approach to communicating about the vaccines, even though his country was among the most affected by the virus.

Looking at the three health minister’s posts on vaccines, it becomes evident that they all uphold an optimistic narrative throughout the first two years of the pandemic. They cope with the everchanging situation by mostly leaving out bad news, and instead focus on the positive.

A benefit of this approach is that this sends the message of having everything under control. The politicians appear faithful regarding the choices they made in leading their country through the pandemic, as well as a successful vaccination campaign paving the way for a swift return to normality.

A downside is that the health ministers leave out important information, like mutations of the virus resulting in the spread of more potent variants, which proved to pose a direct threat to the vaccination campaign, since many vaccines were less effective to variants like Delta or Omicron. This could result in a contrasting image compared to information shared by news media and science reports, who addressed these dangers thoroughly.

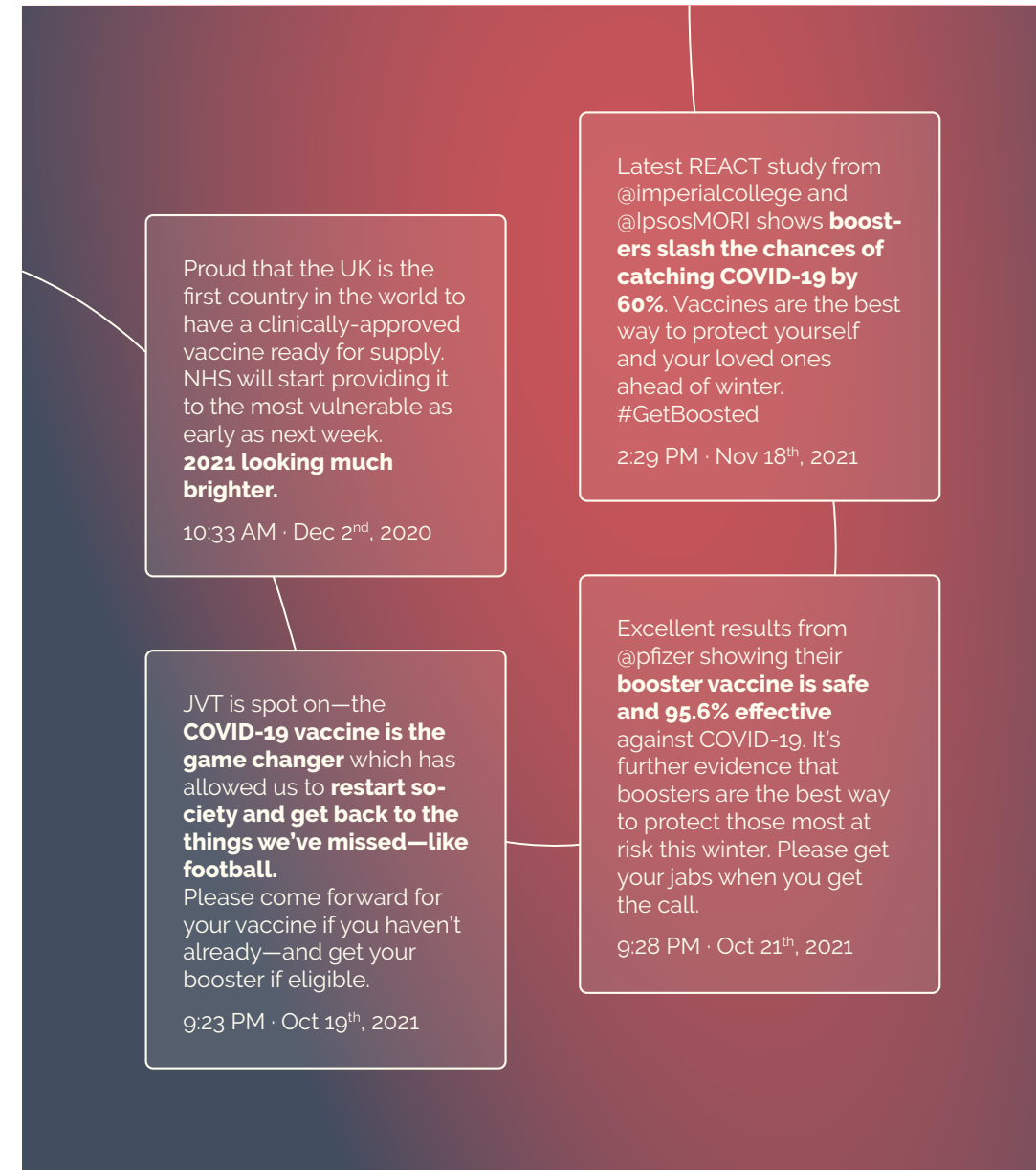


Fig. 3.3. Tweets by Sajid Javid

¹² <https://twitter.com/sajidjavid/status/1461325648396537865> (accessed on 01/02/2022).

4 Non-government related communication

This chapter aims to analyze the reach of non-government related communication about the COVID-19 vaccines on social media. Apart from the decision maker's regular updates on the state of vaccine development, the general public also took part in the discourse.

Here, leading scientists and doctors obtained a special role, with their regular appearances in talk shows and tweets they became the center of the debate. In the first part of this chapter, I am taking a look at the Twitter accounts of the most prominent scientists.

The debate was also not always driven by facts, but equally by emotions. The other extreme to the scientific communication formed anti-vaccination groups, who strongly opposed vaccination as the solution to overcome the pandemic. In the second part, I will look at the online presence of these groups on Facebook and some exemplary posts that were shared there.

4.1 Scientific experts

Leading scientists like virologists or epidemiologists were among the most influential personalities informing the public about the vaccines. On Twitter, their updates provided an alternative to the information by the governments, who had to keep their political agenda in mind and thus seemed to focus more on positive than negative news, as discussed in chapter three.

I researched on scientists from Italy, Germany and the United Kingdom that had regular appearances in radio or television, for example in talk shows, and that also had a high posting activity on Twitter. I then looked at their fields of expertise, the size of their Twitter following, and the amount of posts published since the start of the pandemic.

Using the tool Social Blade, I obtained the daily Twitter activity of the scientists. Data was not available from January 2020 in each case, but in some instances from March or April, however it provided sufficient insights into the scientist's Twitter activities. The data was obtained on December 2nd, 2021.

As for Italy, Roberto Burioni might be the non-government related public figure with the biggest reach. He is a virologist and professor and an open critic of Italy's anti-vaccination movement. On Twitter, he has 327.7 thousand followers, which is the highest number among the Italian scientists taken into account. Between January 2020 and November 2021, Burioni tweeted 11,440 times, by far the highest activity of all scientists or government officials analyzed.

Next is Ilaria Capua, who is a virologist, veterinarian by training, and former politician. She has 115 thousand followers and tweeted 3,123 times since January 2020, most of her posts were made in the summer of 2020, the first months of the pandemic.

Lastly, Walter Ricciardi is a doctor and former actor, and has a Twitter following of 51.8 thousand. No data was available for the specific timeframe, but his total tweet number of 27,931 suggests also a high activity since January 2020.

Comparing the Twitter activity to Italy's government officials, it becomes evident that these non-government related experts tweeted substantially more during the pandemic. They had less reach than Giuseppe Conte, but the same or in Burioni's case even more than Roberto Speranza, Italy's health minister.

In Germany, Christian Drosten has been one of the most well-known faces since the pandemic started. He is a virologist, professor and director of the Charité hospital in Berlin. With 861.6 followers, he has the most among the scientists analyzed, and tweeted 521 times, less than his Italian counterparts.

Hendrik Streeck is a professor and director of two scientific institutes in Germany. He was a controversial figure, accused of having been too pessimistic about the vaccines and having made misleading and false claims. In the summer of 2021, Streeck deleted a big amount of his tweets, probably due to the backlash that he faced.

The last German scientist observed is Karl Lauterbach, an epide-

miologist and politician. As of 2022, he is the current health minister of Germany, but at the time of the analysis, he was a politician of the opposition. He has 722.1 thousand followers and 5,221 tweets, the highest number among the German scientists.

Two things become apparent here. Firstly, Hendrik Streeck is an example of a pessimistic voice regarding the vaccines. The tone of communication was far more diverse than the one coming from the government. Secondly, the non-government related experts have a far bigger reach on Twitter, with Christian Drosden having more than three times as many followers than Jens Spahn.

The UK differs from the findings regarding Italy and Germany. Most of the communication revolving around vaccines seems to have come from the government's side, and not many prominent non-government experts could be found.

Ravindra Gupta, a professor at university of Cambridge who worked on COVID-19 rapid diagnostics, is an influential personality that has a Twitter account with 18.9 thousand followers and a total amount of 1,421 tweets. Here, no data is available regarding the selected time-frame though.

Chris Smith, a consultant virologist and science radio broadcaster who used his platform to talk about the coronavirus and the development of vaccines, has 9,551 followers, but has posted no tweets on his account as of yet.

An explanation could be that Twitter is simply not used by non-government related experts, but as outlined in chapter two, British officials have made extensive use of the platform and have an equally big reach there.

Leaving the United Kingdom aside, it can be concluded that non-government related experts tweeted substantially more than government officials during the pandemic. Roberto Burioni tweeted

11,440 times and Boris Johnson only 117 times, both being the most frequent Twitter users of their groups.

The scientist's numbers of followers also did not differ much from that of the politicians—it was smaller than that of the heads of government but mostly larger than that of the health ministers.

Regarding the communication, the experts also mentioned negative aspects of the vaccine development more frequently than government officials by doubting the efficacy of the vaccines or openly reacting to anti-vaccination groups.

4.2 Anti-vaccination movements

I will now focus on the communication by the vaccine's strongest critics. While most scientists believed in the efficacy and safety of the vaccines, anti-vaccination movements opposed them, using arguments that were not only based on scientific facts but also originated from the realm of conspiracy theories.

Anti-vaccination groups could be found across Europe and were accompanied by misinformation campaigns about the vaccines.¹ The target audience of these messages were people who were still hesitant to get vaccinated, aiming to grow the anti-vaccination movement in Europe. The online presence of some of these groups will be analyzed in order to find insights into their communication. Here, Facebook is the ideal source, being the central platform for open group discussions.

I examined the three largest groups among the Facebook search results for Italy, Germany and the United Kingdom, and for each group at some exemplary posts that were recently made. The information

¹ In a case from July 2021, European Youtubers including Mirko Droschmann from Germany and Léo Grassed from France stated that they had been contacted by an agency called Fazze to promote false information about the vaccines. Fazze is part of a digital marketing company from Russia. The Youtubers were asked to spread wrong, supposedly leaked death rates of the mRNA vaccines. (Source: <https://www.bbc.com/news/blogs-trending-57928647>, accessed on 03/03/2022).

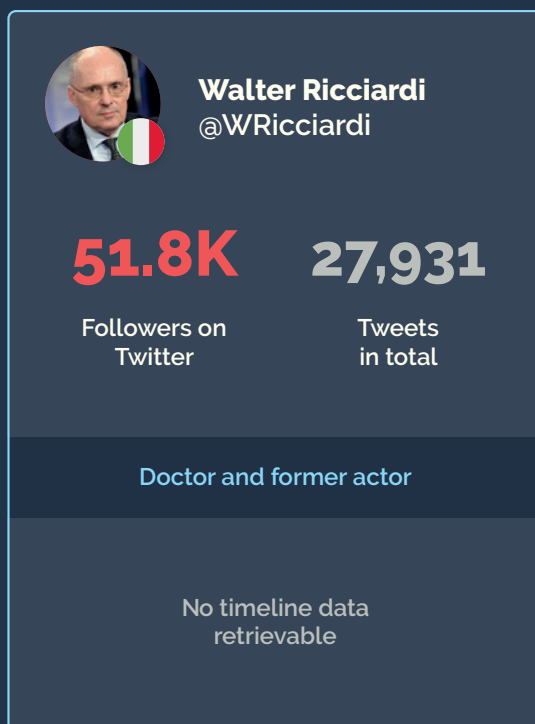
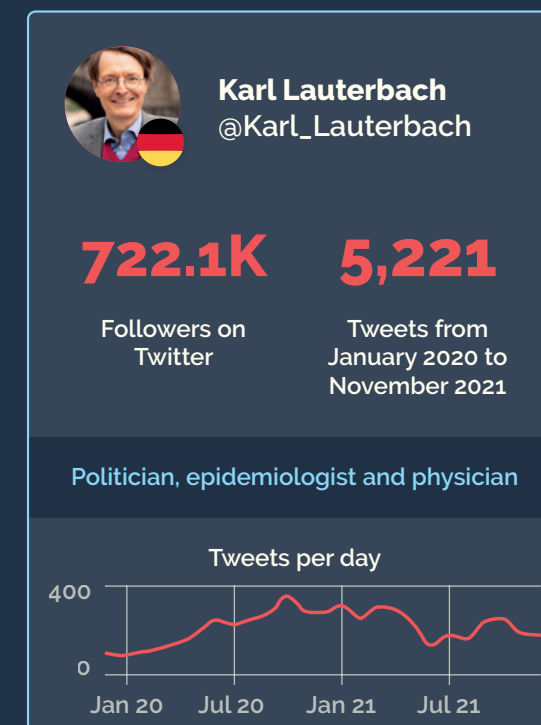
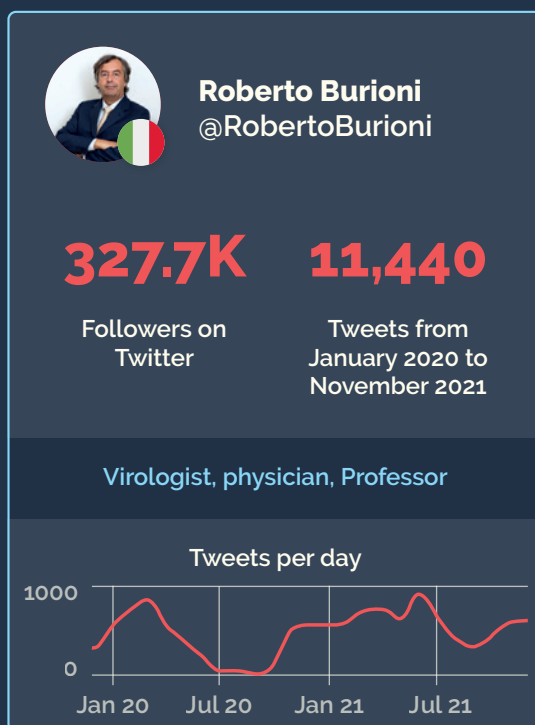


Fig. 4.1. Non-government related experts on Twitter (December 2nd, 2021)

was retrieved on December 10th, 2021.

The largest Italian group among the Facebook search results was *non molliamo ! "NO VAX" with 2,808 members*. The group profile picture includes a text stating "They have made us turn against each other for not letting us turn against them" under the silhouettes of two men arguing, with the Italian flag as a background.² This suggests a political discussion with a proximity to conspiracy theories. Because it is a private group, though, no individual posts could be accessed.

Another group is *Novax* with 340 members, which shows similar tendencies.³ One of the most recent posts shows the image of a person showing facial features which are similar to a wolf. This is accompanied by a caption stating that the sheep are the ones who got vaccinated, but the wolves will prevail. Another user warns in a post that from now on, vaccines will be sprayed through the air conditioning systems in Milanese trams. This claim, while scientifically unfounded, still found support in the comments.

In a third Italian group called *no vax*, a post can be found linking to an alternative news media article stating that the vaccine is a poison. The cover image of the group shows a protest banner criticizing the green pass.⁴

The largest German group is *Impfung? NEIN DANKE!* with 8,799 members.⁵ Here, one post links to an open letter from supposed doctors saying that the vaccines could be harmful. Other screenshots and links

² <https://www.facebook.com/groups/938049356262967/> (translated, accessed on December 10nd, 2021).

³ <https://www.facebook.com/groups/157695109049292/> (accessed on December 10nd, 2021).

⁴ <https://www.facebook.com/groups/530675101345222/> (accessed on December 10th, 2021).

⁵ <https://www.facebook.com/groups/162812019341341/> (accessed on December 10th, 2021).

to articles can be found which state that medication would be a better method to fight the virus than vaccines or that vaccination sceptics would generally be well-informed and scientifically educated.

A second group, *Stillschweigende Impfgegner* or *Silent opponents of vaccination*, is openly accessible, but only posts by its creator can be found. They state that the group will not be a forum for discussing the virus, but merely by joining the group its members would set a sign against the virus.⁶

In another group called *Impffrei - Ungeimpft*, the video of a politician belonging to the German opposition criticizing the government can be found. A second post invites the group members to a demonstration against mandatory COVID-19 vaccines.⁷

The United Kingdom's group with most members is *Anti Covid 19 vaccine* with 1,449 members.⁸ The communication here seems to be more differentiated, in one post an unvaccinated health care worker expresses her fear to lose her job, another post asks why a booster is needed for a vaccine that was deemed effective after two shots, and a third features a video of a supposed doctor listing the dangers of the vaccines.

A group called *Non-Vax Mamas*, apparently meant for mothers to share their concerns about the vaccines, is private.

Finally, a third group is called *Citizens against COVID19 Vaccine*. Here, another link to an article can be found uncovering a supposed conspiracy where official data on the risks of vaccination will be held from the public for the next 75 years.

⁶ <https://www.facebook.com/groups/384654546362975/> (accessed on December 10th, 2021).

⁷ <https://www.facebook.com/groups/155136897867884/> (accessed on December 10th, 2021).

⁸ <https://www.facebook.com/groups/502306834231277/> (accessed on December 10th, 2021).

One post stood out from the others, in which a user seemed to derivate from the group's standpoint, saying that he had just received his vaccine. As a result, other users attacked him in the comment section.

Overall, the groups from all three countries had a similar amount of members, with the largest group coming from Germany.

Reading the posts shared in the anti-vaccination groups, it becomes evident that most of their members do not only criticize the vaccines but also the decision makers. Additionally, they don't base many of their statements on scientific facts and real political decisions, but often on conspiracy theories shared on social media. While Italian groups showed the highest amount of posts sharing fake news or conspiracy theories, they could be found in all of the groups examined.

The posts from the United Kingdom revolved most around the vaccines themselves, with the fewest number of posts criticizing the government or sensing conspiracies.



Figure 4.2. Anti-vaccination movements on Facebook

5 Vaccine hesitancy over time

In this chapter, I will examine the way the COVID-19 vaccines were received by the public. Since the outbreak of the pandemic, many polls have been conducted to measure vaccine hesitancy.

In the first two years of the pandemic, two main vaccine types were available in Europe, which were both released at the end of 2020. Those were mRNA and viral vector vaccines, as discussed in the chapters 1.1 and 1.2.

There are no static numbers on how these vaccines were received. The outbreak of COVID-19 meant an ever-changing status quo, which is why it is necessary to look at vaccine hesitancy over time and how it changed. The timeframe I chose was from January 2020, where the first cases occurred in Europe, to November 2021.

When the coronavirus was first found on the European continent, it only took a few weeks until it was widespread. The course of the pandemic varied across the countries though, and different measures were taken to contain the virus. Together with other factors, this led to vaccine hesitancy differing in the EU countries, thus more than one country should be taken into account. Like in the previous chapters, I selected Italy, Germany and the UK for a national comparison.

I used data from a study conducted by Ipsos which compares the willingness to get vaccinated of adults in 15 countries in four consecutive polls.¹ Since a context was needed to understand the results of the surveys, I also gathered information on key events that took place across the countries in the selected timeframe.

5.1 Italy

Italy was the first European country that was hit by the pandemic. The outbreak occurred in February 2020 in northern Italy, leading to a regional lockdown that was extended to the whole country in March.

¹ <https://www.ipsos.com/en/majorities-unvaccinated-adults-most-15-countries-would-get-vaccine-if-they-could> (accessed on 06/01/2022).

The first poll was conducted between July 24th and Aug 7th, at a time where the first vaccines were already undergoing testing. Here, vaccine hesitancy was relatively high with a mere 67% willing to take a vaccine.

In the end of summer, the second wave started, leading to record infection numbers and forcing the government to declare a new lockdown in November. The Italian zones model was also introduced, with red, orange and yellow zones indicating the anti-corona measures for each region.

At the end of the year, when the first vaccines were approved and rolled out, the second poll was conducted from December 17th to 20th, with 62% willingness to take a vaccine showing that the hesitancy had even increased from the first poll.

Two months later, when the vaccination campaign was well underway and possible side effects were more visible to the public, the next poll was conducted from February 25th to 28th 2021. It showed 85% willingness to get vaccinated, a significant increase from the previous poll.

In the coming month, the situation relaxed and the first white zone, with the most relaxed anti-COVID rules, was declared in Sardinia. A new lockdown took place only to prevent travel during the Easter holidays. The poll conducted between April 22nd and 25th shows an increase in vaccine hesitancy, with now only 79% of the unvaccinated willing to take the vaccine. This number, though, could also be influenced by the fact that at that time, some of those wanting the vaccine had already received it.

5.2 Germany

As with in Italy, the first cases of COVID-19 were found in Germany from the beginning of the year. The outbreak, though, occurred several weeks later, with cases reaching the 100,000 mark in April.

After the first lockdown, the poll on vaccination willingness showed 67%, the same number as Italy. A difference is that early on, protesters

demonstrated against the measures taken, with a demonstration of 40,000 taking place in Berlin in August 2020.

Upon rollout of the first vaccines, only 65% were willing to take it. This number rose to 74% in February 2021 after the third wave hit the country, which is significantly lower than the Italian poll result. In April, this number further dropped to 71%. Upon the compared countries, Germany shows the highest vaccine hesitancy, which could be the reason for the stalling progress of the vaccination campaign by the end of the year.

5.3 United Kingdom

Like in Germany, the first lockdown in the UK started in March of 2020. Over time, the situation worsened, with the country's death toll becoming the second highest in the world by May. This could be a contributor to the results of the first poll conducted in July and August, where 85% of people were willing to get vaccinated.

After the AstraZeneca viral vector vaccine was approved as the world's first COVID-19 vaccine, and the vaccination campaign started in December, this number had dropped to 77%, which is a reduction like in Italy and Germany, yet still the highest of the three.

In January 2021, the UK reached the mark of 100,000 coronavirus-related deaths and a third lockdown was imposed. In the month after, 87% of vaccination willingness were reported.

As public life started to reopen, like with Italy and Germany, it dropped again to 77%. Again, a reason could be that by this time many people had already taken the vaccine.

Overall, the UK shows Europe's highest death toll, and at the same time the lowest vaccine hesitancy in the initial stages of the pandemic.

Similarities across the countries can be found in the change of vaccine hesitancy: In all three countries it increased shortly before the release of the vaccines. Then, two months later, people showed the highest

willingness to take the vaccine. People then became more hesitant again, which could be due to the decreasing number of unvaccinated among the population.

Among the examined countries, Germany stands out as the country with the highest vaccine hesitancy. This manifested early on in the pandemic in country wide protests against the measures to contain the virus, that later mostly targeted unvaccinated people.

The United Kingdom, on the contrary, showed the highest willingness to take the vaccine, which could be due to its exceptionally high number of deaths linked to the coronavirus.

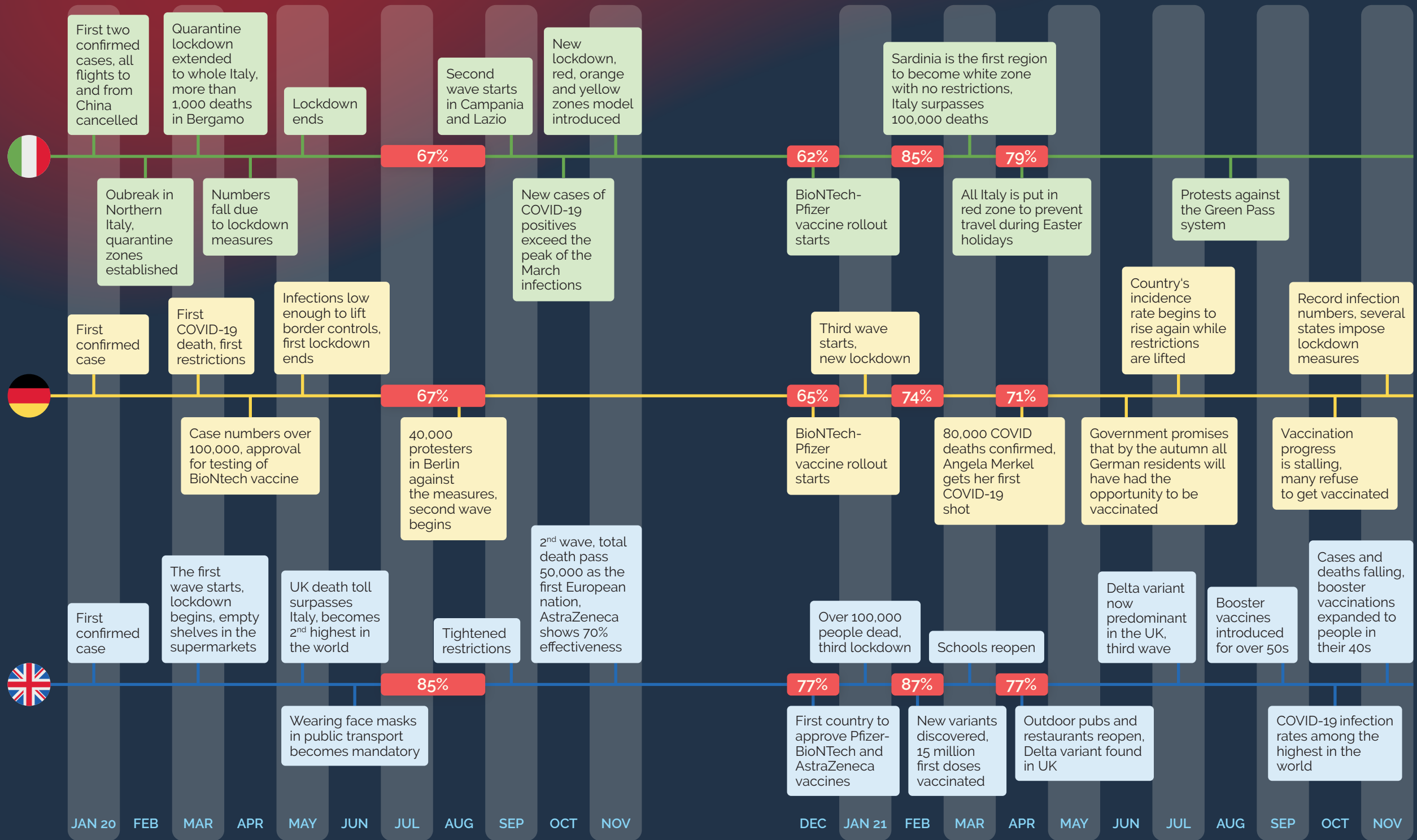


Figure 5.1. Key events across the country matched with vaccine readiness polls (in red)

6 Poll on vaccine readiness

In order to gain more in-depth insights into the public opinion about vaccines, I conducted a poll about vaccine readiness in the previously examined countries Italy, Germany and the United Kingdom.

Vaccine readiness is a term describing “a set of components that increase or decrease an individual’s likelihood of getting vaccinated”.¹ Prior to the pandemic, five components (5C) of vaccine readiness have been identified:²

- *Confidence*, the level of trust in the safety and effectiveness of vaccines and in the information shared by health authorities and experts
- *Complacency*, the tendency to perceive a disease too low and thus to ignore vaccines
- *Constraints*, hurdles of any form that occur in daily life and prevent patients from getting vaccinated
- *Calculation*, how much a person weighs the downsides and benefits of a vaccine
- *Collective responsibility*, the tendency to consider the protection not only of oneself but also of others in the decision to vaccinate.

According to *Measuring the 7Cs of vaccination readiness*, two components can be added to this list in the context of the current pandemic:³

- *Compliance*, the support for the limited personal freedom during the pandemic, caused by societal monitoring and sanctioning of unvaccinated people

¹ Av. Vv., *Measuring the 7Cs of vaccination readiness*, in Aa. Vv., *European Journal of Psychological Assessment*, Berlin, European Association of Psychological Assessment, 2021.

² *Ibidem*.

³ *Ibidem*.

- *Conspiracy*, the tendency to believe fake news and conspiracies related to the COVID-19 vaccines.

In order to target these 7Cs, I adopted the questions proposed in *Measuring the 7Cs of vaccination readiness* and altered them slightly to distinguish between different types of vaccines. I decided to focus on vaccines using the mRNA technology since they are the newest type and were among the first COVID-19 vaccines that were released to the public. Those who took an mRNA vaccine form the first group of respondents. The other two groups were people that were vaccinated with the other available types of vaccines, and those that were unvaccinated. The division by vaccination status was made in order to see if opinions diverged across the groups.

In addition to these questions targeting vaccine readiness, I included four questions regarding the communication about vaccines, specifically about the respondent's view on the government as an information source and about how well they feel informed about the vaccines.

The questions were formulated as statements and the respondents were given five response options according to the Likert scale, ranging from *strongly disagree* to *strongly agree*. For each question, I then calculated the average of the responses.

Finally, I asked about the respondent's main source of information about the vaccines.

In total, the questionnaire consisted of 16 questions. It was shared with friends and family in Germany, the United Kingdom and Italy as well as on social media, and received 69 replies. Of those, 8.7% lived in Italy, 46.4% in Germany, 29% in the United Kingdom and 15.9% in other countries, whose responses were not taken into account. The poll is not representative and does not mirror the public opinion, but is a sample of it aiming to provide further insights into the topic. The results were collected between December 2021 and March 2022.

Regarding the vaccination status, all of the respondents in Italy were vaccinated with an mRNA vaccine. Also 90.6% of those in Germany had received a vaccine based on mRNA technology, while 9.4% had received a different type. In the United Kingdom, the vaccination status was more evenly divided, here 50% had received an mRNA vaccine, 25% a different one and the remaining 25% were still unvaccinated.

As for the first of the 7Cs, confidence, Germany shows the highest trust in the authorities. Italy and the United Kingdom have slightly less confidence, here the group of unvaccinated ranks the lowest with an average response of 3 out of 5. This was to be expected, since we have seen in chapter 4.2 that rejection of the vaccines is often connected to distrust in the authorities.

The same applies to the components complacency, the perception of risk regarding the virus, and constraints, structural or psychological hurdles in everyday life. In both aspects the people living in Germany showed the highest vaccine readiness, followed by Italy and then the United Kingdom.

Interestingly, the aspect of calculation, weighing the risks and benefits of the vaccines, shows a different outcome. All three countries show a high tendency to calculate the risks before taking a vaccine, pointing towards a low vaccine readiness in this component. This makes it an aspect that could be one of the biggest drivers of vaccine hesitancy.

The next question, targeting collective responsibility, shows a similar outcome as before, with Italy and Germany in the lead, followed by the United Kingdom's respondents that admit to a low feeling of responsibility, specifically regarding the group of unvaccinated people.

Regarding the aspect of compliance, the respondents were divided: Slightly more were in favour of compulsory vaccines and sanctions against unvaccinated, with answers falling towards either complete agreement or complete disagreement.

The last component of the 7Cs is conspiracy. The idea that the vac-

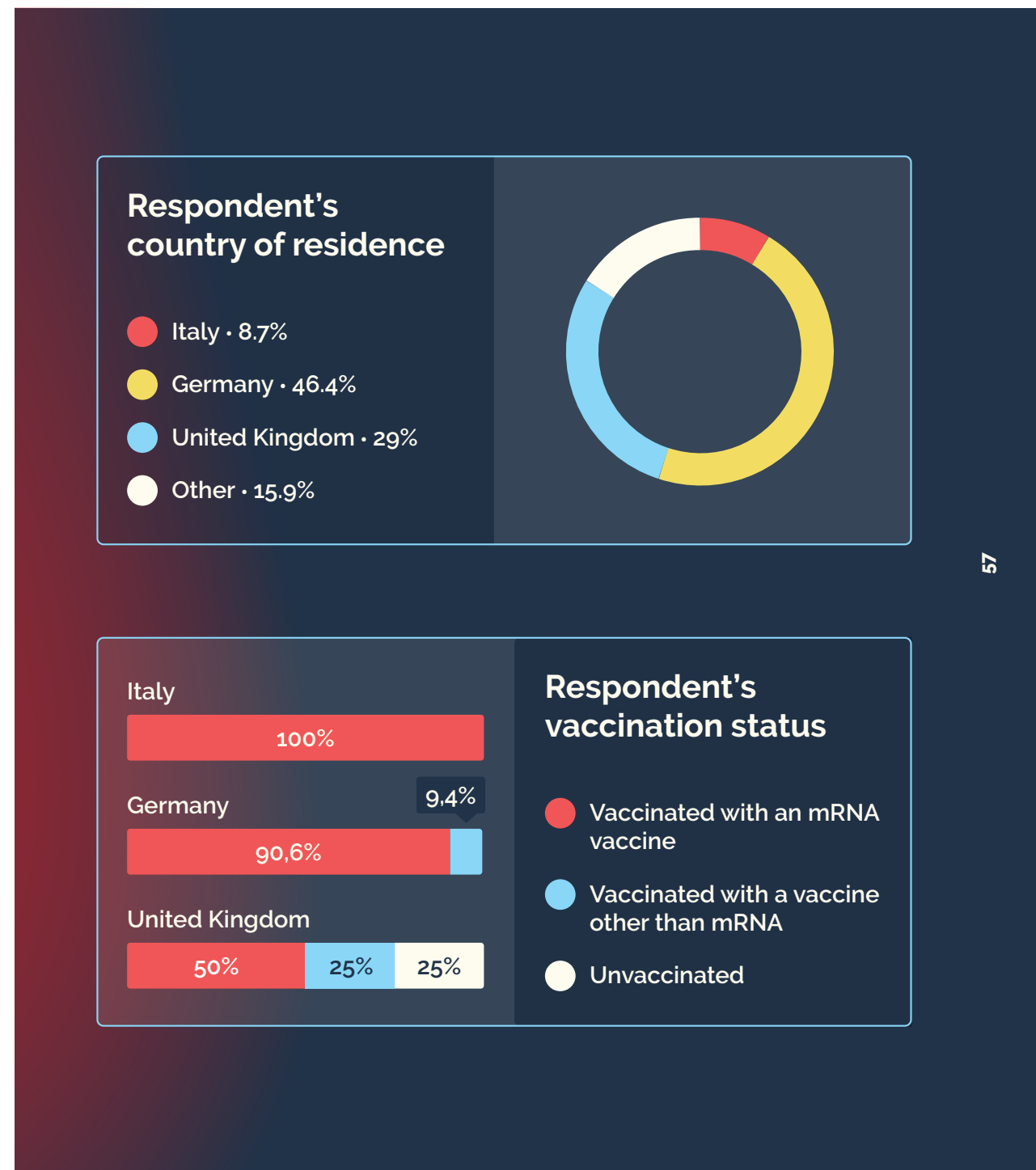


Figure 6.1. Respondent's country of residence and vaccination status

cines have more risks than benefits, which is the main belief of most anti-vaccination groups, is something that is rejected by most respondents. Here, those in the United Kingdom who had a vaccine other than mRNA and those who were unvaccinated showed the lowest vaccine readiness.

Upon examination of these poll results, it becomes clear that Germany shows the highest vaccine readiness, closely followed by Italy. This is a direct contradiction to the results of the poll conducted by Ipsos which was discussed in chapter five, where Germany showed the highest vaccine hesitancy and the United Kingdom the lowest. A reason could be a change of opinion since April 2021, when the last Ipsos survey was conducted.

A second finding is that the respondents who had received an mRNA vaccine showed a higher vaccine readiness than those who received a different type of vaccine. In addition to that, the results of the questions targeting the components calculation and conspiracy indicate that those who were vaccinated with a different type are more doubtful of the mRNA technology than those who had already taken an mRNA vaccine.

Expectedly, the respondents who were unvaccinated showed the lowest vaccine readiness in general. Specifically for the aspect of conspiracy though, both the unvaccinated and those who had received a vaccine other than mRNA who lived in the United Kingdom showed to be prone to conspiracy theories and fake news about the vaccines.

Italy proved to have a consistently high vaccine readiness, with the exception of the aspect of mandatory vaccines and sanctions against unvaccinated, an idea that most respondents opposed.

The second part of the survey aimed to investigate into the communication about the vaccines. Firstly, I asked how well the respondents felt informed about how the vaccines work. Here, Italy was in the lead

with most people claiming to have a very good understanding of the functionality of the vaccines, followed by Germany and then the United Kingdom, in both countries many admitted that they were lacking some information.

I then investigated into the perceived knowledge of risks and repercussions of the vaccines, where all countries only showed mediocre results.

The next topic was the respondent's opinion of their government in the context of the vaccines. Here, Italian residents trusted the least in it's government's decisions, while respondents in the United Kingdom had low trust in news about vaccine development and distribution coming from the government. German respondents showed a high trust in both aspects, an outcome that confirmed the result of the question regarding the confidence component of the 7Cs.

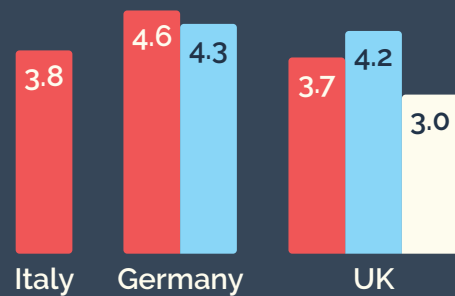
Lastly, I asked about the main source of information about the vaccines. Here, the internet showed to be the most used medium in all countries. Many respondents also used other, more traditional media like radio, TV, newspapers and magazines. What stood out that many also mentioned their friends and family as their information source, while others relied on scientific journals and institutes.

Respondent's vaccination readiness

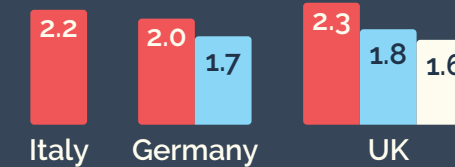
The answers show the calculated average and range from "Strongly disagree" (1) to "Strongly agree" (5)

- Vaccinated with an mRNA vaccine
- Vaccinated with a vaccine other than mRNA
- Unvaccinated

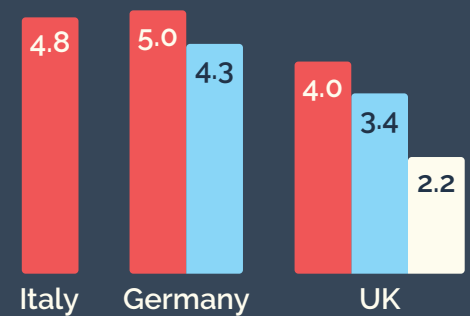
Confidence: I am convinced the appropriate authorities do only allow effective and safe vaccines.



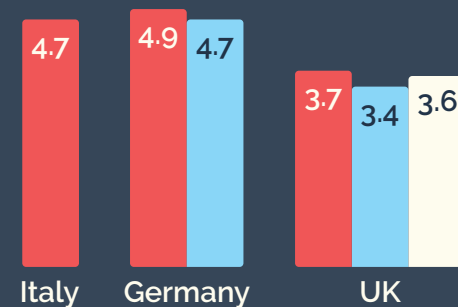
Calculation: I only took an mRNA vaccine because I saw the benefits clearly outweighing the risks. / I will only take an mRNA vaccine when the benefits clearly outweigh the risks. (Reversed answers)



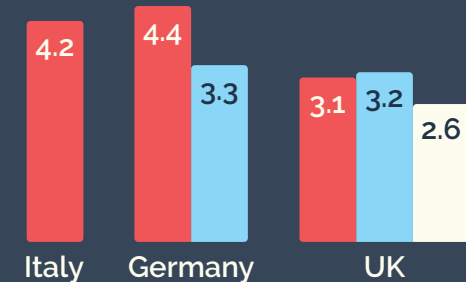
Collective responsibility: I see vaccination as a collective task for ending the pandemic.



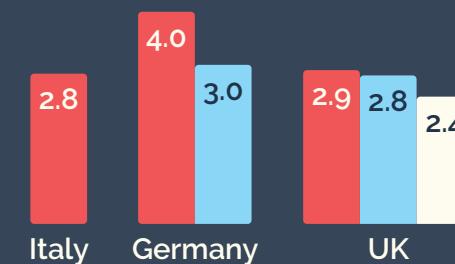
Complacency: I got vaccinated because I wanted to protect me and my close ones from getting infected. / If I get vaccinated, it is because I want to protect me and my close ones from getting infected.



Constraints: The vaccination against COVID-19 was so important to me that I prioritized getting vaccinated over other things.



Compliance: Getting vaccinated against COVID-19 should be compulsory and people who are unwilling to do so should be sanctioned.



Conspiracy: The new mRNA vaccines against COVID-19 have side effects and repercussions that are more serious than the disease they ought to protect from. (Reversed answers)

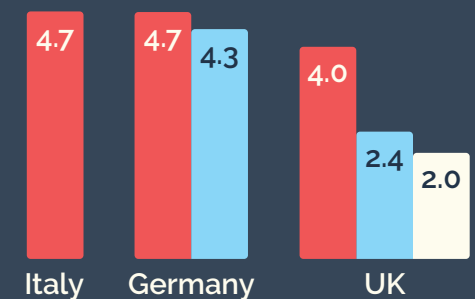


Figure 6.2. Poll results on vaccination readiness

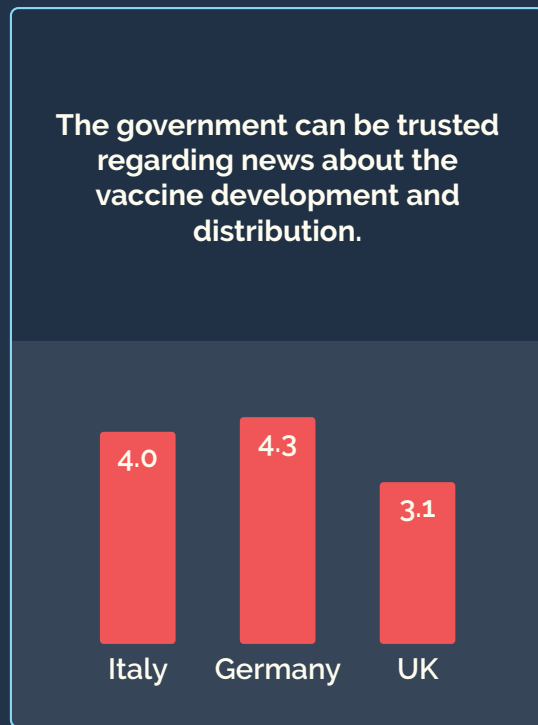
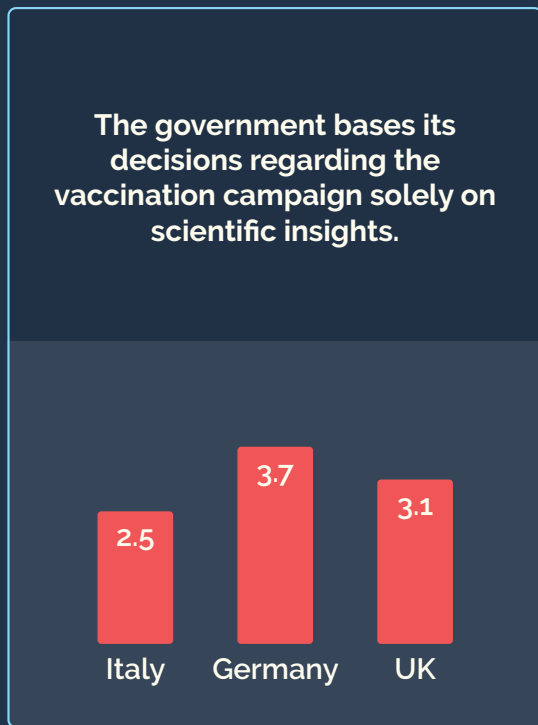
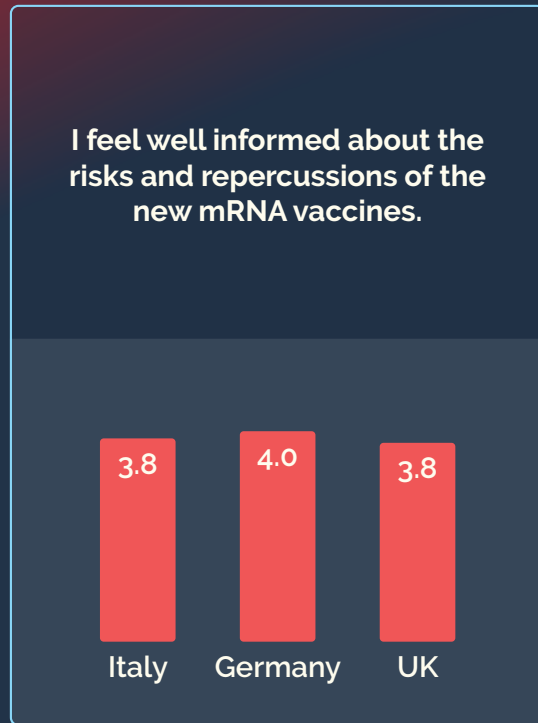
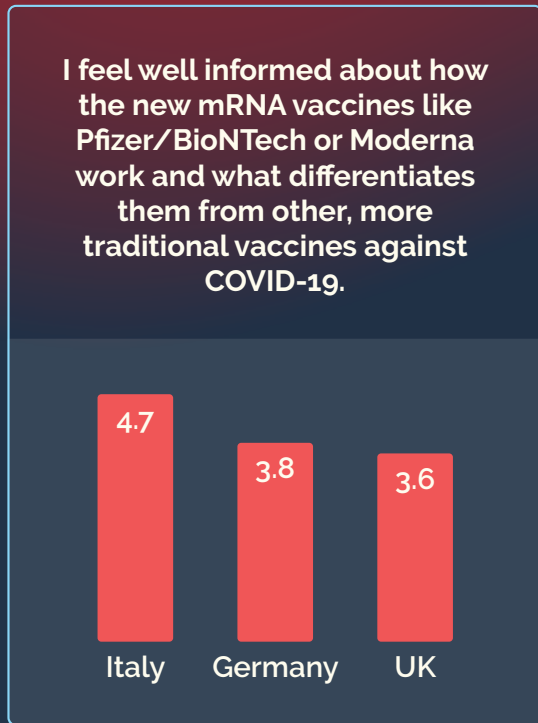


Figure 6.3. Poll results on communication about the vaccines



7 Personas

From the insights gathered through the poll, I created personas which represent the target audience of the design project. This helped identifying the user's needs and marked the starting point for the concept creation.


Since I gathered data from Italy, Germany and the United Kingdom, the three user personas represent respondents from these countries.

Similarities across all personas are that they are vaccinated at least twice and that all use the internet as their information source about vaccines. Another similarity is that all personas are primarily looking for vaccine risks, reflecting the poll results which showed that risk calculation was the respondent's biggest influence on their decision whether to get vaccinated or not.

Differences can be found in other types of information they are looking for. Giusy already has some basic knowledge about vaccines and is looking for a comprehensive comparison of the available vaccine's features, benefits and downsides. Kristin, on the other hand, is overwhelmed by the abundance of information available and wants a high-level overview of the risks that are involved with getting an mRNA vaccine. Lastly, David is also looking for general information on mRNA vaccines, mainly what they are and how they work in comparison to viral vector vaccines. To him, the source of information is also important, which derives from the insight that British respondents showed a distrust in information coming from the government.



Fig. 7.1. Persona 1: Giusy




Kristin
 Young mother

Nationality: German
 Age: 32 y/o

Accounting specialist
 Vaccinated twice with mRNA, recovered
 Regular internet user

“I want to make my **contribution to ending the pandemic by getting vaccinated, but only if it's **safe**.”**



David
 Family father

Nationality: UK
 Age: 47 y/o

Engineer
 Vaccinated three times with viral vector
 Sporadic internet user

“mRNA sounds like something that **influences your genes. It is still fairly new and honestly, I **don't trust it**.”**

66

Bio

Kristin sees vaccines as the best way to protect her and her family. After hearing a friend's story about severe side effects from mRNA vaccines, though, she has been hesitant to take the booster shot. Since she and her family recently recovered from COVID-19, she does not know if she should take the risk.

Personality
 Careful, protective

Technical skills

Desktop computer

Smartphone

Goals

She would like to know about the risks of COVID-19 vaccines. It should be easy to understand, since she does not have much time to look into details.

Frustrations

The abundance of information from the media as well as friends and family has left her confused about the dangers and benefits of getting vaccinated.

Fig. 7.2. Persona 2: Kristin

67

Bio

David's 13 year-old son got the offer from his school to get vaccinated. AstraZeneca, the one David received, is not offered for children, which is why his son would get an mRNA vaccine. He is now worried about the risks of this new technology and would like to learn more about it before allowing his son to take it.

Personality
 Honest, charismatic

Technical skills

Desktop computer

Smartphone

Goals

David would like to compare mRNA vaccines to viral vector vaccines. He needs something that shows the functionality in a way that is easy to understand.

Frustrations

David doesn't have enough time to learn much about mRNA technology, and has yet to find a good source of information. He is worried about the risks for his son.

Fig. 7.3. Persona 3: David

Part II Design project

8 Ideation

In this chapter, I will describe my ideation process that led from the research phase to the concept of the design project. It included gathering the existing knowledge in an affinity map, developing How might we questions and finally ideate on these questions.

8.1 Affinity map

I first gathered all the insights from the research phase. In order to start the ideation process as unbiased as possible, I looked at each topic similarly: The way the vaccines work, their risks and benefits, the communication regarding the vaccines and lastly the public's opinion derived from the poll results. All the insights were subsequently grouped into eight clusters according to the type of information and named to summarize the content.

8.2 How Might We questions

For each cluster, I then formulated a How Might We question. This helped transforming the insights into concrete problems, which could subsequently be tackled in the brainstorming process. The main areas of these questions were how to convey information about the vaccines, how to make it credible, how to inform about the risks of vaccination and how to address those who are still hesitant to take a vaccine.

8.3 Generating ideas

I then started brainstorming ideas for each problem. Even though I had some pre-existing ideas of how the final project could look, I tried to maintain a neutral perspective and not to discard ideas too quickly which I deemed worse than others. It also became clear that while many of the ideas could potentially solve one of the problems, the final concept could not address all of them. At the same time, the process already solidified my idea of how the final project should look, bridging the gap between loose ideas and the final concept.



Figure 8.1. How Might We questions (HMW) derived from the affinity map clusters

9 Concept

9.1 Aim

The final concept of the website addresses most of the previously formulated How Might We questions. Its goal is to provide those who are hesitant or doubtful about the vaccines with helpful information to facilitate their decision. A requirement is that it needs to be credible, which means that to the users it should be evident that the information was gathered purely from objective sources and not from sources following a political agenda. The information should then be presented in a way that is easily digestible for those who have a lower knowledge level, and at the same time comprehensive for those who want to conduct a more thorough research.

9.2 Requirements

Firstly, the project should have free navigation instead of guiding the user through the content since the user personas look for different types of information. Also, information providing and overview on the vaccine types and a list of the vaccine risks should also only be one click away so that the users can easily find what they are looking for.

The website targets users from different European countries, adding the requirement for easily changing the language.

As mentioned before, the project should have two layers of information: Firstly, general information that provides an overview of the topic, and secondly more detailed information on how the different types of vaccines work and what its benefits and downsides are. The presentation of the vaccine risks should fall under this category, since all users want a complete list of risks and side effects.

In order to address the credibility aspect, only scientific sources should be used. These sources should then be prominently displayed to increase trust and provide the opportunity for further research.

In case some users still have unanswered questions, each section should have a comment function where users can further discuss the topic. This feature should require creating a user account and logging

in, which could prevent hate speech and the spread of false information, since users should be able to be reported and then banned for such actions. Logging in should only be required for posting comments though, unobstructed access to the information has the highest priority in regards to the aim.

9.3 Website concept

I decided to give the project the name *spike*. It refers to the spike protein, an essential part of the coronavirus and targeted by most COVID-19 vaccines, as discussed in chapter one. The word *spike* was also a common one in a different context of the pandemic, a rapid increase of infections was frequently described as a *spike of infections*.

spike is a website with a mobile-first approach, allowing users to access information about the vaccines everywhere and anytime. Its design is based on social networks like Instagram. The reason for this is that social networks are the central place to discuss topics like the pandemic, making it some of the most important information sources online. Users will be able to find information on *spike* more easily if its layout is based on a popular social network. Many anti-vaccination groups also connect via social media, so people who are hesitant to get vaccinated might trust information more if it's presented in this way due to their viewing habits. The reason I mainly based my design on Instagram is that I wanted the high-level content to be visual, and since the platform focuses on photo and video sharing it was a good fit.

spike also contains content in similar forms as can be found on the social network. Information about the different types of COVID-19 vaccines is presented in the form of short animated videos to make it easily digestible and understandable. The videos play in a loop and by swiping vertically, the user can navigate from video to video. This way of presenting the content is inspired by Instagram's popular Reels feature and on the videos shared on TikTok. More complex information is presented in the form of images containing photos, illustrations

and text, which can be swiped through horizontally and is based on of the presentation of Instagram posts. Lastly, the comprehensive pages of information about individual vaccine types and the risks of vaccines are purely text-based. This last page allows the user to select a vaccine type and than a vaccine belonging to that type, to see all the possible side effects associated to the vaccine, with information on their likelihood.

9.4 Scope

From the homepage, the users are able to access every part of the website with just one click. On the very top, the general information about the vaccine types can be accessed. Short animations show the different approaches, how each vaccine type trains the immune system to fight the virus, and the date of their invention. Below, a link to the vaccine side effects can be found, where, as mentioned, the users can see the side effects associated with each vaccine. This side effects are ordered by their commonness with the most common side effects on top. This list should include a navigation bar that allows the users to quickly switch the vaccines for a better comparison of side effects. It also needs to provide information on possible high-risk groups who are advised to restrain from taking the vaccine.

Next, texts, images and infographics provide information about the spike protein as well as the immunisation process and where each different type of vaccine enters this process. Lastly, all vaccine types have a dedicated page where users can see which available vaccines belong to this type and read about their benefits and downsides.

Each section should then also contain a list of sources that where used, and a dedicated section should provide a complete list of all sources used on the website. As previously mentioned, the users will also be given a room for discussion on each of *spike's* subsections. Users that create an account will be able to reply to comments and report users that engage in spreading misinformation.

10 User Journey maps

In order to connect the personas with the website concept, I created User Journey maps that visualize the user's perspective of the product. I defined the different points of interaction that each of the personas would have with *spike* and then imagined their emotions as well as their thoughts at each step.

Even though the user journeys show similarities, the personas visit different pages and in a varying order, confirming the need for a free navigation with easily accessible subsections.

Giusy browses the website with her laptop and consumes the most content, the sources section provides her with additional information allowing her to keep on reading. Kristin on the other hand, accesses *spike* on the go, obtains some basic knowledge about mRNA vaccines and then engages in a conversation with other users to adress her open questions. David, looking for a comparison of mRNA vaccine and vector vaccine technology, browses the side effects of the vaccine types and then goes on to watch the animations for a broader overview of each type.

Giusy, 22

Student from Italy

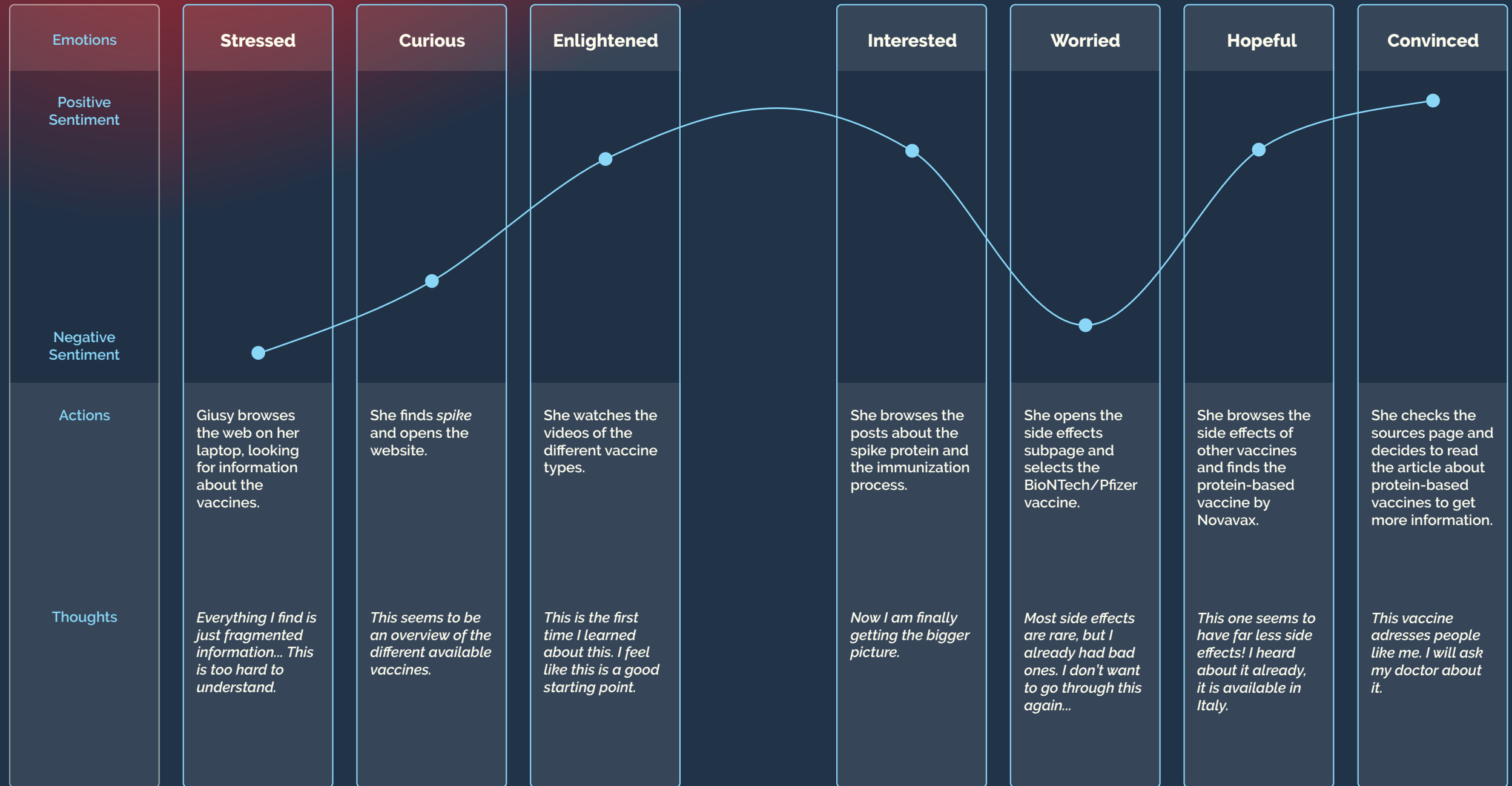
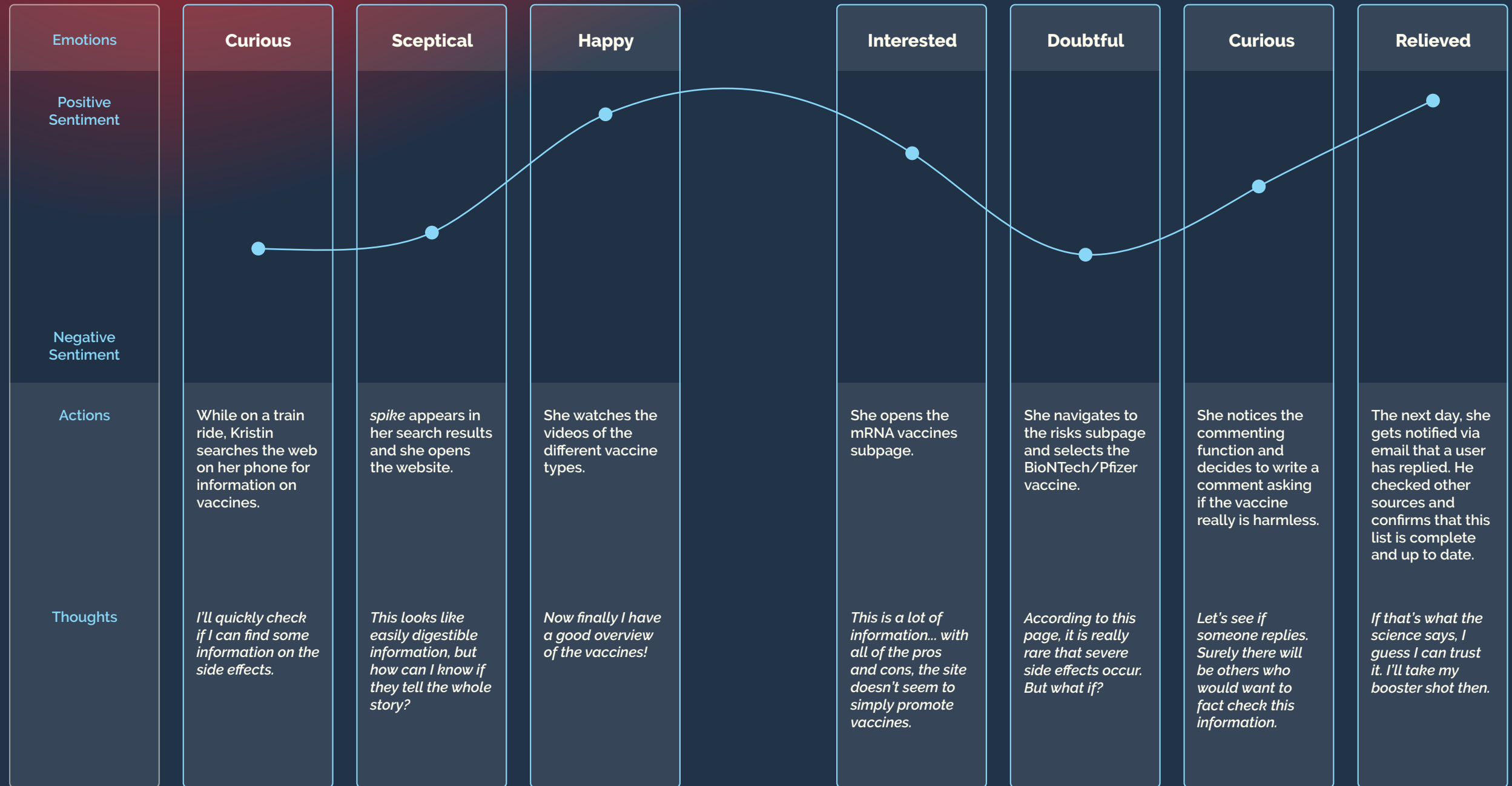


Figure 10.1. User Journey Map 1: Giusy

Kristin, 32

Young mother from Germany



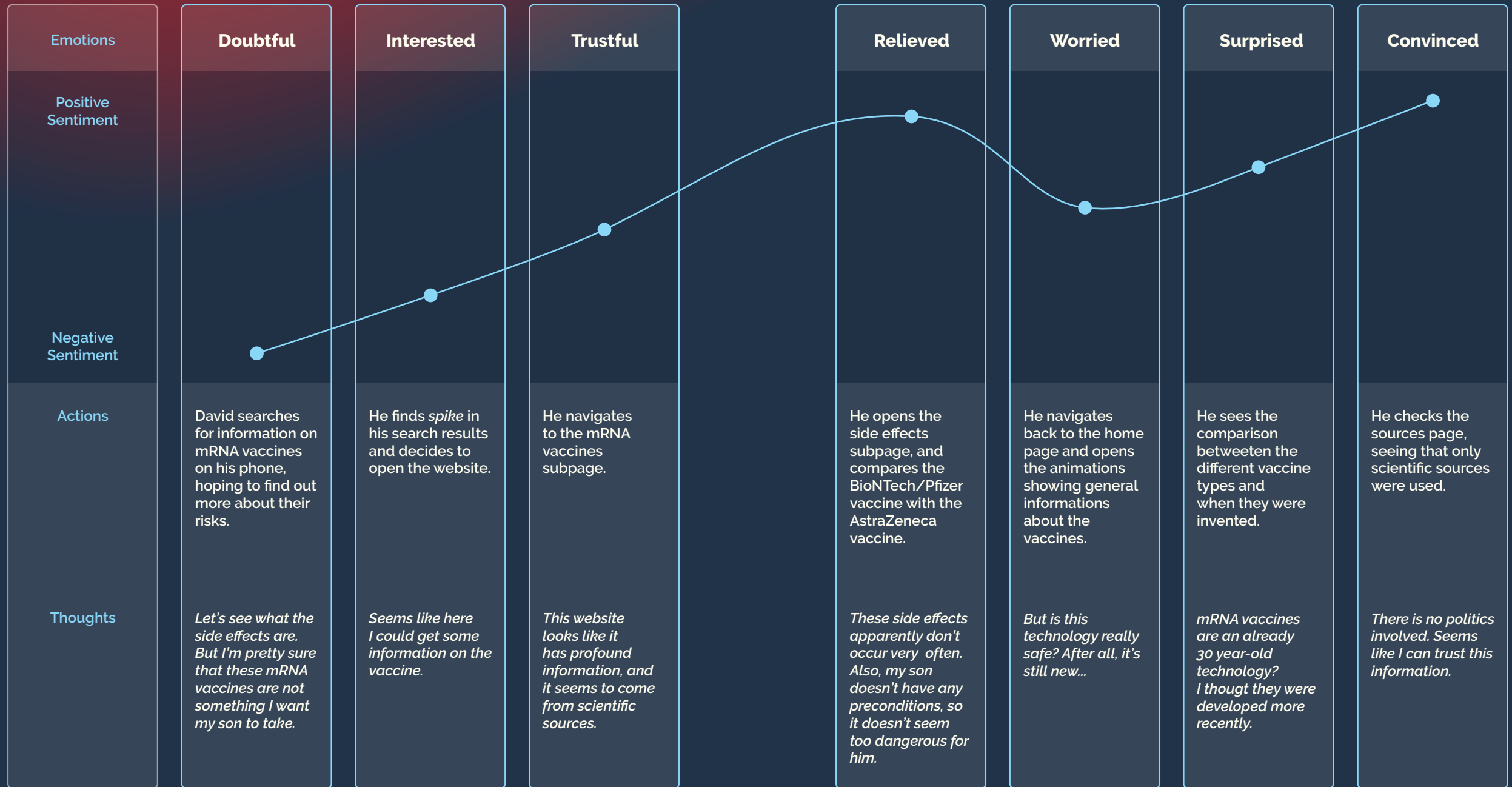
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Figure 10.2. User Journey Map 2: Kristin

David, 47

Family father from the United Kingdom



80

81

Figure 10.3. User Journey Map 3: David

11 Sitemap

Keeping the user's needs in mind, the site map defines the final structure of the website. As mentioned before, all subpages are accessible from the home page, making each piece of information as easily obtainable as possible.

Each content page contains a comment section as well as a dedicated list of sources.

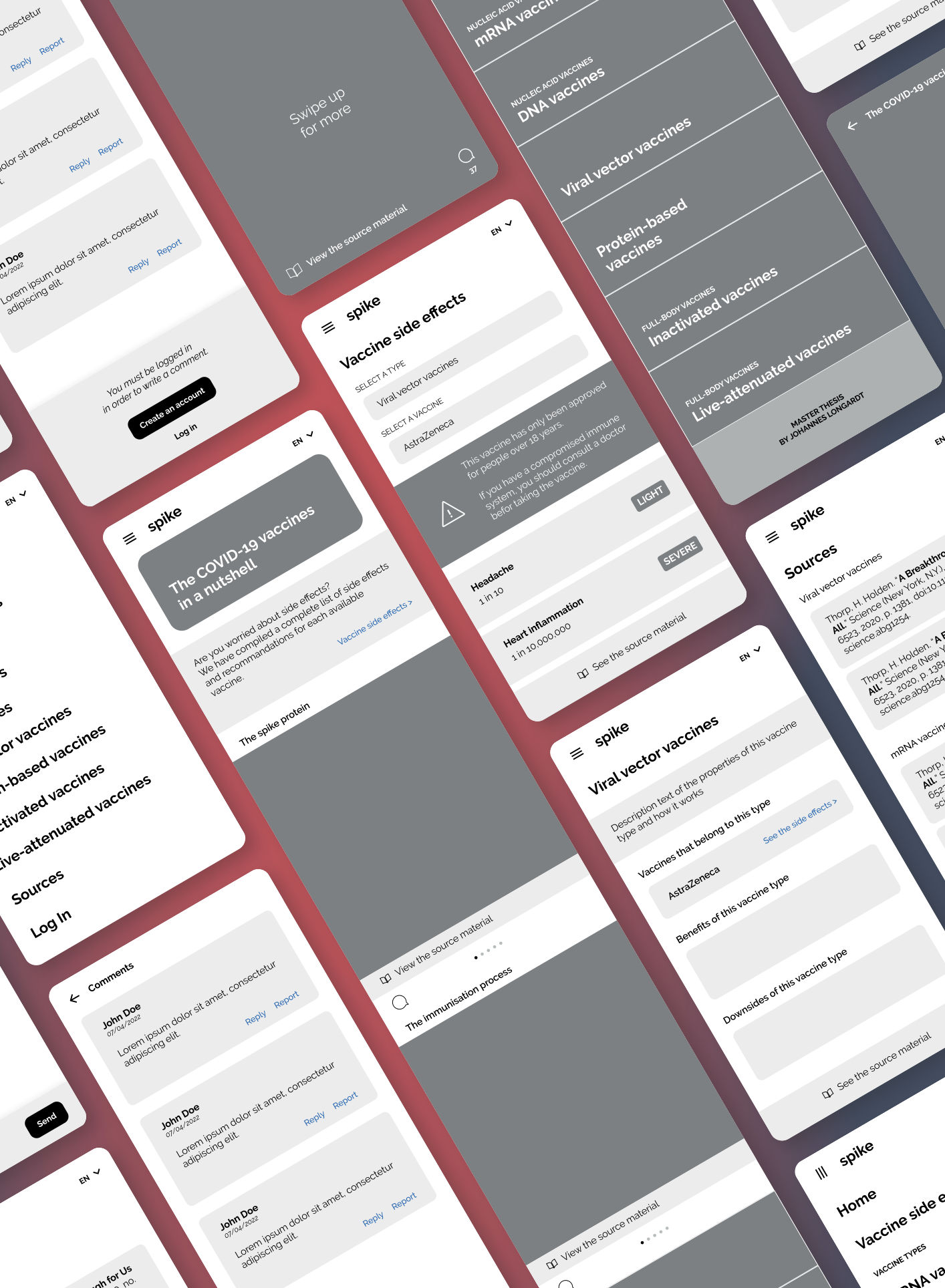
Next to providing links to the subpages, the home page also contains information about the spike protein and the immunisation process which are presented as scrollable series of images that, as discussed before, resemble Instagram posts.

The most prominent subpage is the overview of the different types of COVID-19 vaccines presented in the form of animated videos. The list of side effects, being equally important, can also be accessed from the top of the home page.

The different subpages providing more in-depth information about each vaccine type as well as the list of sources can be found further down on the page.



Fig. 11.1. Sitemap



12 Prototyping

The low-fidelity prototype was the next step in the process. It includes all sections and subpages of the website, shows the page layouts and simulates the user interactions by making buttons clickable and creating links between the pages. What is left out are final design elements and the final page content in order to focus purely on functionality.

Prototyping helped me make different arrangements of content in quick succession, testing the layouts and quickly iterating the prototype. The concept could also be validated regarding the requirements discussed in chapter 9.2.

The prototype includes the homescreen and a menu section for accessing the subpages at any point. The section resembling Instagram Reels was drafted as well, the side effects page showing the process of selecting a vaccine subtype and then a vaccine in order to retrieve a list of side effects, and an exemplary page for the six vaccine subtypes including a list of vaccines belonging to a subtype, the subtype's benefits and downsides. Lastly, the sources page and the comment function were included.

Figure 12.1. Low-fidelity prototype screens

13 Visual identity

In order to create the high-fidelity prototype, I defined the design guidelines that were to be applied throughout the website. This included the typography, color choices and visual elements. The aim of the visual design was to create an appealing experience inviting the users to browse the content, while still maintaining enough clarity to let them find information directly in case they are looking for something specific. The colors and shapes should also reflect the seriousness of the topic.

The primary colors are a dark blue used as the background color and a red gradient reaching in from the top. The choice of blue and red has several reasons, firstly, both colors are often associated with a medical context. The red gradient also symbolizes the coronavirus as an intruder, while the dark blue can be associated with the immune system fighting back.

Secondary colors include a bright red and a light blue, both are used for highlighting elements such as texts or icons. A warm white is mostly used for text paragraphs, providing a strong contrast to the background color, and a bluish black serves as the background color for elements that are meant to stand out. Three additional, tertiary colors come to use mainly in graphics and illustrations where more variety is needed.

The only font used in this project is *Raleway*. Its clarity and elegance allow for an objective, yet appealing visual communication. The style ExtraBold is used for headlines, while text paragraphs appear in Medium.

Other visual elements include containers and buttons which have rounded corners and a light, transparent hue which helps them stand out from the background. Thin, light blue outlines on some elements are used to attract attention and visually complement the typography.

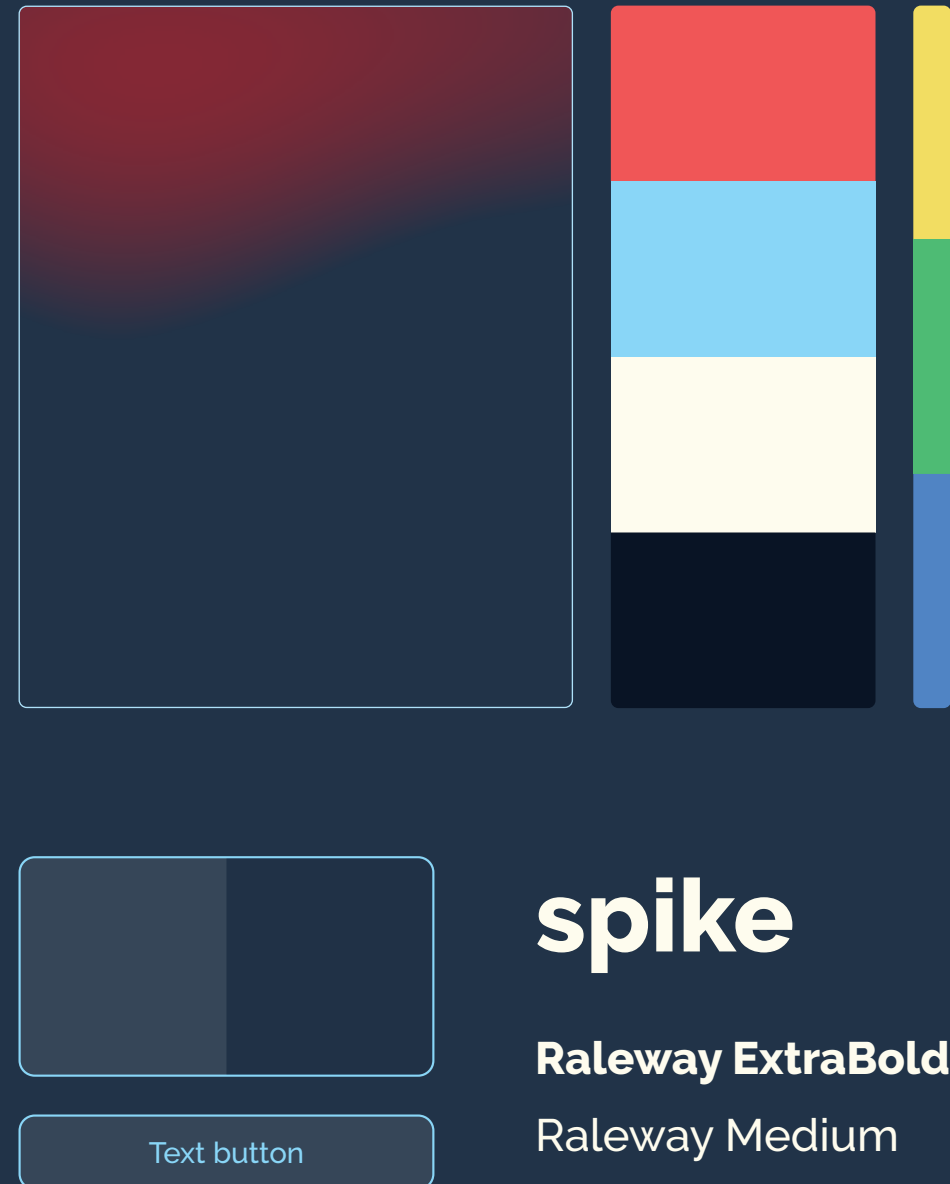


Fig. 13.1. Colors, typography and visual elements

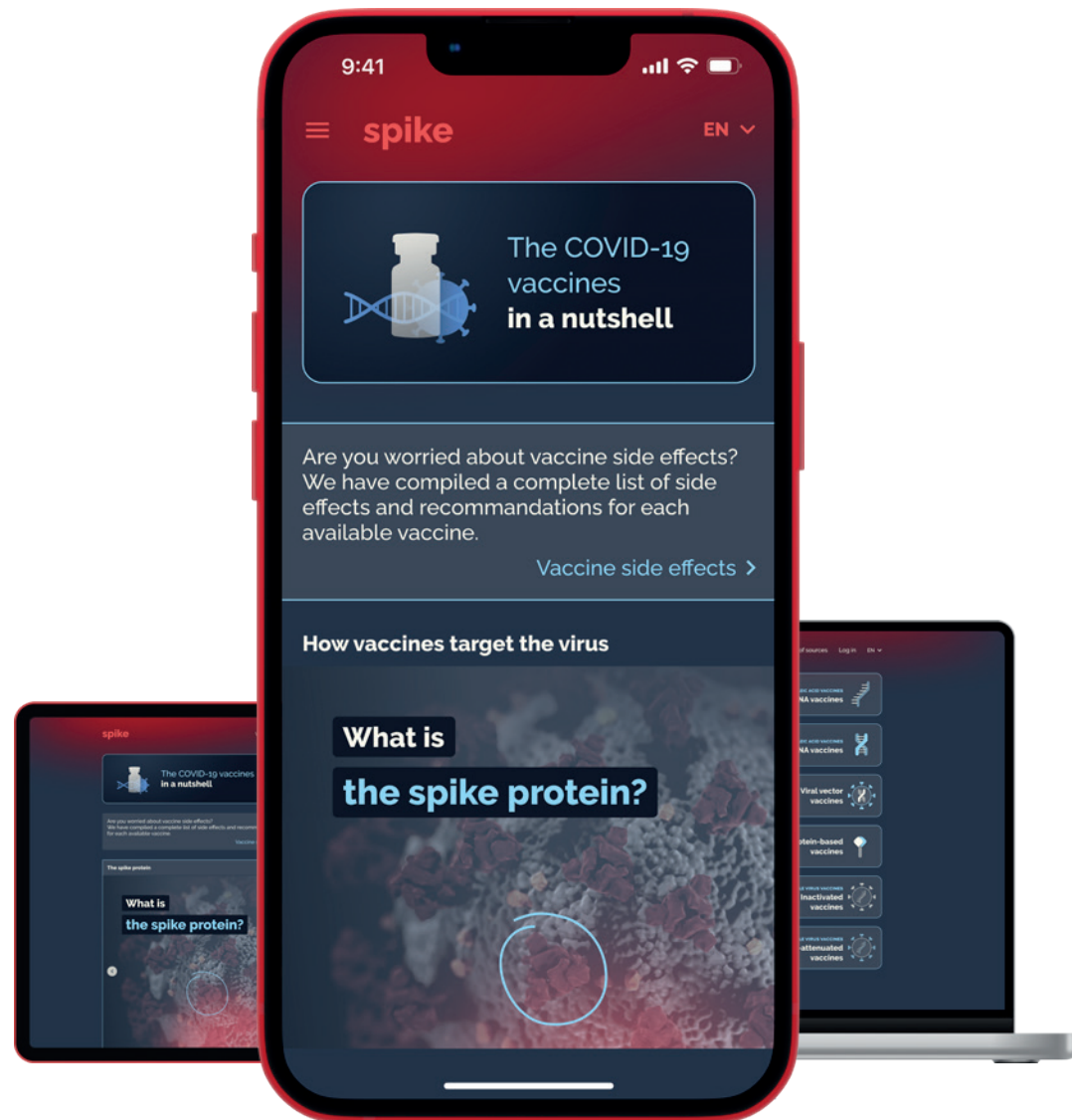


Figure 14.1. The *spike* homepage in its mobile and desktop versions

14 Final Design

With the visual elements defined, the design could now be applied to the website prototype containing the layout, functionality and user interactions. The finalized content was also added, allowing for a simulation of the final user experience with the product.

Two versions of the website were created, a mobile and a desktop version which was based on the mobile design.

On mobile, the homescreen content including the links to other subpages is vertically arranged, while the image content resembling Instagram posts can be explored through horizontal scrolling.

A menu which can be opened from the top bar makes links to the other subpages accessible from all sections of the website.

The desktop layout includes a sidebar which is sticky, meaning that it does not scroll with the rest of the content, containing links to the pages of the vaccine subtypes. The vaccine side effects and sources pages can be accessed from the top bar, making a dedicated menu obsolete.

Further, all scrolling and swiping interactions from the mobile version were replaced by buttons on desktop. This includes the image-based content as well as the series of short videos.

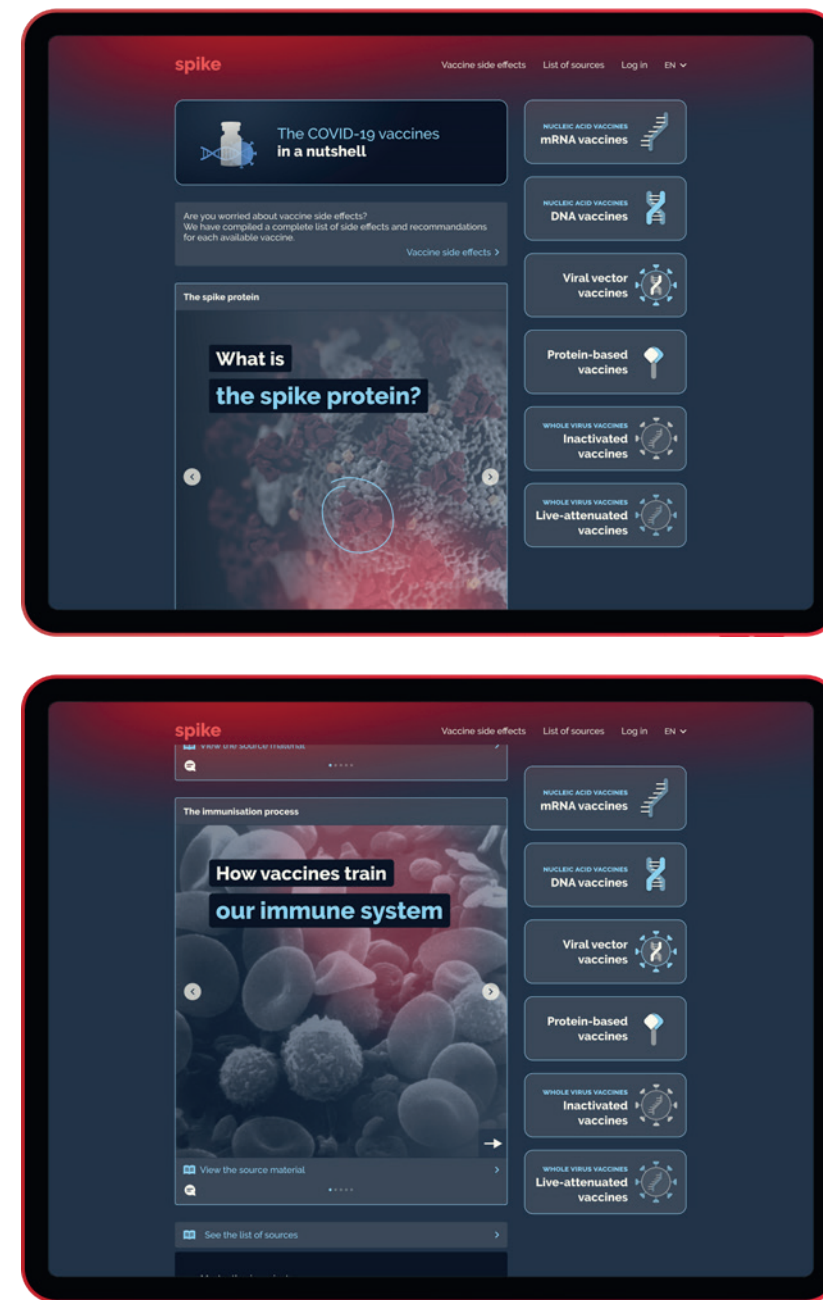
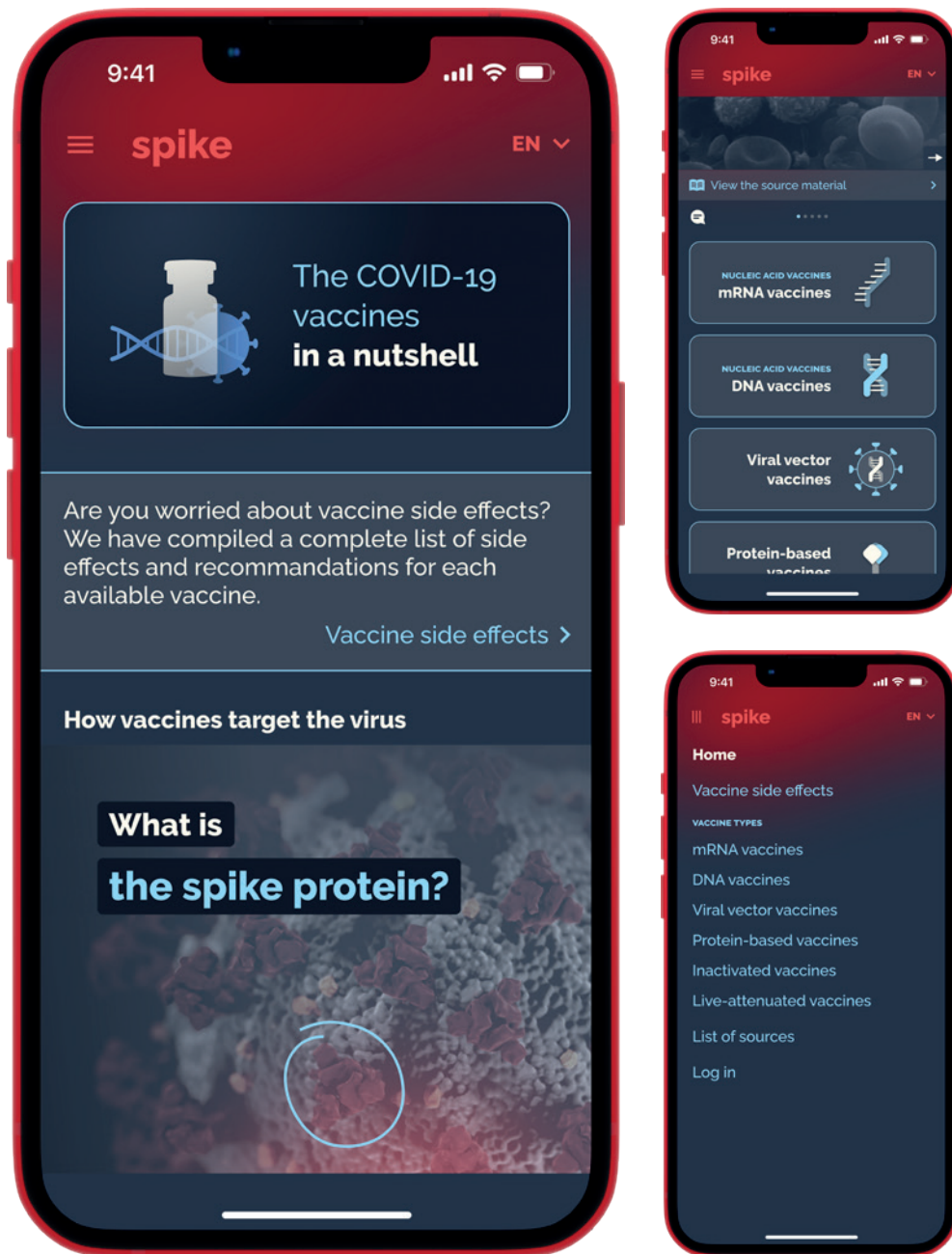


Figure 14.2. The *spike* homepage and navigation in its mobile and desktop versions

14.1 Animated and image-based content

The content based on Instagram's Reels and posts and Tiktok videos is intended to provide an overview of the vaccine types and their functionality in a way that is easily digestible.

The animated videos are split into seven separate videos, each less than 30 seconds long. A narrator is providing context for the animations and subtitles are included in each video, keeping users in mind who are in public places and have the sound of their devices muted.

The first video provides a short explanation of the general functionality of vaccines. This is followed by a video introducing the four different types of COVID-19 vaccines. Next, four videos give further information about each vaccine type. The last video is a conclusion, underlining the efficacy of vaccines.

On mobile devices, the users can tap their phones in order to pause or unpause a video. Swiping up or down, they can browse through the videos. As previously mentioned, the desktop version provides buttons to browse through the videos, facilitating the interaction with a computer mouse. On desktop, the videos also open in a pop-up window with the rest of the content fading out. Only the sources used for the videos and the comments section are accessible while the user watches the videos, allowing for less distractions and a more immersive experience.

The content resembling Instagram posts can be found on the homepage and is split into two segments. The first part is about spike proteins, what they are and why most COVID-19 vaccines target this part of the virus. The second part explains the immunisation process and where the vaccine types enter this process, as shown in figure 1.1. This information aims to build on the content from the animated videos, further explaining the differences between the vaccine types.

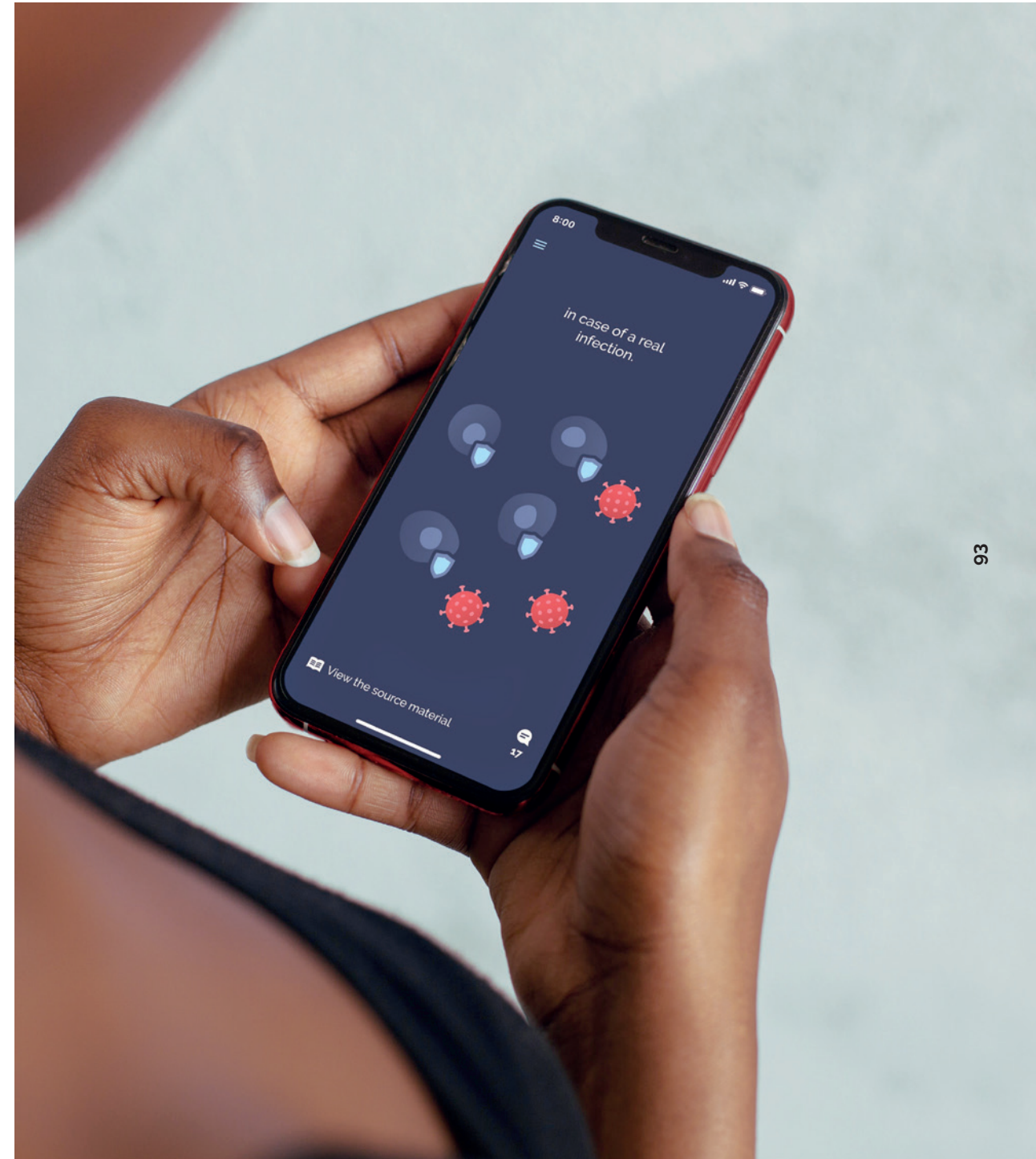


Fig. 14.3. Still of an animated video explaining the functionality of vaccines

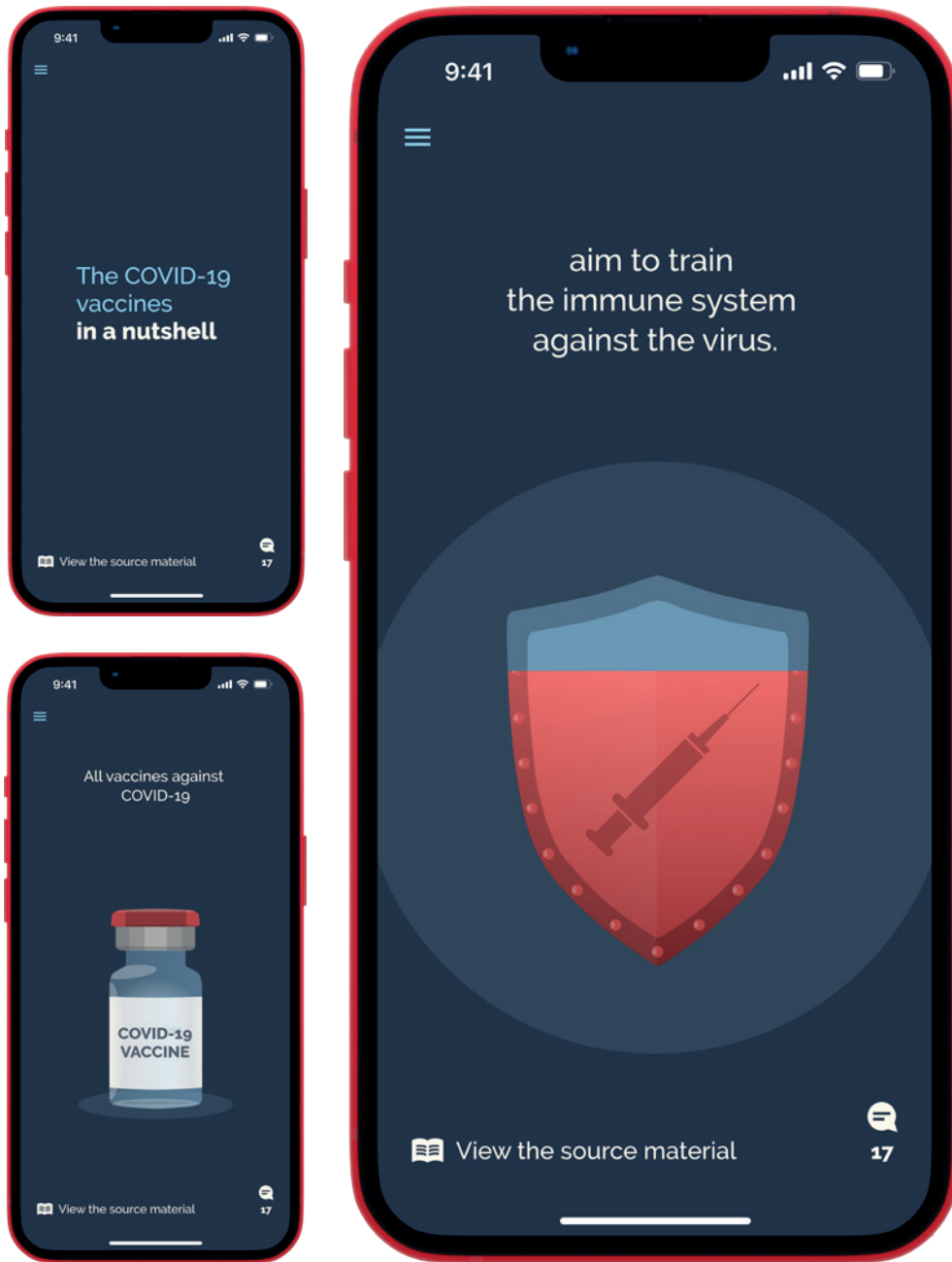


Figure 14.4. Animation stills of the introduction to COVID-19 vaccines



Figure 14.5. Animation stills introducing the different types vaccines



Figure 14.6. Image-based content explaining the spike protein and the immunisation process



Figure 14.7. An animated video displayed together with the sources list on a tablet

14.2 Text-based content

The text-based content addresses some user's needs for in-depth information about the vaccine subtypes and the individual vaccines.

Six dedicated pages present each of the vaccine subtypes. An introductory text provides information about the functionality of a type, followed by a section listing each available vaccine belonging to this type. Two subsequent sections list the vaccine type's benefits and downsides. In each of these sections, elements can be expanded for more information. In the section listing vaccines belonging to the type, a link provides access to the vaccine's list of side effects.

The side effects list is a section which is of high importance to all personas, as discussed in chapter seven. This page contains information about the groups of people who should not take a vaccine or consult a doctor first, and a comprehensive list of side effects sorted by their commonness. Users choose a vaccine type and then a vaccine belonging to the type, then the desired information is displayed. This selection menu allows for quick switching and comparing of vaccines.

The last subpage is a list of sources used for the website, sorted by topic. This allows users to verify the information or, if they want to further deepen their knowledge, to keep on reading.

As previously mentioned, each page also contains a comment section, where users can discuss the topic after logging in, and a dedicated list of sources.

While this type of comprehensive content requires a text-based design, more graphical approaches could be considered for future iterations of the website. For example, infographics providing a better overview of the commonness of side effects or a timeline showing when each vaccine type was invented and first used could be added.

Since the pandemic is still evolving, the website should also remain up to date regarding new vaccine types and scientific insights. It could also be adapted regarding possible new variants or other pathogenes.



Figure 14.8. The viral vector vaccines subpage

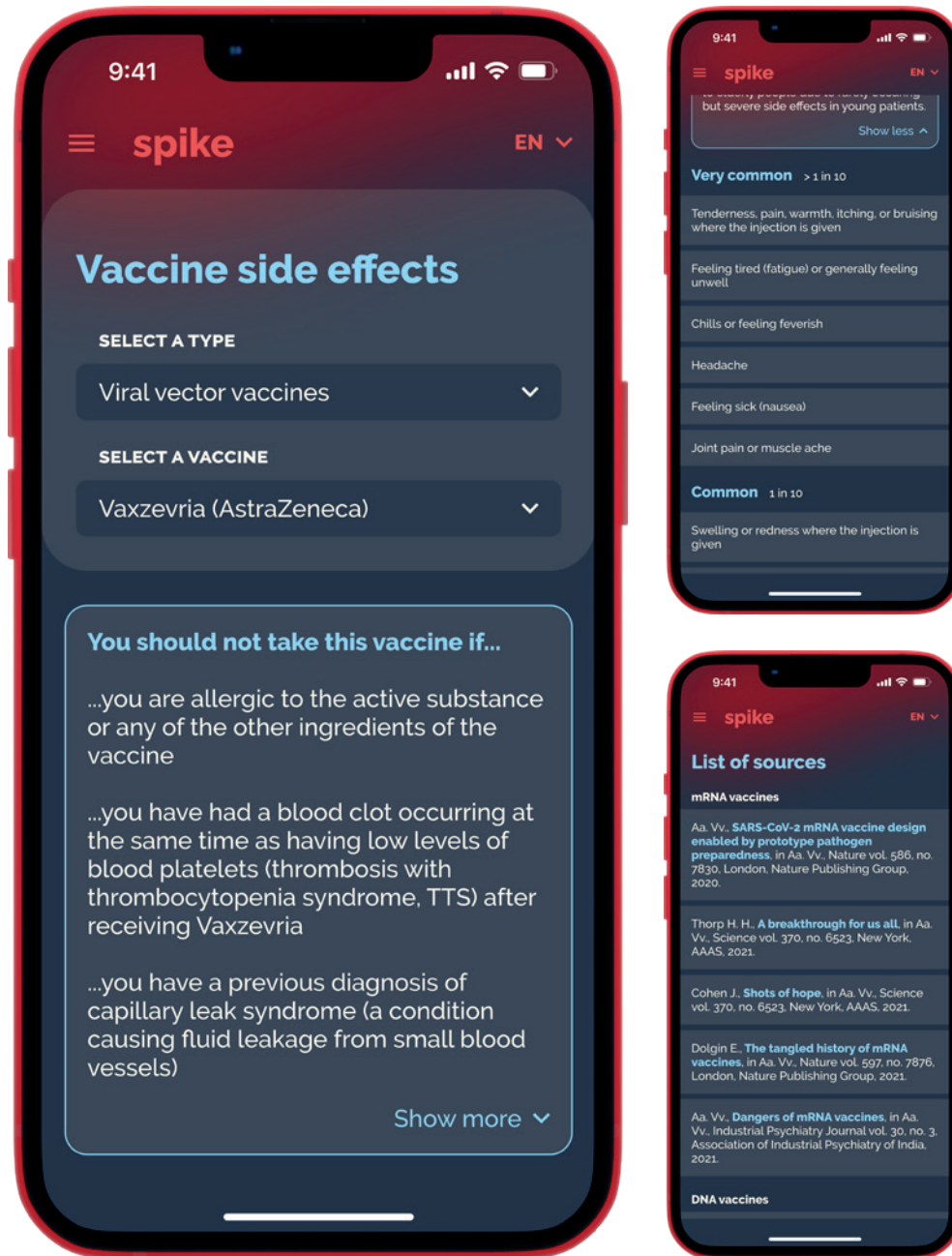


Figure 14.9. The vaccine side effects page and the list of sources

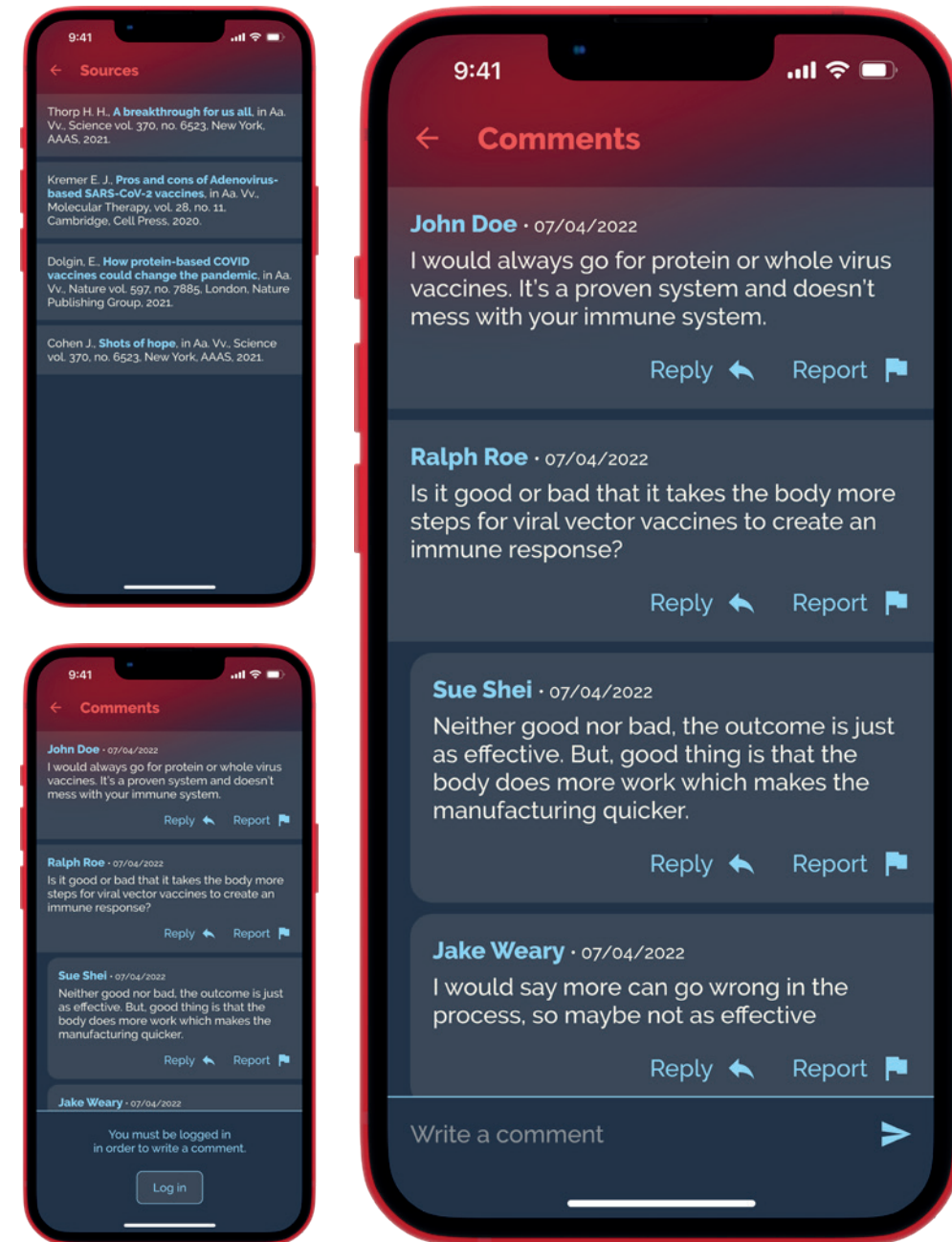


Figure 14.10. The sources and comments sections of a subpage

Conclusion

The starting point of this elaboration was to explore the functionality of COVID-19 vaccines and how this information was discussed both from the government's side and by the general public in Italy, Germany and the United Kingdom.

The four main types of vaccines were analyzed regarding their similarities, differences, benefits and downsides. Nuclear acid vaccines and viral vector vaccines are relatively new technologies, leveraging cell mechanisms to produce antibodies, while protein-based and whole virus vaccines can be seen as more traditional approaches. Upon examination of the vaccine types, it becomes clear that the existing variety is an important factor for a successful global distribution of vaccines, since each region presents different challenges.

Regarding the communication aspect, similarities could be discovered among politicians informing the public about the vaccines. On *Twitter*, officials from all countries focused on sharing positive news about the development and distribution of vaccines, tending to ignore critical voices or negative aspects. This contrasts the communication by non-government related scientific experts with an audience of a similar size to that of the politicians, who mentioned negative aspects more frequently. At the other end of the spectrum, anti-vaccination groups on Facebook displayed distrust not only in the vaccines but also in their governments, sharing conspiracy theories and fake news.

Poll results regarding the public's opinion on vaccines showed a hesitancy to get vaccinated among some respondents, mostly because of skepticism about the safety of vaccines.

The insights have led to the creation of *spike*, a website acting as an objective information source for those who are still hesitant to get vaccinated. Animated and image-based content offers an introduction to the topic, while a second layer of content provides a more detailed presentation of the vaccine types as well as a comprehensive list of side effects for each available vaccine. A list of sources is easily accessible, aiming to increase trust in the presented information.

For users who want to discuss a topic further, a comment section is available for each section.

The complex nature of the topic and the everchanging course of the pandemic make further development of the content and possibly also of its design necessary. The list of vaccine side effects and of the available vaccines should be kept up to date. Future iterations of the website could include a comparison of the different types of vaccines in the form of an interactive infographic, a visual representation of the commonness of vaccine side effects or a timeline displaying the research process for each vaccine type, addressing concerns about the maturity of newer vaccine technologies.

Pathogenes remain a threat to humanity, and future viral outbreaks on a global level cannot be ruled out. Newly emerging coronavirus variants or entirely new viruses could be included in the scope of the website, providing information about the vaccines and possibly helping to increase the public's vaccine readiness.

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